Democratic Socialist Republic of Sri Lanka
Ceylon Electricity Board
(CEB)

Supplemental Survey for Planning National Transmission and Distribution Network Development and Efficiency Improvement Project

Final Report

November 2014
Japan International Cooperation Agency (JICA)

Tokyo Electric Power Services Co., Ltd.

Tokyo Electric Power Co., Inc.

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Abbreviations

Abbreviation	Full Name
ACSR	Aluminum Conductor Steel Reinforced
ADB	Asian Development Bank
AIS	Air Insulated Substation
ATS	Automatic Transfer Switch
CE	Chief Engineer
CEA	Central Environmental Authority
CEB	Ceylon Electricity Board
CT	Current Transformer
DC	Direct Current
DGM	Deputy General Manager
EE	Electrical Engineer
EIRR	Economic Internal Rate of Return
ES	Electrical Superintendent
GIS	Gas Insulated Substation
G/L,GL	Generation and Loading
GS, G/S,GSS	Grid Substation
GTACSR	Gap-Type Aluminum Conductor Steel Reinforced
HMNP	Hydro Maximum generation Night Peak load profile
HMDP	Hydro Maximum generation Day Peak load profile
IED	Intelligent Electronic Device
IEE	Initial Environmental Examination
JPY	Japanese yen
JICA	Japan International Cooperation Agency
LA	Lightning Arrester
LL	Low electrical power Loss conductor
LLF	Load Loss Factor
MM	Man Month
LNG	Liquefied Natural Gas
MOPE	Ministry of Power Energy
MW	Megawatt
O&M	Operation and Maintenance
ODA	Official Development Assistance
PMU	Project Management Unit
OP	Off Peak
PS	Power Station

PSS	Primary Sub Station
RSS	Radial Sub Station
RMU	Ring Main Unit
Rs, LKR	Sri Lanka Rupee
RoW, ROW	Right-of-Way
SAIDI	System average interruption duration index
SAS	Substation Automation System
SS	Switching Station
T&D	Transmission and Distribution
T/L, TL	Transmission Line
TEPCO	Tokyo Electric Power Company, Inc.
TMNP	Thermal Maximum generation Night Peak load profile
TMDP	Thermal Maximum generation Day Peak load profile
TOR	Term of Reference
USD	United States Dollar
XLPE	Cross-linked Polyethylene
Zebra-eq	Zebra equivalent conductor

Chapter 1 Preface

1.1. Background to this project

In Sri Lanka, it has 2,970 MW (2012) electric power supply against 2,146 (2012) of electricity peak demand, and the stable electric power supply is performed as compared with other countries in South Asia. On the other hand, for electricity demand increase at annual average 5-6%, and to correspond to a rapid expansion of electricity demand in connection with the economic growth of 7 % of an annual average and to lower power costs in recent years, the government is advancing construction of a large-scale coal-fired power plant etc. based on the long term electric power development plan.

The transmission losses is improving year by year (12.0% as of year 2012), and, however, it is necessary to make efforts to continuously decrease the transmission losses by introduction of the high voltage and low loss conductor, etc. in order to correspond to the energy demand.

The Ministry of Power Energy (MOPE) holds up the stable energy supply and energy efficiency optimization as one of the most important policy. Thereby they promote the reinforcement of high voltage bulk transmission line network which ensures sufficient transmission capacity in parallel with construction of large-scale power plant. Simultaneously they proceed actively with the introduction of low loss conductor for transmission loss reduction.

Based on this background, the purpose of National Transmission and Distribution Efficiency Project of Democratic Socialist Republic of Sri Lanka (hereinafter referred to as “this project”) is not only to contribute to the stabilized energy supply by reinforcement of transmission and distribution network throughout the country mainly around Colombo (which is the maximum demand area), but also to achieve energy efficiency by introducing the low loss conductor.

Now in order to achieve the above purpose, based on the Feasibility Study Report prepared by the Ceylon Electricity Board (CEB, which is an executing agency), JICA study ream carry out the supplementary survey for this project (7 transmission Subprojects and 2 distribution Subprojects) since it is necessary to gather and analyze further information to form ODA loan project.

1.2. Purpose of this survey

As for “this project”, JICA performed support examination in January – March 2014 as a Japanese Yen loan project based on the Feasibility Study Report prepared by Ceylon Electricity Board (CEB) which contain 7 transmission Subprojects and 2 distribution Subprojects. The location of the Subprojects is shown Figure 1-1.

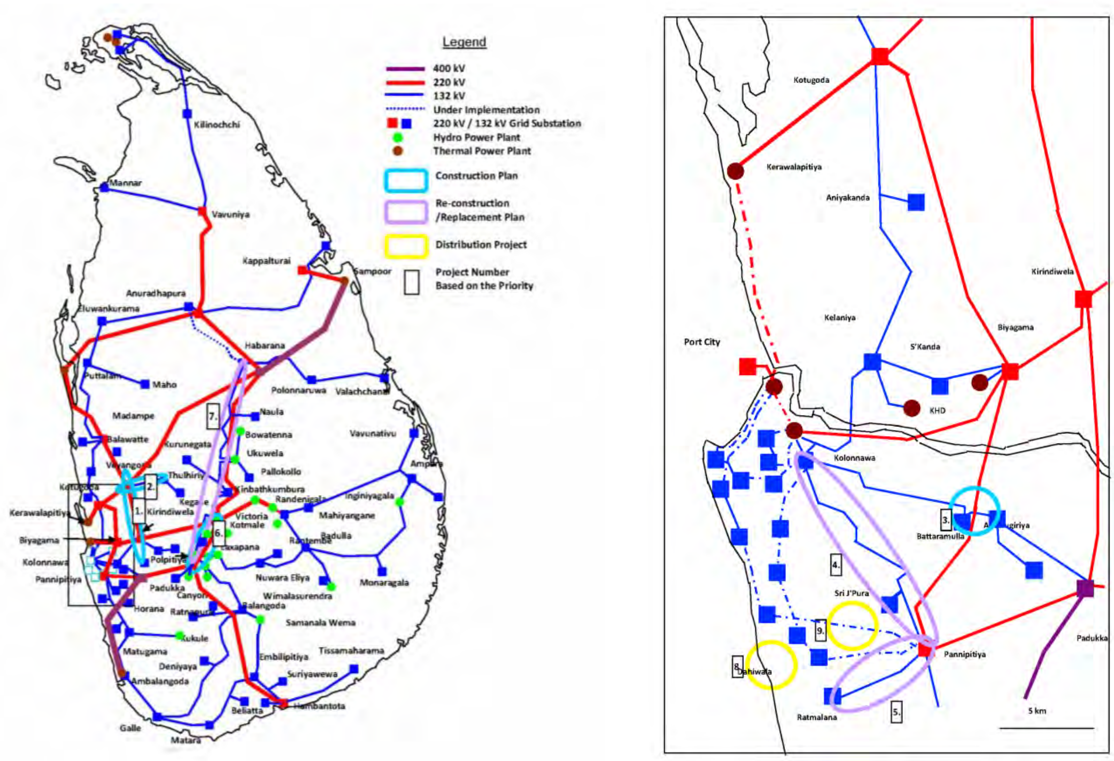


Figure 1-1 the location of the Subprojects in Sri Lanka

The purpose of this supplementary survey is to gather additional information/ data, analyze and make proposal to JICA. As the region is shown in Figure 1-1, it is Sri Lankan whole country and the counterpart agency is the Ceylon Electricity Board (CEB).

1.3. Member of this survey

The members of this supplementary survey are shown Table 1-1.

Table 1-1 Member of mission

Team leader/ Transmission & Substation Planning Engineer	Masahiko TADA
Distribution Planning Engineer	Masaki IWAMA
Transmission Line Facility Engineer	Fumiyasu MINAGAWA
Economist	Kenichi KITAMURA
Power System Analyst	Makoto KAMIBAYASHI
Coordinator	Naoto UTADA

Chapter 2 Power System Analysis

2.1. Power system data provided by CEB

A set of power system data which is necessary to conduct power flow analysis for these Subprojects was provided by CEB in electronic form. CEB considers five Generation and Loading scenarios (G/L scenarios) as conditions to be taken for the analysis as the following table.

Table 2-1 Generation and loading scenarios considered for the studies

Scenario	Load	Generation	
TMNP	Night peak	Thermal	Max
		Hydro	Balance
TMDP	Day peak	Thermal	Max
		Hydro	Balance
HMNP	Night peak	Thermal	Balance
		Hydro	Max
HMDP	Day peak	Thermal	Balance
		Hydro	Max
OP	Off peak	Thermal	Partial
		Hydro	Partial

The JICA survey team conducted power flow calculations in 2017, 2019 and 2021 and power flow diagrams are shown on the figures from A1-1 to A1-15 in Appendix 1. The JICA team found overloading equipment in 2017, which will have been solved by implementing Subprojects dealt with in this report.

2.2. Planning criteria for the power flow analysis

2.2.1. Security criterion

Basically, the adopted contingency level is N-1, i.e. outage of one element of the transmission system at a time for system planning.

2.2.2. Thermal criterion

The loading of elements should not exceed their rated thermal loading values for steady state conditions.

2.2.3. Voltage criterion

Voltages of all buses should be within the allowable limit not only under the normal condition but also under the N-1 condition as shown in the following table.

Table 2-2 Allowable voltage variations

	Allowable voltage variation	
	Normal condition	N-1 condition
132 kV	±10 %	±10 %
220 kV	±10 %	±10 %

2.3. Power system planning and analysis

2.3.1. Study on necessity of 220 kV Kirindiwela-Padukka T/L

The JICA survey team conducted power flow analysis without 220 kV Kirindiwela-Padukka T/L on the basis of the latest power system data provided by CEB. From the result of the analysis, 220 kV Biyagama-Pannipitiya T/L is overloaded on the condition that one circuit of the same T/L is outage under the G/L scenario of TMNP in 2019 as shown on the table below. Relevant power flow diagrams are shown on the figures from A1-16 to A1-20 in Appendix 1.

Table 2-3 Power flow on 220 kV Biyagama-Pannipitiya T/L without 220 kV Kirindiwela-Padukka T/L

GL scenario	Rate of T/L [MVA]		Power flow from Biyagama to Pannipitiya [MVA]	
	Continuous	Short-time	Normal condition	N-1 condition
TMNP	228	285	171.6	292.7

The continuous rate is used for normal system condition without any contingency, and the short-time rate is used for N-1 contingency condition.

The heavily-loading of the 220 kV T/L from Biyagama to Pannipitiya is mainly caused by large amount of power generated by coal fueled power stations at Puttalam and Sampoor.

If the 220 kV Kirindiwela-Padukka T/L is constructed, the overloading will be solved as shown in the table below. A relevant power flow diagram is shown on Figure A1-21 in Appendix 1.

Table 2-4 Power flow on 220 kV Biyagama-Pannipitiya T/L with 220 kV Kirindiwela-Padukka T/L

GL scenario	Rate of T/L [MVA]		Power flow on 220 kV Biyagama-Pannipitiya T/L [MVA]	
	Continuous	Short-time	Normal condition	N-1 condition
TMNP	228	285	117.4	184.1

The report, "Work Report in Sri Lanka, Technical Mission on Transmission System Plan" submitted by Tokyo Electric Power Service Co., Ltd. in March 2014, concluded that 220 kV Kirindiwela-Padukka T/L was NOT necessary in 2022. The major difference from the previous report is the years that power flows were calculated in. In the previous report, power flow analysis was conducted in year 2022, when three units of coal power plant were assumed to be developed at Hambantota. Large amount of power from the power plant in southern area will have eased the heavy loading of 220 kV Biyagama-Pannipitiya T/L.

2.3.2. Power flow analysis during planned outage of T/L

A T/L is expected to be reconstructed on the same route and same ROW if it is possible to operate under the planned outage condition of the T/L without any loss of load during an enough block of time. The JICA survey team conducted power flow analyses during planned outage of a T/L regarding Subproject 4 and 7.

2.3.2.1. Subproject 4

Subproject 4 consists of a re-construction of Kolonnawa-Pannipitiya 132 kV T/L and its removal. When the T/L between Kolonnawa and Sri J'Pura is under planned outage, Sri J'Pura G/S will be supplied from Pannipitiya G/S, and vice versa. The table below shows results of power flow analyses regarding planned outages of Subproject 4.

Table 2-5 Result of Power flow analyses under planned outage of 132 kV T/L between Kolonnawa and Pannipitiya

Voltage	Planned Outage T/L		G/L scenario	Heavily/Over loaded T/L			Heavily/Over loaded T/L			Heavily/Over loaded T/L			Heavily/Over loaded T/L		
	From	To		From	To	Loading	From	To	Loading	From	To	Loading	From	To	Loading
132	Kolonnawa	Sri J'Pura	HMDP	Non											
			TMDP	Biyagama	Pannipitiya	103%	Kolonnawa	Colombo E	103%						
			HMNP	Non											
			TMNP	Biyagama	Pannipitiya	114%	Pannipitiya	Panadura-Kalutara	108%	Kolonnawa	Colombo I	129%	Colombo I	Colombo A	117%
			OP	Non											
132	Pannipitiya	Sri J'Pura	HMDP	Non											
			TMDP	Biyagama	Pannipitiya	107%	Kolonnawa	Colombo E	103%						
			HMNP	Non											
			TMNP	Biyagama	Pannipitiya	111%	Pannipitiya	Panadura-Kalutara	109%	Kolonnawa	Colombo I	109%			
			OP	Non											

2.3.2.1.1. Kolonnawa-Sri J'Pura T/L outage

In the cases of HMDP, HMNP and OP G/L scenarios, there is no overloaded T/L with an outage of a T/L section of Kolonnawa-Sri J'Pura. In the cases of TMDP scenario however, T/L sections of Biyagama-Pannipitiya and Kolonnawa-Colombo E are slightly overloaded with the same T/L section outage. In the cases of TMNP scenario, T/L sections of Biyagama-Pannipitiya, Kolonnawa-Colombo I, Colombo I-Colombo A and Pannipitiya-"T junction on Panadura-Kalutara T/L" are overloaded with the same T/L section outage. Relevant power flow diagrams are shown on the figures from A1-22 to A1-26 in Appendix 1.

2.3.2.1.2. Pannipitiya-Sri J'Pura T/L outage

In the cases of HMDP, HMNP and OP G/L scenarios, there is no overloaded T/L with an outage of a T/L section of Pannipitiya-Sri J'Pura. In the cases of TMDP scenario however, T/L sections of Biyagama-Pannipitiya and Kolonnawa-Colombo E are overloaded with the same T/L section outage. In the cases of TMNP scenario, T/L sections of Biyagama-Pannipitiya, Kolonnawa-Colombo I and Pannipitiya-"T junction on Panadura-Kalutara T/L" are overloaded with the same T/L section outage. Relevant power flow diagrams are shown on the figures from A1-27 to A1-31 in Appendix 1.

2.3.2.1.3. Conclusion of possibility of planned outages for Subproject 4

Planned outages of T/L sections of Kolonnawa-Sri J'Pura and Pannipitiya-Sri J'Pura should be arranged during non-drought period of the year avoiding conditions of TMDP and TMNP G/L scenarios, which might occur in extremely drought conditions. CEB informed the JICA survey team that the planned outages for Subproject 4 would be possible because length of the T/L between Kolonnawa and Pannipitiya is 12.9 km and relatively short.

2.3.2.2. Subproject 7

Subproject 7 consists of a construction of Polpitiya-Kiribathkumbura-Ukuwela-Naula-New Habarana 132 kV T/L and its removal. Power flow analyses were conducted under planned outage of each T/L section in 2017. The table below shows results of power flow analyses regarding planned outages of Subproject 7.

Table 2-6 Result of Power flow analyses under planned outage of 132 kV T/L between Polpitiya and Kiribathkumbura

Voltage	Planned Outage T/L		GL scenario	Over loaded T/L			Over loaded T/L			Over loaded T/L			Over loaded T/L			Over loaded T/L		
	From	To		From	To	Loading	From	To	Loading	To	Loading	Loading	From	To	Loading	From	To	Loading
132	Naula	New Habarana	HMDP	Non														
			TMDP	Nawalapitiya	Kiribathkumbura	104%	Polpitiya	Kiribathkumbura	119%	Polpitiya	Nawalapitiya	103%	Biyagama	Pannipitiya	122%	Kolonnawa	Colombo E	111%
			HMNP	Non														
			TMNP	Nawalapitiya	Kiribathkumbura	154%	Polpitiya	Kiribathkumbura	178%	Polpitiya	Nawalapitiya	154%	Biyagama	Pannipitiya	129%	Kolonnawa	Colombo E	103%
				Kolonnawa	Sri J'Pura	113%	Pannipitiya	Panadura-Kalutara	119%	Matugama	Panadura-Kalutara	105%						
			OP	Non														
132	Ukuwela	Naula	HMDP	Non														
			TMDP	Polpitiya	Kiribathkumbura	102%												
			HMNP	Non														
			TMNP	Nawalapitiya	Kiribathkumbura	133%	Polpitiya	Kiribathkumbura	154%	Polpitiya	Nawalapitiya	133%	Biyagama	Pannipitiya	124%	Kolonnawa	Sri J'Pura	123%
				Pannipitiya	Panadura-Kalutara	118%	Matugama	Panadura-Kalutara	104%									
			OP	Non														
132	Ukuwela	Kiribathkumbura	HMDP	Non														
			TMDP	Biyagama	Pannipitiya	106%	Kolonnawa	Colombo E	103%									
			HMNP	Non														
			TMNP	Biyagama	Pannipitiya	108%	Kolonnawa	Sri J'Pura	107%	Pannipitiya	Panadura-Kalutara	111%						
			OP	Non														
132	Polpitiya	Kiribathkumbura	HMDP	Non														
			TMDP	Ukuwela	Naula	104%	Ukuwela	New Habarana	116%	Naula	New Habarana	133%						
			HMNP	Naula	New Habarana	109%	Ukuwela	Bowatenna	103%									
			TMNP	Ukuwela	Naula	157%	Ukuwela	New Habarana	173%	Naula	New Habarana	195%						
			OP	Non														

2.3.2.2.1. Naula-New Habarana T/L outage

In the cases of HMDP, HMNP and OP G/L scenarios, there is no overloaded T/L with an outage of a T/L section of Naula-New Habarana.

T/L of Polpitiya-Nawalapitiya-Kiribathkumbura is overloaded with an outage of a T/L section of Naula-New Habarana on TMDP and TMNP scenarios. Relevant power flow diagrams are shown on the figures from A1-32 to A1-36 in Appendix 1.

2.3.2.2.2. Ukuwela-Naula T/L outage

In the cases of HMDP, HMNP and OP G/L scenarios, there is no overloaded T/L with an outage of a T/L section of Ukuwela-Naula.

Polpitiya-Kiribathkumbura T/L section is overloaded with an outage of a T/L section of Ukuwela-Naula on TMDP scenario, and T/L sections of Polpitiya-Nawalapitiya-Kiribathkumbura, Biyagama-Pannipitiya, Kolonnawa-Sri J'Pura, and Pannipitiya-Matugama are overloaded with the same T/L section outage on TMNP scenario. Relevant power flow diagrams are shown on the figures from A1-37 to A1-41 in Appendix 1.

2.3.2.2.3. Ukuwela-Kiribathkumbura T/L outage

In the cases of HMDP, HMNP and OP G/L scenarios, there is no overloaded T/L with an outage of a T/L section of Ukuwela-Kiribathkumbura. T/L sections of Biyagama-Pannipitiya and Kolonnawa-Colombo E is overloaded with the same T/L section outage on TMDP scenario. Biyagama-Pannipitiya, Kolonnawa-Sri J'Pura and Pannipitiya-"T junction on Panadura-Kalutara T/L" are overloaded with the same T/L section outage on TMNP scenario. Relevant power flow diagrams are shown on the figures from A1-42 to A1-46 in Appendix 1.

2.3.2.2.4. Polpitiya-Kiribathkumbura T/L outage

In the cases of HMDP and OP G/L scenarios, there is no overloaded T/L with an outage of a T/L section of Polpitiya-Kiribathkumbura.

T/L sections of Ukuwela-Naula, Ukuwela-New Habarana and Naula-New Habarana are overloaded with an outage of a T/L section of Polpitiya-Kiribathkumbura on TMDP and TMNP scenarios, and T/L sections of Naula-New Habarana and Ukuwela-Bowatenna are overloaded with the same T/L section outage on HMNP scenario. Relevant power flow diagrams are shown on the figures from A1-47 to A1-51 in Appendix 1.

2.3.2.2.5. Conclusion of possibility of planned outages for Subproject 7

CEB informed the JICA survey team that they would be able to acquire another route for a new

T/L between Polpitiya and new Habarana and the JICA survey team confirmed it. If another route is prepared, there is no need to arrange planned outages of T/Ls because it worsens the reliability of the grid in general. The figure below shows a part of power flow with planned outage of 132 kV Ukuwela-Kiribathkumbura T/L and with forced outage of Ukuwela-Kiribathkumbura T/L in 2017 on HMNP condition. Polpitiya-Kiribathkumbura T/L is overloaded under this condition.

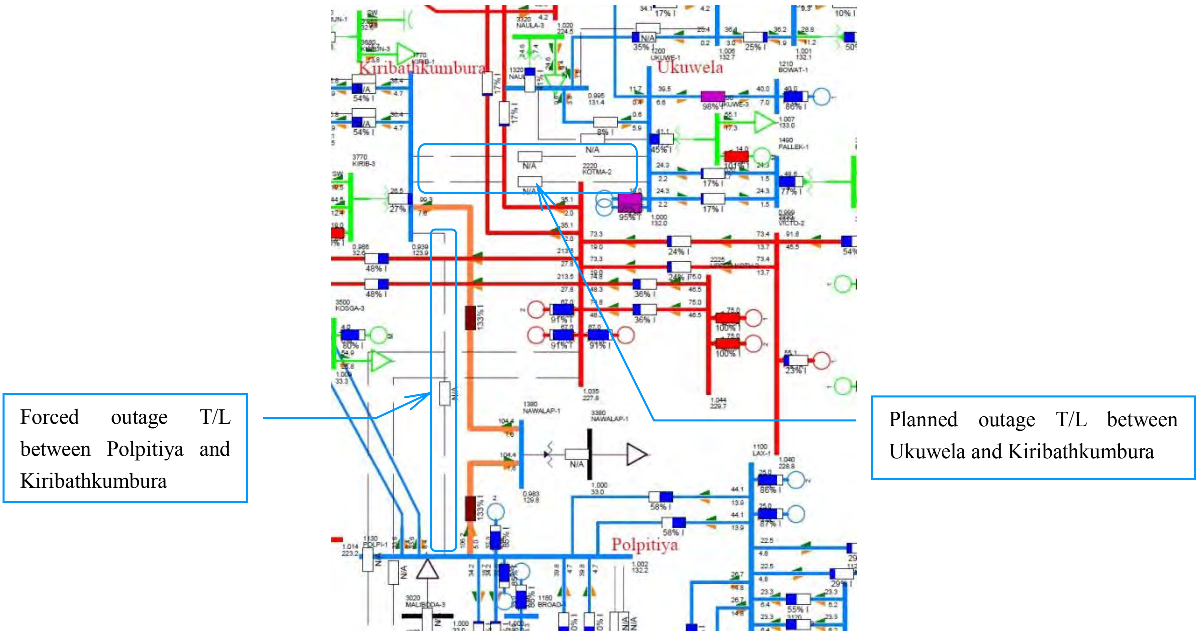


Figure 2-1 Example of overloading with N-1 contingency during planned outage

Usually, N-1 contingency criterion is not considered during a planned outage in CEB if the outage period of time is short enough. The contingency level is actually N-3 on the condition. Even so, if another route is available, planned outage should be prevented to maintain a certain level of reliability.

2.3.3. T/L loss reduction by Subprojects

JICA survey team conducted power flow analyses to calculate T/L loss reduction contributed by implementing Subprojects from 1 to 7. The loss reductions were calculated by comparing total system losses of the all-Subproject-implemented case with without-each-Subproject case. The table below shows T/L losses on five G/L scenarios in 2019 with all Subprojects implemented as a base case for the comparison.

Table 2-7 T/L losses in 2019 with all Subprojects implemented (Base case)

Unit: MW

TMNP	TMDP	HMNP	HMDP	OP
50.01	37.19	47.52	62.57	21.54

The tables show T/L loss reductions by each Subproject. Relevant power flow diagrams are shown on the figures from A1-52 to A1-86 in Appendix 1.

Table 2-8 T/L loss without Subproject 1 and loss reduction by Subproject 1

Unit: MW

	TMNP	TMDP	HMNP	HMDP	OP
Without Subproject 1	54.10	39.91	49.85	65.22	22.07
Loss reduction	4.09	2.72	2.33	2.65	0.53

Table 2-9 T/L loss without Subproject 2 and loss reduction by Subproject 2

Unit: MW

	TMNP	TMDP	HMNP	HMDP	OP
Without Subproject 2	50.51	37.87	47.05	61.36	21.55
Loss reduction	0.50	0.68	-0.47	-1.21	0.01

T/L loss becomes larger than the case without Subproject 2 by implementing Subproject 2 under hydro maximum generation scenarios. In the case without Subproject 2, abundant hydro power is supplied via Polpitiya P/S during high-water seasons, consequently that makes the loss less than supply from Veyangoda S/S.

Table 2-10 T/L loss without Subproject 3 and loss reduction by Subproject 3

Unit: MW

	TMNP	TMDP	HMNP	HMDP	OP
Without Subproject 3	50.08	37.29	47.61	62.88	21.55
Loss reduction	0.07	0.10	0.09	0.31	0.01

Table 2-11 T/L loss without Subproject 4 and loss reduction by Subproject 4

Unit: MW

	TMNP	TMDP	HMNP	HMDP	OP
Without Subproject 4	50.54	37.55	47.72	62.68	21.55
Loss reduction	0.53	0.36	0.20	0.11	0.01

Table 2-12 T/L loss without Subproject 5 and loss reduction by Subproject 5

Unit: MW

	TMNP	TMDP	HMNP	HMDP	OP
Without Subproject 5	50.09	37.25	47.59	62.62	21.54
Loss reduction	0.08	0.06	0.07	0.05	0.00

Table 2-13 T/L loss without Subproject 6 and loss reduction by Subproject 6

Unit: MW

	TMNP	TMDP	HMNP	HMDP	OP
Without Subproject 6	53.06	38.59	49.27	63.49	21.86
Loss reduction	3.05	1.40	1.75	0.92	0.32

Table 2-14 T/L loss without Subproject 7 and loss reduction by Subproject 7

Unit: MW

	TMNP	TMDP	HMNP	HMDP	OP
Without Subproject 7	53.45	37.56	48.78	63.29	21.68
Loss reduction	3.44	0.37	1.26	0.72	0.14

Chapter 3 Study on Facility Design

3.1. Status quo of IEE Report

The JICA survey team confirmed CEB the status quo of the IEE report preparation and approval by Central Environmental Authority (CEA). According to CEB the progress of the IEE report preparation and approval by CEA are as follows:

Subproject 1:

CEB prepared and submitted the IEE report for Subproject 1 to Central Environmental Authority (CEA) in 1st week of October 2014. CEA comment is yet to be communicated.

Subproject 2:

CEB prepared and submitted the IEE report for Subproject 2 to Central Environmental Authority (CEA). CEA comment is yet to be communicated.

Subproject 6:

CEB plans to submit the IEE report for Subproject 6 to Central Environmental Authority (CEA) by the middle of October 2014.

Subproject 7:

CEB prepared and submitted the IEE report for Subproject 7 to Central Environmental Authority (CEA) on 9th October 2014. CEA comment is yet to be communicated.

3.2. Study on each Subproject

JICA survey team carried out study on facility design for each subproject as shown below.

3.2.1. Subproject-1

3.2.1.1. Issues

Colombo area will receive the electric power from Kerawalapitiya GS and Kelanitissa GS by underground cable in 2022. In case that there is not 220kV transmission line between Veyangoda GS and Kirindiwela GS, underground cable between Kerawalapitiya GS and Port GS is overloaded under normal operation condition.

Kosgama and Seethawaka GS area is supplied from Polpitiya GS. However, the capacity of conductor is not enough for the future demand because operation temperature of the conductor is 54 deg. C.

In the case of low hydro generation conditions, Kirindiwela SS can be used as medium of bringing thermal power from Veyangoda to Padukka then to Colombo and suburbs. This will fulfill the power requirement of the Colombo area in drought conditions. CEB has carried out a feasibility study for connecting LNG power plants in Sri Lanka. Kerawalapitiya was selected as the most feasible location for LNG plants. It is planned to construct a 400kV transmission line from Kerawalapitiya to Kirindiwela for transferring power from LNG plants. Also there is a proposal of constructing a 400kV network from Hambantota to Padukka for evacuating power from Coal plants at Hambantota after 2026.

As a result of review of the power system analysis provided by CEB, it is confirmed that the 220kV Kirindiwela – Padukka T/L is needed at the time of the year 2019, however the need of 400kV transmission line for this section is not confirmed until the horizon year 2023. It is, however, recommended to construct the 400kV transmission line between Kirindiwela – Padukka and operate at 220kV for the time being on the following preconditions:

1) CEB plans to construct a pumped storage hydropower plant,
2) There is uncertainty in large power plant development plan which makes large influence of power flow in this section of transmission line because it is located in central part of the power network,
3) Acquisition of Right of Way for 400kV transmission line in this area will be difficult in the future,
4) CEB plans to build up an entire 400kV transmission line from Hambantota to Sampoor in the future.

3.2.1.2. Scope

In order to solve the above-mentioned first issue, it is necessary to construct another transmission line in order to shift the power flow between Kerawalapitiya GS and Port GS. As a result, CEB determined to construct 220/132/33kV Kirindiwela GS and 220kV Veyangoda - Kirindiwela T/L. In addition, CEB determined to connect existing 220kV Biyagama - Kothmale

T/L with Kirindiwela GS in consideration of the reliability and the flexibility of power supply.

In order to solve the above-mentioned second issue, CEB determined to supply the power from Kirindiwela GS to Kosgama GS and Seethawaka GS, and it is necessary to construct 132kV Kirindiwela - Kosgama T/L.

In order to solve the above-mentioned third issue, it is proposed to construct 400kV Kirindiwela - Padukka transmission line. (initially operate at 220kV)

List of Scope:

- **Construction of Kirindiwela 220/132kV Switching Station**
- **Construction of Kirindiwela 220/33kV GS**
- **Construction of Double In and Out T/L from 220kV Biyagama – Kotmale**
- **Modification of existing 220kV protection and control facilities at Biyagama and Kotmale GSS**
- **Construction of 220kV Veyangoda – Kirindiwela T/L**
- **Augmentation at 220kV Veyangoda GS**
- **Construction of 400kV Kirindiwela – Padukka T/L**
- **Augmentation at 220kV Padukka GS**
- **Construction of 132kV Kirindiwela – Kosgama T/L**
- **Augmentation of 132/33kV Kosgama GS**
- **Augmentation of 132/33kV Seethawaka GS**

Modification of Scope:

- **Conductor was changed from CEB planed Zebra to LL-ACSR Zebra-eq on TL construction project of 220kV Veyangoda - Kirindiwela TL, 132kV Kirindiwela - Kosgama TL and 132kV Kirindiwela - Kosgama TL because of economic efficiency.**
- **Demolish of existing TL towers at Veyangoda GS are added to CEB original plan because they are at the place where new 220kV Veyangoda – Kirindiwela TL bay will be extend**

3.2.1.3. Design

- Kirindiwela GS

CEB plans to enhance Kirindiwela GS to 400kV GS in the future. The planed area is a banana plantation at the moment and the site seems to be generally flat. There is sufficient space to construct a future 400kV switchyard as well.

- Veyangoda GS

There is not enough space for additional two 220kV bays and gantry of 220kV Kirindiwela – Veyangoda lines. To construct the bays and gantry, land acquisition is needed in south area of GS. CEB stated that they will acquire the area for public utility use in any case. There are old un-using 132kV towers inside and in front of GS. Those will be removed under this project.

- Biyagama GSS

CEB plans that 220kV T/L protection facility for new Kirindiwela GS will be replaced and the existing control panels will be used.

- Kotmale GSS

Modification to the existing 220kV T/L protection and control facility for Biyagama GS will be made to protect a new 220kV Kirindiwela-Kotmale T/L.

Interface with the existing SAS is required.

- Padukka GS

This area is forest at the moment, and ground condition seems to be good. The construction of this substation under ADB project is yet to be started at the moment. It is scheduled to be completed and commissioned by the end of 2017 according to CEB.

- Kosgama GS

CEB plans to construct new bays both side of existing bay. And the existing 132kV gantries are located at North of GS. The new bays will be constructed same way. But there are some houses at north area. So CEB plans to construct two towers at north boundary area of GS. One circuit will be connected directly and the other will be connected by using cable.

There are some 33kV and 132kV transmission/ distribution line at south and east of GS. And further 132kV Kolonnawa / Polpitiya line come from south of GS and go through over the transformer.

1) In design stage of the 132kV Kirindiwela – Kosgama line, consideration needs to be made about clearance from these existing T/Ls. And during construction period, it needs some special measures for safety.

Space for additional 2 132kV T/L bays for Kirindiwela GS is available in both side of the existing 132kV switchyard.

Space for additional protection and control facility for 2 nos. of 132kV T/L bay switchgear for Kirindiwela GS is available in the existing control room.

DC 110V battery and charger will be Ni-Cd (1.2V x 92 cells 300Ah@5Ah)and a switchboard will be necessary.

CEB proposed, as additional scope of work, the followings items:

2) Replacement of existing protection panels,

3) Introduction of New SAS facility including IED for 132kV system

(The existing 132kV direct control panel will not be used and are to removed.)

- Seethawaka GS

CEB originally plans to install a bus-coupler under JICA project.

CEB proposed, as additional scope of work, the following item:

1) Addition of the second 132kV bus-bar,

2) Replacement of existing T/L protection facility to match with one in the Kosgama GS.

- Double In and Out connection from 220kV Biyagama – Kotmale T/L

Existing 220kV Biyagama – Kotmale T/L goes through near planed Kirindiwela GS. There is enough area to construct T/L.

- 220kV Veyangoda – Kirindiwela T/L

CEB has already selected the transmission line route from Veyangoda GS to Kirindiwela GS. The T/L goes through rural area and almost all is a paddy field. There is no big river or lake near the route.

- 400kV Kirindiwela – Padukka T/L

The planned new T/L goes through a rural area but there are some houses near T/L route.

- 132kV Kirindiwela – Kosgama T/L

The planned new T/L goes through rural mountainous area.

As for transmission line, CEB has standard criteria. In Feasibility Report for Project under JICA 45th Yen Package, Zebra is applied for the conductor. As a result of the cost comparison (refer to Appendix 3), application of Low-Loss type conductor is recommended for 220kV Veyangoda – Kirindiwela T/L and 132kV Kirindiwela – Kosgama T/L.

System configuration after completion of Project 1 is shown in Figure 3-1.

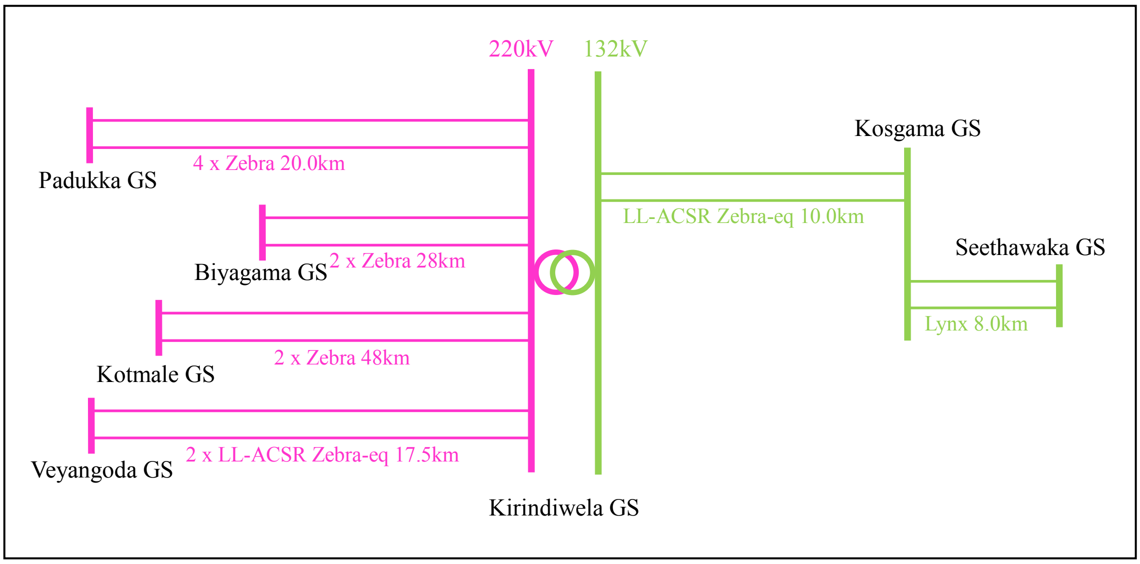


Figure 3-1 System Configurations after Completion of Project 1

3.2.1.4. Cost Estimate

Construction unit price for T/L using conventional conductor was prepared by CEB. Then the construction unit price for T/L using LL-ACSR is calculated by adding price difference between Low-Loss conductor and Zebra. The adopted prices of each conductors were described in the Final Report of “Data Collection Survey on Electricity Supply System Efficiency in Democratic

Socialist Republic of Sri Lanka (December 2012)” performed by JICA.

3.2.1.5. Environmental Aspect

As for Veyangoda GS, based on the site survey, CEB decided to acquire additional area (Approx. 1,200 m2) to construct additional 220kV T/L bay for Kirindiwela GS. It is confirmed that the land level was lower than that of 220kV switchyard of Veyangoda GS. Therefore, it is necessary to fill up the site. Usage of this land seems to be forest at present.

Depending on the result of IEE report, it is necessary to modify the transmission line route and methodology to connect with Veyangoda GS, if necessary.

CEB estimates compensation cost for Right-of-Way (RoW) about 3% of the project cost (Base cost + cost escalation + contingency). This rate comes from project in the past. The latest RoW cost is below;

132kV Madagama – Monaragala T/L
length: 16.1km width of RoW: 27m RoW cost: 64.9 mRp (149.3 Rp/m^2)
environment: home garden and plantation

132kV Mahiyangana – Volvunativ T/L
length: 129.0km width of RoW: 27m RoW cost: 44.3 mRp (12.7 Rp/ m^2)
environment: paddy field

Compensation cost depends on area that T/L passed. CEB doesn’t have calculated exact RoW cost at the moment.

As for new Kirindiwela GS, CEB plans to start the process of land acquisition of the substation site (260m x 160m) when CEB’s project management board (PMU) is set up.

3.2.2. Subproject-2

3.2.2.1. Issues

At present Thulhiriya GS is fed from 132kV Kolonnawa - Polpitiya T/L, and the length of this transmission line is long. Therefore, transmission line loss is large. In addition, this transmission line is constructed in 1959 and capacity of this transmission line is limited. Therefore, capacity of this transmission line does not meet the increasing demand around Thulhiriya GS.

3.2.2.2. Scope

In order to solve the above-mentioned issues, CEB plans to supply the power from Veyangoda GS to Thulhiriya GS.

List of Scope

- **Construction of 132kV Veyangoda – Thulhiriya T/L**
- **Augmentation of Thulhiriya GS**
- **Additional Scope in Thulhiriya GS:**
  (1) 132kV T/L protection and control facility,
  (2) 132kV CT
  (3) 132kV gantry for line termination
  (4) Removal of existing gantries and towers
- **Additional Scope in Veyangoda GS:**
  (1) 132kV T/L protection and control facility,
  (2) 132kV CT

Modification of Scope:

- **Construction of 132kV gantries on Thulhiriya GS are added to CEB original plan because existing gantries don't fit to new 132 kV Thulhiriya - Veyangoda TL.**
- **Demolish of existing gantries and TL towers at Thulhiriya GS are added to CEB original plan because they don't fit to new 132 kV Thulhiriya - Veyangoda TL**

3.2.2.3. Design

- Veyangoda GS

Two spare 132kV bays will be used for connection of 132kV Veyangoda – Thulhiriya line. The gantries for these lines are located in west of 132kV bays, and so the line must come from west. But new 220kV T/L bays (Kirindiwela – Veyangoda line) will be constructed in west area of this bay, and so new 132kV line has to come from south side of GS. Therefore CEB plans to construct 132kV Veyangoda – Thulhiriya line dead-end tower at south boundary area of GS near a private house and connect to existing gantry.

The CT needs to be replaced to match with the new T/L power flow. This work will be additional scope of JICA project.

The T/L protection facility for Thulhiriya GS needs to be modified to match with the Thulhiriya GS.

- Thulhiriya GS

The existing 132kV Polpitiya / Athurugiriya in-out line go over the GS and is connected to the dead-end tower. The gantries for 132kV T/L are not arranged in ordinary way.

CEB plans to connect 132kV Thulhiriya – Kegalle line by the ADB project. By the ADB project, two towers will be constructed at west area (Apparel factory's baseball ground now) of GS to connect its line.

By this JICA project, CEB plans to use these new two towers to connect 132kV Polpitiya / Athurugiriya in-out line and remove existing dead-end tower and gantry.

As an additional scope work of JICA project, the following will be incorporated:

1) Two nos. of 132kV gantries for new transmission line in-take,
2) Replacement of protection and control facility.

CEB has already selected the T/L route and connection point at Thulhiriya GS and Veyangoda GS. However, IEE report has not been accepted by CEA yet. Therefore, it may be necessary to modify the transmission line route and methodology to connect with Veyangoda GS depending on the acceptance result of IEE report by CEA.

System configuration after completion of Project 2 is shown in Figure 3-2.

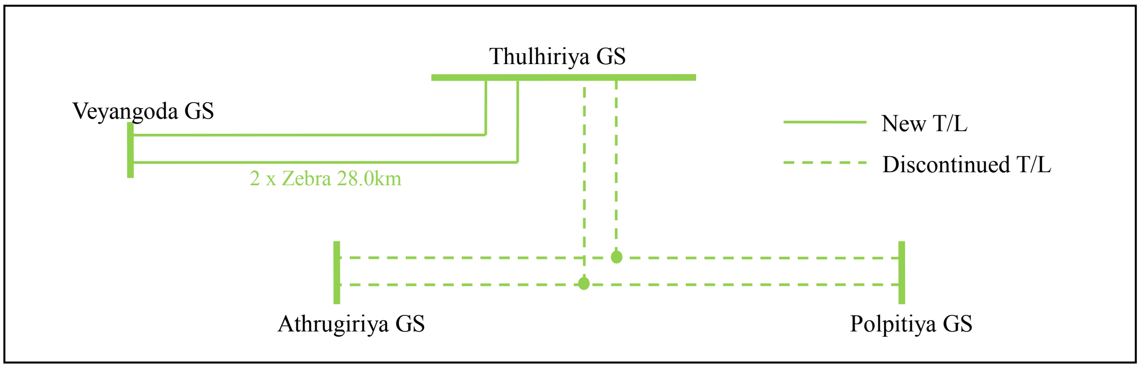


Figure 3-2 System Configurations after Completion of Project 2

3.2.2.4. Cost Estimate

Cost estimate is prepared as the same manner as Project 1.

3.2.2.5. Environmental Aspect

CEB submitted IEE to CEA and yet be accepted. Depending on the result of IEE report, the transmission line route may be modified.

Cost estimate for compensation is prepared as the same manner as Project 1.

3.2.3. Subproject-3

3.2.3.1. Issues

Demand growth around Battaramulla area is increasing rapidly, and the power is supplied from Sri Jayawardanapura GS. However, capacity of Sri Jayawardanapura GS is not sufficient to meet the rapidly increasing demand.

3.2.3.2. Scope

In order to solve the above-mentioned issues, the following transmission lines and grid substation construction are planned.

List of Scope:

- **Construction of 132/33kV Battaramulla GS**

- **132kV Double In and Out connection from Kolonnawa – Athurugiriya T/L**
- **Modification of the existing 132kV protection and control facilities at Kolonnawa and Athurugiriya GSS**

3.2.3.3. Design

- Battaramulla GS

132kV Kolonnawa – Athurugiriya line goes under 220kV T/L. To cross the 220kV T/L, this 132kV T/L uses gantry. CEB plans to make new Battaramulla GS around the gantry. This gantry is located in a field where used to be paddy field but not being cultivated at the moment. CEB doesn't have soil data of this area now, and therefore geological investigation is needed during detailed design stage.

- Kolonnawa GS

132kV T/L Protection facility to be modified.

- Athurugiriya GS

132kV T/L Protection facility to be modified.

- 132kV Double In and Out connection from Kolonnawa – Athurugiriya T/L

The Battaramulla GS is planned to construct under the existing Kolonnawa – Athurugiriya T/L. Then connection between the T/L and the GS will be made without access lines.

CEB has already selected the site for Battaramulla GS, and designed the substation facilities. Single line diagram of this GS has already been prepared. System configuration after completion of Project 3 is shown in Figure 3-3.

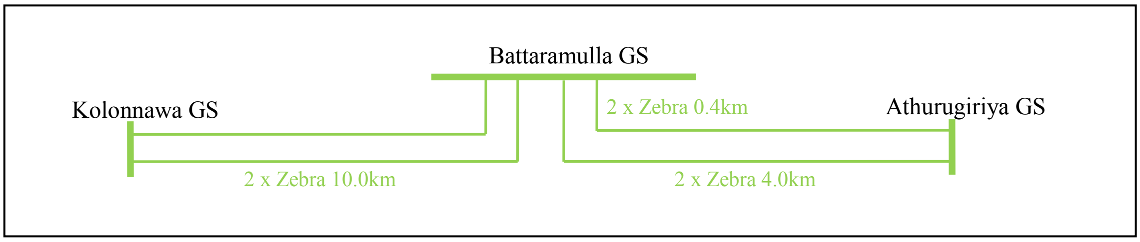


Figure 3-3 System Configurations after Completion of Project 3

3.2.3.4. Cost Estimate

Unit price is prepared by CEB referring to the past contract price with cost escalation thereafter.

Cost estimation is prepared based on the unit price and quantity required.

The connection from T/L to Battaramulla GS is just jumper connection. Then no RoW cost is required.

3.2.3.5. Environmental Aspect

Based on the information from CEB, IEE is not required since the existing T/L route is utilized as it is.

As for new Battaramulla GS, CEB plans to start the process of land acquisition of the substation site when CEB's project management board (PMU) is set up and the substation general layout is fixed.

3.2.4. Subproject-4

3.2.4.1. Issues

Kolonnawa - Pannipitiya transmission line is currently operated at 54 degree C and is more than 40 years old. Therefore the transmission capacity does not meet the increasing demand.

3.2.4.2. Scope

To increase reliability, CEB plans to re-construct 132kV Kolonnawa – Pannipitiya T/L with using LL-ACSR conductor.

List of Scope:

- **Re-construction of 132kV Kolonnawa – Pannipitiya T/L**
- **Removal of the existing T/L**

Modification of Scope:

- **Conductor was changed from CEB planed Zebra to LL-ACSR Zebra-eq on TL re-construction project of 132kV Kolonnawa – Pannipitiya TL because of economic efficiency.**

3.2.4.3. Design

- Kolonnawa GS

CEB plans to use the same gantry for 132kV Kolonnawa – Pannipitiya line. The gantry looks good condition.

- Pannipitiya GS

As same as Kolonnawa GS, this line is old but in good condition. According to CEB plan, the existing gantry will be used for new Kolonnawa – Pannipitiya line.

- 132kV Kolonnawa – Pannipitiya T/L

This line goes through density area. And there is no area to construct another new line. CEB plans to construct new line on the same position because of difficulty of new right of way (RoW) acquisition.

At first, CEB planned re-stringing this T/L to GAP conductor. Because they can't stop supply and don't have temporally T/L route. So the only way to increase T/L capacity is re-stringing to GAP. But considering power supply, switching Sri J'Pura GS supply from Pannipitiya GS to Kolonnawa GS allows Pannipitiya GS - Sri J'Pura GS line stop. Then they can re-construct the T/L and can increase capacity without using GAP conductor.

The towers from No.2 to No.6 are located in very density area. Some towers are located in private houses. At the time of re-construction, removal of those private structures (Store-house, shop, etc.) are required if towers are constructed at the same location. Several towers are difficult to re-construct at the same location. In that case, not to change RoW, CEB plans to construct towers at another place under the existing T/L route.

One third length of this T/L goes along Diyawanna Lake. This area is a marshy land. According to a soil investigation report made for Sri Jayewardenepura (near lake bridge) provide by CEB, support basement is lying under 15m from ground level. For that reason, pile foundation is needed for the tower foundation to be constructed in this area.

This T/L connects Kolonnawa GS to Pannipitiya GS via Sri J'Pura GS. The Sri J'Pura GS power supply is needed any time. Re-construction will be implemented by switching supply from Kolonnawa GS or Pannipitiya GS to Sri J'Pura GS. (ex. The T/L from Pannipitiya to Sri J'Pura GS can be re-constructed, when Sri J'Pura GS is supplied by Kolonnawa GS.)

In Feasibility Report for Project under JICA 45th Yen Package, Zebra is applied for the conductor. As a result of the cost comparison (refer to Appendix 3), application of Low-Loss type conductor is recommended for 132kV Kolonnawa – Pannipitiya T/L.

3.2.4.4. Cost Estimate

Unit price and quantity are prepared by CEB. Cost estimation was prepared based on those. The cost of the tower with pile foundation is twice as normal tower. As referred in the above, one third of towers need pile foundation. From CEB experience, the cost of tower with pile foundation is as twice as normal tower. Then some additional cost for this foundation is estimated. Then CEB added additional cost for foundation to construction cost.

3.2.4.5. Environmental Aspect

It is considered that IEE is not required because of the replacement on the same T/L route.

CEB uses the same RoW for re-construction. Then there is no need for compensation for RoW. But one or two towers will be constructed in different position under the existing T/L route. Therefore land acquisition will be needed for towers. One tower needs about 50m^2 (7x7m) area. CEB has not decided detail design of the T/L.

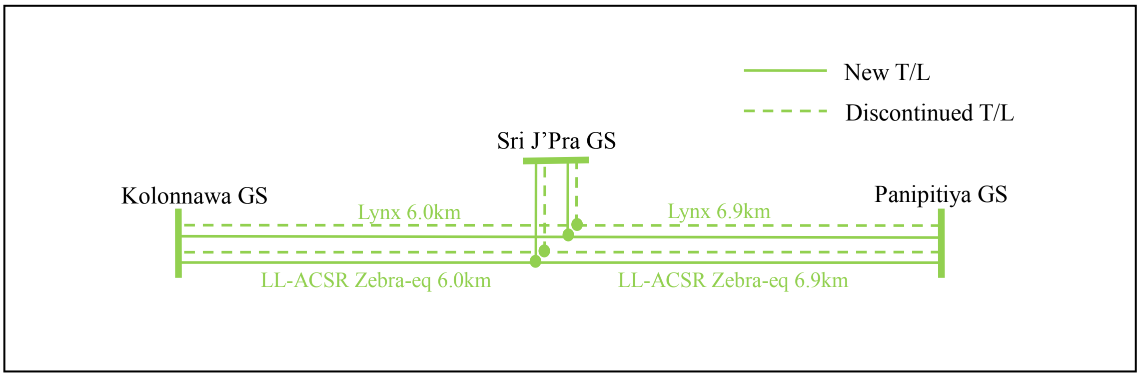


Figure 3-4 System Configurations after Completion of Project 4

3.2.5. Subproject-5

3.2.5.1. Issues

The condition of Pannipitiya - Ratmalana transmission line and the demand situation around this area is the same as the one of Kolonnawa - Pannipitiya transmission line project. Therefore the transmission capacity does not meet the increasing demand.

3.2.5.2. Scope

Scope and Design is the same situation with Project 4.

List of Scope:

- **Re-construction of 132kV Pannipitiya - Ratmalana T/L**
- **Removal of existing T/L**
- **Rehabilitation of Ratmalana SS**
- **Rehabilitation of Pannipitiya SS**

Modification of Scope:

- **Conductor was changed from CEB planed Zebra to LL-ACSR Zebra-eq on TL re-construction project of 132kV Pannipitiya - Ratmalana TL because of economic efficiency.**
- **Construction and removal of temporally tower are added to CEB original plan. CEB originally planned to make tubular tower to re-construction. But it costs high and needs special technology. Temporally TL method is normal way to re-construction, and use existing technic.**

3.2.5.3. Design

- Pannipitiya SS

This line is old but in good condition. According to CEB plan, the existing gantry will be used for new Pannipitiya - Ratmalana line.

According to CEB this substation has been constructed and commissioned in 1983, and therefore most of the equipment used more than 30 years and aged enough.

The 132kV circuit breakers have been manufactured in 1982 and therefore those should be replaced.

It is confirmed that the existing 132kV CT both for Kolonnawa line and Ratmalana line needs to be replaced because the rated primary current is not suitable. This replacement work will be an additional scope of work of JICA Project.

- Ratmalana SS

As same as Pannipitiya SS, this line is old but in good condition. According to CEB plan, the existing gantry will be used for new Pannipitiya - Ratmalana line.

According to CEB this substation has constructed and commissioned in 1960s, and therefore most of the equipment used more than 45 years and aged enough.

It is confirmed that the existing 132kV CT for Pannipitiya line needs to be replaced because the rated primary current is not suitable. This replacement work will be an additional scope of work of JICA Project.

CEB plans to construct a new control building under JICA project as an additional scope.

- 132kV Pannipitiya – Ratmalana T/L

Almost all of this line goes through rural area. But some towers are at residential area (No18 – No20). It may be difficult to construct another new line in this area because new line has to get new RoW. Then CEB plans to use the same RoW in this area.

The Ratmalana GS is supplied only from Pannipitiya GS so that this T/L can't stop supply. At first, CEB plans to use tubular tower for this re-construction of towers those are located in residential area. But this type tower costs high and use special technology. From the site survey, there are some area for temporally tower at Kindergarten, factory and rode beside Ratmalana GS. Temporally T/L using temporally tower is easy to construct and cost efficient and it not need new RoW. So, in case of re-construction, CEB plans to use temporally T/L on the residential area as referred above. Then the new towers can be constructed at same area without stoppage of supply.

In Feasibility Report for Project under JICA 45th Yen Package, Zebra is applied for the conductor. As a result of the cost comparison (refer to Appendix 3), application of Low-Loss type conductor is recommended for 132kV Pannipitiya – Ratmalana T/L.

3.2.5.4. Cost Estimate

CEB plans to use temporally 1cct T/L from No17 tower to Ratmalana SS. Accordingly construction and removal cost are estimated.

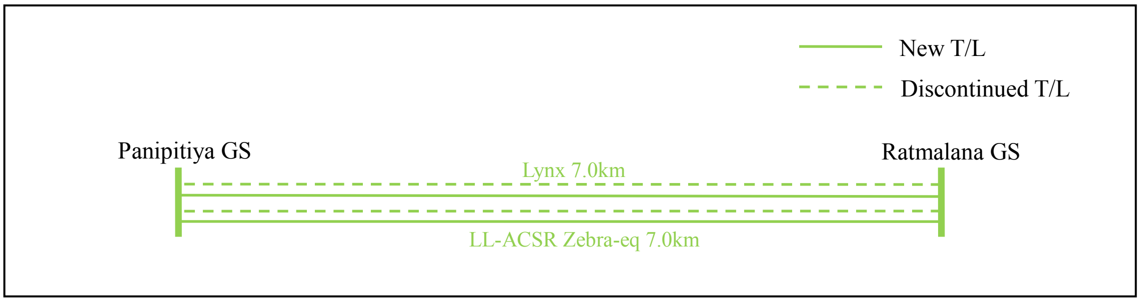


Figure 3-5 System Configurations after Completion of Project 5

3.2.5.5. Environmental Aspect

IEE seems to be not required because the length of re-constructing T/L is shorter than 10km.

Cost estimate for compensation is prepared as the same manner as Project 1.

The new RoW is needed for T/L from Pannipitiya GS to No17 tower because CEB plans to construct new T/L. The width of RoW is 27m and length of it is about 6km (about 16.2 ha). Land acquisition is about 800m^2 (7x7m x 16towers) according to the CEB practice.

3.2.6. Subproject-6

3.2.6.1. Issues

At present, there is only one (1) 220kV transmission line from Mahaweli complex to Colombo area. Therefore, the system reliability around this area is decreasing.

3.2.6.2. Scope

In order to solve the above-mentioned issues, it is necessary to construct another transmission line in order to shift the power flow from Kothmale GS. As a result, CEB determined to construct 220kV Kothmale – New Polpitiya T/L.

List of Scope

- **Construction of 220kV Kothmale – New Polpitiya T/L**
- **Construction of 2x220kV one-and-half breaker bus bar line bay at Kotmale PS**

Modification of Scope:

- **Conductor was changed from CEB planed Zebra to LL-ACSR Zebra-eq on TL re-construction project of 220kV Kothmale – New Polpitiya TL because of economic efficiency.**
- **Removal of existing 132kV bay at Kothmale PS is added to CEB original plan. Because there is no bay extension area for 220kV Kothmale – New Polpitiya TL bay.**

3.2.6.3. Design

- Kothmale PS

CEB plans to construct 220kV bay for Kothmale – Polpitiya T/L at the existing 132kV bay area. This 132kV bay is not used at the moment.

CEB prepared a layout for accommodating the additional two 220kV T/L bays considering T/L accessibility to the Switchyard.

- 220kV Kothmale – New Polpitiya T/L

CEB has already selected the transmission line route and connection point at Kothmale GS and New Polpitiya GS. New line will go through rural area. There is some area to construct new line. Most of area for new tower has no road to access, and therefore temporally roads are required.

CEB is preparing IEE report, and planning to submit it in October 2014. Therefore, depending on the result of IEE report, necessary modification to the transmission line route and methodology to connect with Kothmale GS and New Polpitiya GS should be made.

In CEB's Feasibility Report for Project under JICA 45th Yen Package, Zebra is applied for the conductor. However, as a result of the cost comparison (refer to Appendix 3), application of Low-Loss type conductor is recommended for 220kV Kothmale – New Polpitiya T/L.

System configuration after completion of Project 6 is shown in Figure 3-6.

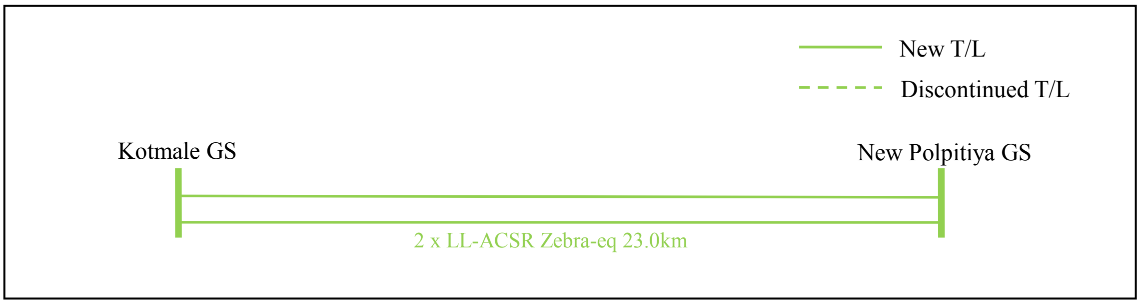


Figure 3-6 System Configurations after Completion of Project 6

3.2.6.4. Cost Estimate

Cost estimate is prepared as the same situation with Project 1.

3.2.6.5. Environmental Aspect

CEB is preparing IEE report at the moment. Depending on the result of IEE report, it may be necessary to modify the transmission line route and methodology to connect with Kothmale GS and New Polpitiya GS, if necessary.

Cost estimate for compensation is prepared as the same manner as Project 1.

3.2.7. Subproject-7

3.2.7.1. Issues

In order to meet the increasing demand in Northern and Eastern provinces, it is necessary to increase the capacity of existing transmission line.

3.2.7.2. Scope

This transmission line is constructed more than 40 years, and there is enough space to construct new transmission line next to the existing transmission line. CEB determined to construct new transmission line.

List of Scope

- **Construction of 132kV Polpitiya – Kiribathkumbura T/L**
- **Construction of 132kV Kiribathkumbura – Ukuwela T/L**
- **Construction of Ukuwela – Naula – New Habarana T/L**
- **Removal of the existing T/L**

Modification of Scope:

- **Conductor was changed from CEB planed Zebra to LL-ACSR Zebra-eq on TL re-construction project of 132kV Polpitiya - Kiribathkumbura TL, Kiribathkumbura - Ukuwela TL and Ukuwela – New Habarana TL because of economic efficiency.**
- **Connection from Ukuwela – New Habarana TL to Naula GS is added from CEB original plan because CEB forgot to consider it.**

3.2.7.3. Design

- Polpitiya PS

CEB plans to use the existing 132kV bays for new transmission lines. The bay is now used for Kothmale 1 and 2 lines. There are some T/L coming in and out from Polpitiya PS. So New T/L will come along with valley to go through under existing T/L.

It is confirmed that the existing CT will be replaced under JICA project as an additional scope since the existing CT rated current does not match with new power flow.

- Kiribathkumbura GS

CEB plans to use existing 132kV bay. As same as Polpitiya GS, there are some existing T/Ls. To avoid these existing T/L, CEB plans to construct gantry, and new T/L will go through under existing T/L by using this gantry.

- Ukuwela GS

CEB plan to use existing 132kV bay to connect new line to Ukuwela GS.

It is confirmed that the existing CT will be replaced under JICA project as an additional scope since the existing CT rated current does not match with new power flow.

- Naula GS

This GS is a new substation. The GS is connected to Naula and Habarana by single in-out connection. The existing in-out line and 132kV bay will be used for new line.

- New Habarana GS

There is enough area to construct GS and no obstacle for T/L. A big road goes in front of the planed area. The area is generally flat.

In CEB's Feasibility Report for Project under JICA 45th Yen Package, Zebra is applied for the conductor. However, as a result of the cost comparison (refer to Appendix 3), Low-Loss type conductor shall be applied for this T/L. Therefore, it is recommended to apply Low-Loss type conductor in all sections in consideration of construction and operation management.

System configuration after completion of Project 7 is shown in Figure 3-7.

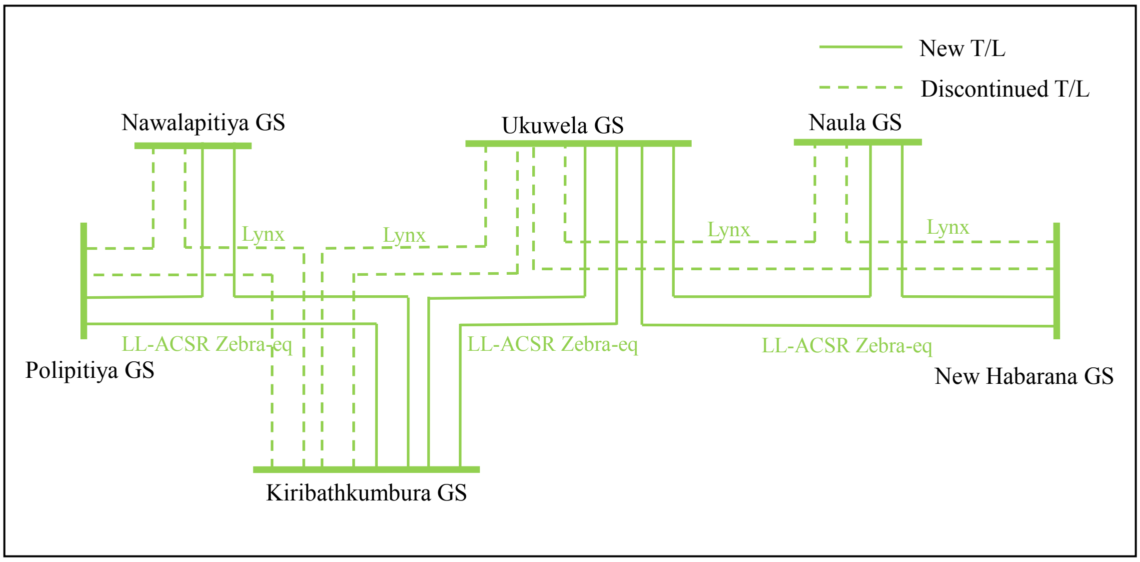


Figure 3-7 System Configurations after Completion of Project 7

3.2.7.4. Cost Estimate

Cost estimate is the same situation with Project 1.

3.2.7.5. Environmental Aspect

CEB has submitted the IEE report to CEA. But it has not commented by CEA yet.

Cost estimate for compensation is prepared as the same manner as Project 1.

3.2.8. Subproject-8

3.2.8.1. Issues

Kalubowila PSS loading exceeded the firm capacity level. The 11 kV system has limited load transfer capability. Hence (N-1) reliability/ security criteria cannot be maintained at the present demand levels. The predominantly overhead 11 kV system and bare conductor overhead LV distribution system present number of issues in a congested city like the Dehiwala Mount Lavinia (DML) area. These include safety issues in maintaining required clearances, reliability of supply and aesthetic reason.
Hence there is a requirement to formulate a project to upgrade the distribution network in DML to overcome the said issues.

3.2.8.2. Scope

The revised project proposal mainly includes two new primary substations in order to cater to the forecasted electricity demand due to apartment complexes and multi-purpose buildings and would facilitate to maintain (n-1) reliable criteria.
Further this proposal is capable of providing adequate network capacity, voltage improvement, high reliability, power quality, minimizing the system losses, economic and speedy operation.
List of Scope are below.

- 10 MVA x 2 –33/ 11 kV PSS - GIS – with 6 feeders at Dehiwala Area Office premises (Council lane PSS) and 3.1 km 33 kV/ XLPE/ Cu/ 3C/ 240mm^2 UG cable from Dehiwala GSS and 2.0 km 33kV/ XLPE/ Cu/ 3C/ 240 mm^2 UG cable from Dehiwala GSS F1/ F3 tapping point at Galvihara.
- 5 MVA x 2 – 33/ 11 kV PSS – GIS with 4 feeders on CEB land at Mount Lavinia Bus Stand and 1.8km 33 kV/ XLPE/ Cu/ 3C/ 240 mm^2 underground cable from Dehiwala GSS F6/F8 tapping point at Attidiya (Templers Road) to PSS.
- Installation of 1.7 km 33 kV/ XLPE/ Cu/ 3C/ 240mm^2 UG cable form Dehiwala GSS to Dehiwala PSS.
- Installation of 6 Nos. Radial Substation (RSS) namely at Kohuwala 1, Kohuwala 2, Frazer Avenue, Station Road (LHP), Telecom and Alubogahawatta, between the PSS to the RSS will be interconnected by 11 kV/ XLPE/ Cu/ 3C/ 240 mm^2 UG cables.

The details of new interconnection are as follows.

Table 3-1 New installation of UG cable and length

No.	Interconnection between	Length in Km.
1.	Telecom – Dehiwala PS	1.6
2.	Dehiwala PS – LHP RS	1.1
3.	LHP RS – Frazer Avenue RS	1.0
4.	Council Lane PS – Frazer Avenue RS	1.0
5.	Kirulapana PS – Kohuwala 2 RS	2.5
6.	Kalubowila PS – Kohuwala 1 RS	1.0
7.	Kalubowila PS – Kohuwala 2 RS	1.9
8.	Kalubowila PS – Alubogahawatta RS	1.9
9	Mt. Lavinia Bus Stand PS – Telecm RS(Express Line)	1.2
10	Kohuwaka 1 RS to Kohuwala 2 RS	0.9
Total Length		**14.10**

The Details of Replacement of Underground Cable (11kV/ XLPE/ Cu/ 3C/ 240mm^2) are follows.

Table 3-2 Replacement of UG cable and length

No.	Interconnection between	Length in Km.
1.	Mt. Lavinia Bus Stand PS – Telecom RS(with Ring Main Units connected)	1.2
2.	Dehiwala PS – Council Lane PS	2.3
	Total Length	**3.5**

- 5km 11 kV/ XLPE/ Cu/ 3C/ 95 mm^2 cable to connect existing overhead 11kV lines from PSS and RSS.

- Switching Arrangements
    - 6Nos 33kV LBS switching arrangement with remote operation facility near the zoo.
    - 2Nos 33kV LBS switching arrangement with remote operation facility near Galvihara canal.
    - 2Nos 33kV LBS switching arrangement with remote operation facility at Katukurunduwatte.
    - 1No 11kV LBS switching arrangement with remote operation facility near the Kirulappona Mosque.
    - Installation of 10 Nos Ring Main Units at Dehiwala along the Galle Road
- Supply of tools, equipment, vehicles and spare parts for maintenance of underground cable network. Training of CEB staff on Maintenance of UG system including fault location, jointing etc.
- SCADA System and Fiber Optical Cabling and LBS/ ACB switching arrangement with remote operation facility.

3.2.8.3. Cost Estimate

Unit price and quantity are prepared by CEB. Cost estimation was prepared based on those. The cost of the UG cables, panels (33 kV, 11 kV and LV), Compact Substations, Feeder Pillars and mini feeder pillars are based on the CEB price list of material, and others are estimated based on former construction price. Some equipment and vehicles are estimated by web site. Then some additional cost is estimated for this foundation work, and therefore CEB added an additional cost for civil work to construction cost.

3.2.8.4. Project Design

Project 8 will implement DML Area of CEB DD4. Existing OH facilities (MV OH line, MV/ LV Tr and LV line) will be used after Project. The project will construct some PSS, RSS and MV UG trunk line, and load of the existing lines will be divided, and the loss of MV lines will decrease. Furthermore improvement of the supply reliability is expected by the division of the load and the construction of UG trunk line. The revised project proposal mainly include two new primary substations in order to cater to the forecasted electricity demand due to apartment complexes and multi-purpose buildings and would facilitate to maintain (n-1) reliable criteria.

Further this project is capable of providing adequate network capacity, voltage improvement, high reliability, power quality, minimizing the system losses, economic and speedy operation.

CEB DD4 will also use the existing OH MV and LV facilities after the implemented of the project 8. They will install the new PSS, new RSS and new UG cable, to divide the demand of the existing 11kV OH MV line.

As a result of the site survey and the discussion with CEB DD4, survey team confirmed that there is possible to implement all items in the scope.

Fore locations needing the land acquisition newly in PJ8 is "Frazer Avenue RSS", the connection point to the 33kV OH line of 33 kV UG power supply cable for "Mt. Lavinia Bus Station PSS", the connection point to the 33 kV OH line of 33 kV UG power supply cable for "Council Lane PSS", and the switching station between "kohiwala 2 RSS" and "Kirulapana PSS". "Frazer Avenue RSS" gets the land about approximate 7 m x 4 m, other places get the land of poles. In "Frazer Avenue RSS" land is government-owned lands, CEB DD4 said that it will be finished land acquisition in November or December by the request to government. And three places of other site acquisition work will be carried out from now on. Other land of project proposed sites have been already owned by CEB.

It addition, CEB DD4 said that regard to road excavation associated with the UG cable construction, a road permission will be issued immediately by the application to the road administrator

At the moment, the UG cable route has been fixed, but the detailed design of the building (new PSS and RSS) not executed.

The designs of the UG cable route as for project 8 are shown Figure 3-8, Figure 3-9

Figure 3-8 Design of the single line diagram on GIS map of Project 8

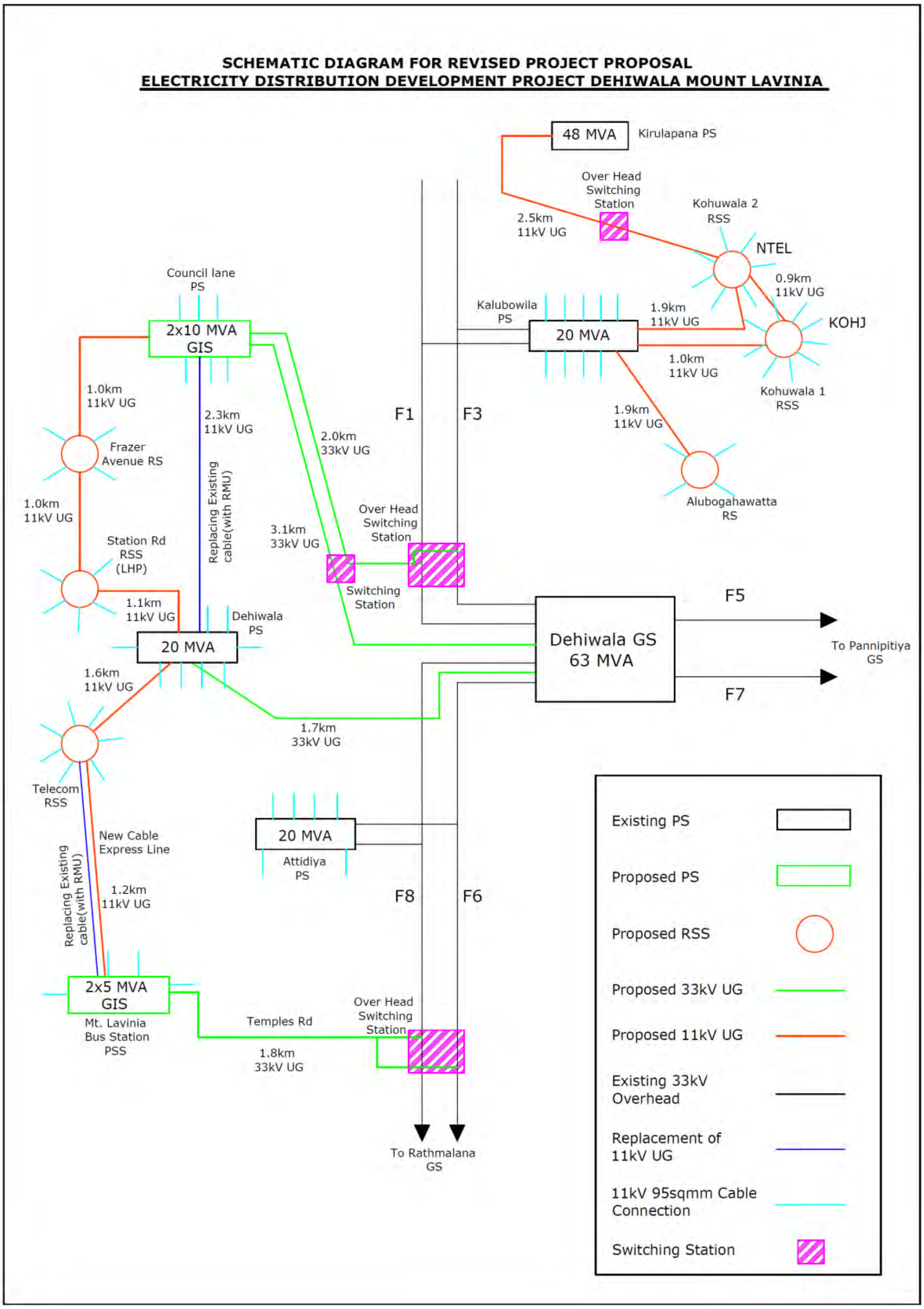


Figure 3-9 Schematic single line diagram design of the project of project 8

3.2.8.5. Power flow analysis in MV distribution system

3.2.8.5.1. Existing system problems

Power flow analysis was simulated using by the SynerGEE®. If the project will not be implemented, some supply difficulty occurs in existing MV distribution line, and other problems also happen near future. Some problems are shown below:

- Nugegoda town area (highly urban) is fed by only one feeder from Kalubowila PSS (that feeder not has interconnections). If this feeder is out, power cannot be supplied to that location until it is repaired.

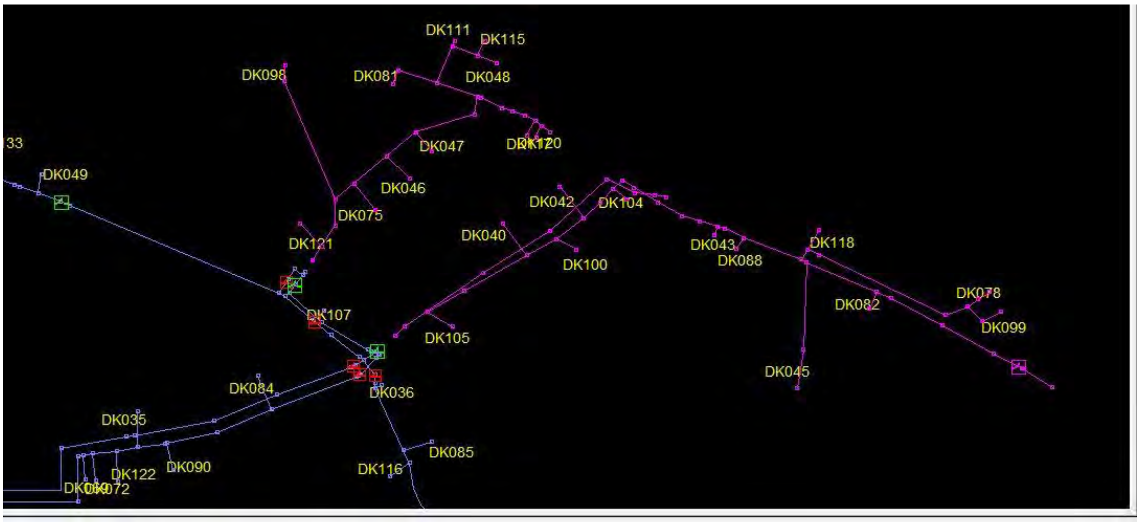


Figure 3-10 Supply difficulty on Nugegoda town area

- Marine city area only supplied by a one feeder. If this feeder is out power cannot be supplied to that location until it is repaired. (There is a very big consumer/demand (3 MVA) in Dehiwala area).

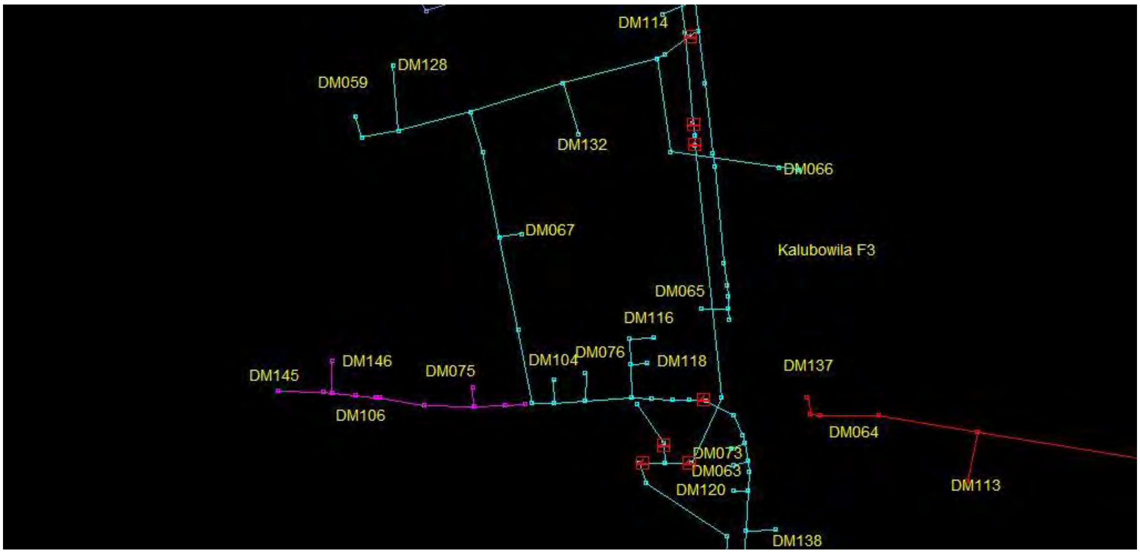


Figure 3-11 Supply difficulty on Marine city area

- Kalubowila PSS will be over loaded more than its firm capacity (12.5 MVA – to supply power by loading 125% when one transmission line/ feeder is out) beyond 2014.
- Athidiya PSS will be over loaded more than its firm capacity beyond 2019.
- Existing UG cables are very old (more than 25 years) and replacement of these cables is needed.
- Stipulated voltage limits (within + or – 6% from rated voltage) cannot be maintained at Mt. Lavinia area after 2017.

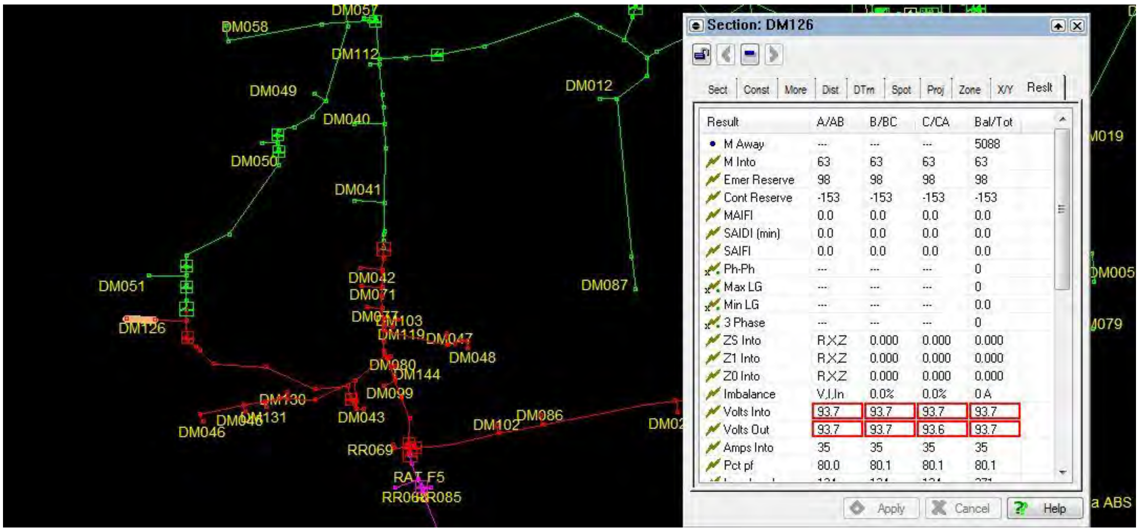


Figure 3-12 Stipulated voltage limits (after 2017)

- Stipulated voltage limits (within + or – 6% from rated voltage) cannot be maintained at many other places beyond 2018.

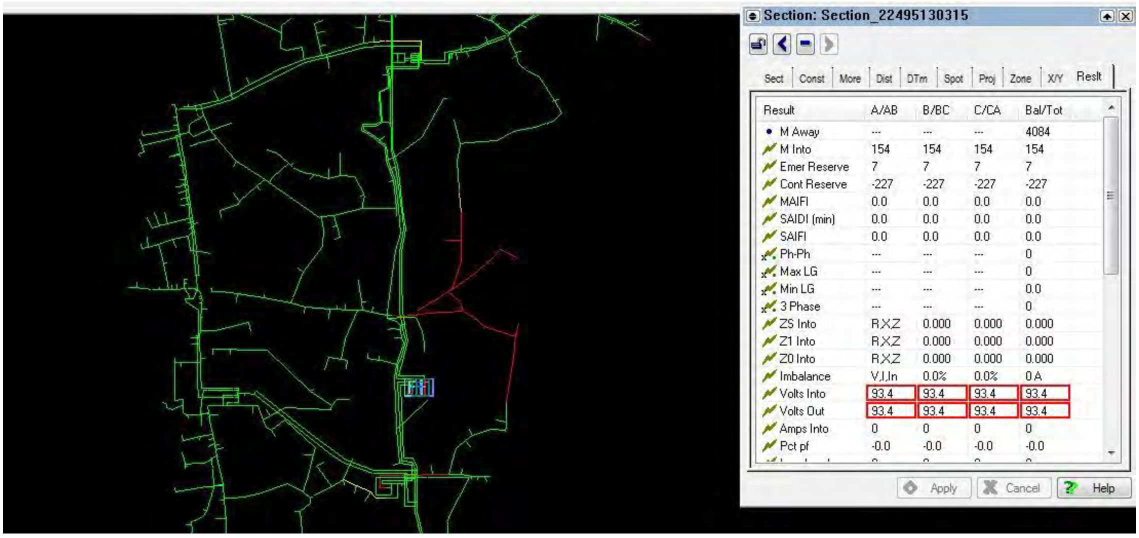


Figure 3-13 Stipulated voltage limits (after 2018)

- Feeder overloading will occur beyond 2016

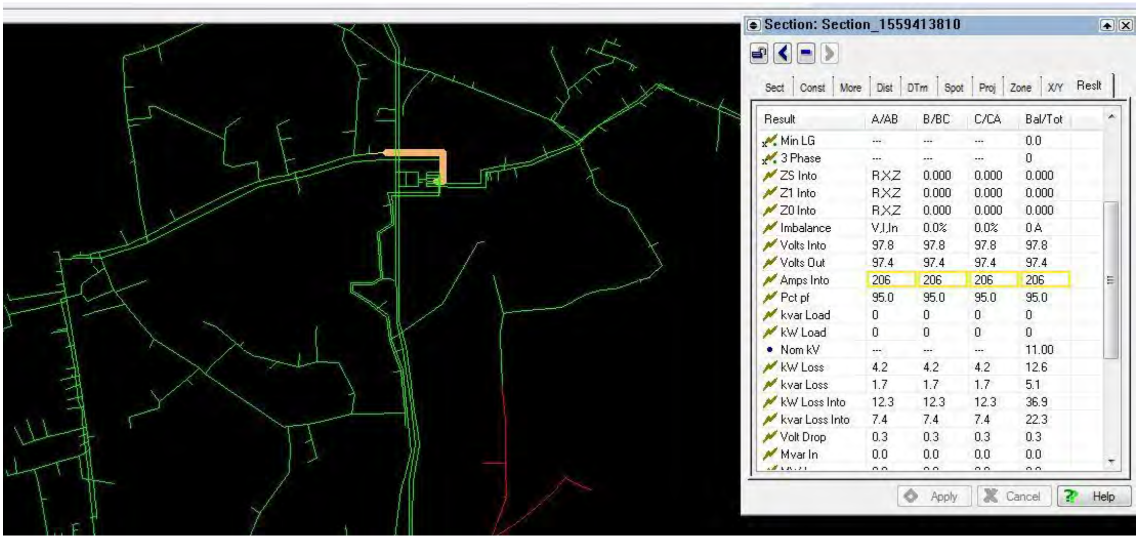


Figure 3-14 Feeder overloading (1)

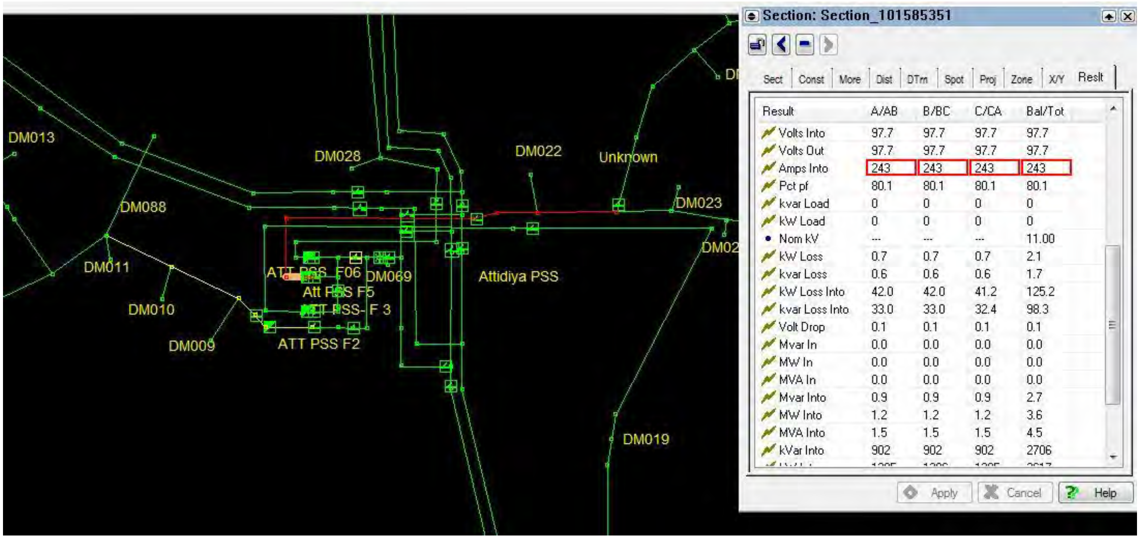


Figure 3-15 Feeder overloading (2)

- If Kalubowia PSS shuts down or feeder coming to council lane side shuts down, the area beyond William junction cannot be supplied with power (overloading and low voltage occurs).

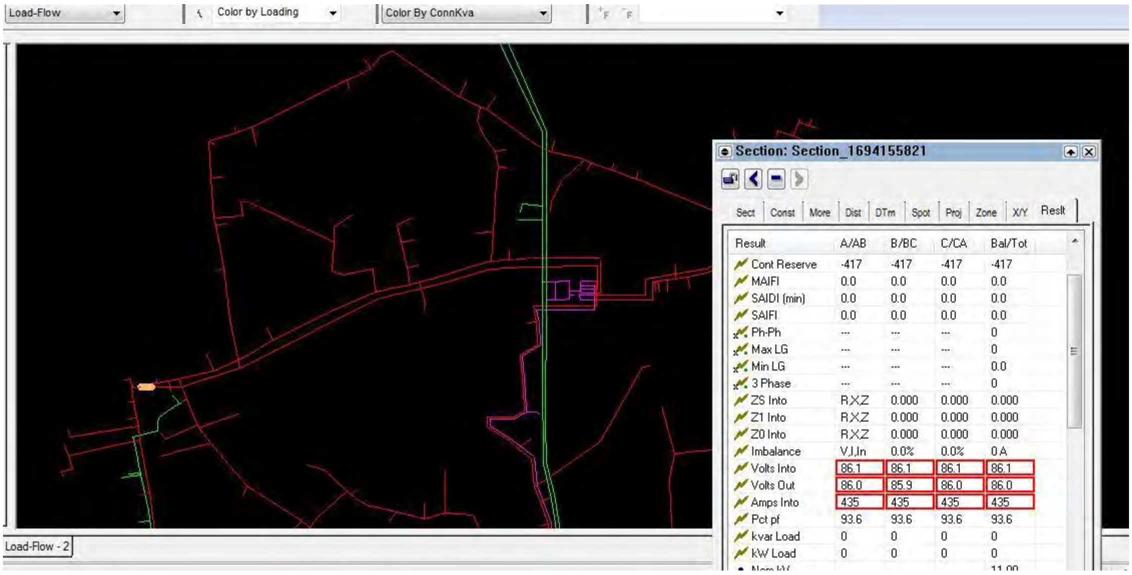


Figure 3-16 Kalubowia PSS out or feeder coming to council lane side out

- If Dehiwala PSS shuts down or feeder coming to Council lane side is shuts down, the area Beyond William junction cannot be supplied with power (overloading and low voltage occurs).

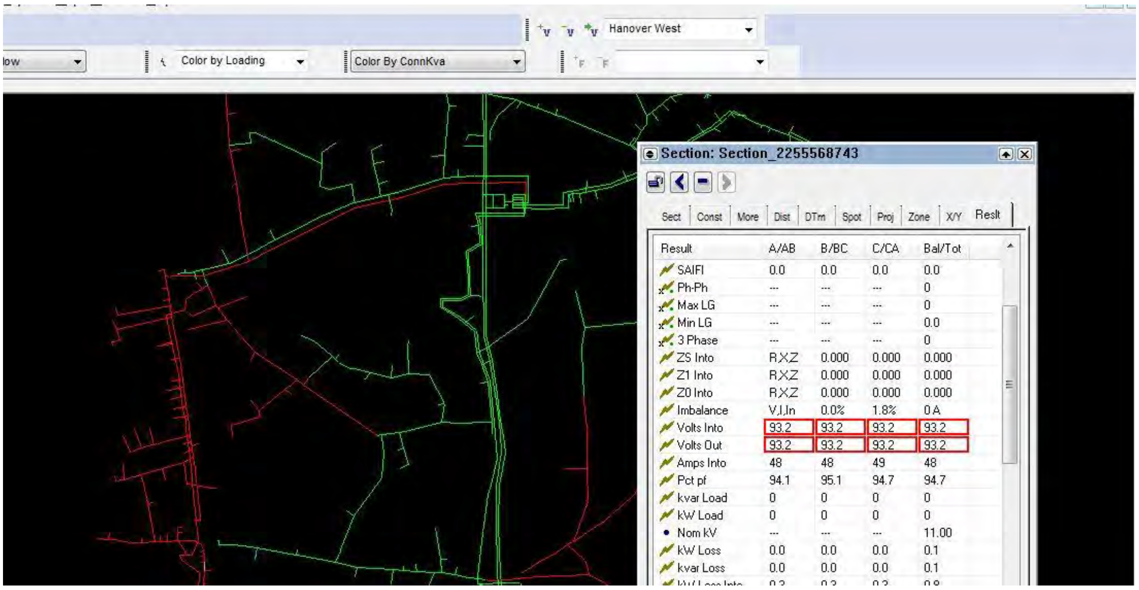


Figure 3-17 Beyond William junction (overloading and low voltage)

3.2.8.5.2. Confirmation for the substation capacity and the feeder capacity

These confirmations were carried out based on demand forecast and substation capacity, demand forecast and capacity of each feeder in the normal operation. After having carried out the project, up to 2024, the supply difficulty does not exist. The confirmation results of all related project shown below.

a) GSS

- Dehiwala GSS

Dehiwala GSS is supplying power for all of the project implementation area.

Table 3-3 Dehiwala GSS total Tr capacity and demand planning

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Tr Capacity (MVA)	63	63	94.5	94.5	94.5	94.5	94.5	94.5	94.5	94.5	94.5
Demand (MVA)	38.7	40.4	42.1	43.9	45.8	47.8	50.6	53.7	56.9	60.3	63.9

There established 132 kV/ 33 kV 31.5 MVA x 2 transformers. CEB has planned an augmentation of 31.5MVA x 1 transformer in 2016(tentative; out of the JICA projects scope).

Table 3-4 Dehiwala GSS Feeders demand Planning

		Maximum Demand Planning (A)										
feeder No.	OCR	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
feeder 1	400	75	78	81	155	185	192	202	218	231	245	261
feeder 2*	400	N/A	N/A	N/A	143	172	178	187	202	214	227	241
feeder 3*	400	221	230	239	6	7	8	8	9	9	10	10
feeder 4	400	N/A	N/A	N/A	147	175	182	191	206	219	232	246
feeder 6	400	136	141	147	95	113	118	124	134	142	150	159
feeder 8	400	204	212	221	173	207	215	226	244	258	274	290

*Feeder 2 & 3: CEB Will connect the new 33 kV MV feeder within the JICA project scope

b) PSS

- Kalubowila PSS

Kalubowila PSS is supplying power for East side of the project implementation area.

Table 3-5 Kalubowila PSS total Tr capacity and demand planning

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total Tr Capacity (MVA)	20	20	20	20	20	20	20	20	20	20	20
Maximum Demand (MVA)	12.0	12.5	13.0	11.4	11.9	12.4	13.1	13.9	14.8	15.7	16.6

Kalubowila PSS establishes 33 kV/ 11 kV 10.0 MVA x 2 transformers.

Table 3-6 Kalubowila PSS feeders demand planning

		Maximum Demand(A)										
feeder No.	OCR	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
feeder 1	200	10	10	11	50	52	54	58	61	65	69	73
feeder 2	250	80	83	87	142	148	154	164	174	184	195	207
feeder 3	200	110	115	120	88	92	96	101	108	114	121	128
feeder 4	200	160	167	174	115	120	125	133	141	149	158	167
feeder 5	200	130	136	141	64	67	70	74	78	83	88	93
feeder 6	250	140	146	152	140	146	152	161	171	181	192	204

Note:

Feeder 5 & 6 will be added to feeder 5 and feeder 6 will be allocated to Kohu 1 new UG feeder.

Feeder 1 & 2 will be added to feeder 1 and feeder 2 will be allocated to Alubogahawatta new UG feeder.

Feeder 3 & 4 will be added to feeder 3 and feeder 4 will be allocated to Kohuwala 2 new UG feeder.

Kalubowila PSS has total 6(six) circuit of 11 kV MV feeders. The existing six feeders are all in use. CEB will reallocate 3(three) feeders from the existing 6(six) feeders, by combining to 1(one) feeder from each 2(two) feeders that are feeding power for the same direction before the

JICA Project (CEB own loan). CEB will install 3 (three) new UG 11 kV feeder under the JICA project.

- Dehiwala PSS

Dehiwala PSS is supplying power for north west side of the project implementation area, and Dehiwala PSS will supply power for middle west side of the project implementation area after implemented the JICA Project.

Table 3-7 Dehiwala PSS total Tr capacity and demand planning

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total Tr Capacity (MVA)	20	20	20	20	20	20	20	20	20	20	20
Maximum Demand (MVA)	7.7	8.0	8.4	9.6	10.0	10.5	11.1	11.7	12.5	13.2	14.0

Dehiwala PSS installed 33 kV/ 11 kV 10.0 MVA x 2 transformers.

Table 3-8 Dehiwala PSS feeders demand planning

		Maximum Demand (A)										
feeder No.	OCR	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
feeder 1	200	90	94	98	42	44	46	48	51	54	58	61
feeder 2	200	126	131	137	46	48	50	53	56	60	63	67
feeder 3	200	12	13	13	143	149	156	165	175	185	196	208
feeder 4	200	52	54	57	98	102	107	113	120	127	135	143
feeder 5	250	125	130	136	161	168	175	186	197	209	221	234
feeder 6	200	N/A	N/A	N/A	15	16	16	17	18	19	21	22

Note:

A spare feeder will be allocated to New Station Rd RSS UG cable.

Feeder 3 & 4 will be added to feeder 3 and feeder 4 will be allocated to Telecom RS new UG feeder.

Dehiwala PSS has total 6(six) circuit of 11 kV MV feeders. The five existing feeders are in use. CEB will reallocate to 4(three) feeders from the existing 5(five) feeders, by combine to 1(one) feeder from 2(two) feeders that are feeding power for same direction before the JICA Project (CEB own loan). CEB will install 2 (two) new UG 11 kV feeders under the JICA project.

- Council lane PSS (Proposed)

Council lane PSS is a proposed PSS for this JICA project. Council lane PSS will supply power for north side and north west side of the project implementation area after implemented the JICA Project.

Table 3-9 Council lane PSS total Tr capacity and demand planning

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total Tr Capacity (MVA)	N/A	N/A	N/A	20	20	20	20	20	20	20	20
Maximum Demand (MVA)	N/A	N/A	N/A	8.8	9.2	9.6	10.1	10.7	11.4	12.1	12.8

Council lane PSS will have 33 kV/ 11 kV 10.0 MVA x 2 transformers.

Table 3-10 Council lane PSS feeders demand planning

		Maximum Demand (A)										
feeder No.	OCR	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
feeder 1	200	N/A	N/A	N/A	109	114	119	126	133	141	150	159
feeder 2	200	N/A	N/A	N/A	0	0	0	0	0	0	0	0
feeder 3	200	N/A	N/A	N/A	62	65	67	71	76	80	85	90
feeder 4	200	N/A	N/A	N/A	0	0	0	0	0	0	0	0
feeder 5*	200	N/A	N/A	N/A	161	168	175	186	197	209	221	234
feeder 6*	200	N/A	N/A	N/A	130	136	141	150	159	168	179	189

* Feeder 5 and 6: CEB will reallocate feeder demand after a few years later of JICA project completion.

- Mt Lavinia Bus Station PSS (Proposed)

Mt Lavinia Bus Station PSS is a proposed PSS for this JICA project. Mt Lavinia Bus Station PSS will supply power for north side and north-west side of the project implementation area after implementation of the JICA Project.

Table 3-11 Mt Lavinia Bus Station PSS total Tr capacity and demand planning

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total Tr Capacity (MVA)	N/A	N/A	N/A	10	10	10	10	10	10	10	10
Maximum Demand (MVA)	N/A	N/A	N/A	3.0	3.2	3.3	3.5	3.7	3.9	4.2	4.4

Mt Lavinia Bus Station PSS will have 33 kV/ 11 kV 5.0 MVA x 2 transformers.

Table 3-12 Mt Lavinia Bus Station PSS feeders demand planning

		Maximum Demand (A)										
feeder No.	OCR	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
feeder 1	200	N/A	N/A	N/A	95	99	103	110	116	123	130	138
feeder 2	200	N/A	N/A	N/A	11	11	12	13	13	14	15	16
feeder 3	200	N/A	N/A	N/A	53	55	58	61	65	69	73	77
feeder 4	200	N/A	N/A	N/A	0	0	0	0	0	0	0	0
feeder 5	200	N/A	N/A	N/A	0	0	0	0	0	0	0	0
feeder 6	200	N/A	N/A	N/A	0	0	0	0	0	0	0	0

- Kirulapana PSS feeder demand PSS (Existing PSS: managed by CEB Colombo city office)

Kirulapana PSS is managed by CEB Colombo City office. Kirulapana PSS is supplying power for South side of the Colombo city. "The proposed 33 kV UG line from Kirulapana PSS to Kohuwala 2 RSS" will use for emergency power supply in case that a fault occurs in new 11 kV UG trunk line from Kalubowila PSS after implementation of JICA Project.

Table 3-13 Kirulapana PSS total Tr capacity and demand planning

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total Tr Capacity (MVA)	48	48	48	48	48	48	48	48	48	48	48
Maximum Demand (MVA)	21	22	23	24	25	26	28	30	32	33	35

Table 3-14 Kirulapana PSS feeders demand planning

		Maximum Demand (A)										
feeder No.	OCR	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
F1 (Spare)	340 A, 400 A, 420 A for out going feeders and 200 A for station transformer	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F2 (RAD 1023-1)		95	99	104	108	113	118	125	132	140	148	157
F3 (RAD 561)		98	103	107	112	116	121	129	136	145	153	162
F4 (RAD 24)		207	216	226	235	245	256	271	288	305	323	343
F5 (RAD 23)		317	331	345	360	375	391	415	440	466	494	524
F6 (RAD 56)		274	285	298	310	324	338	358	379	402	426	452
F7 (STR)		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F8 (RAD 1023-2)		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F9 (RAD 1342)		9	9	9	10	10	11	11	12	13	13	14
F10 (RAD 656)		126	132	137	143	150	156	165	175	186	197	209
F11 (Spare)		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F12 (Spare)*		N/A	N/A	N/A	3	3	3	3	3	3	3	3

*One spare feeder will be allocated to NTEL RS feeder in 2017. JICA survey team allocated the feeder to Kohuwala RSS in F12 tentatively in this report.

c) RSS

- Alubogahawatta RSS (Proposed)

Alubogahawata RSS will be constructed under this project, and it connects to the new 11 kV UG trunk line from Kalubowila PSS.

Table 3-15 Alubogahawata RS feeders demand planning

		Maximum Demand (A)										
feeder No.	OCR	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
feeder 1(incoming from Kalubowila PSS)	400	N/A	N/A	N/A	142	148	154	164	174	184	195	207
feeder 2	200	N/A	N/A	N/A	0	0	0	0	0	0	0	0
feeder 3	200	N/A	N/A	N/A	19	20	21	22	23	25	26	28
feeder 4	200	N/A	N/A	N/A	27	28	29	31	33	35	37	39
feeder 5	200	N/A	N/A	N/A	96	100	104	111	117	124	132	140
feeder 6	200	N/A	N/A	N/A	0	0	0	0	0	0	0	0

- Kohuwala 1 RSS (Proposed)

Kohuwala 1 RSS will be constructed in this project, and connects to the new 11 kV UG trunk line from Kalubowila PSS and to/ from Kohuwala 2 RSS.

Table 3-16 Kohuwala 1 RSS feeders demand planning

		Maximum Demand (A)										
feeder No.	OCR	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
feeder 1(incoming from Kalubowila PSS)	400	N/A	N/A	N/A	140	146	152	161	171	181	192	204
feeder 2 (incoming from Kohuwala 2 RSS)	400	N/A	N/A	N/A	0	0	0	0	0	0	0	0
feeder 3	200	N/A	N/A	N/A	63	66	69	73	77	82	87	92
feeder 4	200	N/A	N/A	N/A	78	81	85	90	95	101	107	114
feeder 5	200	N/A	N/A	N/A	0	0	0	0	0	0	0	0
feeder 6	200	N/A	N/A	N/A	0	0	0	0	0	0	0	0

- Kohuwala 2 RSS (Proposed)

Kohuwala 2 RSS will be constructed in this project, and connects to the new 11 kV UG trunk line from Kalubowila PSS, Kirulapana PSS and to/ from Kohuwala 1 RSS.

Table 3-17 Kohuwala 2 RSS feeders demand planning

		Maximum Demand (A)										
feeder No.	OCR	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
feeder 1(incoming from Kalubowila PSS)	400	N/A	N/A	N/A	88	92	96	101	108	114	121	128
feeder 2 (incoming from Kirulapana PSS)	400	N/A	N/A	N/A	0	0	0	0	0	0	0	0
feeder 3	200	N/A	N/A	N/A	48	50	52	55	59	62	66	70
feeder 4	200	N/A	N/A	N/A	40	42	44	46	49	52	55	58
feeder 5	200	N/A	N/A	N/A	0	0	0	0	0	0	0	0
feeder 6	200	N/A	N/A	N/A	0	0	0	0	0	0	0	0

*Using one of spare feeder to connect to Kohuwala 1 RSS

- Frazer Avenue RSS (Proposed)

Frazer Avenue RSS will be constructed in this project, and connects to the new 11 kV UG trunk line from Council Lane PSS (proposed in this project) and to/ from Station Road RSS

Table 3-18 Frazer Avenue RSS feeders demand planning

		Maximum Demand (A)										
feeder No.	OCR	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
feeder 1(incoming from council lane PSS)	400	N/A	N/A	N/A	0	0	0	0	0	0	0	0
feeder 2 (incoming from Station road RSS)	400	N/A	N/A	N/A	32	33	35	37	39	41	44	47
feeder 3	200	N/A	N/A	N/A	15	16	16	17	18	19	21	22
feeder 4	200	N/A	N/A	N/A	22	23	24	25	27	29	30	32
feeder 5	200	N/A	N/A	N/A	0	0	0	0	0	0	0	0
feeder 6	200	N/A	N/A	N/A	0	0	0	0	0	0	0	0

- Station Road RSS (Proposed)

Station Road RSS will be constructed in this project, and connects to the new 11 kV UG trunk line from Dehiwala PSS and to/ from Frazer Avenue RSS.

Table 3-19 Station Road RSS feeders demand planning

		Maximum Demand (A)										
feeder No.	OCR	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
feeder 1(incoming from Dehiwala PSS)	400	N/A	N/A	N/A	132	138	144	152	161	171	181	192
feeder 2 (outgoing to Frazer avenue RSS)	400	N/A	N/A	N/A	37	39	40	43	45	48	51	54
feeder 3	200	N/A	N/A	N/A	47	49	51	54	57	61	65	68
feeder 4	200	N/A	N/A	N/A	52	54	57	60	64	67	71	76
feeder 5	200	N/A	N/A	N/A	0	0	0	0	0	0	0	0
feeder 6	200	N/A	N/A	N/A	0	0	0	0	0	0	0	0

- Telecom RSS (Proposed)

Telecom RSS will be constructed in this project, and connects to the new 11 kV UG trunk line from Dehiwala PSS and to/ from Frazer Avenue RSS.

Table 3-20 Telecom RSS feeders demand planning

		Maximum Demand (A)										
feeder No.	OCR	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
feeder 1(incoming from Dehiwala PSS)	400	N/A	N/A	N/A	98	102	107	113	120	127	135	143
feeder 2 (incoming from Mt.Lavinia PSS)	400	N/A	N/A	N/A	0	0	0	0	0	0	0	0
feeder 3	200	N/A	N/A	N/A	98	102	107	113	120	127	135	143
feeder 4	200	N/A	N/A	N/A	0	0	0	0	0	0	0	0
feeder 5	200	N/A	N/A	N/A	0	0	0	0	0	0	0	0
feeder 6	200	N/A	N/A	N/A	0	0	0	0	0	0	0	0

3.2.8.5.3. Contingency analysis after implemented project

Contingency analysis carried out by the SynerGEE® only in 2024 after implementation of the project. This analysis simulates supply difficulty in faulty situation by opening the switch of the trunk line at the feeding point, and power supply from the other feeder possibility by switching is judged. If the problem or the outage occurs after this simulation input, a warning is displayed on the screen. Simulation result table shows that after implementation of the project, even if one feeder is shut down in 2024, supply power is still possible from other routes.

Table 3-21 Contingency Analysis in 2024 after implemented of the project 8

UG Trunk line root (Feeder)	Load Flow at Normal Condition (A)	Contingency Analysis (A) in 2024								
		Failure of UG cable Kaubowila PS to Alubogahawatta RS	Failure of UG cable Kaubowila PS to Kohu 1 RS	Failure of UG cable Kaubowila PS to Kohu 2 RS	Failure of UG cable Council lane PS Dehiwala PS	Failure of UG cable Council lane PS Frazer Avenue RS	Failure of UG cable Council lane PS Frazer Avenue RS	Failure of UG cable Dehiwala PS to Telecom RSS	Failure of UG cable Mt.avinia PS to Telecom RSS at Mt.avinia Ps side	Failure of 33 kV UG cable to Mt.Lavinia PSS
Kaubowila PS to Kohuwala 1 RS	207	231	N/A	207	Failure of this line not creates changes in other feeders (but substations connected to this UG cable will be affected)	207	207	207	207	207
Kaubowila PS to Kohuwala 2 RS	128	239	242	N/A		128	128	128	128	128
Kirulapana PS to Kohuwala 2 RS	0	0	0	126		0	0	0	0	0
Kaubowila PS to Alubogahawatta RS	207	N/A	207	139		207	207	207	207	207
Kohuwala 1 RS to Kohuwala 2 RS	0	0	61	0		0	0	0	0	0
Dehiwala GS to Council lane PS	244	244	244	252		244	244	244	244	244
O/H tapping to Council lane PS	0	0	0	0		0	0	0	0	0
Council lane PS Dehiwala PS	61	61	61	61		61	61	61	61	61
Council lane PS Frazer Avenue RS	0	0	0	0		N/A	22	0	0	0
Frazer Avenue RS to Station Rd RSS	22	22	22	22		22	N/A	22	22	22
Dehiwala PS to Station rd RSS	22	22	22	22		22	22	22	22	22
Dehiwala PS to Telecom RSS	142	142	142	142		142	142	N/A	280	295
Telecom RSS to Mt.Lavinia Bus Station PS(new cable)	N/A	N/A	N/A	N/A		N/A	N/A	98	N/A	16
Telecom RSS to Mt.Lavinia Bus Station PS(replaced cable)	138	138	138	138		138	138	138	138	138
O/H tapping to Mt.avinia Bus Station PS	119	119	119	119		119	119	145	119	N/A

*"Failure of 33kV UG cable of Dehiwala GSS to Dehiwara PSS" was not made because two 33 kV UG feeders comes to (from Dehiwala GSS and other one from tapping point at Galwihara place) council lane PSS. If a fault occurs in UG cable from Dehiwala GSS power can be fed from the other UG feeders easily. therefore reliability is higher. (problem occurs only if both of these feeders are out).

3.2.9. Subproject-9

3.2.9.1. Issues

Present loading levels of Sri J'Pura GSS l32/ 33 kV 31.5 MVA x 2 indicate a red light showing that the firm capacity level have been exceeded so that the augmentation has already been committed to enhance to 31.5 MVA x 2 to cater for the future load of defense headquarters. The 33/ 11 kV PSS at Ethulkotte and Pelawatta which feed the 11 kV supply network in the area are more than 25 years old and the firm capacity level of Ethulkotte PSS have already been exceeded. The existing 11 kV system has limited load transfer capability so that the (N-1) reliability criteria couldn't be maintained. So in the event of failure of a PSS, the flexibility of transferring the load to the other PSS is not possible to be maintained and this would become a critical factor in the future. As per the energy loss studies 6 % distribution energy loss exists in the prevailing network.

Further, the existing 11 kV overhead system and bare conductor overhead LV distribution system have number of issues in a congested city like Battaramulla. This includes safety issues in maintaining statutory clearances to the buildings, reliability of supply and aesthetic reasons. Hence there is a requirement of formulating a project to upgrade the 11 kV electricity network system in Battaramulla area to overcome the various issues such as network capacity limitations, reliability, safety etc.

3.2.9.2. Scope of Work

- 33/11 kV Primary Substation (PSS) at Koswatta (Capacity 2 X 10 MVA)
  33/ 11kV 10 MVA x 2 Transformers, 33 kV and 11 kV Panels and PSS control building (concrete type) construction etc.
- 11kV Radial Substations (RSS)
  11 kV Panels of 9 circuit, RSS building (concrete type), Civil Works and SCADA for RSS etc.
- 240mm^2 / 1C 33kV XLPE from Densil Kobbekaduwa Mawatha to PSS at Koswatta along Robert Gunawardena Mawatha
  240 mm2/3C 33 kV XLPE Cable, Joints and civil work, etc.

Table 3-22 Cable Length of 240 mm^2 / 3C 33 kV XLPE

No.	Line Section	Length/ m
1	Dencil Kobbekaduwa Mw. to PSS at Koswatta along Robert Gunawardena Mw.	1,310
Total		1,310

- 400mm^2 / 1C 11kV XLPE connecting Primary Substations and Radial Substations.

400 mm^2/ 1C 11 kV XLPE Cable, Cost for Joints, Civil work etc.

Table 3-23 Cable Length of 400 mm^2/ 1C 11 kV XLPE

No.	Line Section	Length/ m
1	KSPSS PR1	1,500
2	PLPSS PR2	720
Total		2,220*

*1C: The quantity of total of the 1C cable is 6,660m

- 240mm^2 / 3C 11kV XLPE connecting Primary Substations and Radial Substations.

240 mm^2/3C 11 kV XLPE Cable, Cost for Joints and civil work etc.

Table 3-24 Cable Length of 240 mm^2 / 3C 11 kV XLPE

No.	Line Section	Length/ m
1	EKPSS ER1	450
2	KSPSS KR1	1,000
3	KSPSS KR2	380
4	KSPSS KR3	1,380
5	PLPSS PR3	570
6	ER1-KR1 Sat 2	1,900
7	KR1-PR1 Sat	920
8	PR1-PR2 Sat	1,020
Total		7,620

- 95 mm^2/ 3C 11 kV XLPE to interconnection between Radial Substation and 11 kV distributors

95 mm^2/ 3C 11 kV XLPE Cable, Cost for Joints and civil work etc.

Table 3-25 Cable Length of 95 mm^2/ 3C 11 kV XLPE

No.	Line Section	Length/ m
1	ER1-ER1 Sat	600
2	ER1-KR1 Sat 1	930
3	KR1-KR2 Sat	2310
4	KR1 spur 1	390
5	KR1 Spur 2	300
6	KSPSS Dist PR1	1720
7	KR2-KR3 Sat	1150
8	KR3-PR2 Sat	1160
9	PLPSS Dist PR1	2000
10	PR2-PR3 Sat 1	1610
11	PR2-PR3 Sat 2	1380
12	PR3 Spur 1	100
13	PLPSS Dist PR3	610
Total		14,260

- Laying of Optical Fiber Cables Replacement of 33kV Substations with 11kV compact substations.

Optical Fiber Cables, HDPE Pipes

- Replacement of 33 kV Substations with 11 kV compact substations

Compact Substations (160 kVA & 250 kVA), Compact Substations (400 kVA & 630 kVA), Ring Main Units only, Civil Works

- 11 kV indoor substations

Ring Main Unit (RMU), Transformer, Low Voltage Panel and Civil work

- Anticipated UG LV Network

Feeder Pillars, Mini Feeder Pillars, 240mm2/4C Al UG Cables, 95mm2/4C AL UG Cables, Civil Works

- Specialized vehicle for distribution of work

Lorry mounted 6 ton crane (Lorry should be able to carry 10 tons), Fork lift, Cable trailer

- Equipment and tools for distribution of work

Cable fault locator(Time domain reflect meter), Cable route locator, Cable Identifier, Phase Sequence Meter, MV Phasing Tester, MV Voltage Detector, Sheath Fault Locator, Cable condition monitor, Digiphone, Cable Spiker, Insulation Tester, Portable Generator, Testing and Fault Locating Unit, AC Testing Unit and DC Testing Unit

- 33/11 kV Primary Substation at Pelawatta

Transformers Panels (33 kV & 11 kV), SCADA component, Civil works

- Training
    - As CEB DD3 Western Province South II is new to underground electricity distribution system it may be necessary to get an exposure to urban utilities overseas with regard to followings.
    - Planning of Distribution Network
    - Bulk / Retail consumer connections
    - Operations and Maintenance
    - DAS and SCADA system
    - Introduction of any New product which are different to what is available in Colombo

City with related to Switch Gear

- Introduction of any New product which are different to what is available in Colombo City with related to Equipment

3.2.9.3. Cost Estimate

Unit price and quantity are prepared by CEB. Cost estimation was prepared based on those. The cost of the UG cables, panels (33 kV, 11 kV and LV), Compact Substations, Feeder Pillars and mini feeder pillars are based on the CEB price list of material, and others are estimated by former construction price. Some equipment and vehicles are estimated by web site. Then some additional cost for this foundation is estimated. Then CEB added the additional cost for civil work to construction cost.

3.2.9.4. Project Design

Project 9 will implement in Battaramulla Area of CEB DD3. The Proposed UG network should be capable of providing adequate network capacity, high reliable power supply to the existing as well as future loads and economic operation of the system with minimum losses. Hence it is proposed to construct a new 33/ 11 kV PSS at Koswatta and replacing existing 11 kV overhead distribution network with UG cable network with suitable capacities. The proposed 11 kV UG system will connect the above new primary substation and the existing Pelawatta PSS 11 and Ethulkotte PSS with 07 Nos. radial substations. All the existing and future loads will be connected to the proposed 11 kV UG system except the existing and future major 33 kV loads in the area.

CEB DD3 will replace the existing OH MV and LV facilities after the implemented of the project 9. But they planned will be replace the existing OH facility by CEB own loan. CEB will supply LV power using the existing facilities for customers other than customers facing the wide streets with UG project. In this case, CEB will connect the LV UG cable to poles that exist at the entrance of the location using the existing facilities

As a result of the site survey and the discussion with CEB DD3, survey team confirmed that there are possible to implement all items in the scope.

There are 29 (twenty nine) locations needing the land acquisition newly in PJ9. These lands will be used the PSS, the RSS, and the compact substation, 1 (one) land is for the PSS (1 is private), 6 (six) land are for the RSS (5 are government and 1 is private), 22 (twenty two) lands are for compact substation (16 are government, 2 are private and 4 are government/ private). Urban Develop Authority is in charge with the permission to use government land and the acquisition of private land. CEB DD3 has already issued a land acquisition application to UDA, and they are expecting to the land acquisition will be finished in November or December. Other land of project proposed sites have been already owned by CEB.

It addition, CEB DD3 said that regard to road excavation associated with the UG cable construction, a road permission will be issued immediately by the application to the road administrator

At the moment, the cable route has been fixed, but the detailed design of the building (new PSS and RSS) not executed. According to CEB DD3, I said that the design of new PSS building wants to use a design of Nawala PSS of LECO.

The designs of the UG cable route as for project 9 are shown below.

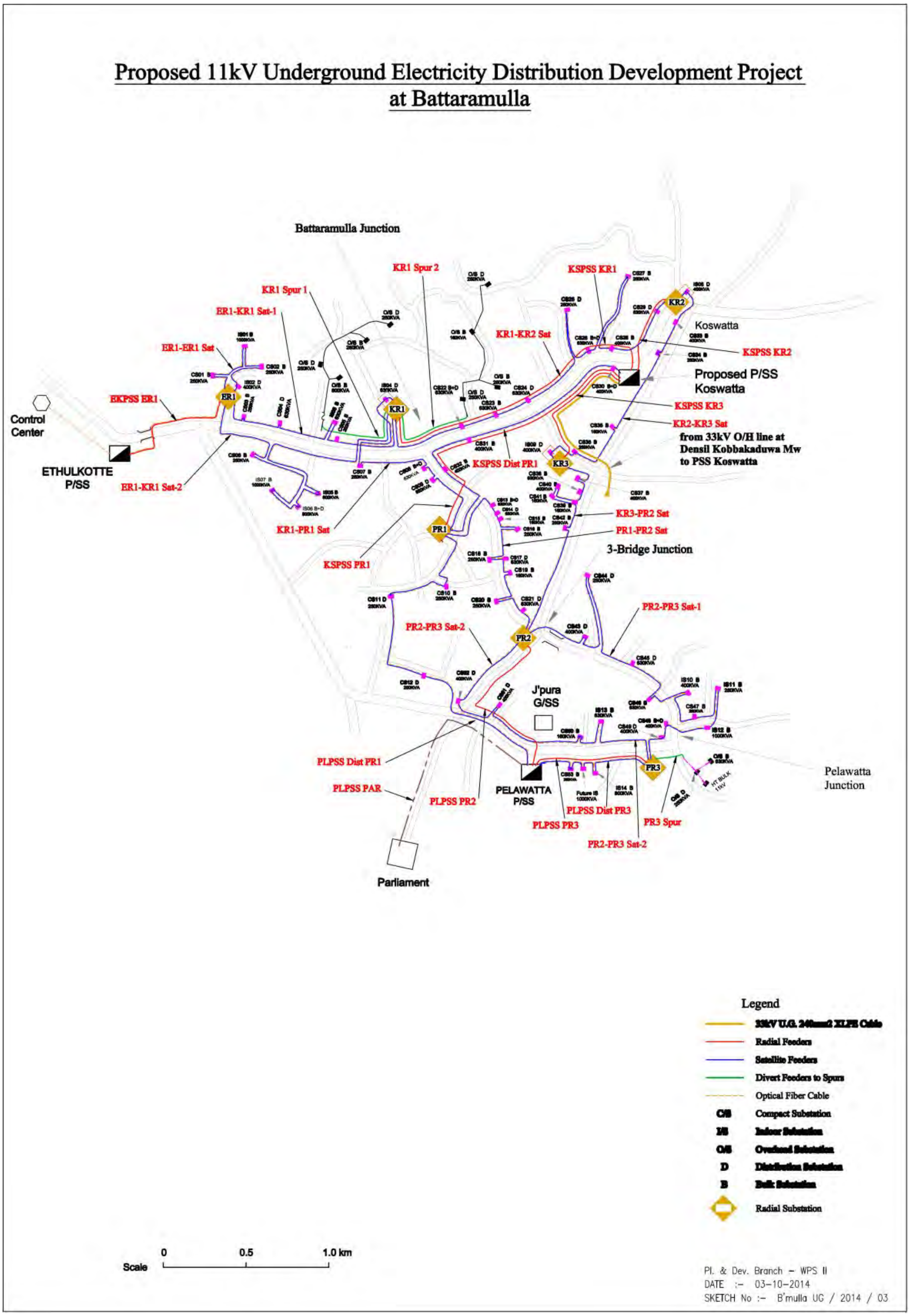


Figure 3-18 Design of the single line diagram on GIS map of Project 9

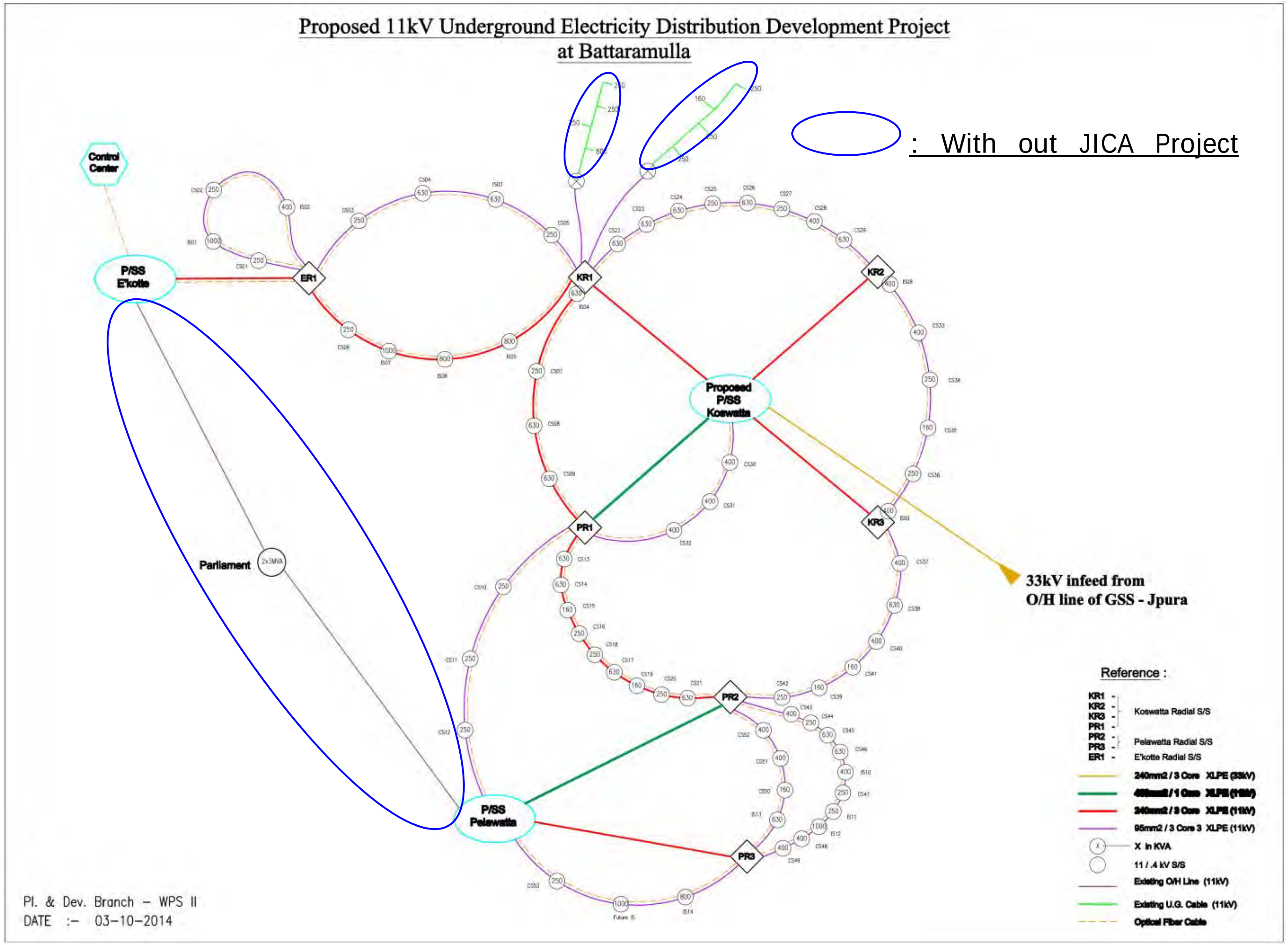


Figure 3-19 Schematic single line diagram design of the project of project 8

3.2.9.5. Power flow analysis

3.2.9.5.1. Existing system problems

Power flow analysis was simulated by the same method as project 8. If the project will not be implemented, this area also has the same problems as DML area in the existing MV distribution line. Some problems case shows below:

- When MV feeder failure occurs in EKPSS F1, PLPSS F4 will be overloaded, and PLPSS F1 will be marginally overloaded.

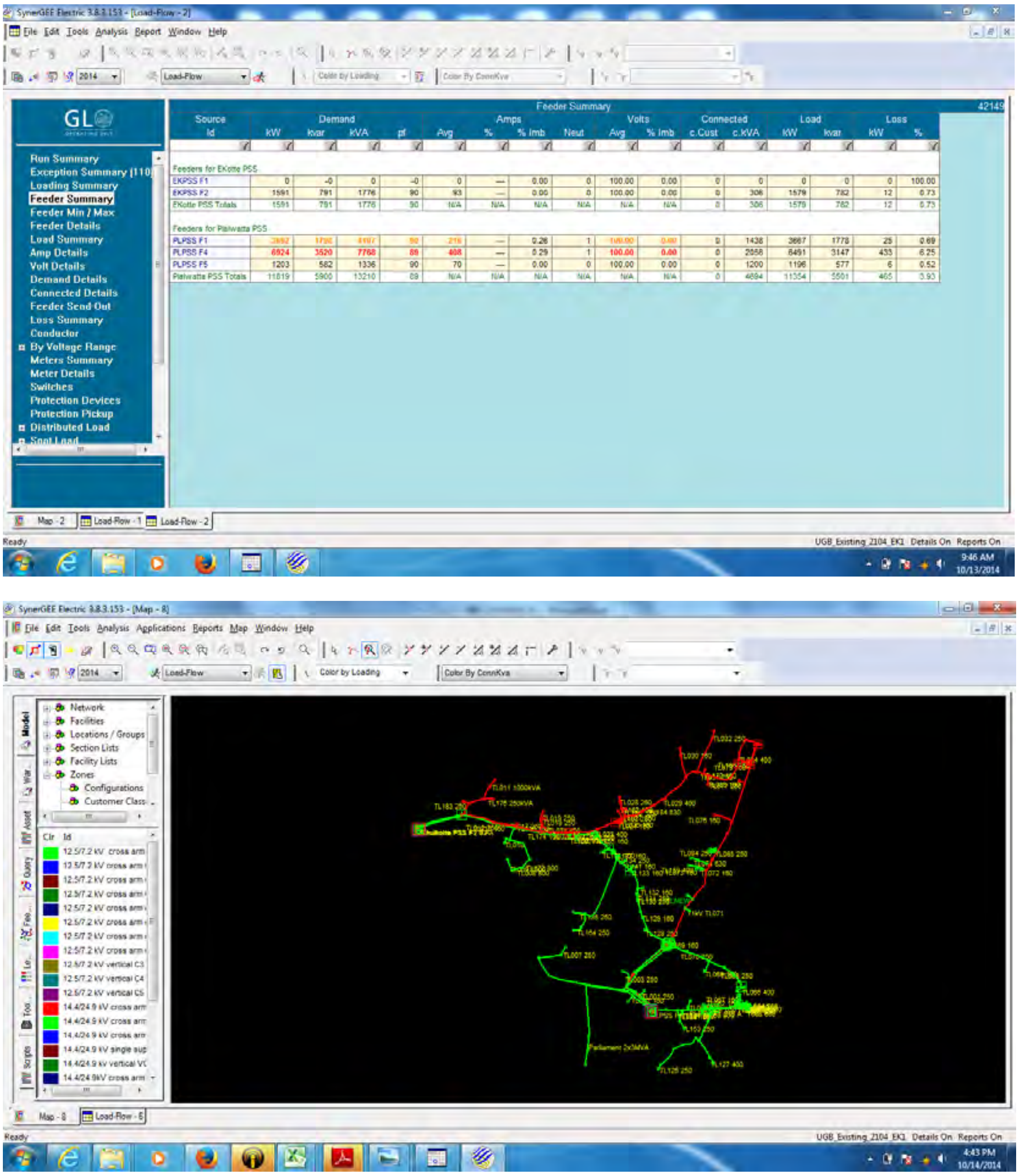
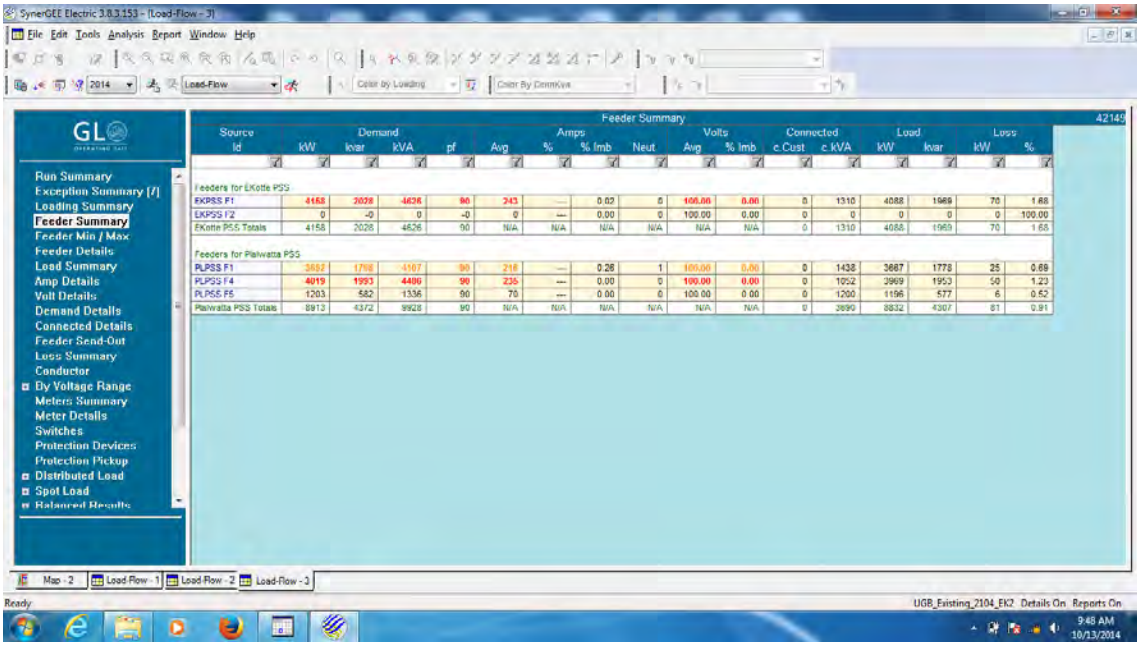


Figure 3-20 MV feeder failure occurs in EKPSS F1

- When MV feeder failure occurs at EKPSS F2, PLPSS F4 and EKPSS F1 will be overloaded, and PLPSS F1 will be marginally overloaded.



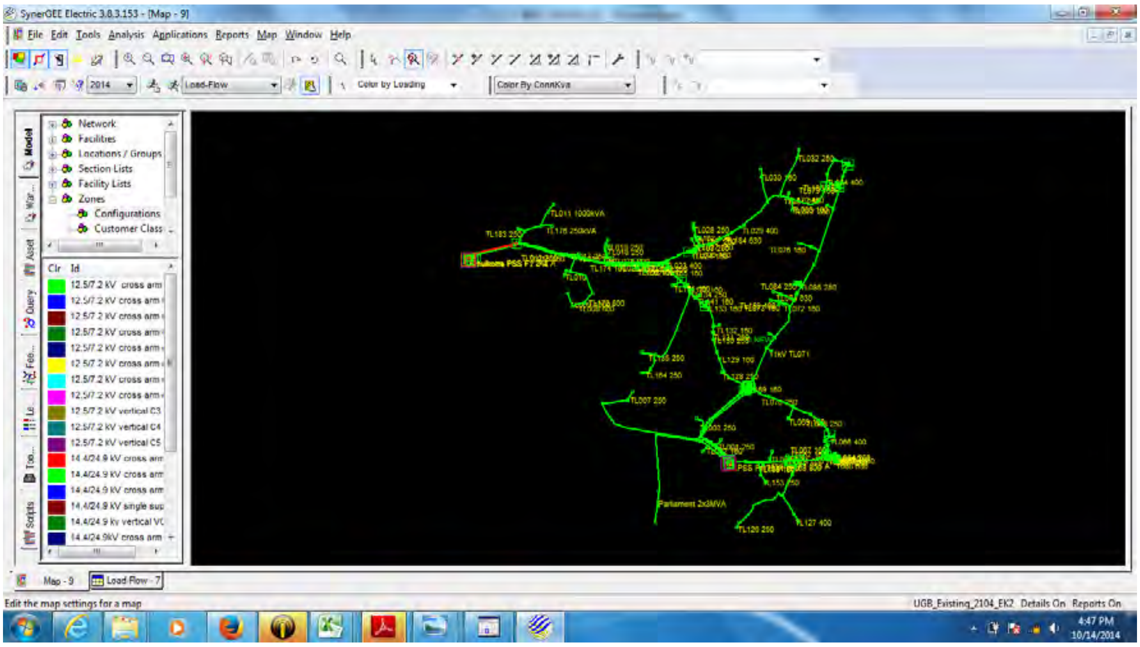
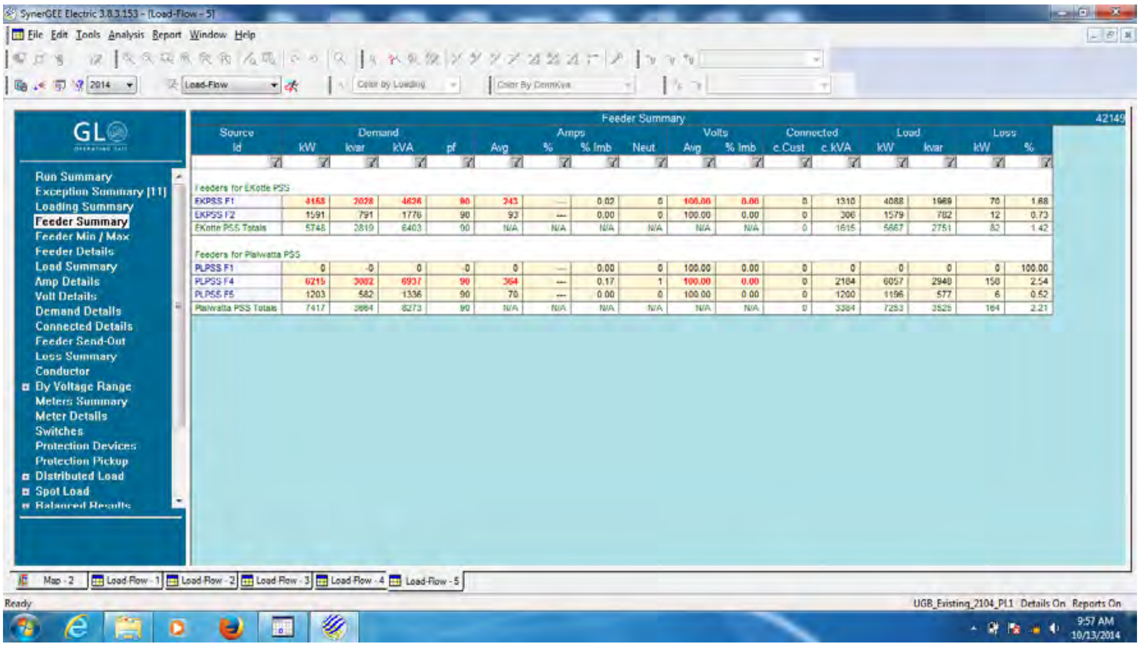


Figure 3-21 MV feeder failure occurs at EKPSS F2

- When MV feeder failure occurs at PLPSS F1, PLPSS F4 and EKPSS F1 will be overloaded.



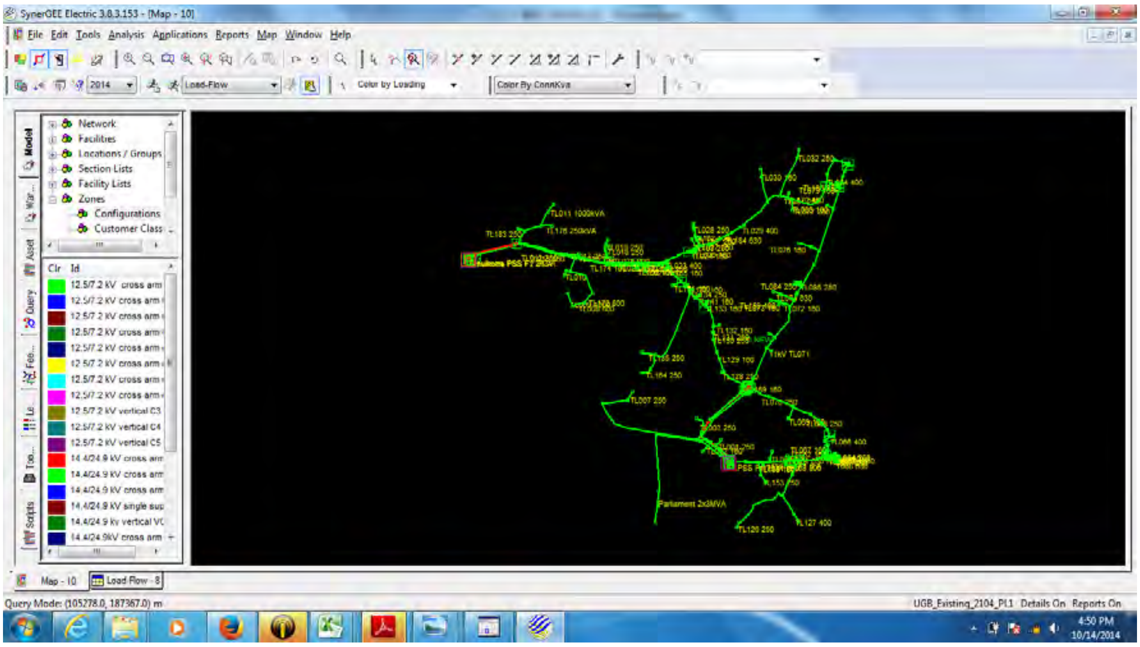
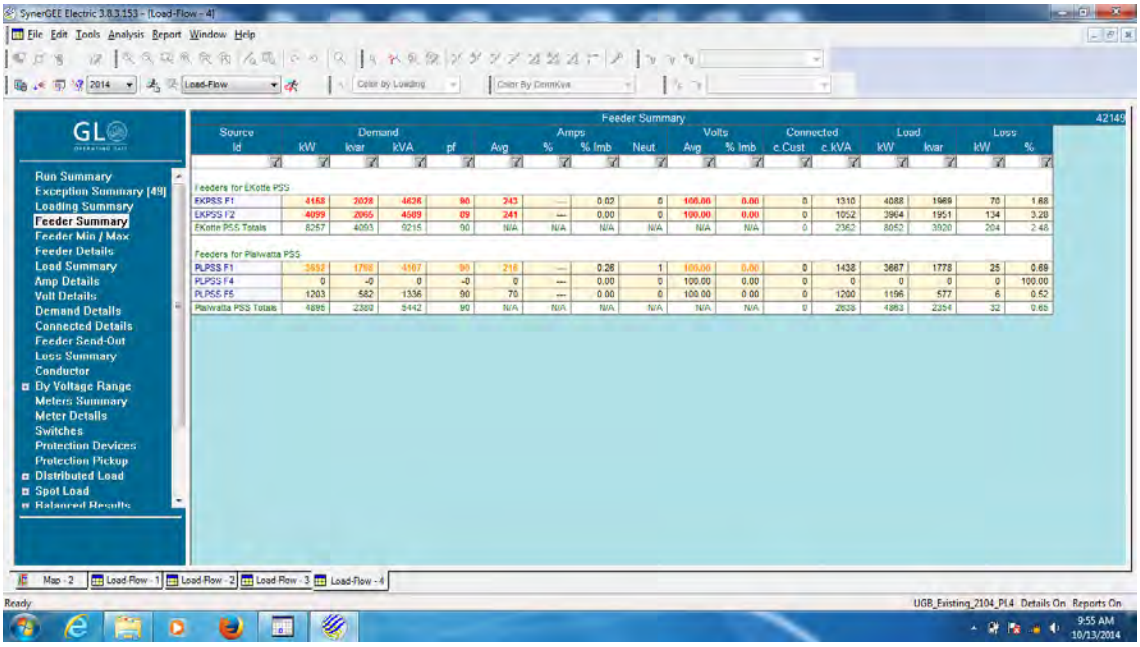


Figure 3-22 MV feeder failure occurs at PLPSS F1

- When MV feeder failure occurs at PLPSS F4, EKPSS F1 and EKPSS F2 will be overloaded, and PLPSS F1 will be marginally overloaded.



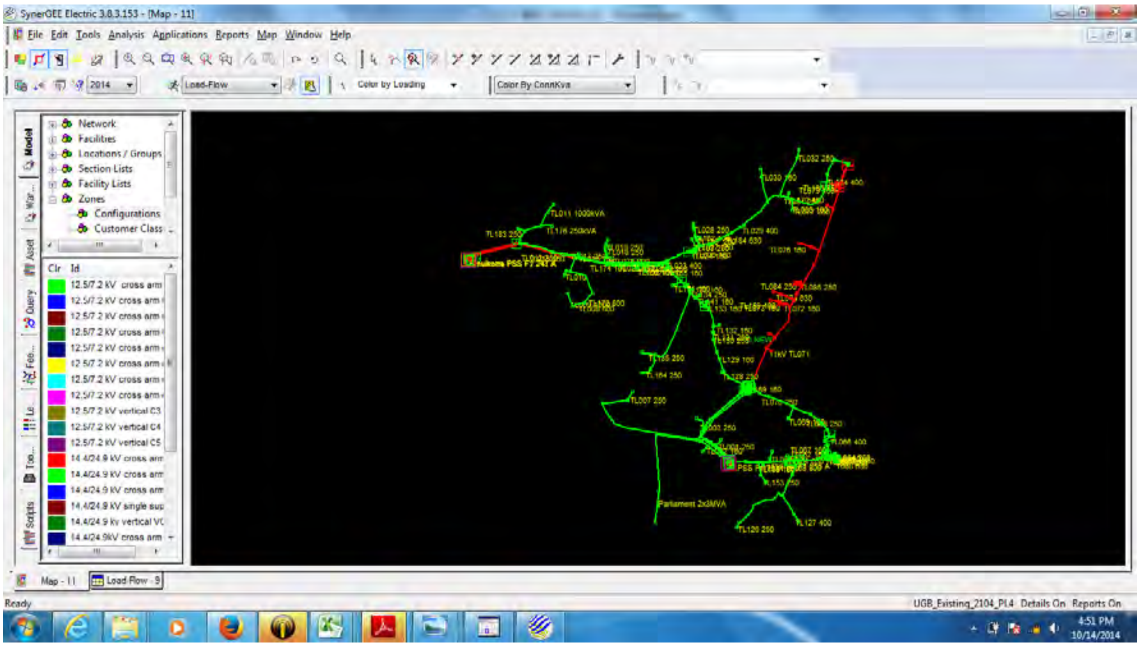


Figure 3-23 MV feeder failure occurs at PLPSS F4

3.2.9.5.2. Confirmation for the substation capacity and the feeder capacity

These confirmations were carried out by the same method as project 8. After having carried out a project, up to 2024, the supply difficulty also does not exists as same as project 8. The confirmation results of all related project shown below.

a) GSS

- Sri J'Pura GSS

The existing 33 kV OH distribution line power are supplied by 4 (four) GSS. Sri J'Pura GSS will supply power for the project planned area after implemented project. Therefore JICA survey team report only capacity of Sri J'Pura GSS.

Sri J'Pura GSS is supplying power for all of the project 9 implementation area.

Table 3-26 Sri J'Pura GSS total Tr capacity and demand planning

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Tr Capacity (MVA)	63	63	94.5	94.5	94.5	94.5	94.5	94.5	94.5	94.5	94.5
Demand (MVA)	43.5	49	57.8	60.7	58	53	46.7	44.8	46.4	48.1	49.8

There are 132 kV/ 33 kV 31.5 MVA x 2 transformers. CEB has planned an augmentation of 31.5MVA x 1 transformer in 2016(out of the JICA projects scope).

Table 3-27 Sri J'Pura GSS Feeders demand Planning

		Maximum Demand Planning (A)										
feeder	OCR	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
To Ethul Kotte PSS	392	112	116	120	36	36.7	37.3	38	39	39.6	40.7	41.5
To Pelawatta PSS	392	143	148	153	144	147	150	153	155	159	162	165
To Koswatta PSS*	392	N/A	N/A	N/A	159	162	165	169	172	175	179	183

*Feeder To Koswatta PSS: CEB will use this feeder after the implementio0n of JICA project.

b) PSS

- Ethulkotte PSS

Ethulkotte PSS is located next to the CEB DD3 headquarters site, and is supplying power for West side of the project implementation area.

Table 3-28 Ethulkotte PSS total Tr capacity and demand planning

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total Tr Capacity (MVA)	20	20	20	20	20	20	20	20	20	20	20
Maximum Demand (MVA)	6.4	6.6	6.9	2.1	2.1	2.1	2.2	2.2	2.3	2.3	2.4

Ethulkotte PSS installs 33 kV/ 11 kV 10.0 MVA x 2 transformers.

Table 3-29 Ethulkotte PSS feeders demand planning

		Maximum Demand(A)										
feeder	OCR	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
EKPSS ER1	392	N/A	N/A	N/A	108	110	112	114	117	119	122	124

- Pelawatta PSS

Pelawatta is located next to the Sri J'Pura GSS, supplying power for south side of the project implementation area.

Table 3-30 Pelawatta PSS total Tr capacity and demand planning

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total Tr Capacity (MVA)	10	10	10	20	20	20	20	20	20	20	20
Maximum Demand (MVA)	8.1	8.4	8.7	8.4	8.5	8.7	8.9	9.1	9.2	9.4	9.6

Pelawatta PSS installs 33 kV/ 11 kV 5.0 MVA x 2 transformers. CEB will augment the existing transformers to 10 MVA x 2 Transformers under the JICA project.

Table 3-31 Pelawatta PSS feeders demand planning

		Maximum Demand(A)										
feeder	OCR	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
PLPSS Dist PR1	228	N/A	N/A	N/A	41	41	42	43	44	45	46	47
PLPSS Dist PR3	228	N/A	N/A	N/A	89	91	93	95	96	98	100	102
PLPSS PR2	450	N/A	N/A	N/A	67	68	70	71	73	74	76	77
PLPSS PR3	392	N/A	N/A	N/A	157	161	164	167	170	174	177	181
PLPSS Dist PR1	228	N/A	N/A	N/A	41	41	42	43	44	45	46	47

- Koswatta PSS (proposed)

Koswatta PSS will be constructed in center of the project implementation area under the JICA project.

Table 3-32 Koswatta PSS total Tr capacity and demand planning

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total Tr Capacity (MVA)	N/A	N/A	N/A	20	20	20	20	20	20	20	20
Maximum Demand (MVA)	N/A	N/A	N/A	9.4	9.6	9.7	9.9	10.1	10.3	10.6	10.8

Koswatta PSS will have 33 kV/ 11 kV 10.0 MVA x 2 transformers.

Table 3-33 Ethulkotte PSS feeders demand planning

		Maximum Demand(A)										
feeder	OCR	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
KSPSS Dist PR1	228	N/A	N/A	N/A	13	13	13	14	14	14	15	15
KSPSS KR1	392	N/A	N/A	N/A	160	163	166	170	173	176	180	184
KSPSS KR2	392	N/A	N/A	N/A	39	40	40	41	42	43	44	45
KSPSS KR3	392	N/A	N/A	N/A	143	146	149	152	155	158	161	165
KSPSS PR1	450	N/A	N/A	N/A	121	124	126	129	131	134	137	139

c) RSS

- ER1 RSS (Proposed)

ER 1 RSS will be constructed under this project, to receive power from Ethulkotte PSS by using the new 11 kV UG trunk line, 2 (two) circuits connected to ES1 itself by the loop circuit, and two circuits connected to the KE1 by another two distribution feeder.

Table 3-34 ER1 RSS feeders demand planning

		Maximum Demand (A)										
feeder	OCR	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
ER1-ER1 Sat (outgoing)	228	N/A	N/A	N/A	50	51	52	53	54	55	56	58
ER1-ER1 Sat (incoming)	228	N/A	N/A	N/A	0	0	0	0	0	0	0	0
ER1-KR1 Sat1	228	N/A	N/A	N/A	12	12	12	12	13	13	13	13
ER1-KR1 Sat2	392	N/A	N/A	N/A	46	47	48	49	50	51	52	53

- PR1 RSS (Proposed)

PR1 RSS will be constructed under this project, to receive power from Koswatta PSS by using the new 11 kV UG trunk line, 4 (four) circuits connected to distribution feeder for Koswatta PSS, KR1 RSS, Pelawatta PSS and PR2 RSS.

Table 3-35 PR1 RSS feeders demand planning

		Maximum Demand (A)										
feeder No.	OCR	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
KR1-PR1 Sat	228	N/A	N/A	N/A	7	7	8	8	8	8	8	8
KSPSS Dist PR1	228	N/A	N/A	N/A	0	0	0	0	0	0	0	0
PR1-PR2 Sat	392	N/A	N/A	N/A	114	116	119	121	124	126	129	131
PLPSS Dist PR1	228	N/A	N/A	N/A	0	0	0	0	0	0	0	0

- PR2 RSS (Proposed)

PR2 RSS will be constructed under this project, to receive power from Pelawatta PSS by using the new 11 kV UG trunk line, 2 (two) circuits connected to distribution feeder for PR1 RSS, KR2 RSS, and 2 (two) circuits connected to the PR3 by another 2 (two) distribution feeders.

Table 3-36 PR2 RSS feeders demand planning

z		Maximum Demand (A)										
feeder No.	OCR	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
PR2-PR3 Sat1	228	N/A	N/A	N/A	30	30	31	31	32	33	33	34
KR3-PR2 Sat	228	N/A	N/A	N/A	0	0	0	0	0	0	0	0
PR1-PR2 Sat	392	N/A	N/A	N/A	24	30	30	31	32	32	33	34
PR2-PR3 Sat2	228	N/A	N/A	N/A	9	9	9	9	9	9	10	10

- PR3 RSS (Proposed)

PR3 RSS will be constructed under this project, to receive power from Pelawatta PSS by using the new 11 kV UG trunk line, 1 (one) circuits connected to distribution feeder for Pelawatta PSS, and 2 (two) circuits connected to the PR2 by another 2 (two) distribution feeders.

Table 3-37 PR3 RSS feeders demand planning

		Maximum Demand (A)										
feeder No.	OCR	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
PR2-PR3 Sat2	228	N/A	N/A	N/A	21	21	22	22	23	23	24	24
PR2-PR3 Sat1	228	N/A	N/A	N/A	104	106	108	111	113	115	117	120
PR3 Spur	228	N/A	N/A	N/A	33	33	34	35	35	36	37	37
PLPSS Dist PR3	228	N/A	N/A	N/A	158	161	164	167	171	174	178	181

- KR1 RSS (Proposed)

KR1 RSS will be constructed under this project, receive power from Koswatta PSS by using the new 11 kV UG trunk line, 2 (two) circuits connected to distribution feeder for KR2, PR1, 2 (two) circuits connected to the 2 (two) spur distribution feeder, and 2 (two) circuits connected to the ER1 by another two distribution feeders.

Table 3-38 ER1 feeders demand planning

		Maximum Demand (A)										
feeder No.	OCR	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
KR1 Spur2	228	N/A	N/A	N/A	27	28	28	29	30	30	31	31
KR1-KR2 Sat	228	N/A	N/A	N/A	49	50	51	52	53	54	55	56
ER1-KR1 Sat2	392	N/A	N/A	N/A	34	34	35	36	37	37	38	39
KR1-PR1 Sat	392	N/A	N/A	N/A	0	0	0	0	0	0	0	0
ER1-KR1 Sat1	228	N/A	N/A	N/A	20	20	21	21	21	22	22	23
KR1 Spur1	228	N/A	N/A	N/A	31	31	32	33	33	34	35	35

- KR2 RSS (Proposed)

KR2 RSS will be constructed under this project, and connect to the new 11 kV UG trunk line from Kalubowila PSS, 2 (two) circuits connected to distribution feeder for KR1 and KR3.

Table 3-39 KR2 RSS feeders demand planning

		Maximum Demand (A)										
feeder No.	OCR	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
KR1-KR2 Sat	228	N/A	N/A	N/A	21	22	22	23	23	23	24	24
KR3-KR2 Sat	228	N/A	N/A	N/A	18	18	18	19	19	20	20	20

- KR3 RSS (Proposed)

KR3 RSS will be constructed under this project, and connect to the new 11 kV UG trunk line from Kalubowila PSS, 2 (two) circuits connected to distribution feeder for PR2 and KR2.

Table 3-40 KR3 RSS feeders demand planning

		Maximum Demand (A)										
feeder No.	OCR	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
KR2-KR3 Sat	228	N/A	N/A	N/A	12	12	12	13	13	13	13	14
KR3-PR2 Sat	228	N/A	N/A	N/A	127	129	132	134	137	140	143	146

3.2.9.5.3. Contingency analysis after implemented project

Contingency analysis is carried out as same method as project 8. Simulation result table shows that after implemented the project, even if one feeder is shut down in 2024, supply power is still possible from other routes

Table 3-41 Contingency Analysis in 2024 after implemented of the Project 9

Feeder Section	Load Flow at Normal Condition	Contingency Analysis (A) in 2024						
		Load flow at a failure of incoming to ER1	Load flow at a failure of incoming to KR1	Load flow at a failure of incoming to KR2	Load flow at a failure of incoming to KR3	Load flow at a failure of incoming to PR1	Load flow at a failure of incoming to PR2	Load flow at a failure of incoming to PR3
EKPSS ER1	210.5	0.0	534.8	210.5	210.5	210.5	210.5	210.5
EKPSS Total	210.5	0.0	534.8	210.5	210.5	210.5	210.5	210.5
KSPSS Dist PR1	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0
KSPSS KR1	322.3	537.9	0.0	322.3	322.3	322.3	322.3	322.3
KSPSS KR2	78.3	78.3	78.3	0.0	78.3	78.3	78.3	78.3
KSPSS KR3	289.0	289.0	289.0	367.9	0.0	289.0	289.0	289.0
KSPSS PR1	244.5	244.5	244.5	244.5	244.5	0.0	381.5	244.5
KSPSS Total	959.7	1126.5	637.7	960.6	671.0	715.5	1097.0	960.0
PLPSS Dist PR1	81.9	81.9	81.9	81.9	81.9	81.9	81.9	81.9
PLPSS Dist PR3	173.7	173.7	173.7	173.7	173.7	173.7	173.7	173.7
PLPSS PAR	148.5	148.5	148.5	148.5	148.5	148.5	148.5	148.5
PLPSS PR2	135.5	135.5	135.5	135.5	433.4	380.3	0.0	465.0
PLPSS PR3	317.5	317.5	317.5	317.5	317.5	317.5	317.5	0.0
PLPSS Total	856.8	856.8	856.8	856.8	1155.0	1101.9	721.6	869.2

Only one 33kV UG cable line from J'Pura GSS to Koswatta PSS will be installed under JICA project, and this feeder supplies power to Koswatta PSS. But there is the existing 33 kV OH line from Makabe GSS near the proposed Koswatta PSS. The primary side of Koswatta PSS will be connected to this 33kV OH line (out of JICA project scope).

J'Pura GSS supplies power to Koswatta PSS in normal operation. If a fault occurs in the 33 kV UG cable, CEB have energized Koswatta PSS via alternative route (OH 33 kV Lynx) from Malabe GSS. Therefore in such a case, the power supply from Koswatta PSS is still possible.

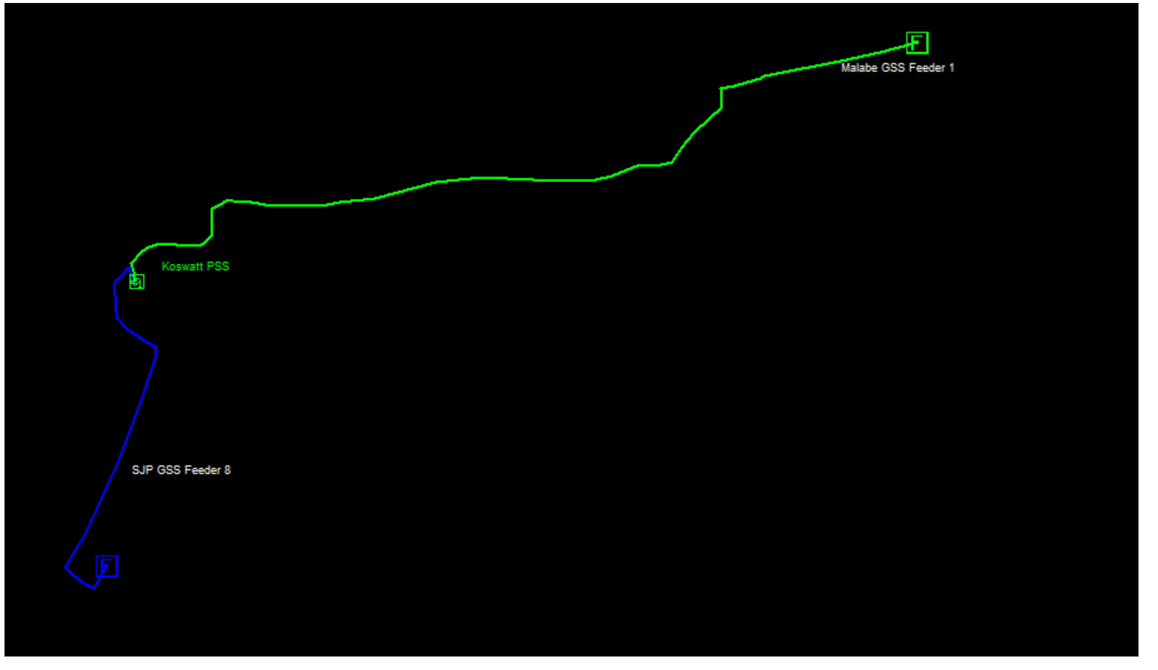


Figure 3-24 Single line diagram of Koswatta PSS primary (33 kV) side

Chapter 4 Project Packaging and Conditions of Contract

4.1. Project Packaging

JICA survey team confirmed CEB about project package that CEB considers to apply for this project at the moment. As result, it is clarified that CEB proposes the following project packages for this project:

1) Package 1: Construction of Transmission Lines

   a) Construction of 1xLL-ACSR Zebra equivalent (Zebra-eq), 132kV, 10km, double circuit transmission line between Kirindiwela and Kosgama substations.

   b) Construction of 2xZebra, 132kV, 28km, double circuit transmission line between Thulhiriya and Veyangoda substations.

   c) Construction of 2xLL-ACSR Zebra-eq, 220kV, 17.5km, double circuit transmission line between Veyangoda and Kirindiwela substations.

   d) Construction of 2x Zebra, 220kV double in & out connection from Biyagama – Kotmale 220kV Transmission Line to connect Kirindiwela 220/132kV substation.

   e) Construction of 4x Zebra., 400kV, 20km, double circuit transmission line between Kirindiwela and Padukka substation

   f) Reconstruction of LL-ACSR Zebra-eq, 132kV, 12.9km, double circuit transmission line between Kolonnawa and Pannipitiya substations.

   g) Removal of the existing Lynx, 132kV, 12.9km, double circuit transmission line between Kolonnawa and Pannipitiya substations.

   h) Reconstruction of LL-ACSR Zebra-eq, 132kV, 7km, double circuit transmission line between Pannipitiya and Ratmalana substations.

   i) Removal of the existing Lynx, 132kV, 7km, double circuit transmission line between Pannipitiya and Ratmalana substations.

   j) Supply of O&M tools as live tools (bare hand, including sticks)

2) Package 2: Construction Substations

   a) Construction of Kirindiwela 220/132kV SS (2x150MVA, transformers, 220kV double bus bar arrangement including bus coupler, 132kV double bus bar arrangement including bus coupler, two 220kV double bus bar transformer bays, eight 220kV double bus bar transmission line bays, two 132kV double bus bar transformer bays, two 132kV double bus bar transmission line bays)

b) Construction of Kirindiwela 220/33kV GS (2x45MVA, transformers, two 220kV double bus bar transformer bays, two 33kV single bus bar transformer bays, twelve 33kV feeder bays, 33kV single bus bar arrangement including bus section)

c) Modification of existing 220kV protection and control facilities at Biyagama and Kotmale GS.

d) Augmentation of Veyangoda GS (two 220kV double bus bar transmission line bays)

e) Augmentation of Padukka GS (two 220kV double bus bar transmission line bays)

f) Augmentation of Kosgama GS (two 132kV single bus bar transmission line bays, 132kV bus section bay, 132kV circuit breaker and isolator replacements for existing bays, 33kV single bus bar arrangement including bus section, 33kV isolator replacements for existing bays, automatic voltage regulator replacements for transformers and installation of dc battery system)

g) Augmentation of Seethawaka GS (one 132kV bus section bay)

h) Equipment replacement of Thulhiriya existing two 132kV Lynx single bus bar transmission line bays

i) Augmentation of Kotmale Substation (two 220kV one-and-half breaker system line bays)

j) Construction of Battaramulla 132/33kV GS (two 31.5MVA, 132/33kV transformers, two 132kV indoor single bus bar transformer bays, four 132kV indoor single bus bar transmission line bays one 132kV bus section with single bus bar arrangement, two 33kV indoor bus section bays with single bus bar arrangement)

k) Double In & Out Connection from Kolonnawa – Athurugiriya 132kV transmission line to connect Battaramulla GS (2x Zebra, 132kV, 0.4km, double circuit)

l) Modification of existing 132kV protection and control facilities at Kolonnawa and Athurugiriya GSs

m) Augmentation of Ratmalana GS (replacement of 132kV pneumatic circuit breakers of one line bay and two transformer bays, replacement of all 132kV isolators with remote control facility, replacement of all 132kV control and protection panels of all bays, replacement/installation of 33kV outgoing line isolators at all gantries, complete rehabilitation of control room building, replacement of both AC and DC auxiliary panels, installation of ATS panel with a Stand by generator, installation of bay controllers for all 33kV feeders, provide a SAS for the grid substation)

n) Augmentation of Pannipitiya GS (Replacement of all 132kV pneumatic air circuit breakers, replacement of all 132kV control and protection panels, replacement of all 132kV voltage transformers, replacement of SAS system)

o) Supply of vehicles and O&M equipment (one 10 Ton Lorry, three Online oil filtering plants, three Secondary injection sets, three Primary injection sets, three Dissolve gas analyzer,)

3) Package 3: Construction of Transmission Lines

a) Reconstruction of 1xLL ACSR550, 132kV, 164km, double circuit transmission line between Polpitiya-Kiribathkumbura- Ukuwela-Naula- New Habarana GS and removal of the existing 132kV transmission line between Polpitiya-Kiribathkumbura-Ukuwela-Naula- New Habarana GS

b) Construction of 2xLL ACSR550, 220kV, 23km, double circuit transmission line between Kothmale and New Polpitiya GS

4) Package 4: Construction of Distribution Cables

a) Underground electricity distribution development project in Dehiwala, Mount Lavinia Area

b) Underground electricity distribution development project in Battaramulla Area

CEB explained that the above packaging for transmission line, substations and distribution are made in view of their project implement practice so far i.e. division of transmission, substation and distribution facility, and also consider geographical location the project sites i.e. Colombo suburbs & mid zone and central zone. Those packaging is generally acceptable.

CEB also proposed another one package for the specialized vehicles. However quantity and kind of the vehicles requested by CEB is small, and, therefore, the scope of those vehicles are incorporated in the Package 1 and package 2 respectively.

4.2. Conditions of Contract

The conditions of contract will be FIDIC Yellow Book (1999), “Plant and Design-Built Contract”.

Chapter 5 Project Implementation Schedule

This project is categorized as a project which requires special cares for safety measures during construction work since this project includes work at high place because of transmission lines. The Consultant will, therefore, be selected as per QBS scheme as per JICA Guideline for Evaluation Procedure for Procurement of Consultant. Accordingly evaluation of the Consultant will be made for technical proposal, and the contract price will be finalized by negotiation with the highest (first) evaluated consultant.

On the other hand, the selection of the Contractor will be made as per Single Stage Two Envelop method, and therefore evaluation will be made in two stages, i.e. one is for technical proposal and another is for financial proposal.

JICA survey team reviewed the previous project implementation schedule and also other aspects which may impact the implementation schedule.

5.1. Review of the previous project implementation schedule

At initial survey stage, Power system analysis is thought be required for firming up design parameters prior to design of transmission system when a new higher system voltage i.e. 400kV is introduced for the first time like Sri Lanka. It is, however, revealed that the power system analysis and design of 400kV transmission system have almost been prepared by CEB.

Therefore, no additional time period for the power system analysis required for firming up design parameters and fundamental design of 400kV transmission system is considered.

As a result the same period as the pervious project implementation schedule prepared by JICA in February 2014 is, therefore, applicable as a standard schedule, according to which (1) Tender/ selection period is 15 months and (2) Construction period is 24 months.

Therefore, for this project (the 45th Japanese Yen portion) the same project implementation period ((1) Tender/ selection period is 15 months and (2) Construction period is 24 months) is considered. The consultant services finishes after 12 months of defect liability period/ warrantee period after commissioning.

5.2. Other aspects such as IEE and land acquisition, etc.

As for IEE report, according to CEB, the present status of the finalization of IEE report is as described in Sub-clause 3.1

Most of the IEE report has been submitted to Central Environmental Authority (CEA) by CEB.

Under the circumstances, those are expected to be commented and finalized in 3 to 4 months by CEA.

As for land acquisition, according to CEB, the land acquisition of project sites will be done by CEB's Project Management Unit (PMU), and PMU is schedule to be established in November 2014.

Accordingly those aspects seems not have impact on the project implementation schedule.

5.3. Other aspects such as consultant services for the 46th Japanese Yen Loan Project

JICA intends to include the design service (design, preparation of tender document, evaluation of tender etc.) of 400kV New Habarana – Sampoor TL project (the 46th Japanese Yen Loan) into the consultant services of this project.

As stated in Sub-clause 5.1 above, the condition that design parameters and fundamental design of 400kV transmission system have almost been prepared by CEB. Accordingly, for the implementation of design of the 400kV New Habarana – Sampoor TL project (the 46th Japanese Yen Loan), the same period as the 45th Japanese Yen Loan Project being15 months for design is allocated.

Chapter 6 Operation & Maintenance Capability for 400kV TL

6.1. Existing Operation and Maintenance system for 220kV and 132kV T/L

The existing system of maintenance for 220kV and 132kV T/L is shown below. There are two maintenance groups that maintain T/L. The group directly managed by DGM (Deputy General Manager) and doesn't have chief engineer. The one group managed by Electrical Engineer (EE-1) covers south area (Colombo and Galle area) and the other (EE-2) covers north area (Anuradhapura and Kandy area). One group has now five maintenance teams headed by ES (Electrical Superintendent) that consist of ten to fifteen members. CEB calls this team 'Gang'. T/L maintenance is covered by these ten teams now. In case of having much work to be done, number of team will be increased.

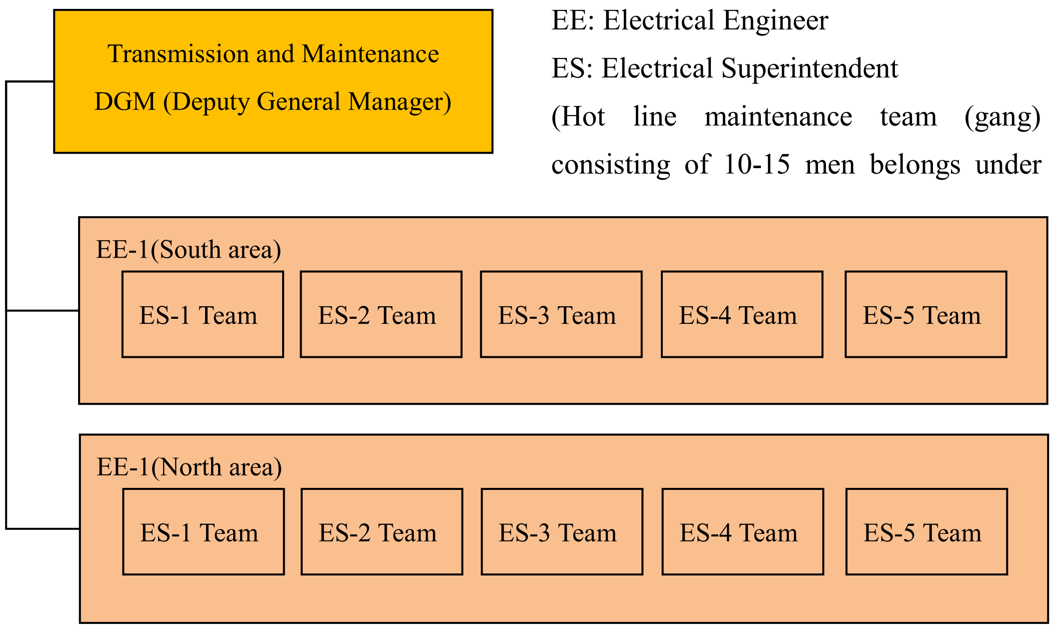


Figure 6-1 Existing O&M System for 220kV and 132kV T/L

Figure 6-2 Office of D.G.M (O&M)' Building

6.2. Operation and Maintenance for 400kV T/L

CEB plan to maintain 400kV T/L by the same system. It is adequate and efficient to maintain T/L because almost all 400kV T/L maintenance is same as 220kV. The 400kV T/L uses the same tower structure, members, conductor and insulator. Differences from 220kV are tower size, clearance and newly introduced 4 bundle conductor but they don't make change in maintenance significantly. CEB have enough experience and knowledge about fixing towers or conductors.

But hot line maintenance technique may be different because clearance from tower to conductor is very long and equipments (insulators, conductors) are heavier than 220kV T/L, and also line voltage is higher than the existings. So they have to use another tools and safe management. Then training of 400kV hot line maintenance technique from well-experienced other country before installation of 400kV T/L is required.

6.3. Maintenance tools and method for T/L

CEB maintains T/L at hot line. Maintenance technique on hot line is learned from Australia and other Europe country. All tools come from these countries too.

Hot line tool has enough length to maintain 220kV. The length of tools (rods) depends not on dielectric strength but on clearance from tower to conductor.

CEB says that their teams (gangs) are well educated for hot line maintenance so there is no electrification accident.

Other tools are normal tool and they can be used every voltage (They don't depend on voltage). CEB has conductor riding equipment for single conductor and twin conductor.

Figure 6-3 Stick Tool for hot line (Dielectric strength is 100kV/feet. According to product catalog, minimum length to keep safety is 1.09m for 132kV and 1.59m for 220kV and CEB keeps this length when they use this tool.)

Figure 6-4 Stick Tool for hot line (When they change insulator, they connect attachment to stick tool like this)

Figure 6-5 Clamp commpressor

Figure 6-6 Conductor Rider (left: for single right: for double)

6.4. Operation and Maintenance for LL-ACSR

Operation system will not change. All tools including hot line tools can be used for LL-ACSR because the size of conductor is same as conventional Zebra.

In case of accident, preparation of some repair parts like sleeve, repair-sleeve, dead-end-clump and conductor for LL-ACSR are recommended because LL-ACSR is not normal conductor so manufacturer may not have stocks.

Chapter 7 Bill of Quantity and Cost Estimate

7.1. Condition of calculation

Conditions of calculation are follows:

- Base year for cost estimation: 2014/8
- Exchange rate:
  US$1.00 = JP Yen 107.1
  US$1.00 = LKR 130.2
  LKR 1.00 = JP Yen 0.823
- Price escalation rate
  Annual average of foreign currency: 2.0%
  Annual average of local currency: 3.8%
- Physical contingency
  Construction: 5.0%
  Consultant: 5.0%
- Administration cost
  (Base cost + Price escalation + contingency) x 1% source CEB
- Compensation and Land acquisition cost
- (Base cost + Price escalation + contingency) x 3% source CEB

7.2. Bill of Quantity and Cost Estimate in Subproject-wise

Estimated construction cost in Subproject-wise is shown in Table 7-1. Detailed construction cost in Subproject-wise is described in Appendix 12.

Table 7-1 Estimated Construction Cost in Subproject-wise

Subproject	FC (JPY)	LC (LKR)	Total (JPY)
Subproject 1 Inc. vehicles and equipment	5,954,711,165	1,494,640,000	7,184,799,885
Subproject 2	734,840,240	405,810,000	1,068,821,870
Subproject 3	1,225,670,856	263,086,000	1,442,190,634
Subproject 4	248,989,221	177,762,000	395,287,347
Subproject 5	644,633,022	159,410,000	775,827,452
Subproject 6	1,012,577,730	421,580,000	1,359,538,070
Subproject 7	3,209,830,890	1,909,030,000	4,780,962,580
Subproject 8	1,184,203,961	302,470,000	1,433,136,771
Subproject 9	1,378,353,436	542,310,416	1,824,674,908
Total	15,593,810,520	5,676,098,416	20,265,239,517

7.3. Bill of Quantity and Cost Estimate in Package-wise

Estimated construction cost in Package-wise is shown in Table 7-2. Detailed construction cost in Package-wise is described in Appendix 13.

Table 7-2 Estimated Construction Cost in Package-wise

Package	Related Project	FC (JPY)	LC (LKR)	Total (JPY)
Package 1	Transmission lines of Subproject 1 - 5 Inc. equipment for T/L	4,143,594,338	1,611,072,000	5,469,506,594
Package 2	Substations of Subproject 1 - 7 Inc. vehicles and equipment for SS	5,222,143,446	913,796,000	5,974,197,554
Package 3	Transmission lines of Subproject 6 - 7	4,092,943,540	2,306,450,000	5,991,151,890
Package 4	Distribution (Subproject 8, 9)	2,562,557,396	844,780,416	3,257,811,679
Total		16,021,238,720	5,676,098,416	20,692,667,717

7.4. Cost Estimate for Consulting Services

The estimated cost for the consulting services is shown in Table 7-3. Detailed cost for the consulting services is described in Appendix 9.

The following cost covers both for 45th and 46th Japanese Yen Loan.

Table 7-3 Estimated Construction Cost in Package-wise

Item	FC (JPY)	LC (LKR)	Total (JPY)
Remuneration	1,314,100	480,283	1,709,373
Direct Cost	302,620	367,645	605,192
Total	1,616,720	847,928	2,314,565

The consultant services Man-Month schedule is prepared taking into account the followings:

1) The project area is widely spread over the country,
2) The total length of 400, 220 and 132kV transmission lines are long i.e. more than 285km with 13 sections with removal of some of them,
3) The total number of 220 and 132kV substations under the scope is 16 numbers,
4) The period of design stage to contract sign is limited to be 15 months,
5) The period of construction supervision is limited to be 24 months,
6) Engineers and experts are nominated referring to the existing CEB project (Greater Colombo Transmission & Distribution Project).

To consider the project size, project area and project schedule, these consultant services Man-Month schedule is necessary and justified.

Chapter 8 Calculation of Loss Reduction

8.1. Calculation of LL-ACSR Loss Reduction

8.1.1. Condition of calculation

Conditions of calculation are as follows:

Power factor: 0.9

Load factor: 0.631

Conductor resistance: ACSR Zebra 0.0841 Ohm/km at 63deg.C

LL-ACSR Zebra-eq 0.0621 Ohm/km at 61deg.C

8.1.2. Result of calculation

As a result of the cost comparison (refer to Appendix 3), Low-Loss type conductor shall be applied for some projects. In case the LL-ACSR being installed in each project, Loss reduction is estimated as shown in Table 8-1.

Table 8-1 Loss Reduction of LL-ACSR

Transmission Line	Line Length (km)	Peak Load in 2019	Annual Loss Savings (MWh/cct)
Project 1: 220kV Veyangoda – Kirindwela TL (double)	17.5	140.5	18.9
Project 1: 132kV Kirindiwela – Kosgama TL (single)	10.0	42.6	9.7
Project 4: 132kV Kolonnawa – Sri J Pura TL (single)	6.0	68.4	24.9
Project 4: 132kV Sri J Pura – Panipitiya TL (single)	6.9	46.3	11.4
Project 5: 132kV Ratmalana – Panipitiya TL (single)	7.0	25.0	3.3
Project 6: 220kV Kothmale – New Polpitiya TL (double)	23.0	126.2	15.3
Project 7: 132kV Polpitiya – Nawalapitiya TL (single)	7.0	64.6	22.2
Project 7: 132kV Polpitiya – Moragolla TL (single)	16.5	24.8	3.3
Project 7: 132kV Nawalapitiya – Kiribathkumbura TL (single)	45.0	50.5	13.6
Project 7: 132kV Moragolla – Kiribathkumbura TL (single)	45.3	51.4	14.1
Project 7: 132kV Kiribathkumbura – Ukuwela TL (single)	30.0	28.7	4.4
Project 7: 132kV Ukuwela – Naula TL (single)	45.0	37.8	7.6
Project 7: 132kV Ukuwela – New Habarana TL (single)	80.0	49.5	13.1
Project 7: 132kV Naula – Habarana TL (single)	34.0	65.5	22.9

8.2. Calculation of Distribution Loss Reduction

Both Project 8 and Project 9, was evaluated by the value that was analyzed by the SynerGEE® to the value of the current flowing through the MV lines involved in the project distribution line loss. Calculates the operation rate of the transformer by using the total value of distribution transformer capacity and the feeder current value in the substation. The amount of decrease of the current due to distribution transformer operation that is connected to the MV power distribution line, each distribution transformer this value was calculated by the re-allocation.

Both Project 8 aria and Project 9 aria haven't been managing the LV line loss and the MV/ LV loss Both Project 8 aria and Project 9 aria haven't been managing the LV line loss and the MV/ LV loss currently. Therefore, the survey team has judged the exact loss evaluation of the MV/ LV DTs and the LV distribution lines are difficult.

The other hand, the loss of the MV line evaluation can be calculated relatively accurately. Therefore, it was decided carrying out the loss evaluation be executed only by the MV line.

It is to be noted that connected by New UG distribution lines between the RSS and the PSS that utilizes as distribution line of the existing (OH lines and UG line), PJ8 to perform load dividing. Therefore, the losses of MV / LV DTs and LV will not change after implemented project.

In Project 9 (DD3 area), The DD3 engineer calculated the LV line resistance value of the project implementation and after existing facilities resistance value, and was used for the approximate calculation of the LV loss values obtained by pro-rata the electric current value for each cross section wire. As a result, there are expected that the loss of new facilities to improve clearly from existing facilities (34.9% reduction). Ross of the transformer and the LV line will omit by this results.

The simulation results of MV distribution line loss reduction of the project implementation area are below.

-Project 8-

Table 8-2 Losses of the existing system without the project

year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Demand (MVA)	41.9	43.6	45.4	47.2	49.1	51.0	54.1	57.4	60.8	64.5	68.4
Peak Loss in MV distribution system (KW)	530	573	620	670	724	783	880	988	1110	1247	1401
Loss %	1.70	1.77	1.84	1.91	1.99	2.07	2.19	2.33	2.47	2.62	2.78

Table 8-3 Losses of the proposed system (after completing the UG project)

year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Demand (MVA)	41.9	43.6	45.4	47.2	49.1	51.0	54.1	57.4	60.8	64.5	68.4
Peak Loss in MV distribution system (KW)	419	445	489	529	571	618	693	778	874	981	1102
Loss %	1.19	1.22	1.28	1.33	1.39	1.44	1.53	1.62	1.72	1.82	1.93

Table 8-4 Effect of Loss reduction

year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Power Saving at peak time by UG project (kW)	111	128	131	141	153	165	187	210	236	266	299
Annual saving (MWh)	797	919	941	1,013	1,099	1,185	1,343	1,508	1,695	1,911	2,148
Energy loss reduction %	21	22	21	21	21	21	21	21	21	21	21
Expected Saving (LKR mil)	24	28	28	30	33	36	40	45	51	57	64

Expected load factor-82%

Expected highest generation cost-30.00 LKR/kWh

--Project 9 (DD3) Area--

Table 8-5 Losses of the existing system without the project

year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Demand (MVA)	14.5	15.1	15.6	20.1	20.5	20.9	21.4	21.8	22.3	22.7	23.2
Peak Loss in MV distribution system (kW)	129	138	147	220	229	239	248	258	269	280	291
Loss %	2.06	2.14	2.21	2.60	2.65	2.71	2.77	2.88	2.88	2.94	3.00

Table 8-6 Losses of the proposed system (after completing the UG project)

year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Demand (MVA)	15.0	15.5	16.1	19.8	20.2	20.5	21.0	21.4	21.8	22.3	22.8
Peak Loss in MV distribution system (KW)	24	26	26	42	69	45	47	48	51	53	55
Loss %	0.47	0.49	0.5	0.60	0.60	0.63	0.64	0.65	0.66	0.67	0.70

Table 8-7 Effect of Loss reduction

year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Power Saving at peak time by UG project (kW)	105	112	121	178	160	194	201	210	218	227	236
Annual saving (MWh)	552	589	636	936	841	1,020	1,056	1,104	1,146	1,191	1,240
Energy loss reduction %	81	81	82	81	70	81	81	81	81	81	81
Expected Saving (LKR mil)	10	10	11	17	15	18	19	20	20	21	22
Expected Saving (LKR mil)	16.56	17.66	19.08	28.07	25.23	30.59	31.69	33.11	34.37	35.74	37.21

Expected load factor-60%

Average Unit energy cost - 17.7 Rs/kWh (According to CEB statistical digest 2013)

Expected highest generation cost-30.00 LKR/kWh (Considering the generation unit cost of highest cost power plant in Sri Lanka)

With both projects area, reduction of the MV distribution line loss are expected after implemented the projects, and thereby contributing to the improvement of the EIRR.

Chapter 9 Calculation of Economic Internal Rate of Return (EIRR)

9.1. Item for Calculation of EIRR

As for item for calculation of EIRR, the following items are considered as capital outflow and cash inflow.

(For Capital Outflow)

- Capital expenditure
- O&M cost

(For Cash Inflow)

- Savings due to loss reduction (Transmission and distribution project)
- Benefit of unserved energy (distribution project)
- Benefit of avoided demand suppression (distribution project)

9.2. Detailed Calculation Condition in each Item

1) Capital Expenditure

Items for capital expenditure is considered as follows, and its cost is distributed from 2015 to 2019 based on the construction schedule,

- Base Cost for Construction including Physical Contingencies
- Administration Cost
- Base Cost for Engineering Services including Physical Contingencies
- Standard Conversion Factor: 0.9

2) O & M Cost

1.0% of total construction cost for transmission, substation and distribution project.

3) Revenue from savings due to loss reduction (transmission and substation projects)

Savings due to Loss Reduction is calculated based on the following formula, [Loss Revenue] = [Maximum Loss Reduction in each subproject] × [Operation Hours] × [Load Loss Factor] × [Standard Conversion Factor] × [Average Cost per Unit (at Selling Point)]

The followings show the other items;

- Operation Hours: 8760 hours per year
- Loss Load Factor: 0.445 (0.2 x 0.631 + 0.8 x 0.631^2) based on the CEB's information)
- Standard Conversion Factor: 0.9
- Average Cost per Unit (at Selling Point): 17.70 LKR/kWh

As for transmission and substation projects (Subproject 1 – 7), loss reduction volume is considered to increase in accordance with the square value of the demand growth, and the averaged demand growth in a recent ten-year period is 3.9%. On the other hand, the capacity of transmission and substation facilities is limited, and there is a possibility to change the system.

The duration of loss reduction volume in each Subproject is shown in Table 9-1 based on the above-mentioned condition.

Table 9-1 Duration of Loss Reduction Volume

Subproject	Duration
1	13 years
2	47 years
3	15 years
4	3 years
5	29 years
6	18 years
7	4 years

After reaching the maximum electricity loss reduction, it is assumed that the same amount of loss reduction is sustained up to the end of the project life which ends 30 years after the completion of each project.

As for distribution projects (Subproject 8 and 9), loss reduction volume in each year is referred to the calculation result performed by CEB.

4) Benefit of unserved energy (distribution project)

Benefit of unserved energy is calculated based on the following formula,

[Benefit] = [Improved SAIDI]/ [Operation Minutes] × [Energy Demand] × [Unserved Energy Unit Cost]

5) Benefit of avoided demand suppression (distribution project)

Benefit of avoided demand suppression is calculated based on the following formula,

[Benefit] = {[Future Demand] – [Existing Capacity]} × [Avoided Demand Suppression Unit Cost]

6) Project Life

Project life is considered to be 30 years.

9.3. Result of EIRR

Result of EIRR is shown in Table 9-2.

Table 9-2 Result of EIRR

Subproject	EIRR
1	2.60%
2	5.84%
3	-3.48%
4	4.98%
5	-4.72%
6	14.58%
7	0.21%
8	61.45%
9	43.66%
Total	18.97%

Chapter 10 Calculation of Greenhouse Generation Reduction

10.1. Methodology

As for transmission and substation system (Subproject 1-7), CO_2 reduction in each subproject is calculated as the following steps.

(Step 1) Power system analysis including all subprojects in 2019is carried out in 5 cases (TMNP, TMDP, HMNP, HMDP and OP), and total loss of whole system is calculated [Case A].

(Step 2) Power system analysis excluding one subproject in 2019 is carried out in 5 cases (TMNP, TMDP, HMNP, HMDP and OP), and total loss of whole system is calculated [Case B].

(Step 3) Difference of total loss of whole system in Case A and Case B is calculated in each subproject.

(Step 4) CO_2 reduction in each subproject is calculated by the following formula;

[CO_2 Reduction] = [Maximum Loss Reduction in each subproject] x [Operation Hours] x [Load Loss Factor (LLF)] x [CO_2 Emission Factor]

As for distribution system (Subproject 8-9), CO_2 reduction in each subproject is calculated as following steps by using the CEB's information.

(Step 1) Power system analysis calculated by SynerGEE® for existing MV distribution system in each subprojects in 2019 is carried out, and total loss of each subprojects is calculated [existing MV system].

(Step 2) Power system analysis calculated by SynerGEE® for proposed MV distribution system in each subprojects in 2019 is carried out, and total loss of each subprojects is calculated [proposed MV system]

(Step 3) Difference of total loss of each system in the existing MV system and the proposed MV system is calculated in each subproject.

(Step 4) Loss Load Factor (LLF) and 8760 hours are multiplied with the difference of total loss of whole system in each subproject.

10.2. Loss Reduction by Transmission and Substation in 2019 in each subproject

Maximum loss reduction (MW) by transmission and substation in 2019 in each subproject is shown in Table 10-1.

Table 10-1 Maximum Loss Reduction (MW) by TL and SS in 2019 in each subproject

Subproject	Maximum Loss Reduction	Condition of Power System Analysis
1	4.24 MW	TMNP
2	0.66 MW	TMDP
3	0.32 MW	HMDP
4	0.53 MW	TMNP
5	0.08 MW	TMNP
6	2.72 MW	TMNP
7	3.44 MW	TMNP

Based on the CEB's information, Load Factor (LF) is 0.631. Therefore, LLF is calculated as 0.445 (0.2 x 0.631 + 0.8 x 0.631^2). In addition, CO_2 emission factor of electricity in Sri Lanka is 0.6877 tCO_2/MWh by the attached information to JICA's Climate Finance Impact Tool for Mitigation. Therefore, CO_2 reduction by TL and SS in 2019 in each subproject is shown in Table 10-2.

Table 10-2 CO2 reduction by TL and SS in 2019 in each subproject

Subproject	CO2 reduction
1	11,367 tCO2
2	1,769 tCO2
3	858 tCO2
4	1,421 tCO2
5	214 tCO2
6	7,292 tCO2
7	9,222 tCO2

10.3. Loss Reduction by Distribution System in 2019 in each subproject

Yearly loss reduction (MWh) by MV distribution system in 2019 in each subproject is shown in Table 10-3.

Table 10-3 Maximum Loss Reduction (MWh) by MV Distribution system Loss in 2019 in each subproject

Subproject	Loss Reduction
8	1,185 MWh/ year
9	1,020 MWh/ year

Therefore, CO_2 reduction by distribution system in 2019 in each subproject is shown in Table 10-4.

Table 10-4 CO_2 reduction by MV Distribution system Loss in 2019 in each subproject

Subproject	CO_2 reduction
8	815 tCO_2
9	701 tCO_2

Chapter 11 Operation and Effect Indicator

11.1. Basic theory for the selection of Operation & Effect Indicators

Operation & Effect Indicators requested by JICA in the meeting for inception report are as follow;

- Transformer Availability Factor (%)
- Transmission Line Availability Factor (%)
- Reduction Volume of Transmission System Losses (%)
- Reduction Volume of Distribution System Losses (%)
- System average interruption duration index (SAIDI: Min/Year)

In order to appropriately express the situation of operation and effectiveness of the Project at the post evaluation stage, JICA study team takes into consideration the following points.

- Acquisition of data is easy. (It is data obtained via the processing of direct data obtained from the installed measuring instrument.)
- Data reliability is high. (Periodical proofreading should be performed in respect of the accuracy of the measuring instrument).
- Definition is clear. (There needs to be no room of an arbitrary element to enter, and even if who acquires, becomes the same value).

Continuous trend management is easy. (Verifying the effects is easy if especially the past data is available.)

11.2. Proposed Operation & Effect Indicators

In consideration of the above-mentioned points, JICA study team proposed the following Operation & Effect Indicators. In addition, target year is set 2 years after completion of the Project. Therefore, the results of system analysis in 2021 are applied.

- Transformer Availability Factor (%)
- Transmission Line Availability Factor (%)
- Reduction Volume of Transmission System Losses (%)
- Reduction Volume of Distribution System Losses for MV Level (%)

- System average interruption duration index (SAIDI: Min/Year)
- Installation capacity of transformers

Table 11-1 Operation and Effect Indicator proposed by JICA study team

Name	Policy and method of establishing the indicator	Target
Transformer Availability Factor (%)	Maximum load (MW) / {Rated capacity of the facility (MVA) x power factor}	Within the range that operation is possible. Estimated transformer availability factor is shown in Table 11-2.
Transmission Line Availability Factor (%)	Maximum load (MW) / {Rated capacity of the facility (MVA) x power factor}	Within the range that operation is possible. Estimated transformer availability factor is shown in Table 11-3.
Reduction Volume of Transmission System Losses (%)	{Electricity Supply (kWh) - electricity consumption in the substation (kWh) - receiving electric energy (kWh)}/ Electricity Supply (kWh)	Estimated reduction volume of transmission system loss is shown in Table 11-4. This volume is calculated by the following formula; {Maximum Sending Load (MW) – Maximum Receiving Load (MW)}/ Maximum Sending Load (MW) x Loss Load Factor
Reduction Volume of Distribution System Losses for MV Level (%)	Distribution system losses for MV Level (kWh) calculated by SynerGEE® (Tentative) (Adopted for supplying work)	Estimated reduction volume of Distribution system losses for MV level is shown in Table 11-5. This value is calculated by SynerGEE® using feeder wise actual maximum demand value on the each feeder at substations (Tentative).

System average interruption duration index (SAIDI: Min/Year)	Cumulative outage hours per year (minutes)/ Number of end-users (households) (Adopted for repair work)	Estimated reduction volume of SAIDI is shown in Table 11-6.
Installation capacity of transformers at the PSS	Total transformer capacity after implemented project (kW) - Total transformer capacity existing system (kW)	Increased total transformer capacity at the PSS of the project implemented area is shown in Table 11-7.

Table 11-2 Target for Transformer Availability Factor

Name of GS or SS	Target (2021)
220/132kV Tr. at Kirindiwela SS	29.2 %
220/33kV Tr. at Kirindiwela GS	50.6 %
132/33kV Tr. at Battaramulla GS	38.1 %

Table 11-3 Target for Transmission Line Availability Factor

Name of Transmission Line	Target (2021)
220kV Veyangoda - Kirindiwela TL	26.3 %
220kV Kirindiwela – Padukka TL	10.3 %
132kV Kirindiwela - Kosgama TL	30.2 %
132kV Thulhiriya - Veyangoda TL	15.2 %
132kV Kolonnawa – Sri J'Pura TL	26.4 %
132kV Sri J'Pura - Pannipitiya TL	13.6 %
132kV Pannipitiya - Ratmalana TL	16.0 %
220kV Kothmale – New Polpitiya TL	14.4 %
132kV Polpitiya - Nawalapitiya TL	63.4 %
132kV Polpitiya - Moragolla TL	45.3 %
132kV Nawalapitiya - Kiribathkumbura TL	58.8 %
132kV Moragolla - Kiribathkumbura TL	65.8 %
132kV Kiribathkumbura - Ukuwela TL	23.2 %
132kV Ukuwela - Naula TL	41.6 %
132kV Naula – New Habarana TL	53.5 %

Table 11-4 Target for Reduction volume of Transmission System Losses

Name of Transmission Line	Target (2021)
220kV Veyangoda - Kirindiwela TL	0.16 %
220kV Kirindiwela – Padukka TL	0.07 %
132kV Kirindiwela - Kosgama TL	0.20 %
132kV Thulhiriya - Veyangoda TL	0.28 %
132kV Kolonnawa – Sri J'Pura TL	0.12 %
132kV Sri J'Pura - Pannipitiya TL	0.34 %
132kV Pannipitiya - Ratmalana TL	0.10 %
220kV Kotmale – New Polpitiya TL	0.13 %
132kV Polpitiya - Nawalapitiya TL	0.59 %
132kV Polpitiya - Moragolla TL	0.44 %
132kV Nawalapitiya - Kiribathkumbura TL	1.50 %
132kV Moragolla - Kiribathkumbura TL	1.65 %
132kV Kiribathkumbura - Ukuwela TL	0.43 %
132kV Ukuwela - Naula TL	1.12 %
132kV Naula – New Habarana TL	1.15 %

Table 11-5 Target for Reduction volume of Distribution system losses for MV level

Project implementation area	Target (2021)
Dehiwala Mount Lavinia (Subproject 8)	1,508 MWh/ year
Battaramulla area (Subproject 9)	1,104 MWh/ year

Table 11-6 Target for Reduction volume of SAIDI

Project implementation area	Target (2021)
Dehiwala Mount Lavinia area (Subproject 8)	1,440 Min.
Battaramulla area (Subproject 9)	362 Min.

Table 11-7 Target for Increase capacity of Transformer at PSS

Project implementation area	Target (2021)
Dehiwala Mount Lavinia area (Subproject 8)	30 MVA
Battaramulla area (Subproject 9)	10 MVA

Appendix

Appendix 1

Power flow diagram

Figure A1-1	Power flow in 2017 on HMDP G/L scenario
Figure A1-2	Power flow in 2017 on TMDP G/L scenario
Figure A1-3	Power flow in 2017 on HMNP G/L scenario
Figure A1-4	Power flow in 2017 on TMNP G/L scenario
Figure A1-5	Power flow in 2017 on OP G/L scenario
Figure A1-6	Power flow in 2019 on HMDP G/L scenario
Figure A1-7	Power flow in 2019 on TMDP G/L scenario
Figure A1-8	Power flow in 2019 on HMNP G/L scenario
Figure A1-9	Power flow in 2019 on TMNP G/L scenario
Figure A1-10	Power flow in 2019 on OP G/L scenario
Figure A1-11	Power flow in 2021 on HMDP G/L scenario
Figure A1-12	Power flow in 2021 on TMDP G/L scenario
Figure A1-13	Power flow in 2021 on HMNP G/L scenario
Figure A1-14	Power flow in 2021 on TMNP G/L scenario
Figure A1-15	Power flow in 2021 on OP G/L scenario
Figure A1-16	Power flow without 220 kV Kirindiwela-Padukka T/L, under N-1 condition of 220 kV Biyagama-Pannipitiya T/L outage in 2019 on HMDP G/L scenario
Figure A1-17	Power flow without 220 kV Kirindiwela-Padukka T/L, under N-1 condition of 220 kV Biyagama-Pannipitiya T/L outage in 2019 on TMDP G/L scenario
Figure A1-18	Power flow without 220 kV Kirindiwela-Padukka T/L, under N-1 condition of 220 kV Biyagama-Pannipitiya T/L outage in 2019 on HMNP G/L scenario
Figure A1-19	Power flow without 220 kV Kirindiwela-Padukka T/L, under N-1 condition of 220 kV Biyagama-Pannipitiya T/L outage in 2019 on TMNP G/L scenario
Figure A1-20	Power flow without 220 kV Kirindiwela-Padukka T/L, under N-1 condition of 220 kV Biyagama-Pannipitiya T/L outage in 2019 on OP G/L scenario
Figure A1-21	Power flow with 220 kV Kirindiwela-Padukka T/L, under N-1 condition of 220 kV Biyagama-Pannipitiya T/L outage in 2019 on TMNP G/L scenario
Figure A1-22	Power flow under N-1 condition of 132 kV Kolonnawa-Sri J’Pura T/L outage in 2017 on HMDP G/L scenario
Figure A1-23	Power flow under N-1 condition of 132 kV Kolonnawa-Sri J’Pura T/L outage in 2017 on TMDP G/L scenario

Power flow diagram

Figure A1-24	Power flow under N-1 condition of 132 kV Kolonnawa-Sri J'Pura T/L outage in 2017 on HMNP G/L scenario
Figure A1-25	Power flow under N-1 condition of 132 kV Kolonnawa-Sri J'Pura T/L outage in 2017 on TMNP G/L scenario
Figure A1-26	Power flow under N-1 condition of 132 kV Kolonnawa-Sri J'Pura T/L outage in 2017 on OP G/L scenario
Figure A1-27	Power flow under N-1 condition of 132 kV Pannipitiya-Sri J'Pura T/L outage in 2017 on HMDP G/L scenario
Figure A1-28	Power flow under N-1 condition of 132 kV Pannipitiya-Sri J'Pura T/L outage in 2017 on TMDP G/L scenario
Figure A1-29	Power flow under N-1 condition of 132 kV Pannipitiya-Sri J'Pura T/L outage in 2017 on HMNP G/L scenario
Figure A1-30	Power flow under N-1 condition of 132 kV Pannipitiya-Sri J'Pura T/L outage in 2017 on TMNP G/L scenario
Figure A1-31	Power flow under N-1 condition of 132 kV Pannipitiya-Sri J'Pura T/L outage in 2017 on OP G/L scenario
Figure A1-32	Power flow under N-1 condition of 132 kV New Habarana-Naula T/L outage in 2017 on HMDP G/L scenario
Figure A1-33	Power flow under N-1 condition of 132 kV New Habarana-Naula T/L outage in 2017 on TMDP G/L scenario
Figure A1-34	Power flow under N-1 condition of 132 kV New Habarana-Naula T/L outage in 2017 on HMNP G/L scenario
Figure A1-35	Power flow under N-1 condition of 132 kV New Habarana-Naula T/L outage in 2017 on TMNP G/L scenario
Figure A1-36	Power flow under N-1 condition of 132 kV New Habarana-Naula T/L outage in 2017 on OP G/L scenario
Figure A1-37	Power flow under N-1 condition of 132 kV Ukuwela-Naula T/L outage in 2017 on HMDP G/L scenario
Figure A1-38	Power flow under N-1 condition of 132 kV Ukuwela-Naula T/L outage in 2017 on TMDP G/L scenario
Figure A1-39	Power flow under N-1 condition of 132 kV Ukuwela-Naula T/L outage in 2017 on HMNP G/L scenario
Figure A1-40	Power flow under N-1 condition of 132 kV Ukuwela-Naula T/L outage in 2017 on TMNP G/L scenario
Figure A1-41	Power flow under N-1 condition of 132 kV Ukuwela-Naula T/L outage in 2017 on OP G/L scenario
Figure A1-42	Power flow under N-1 condition of 132 kV Ukuwela-Kiribathkumbura T/L outage in 2017 on HMDP G/L scenario
Figure A1-43	Power flow under N-1 condition of 132 kV Ukuwela-Kiribathkumbura T/L outage in 2017 on TMDP G/L scenario
Figure A1-44	Power flow under N-1 condition of 132 kV Ukuwela-Kiribathkumbura T/L outage in 2017 on HMNP G/L scenario
Figure A1-45	Power flow under N-1 condition of 132 kV Ukuwela-Kiribathkumbura T/L outage in 2017 on TMNP G/L scenario
Figure A1-46	Power flow under N-1 condition of 132 kV Ukuwela-Kiribathkumbura T/L outage in 2017 on OP G/L scenario

Power flow diagram

Power flow diagram

Generation / Loading condition: Hydro Max, Day Peak

Year: 2017

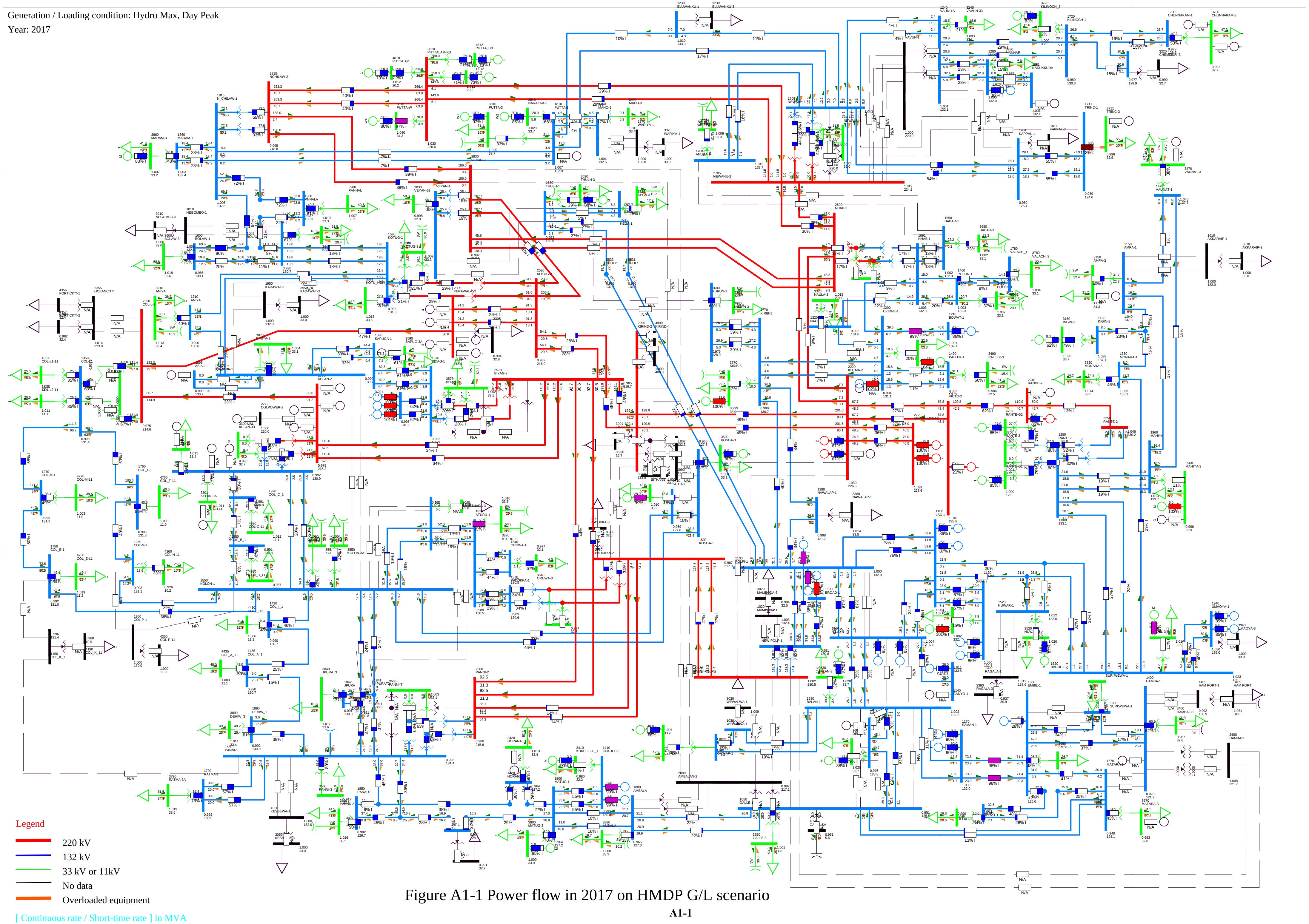


Figure A1-1 Power flow in 2017 on HMDP G/L scenario

Generation / Loading condition: Thermal Max, Day Peak

Year: 2017

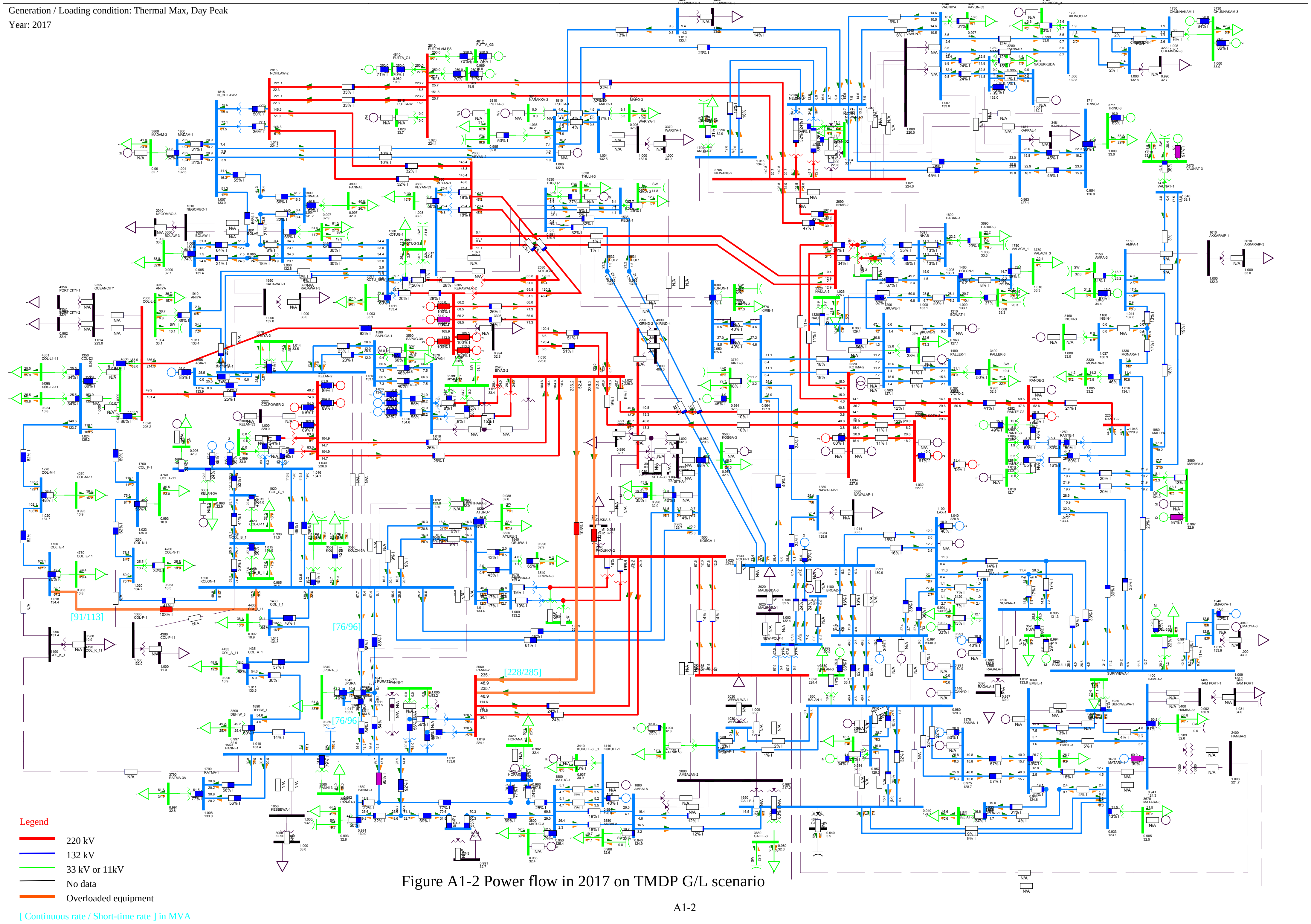


Figure A1-2 Power flow in 2017 on TMDP G/L scenario

Generation / Loading condition: Hydro Max, Night Peak
Year: 2017

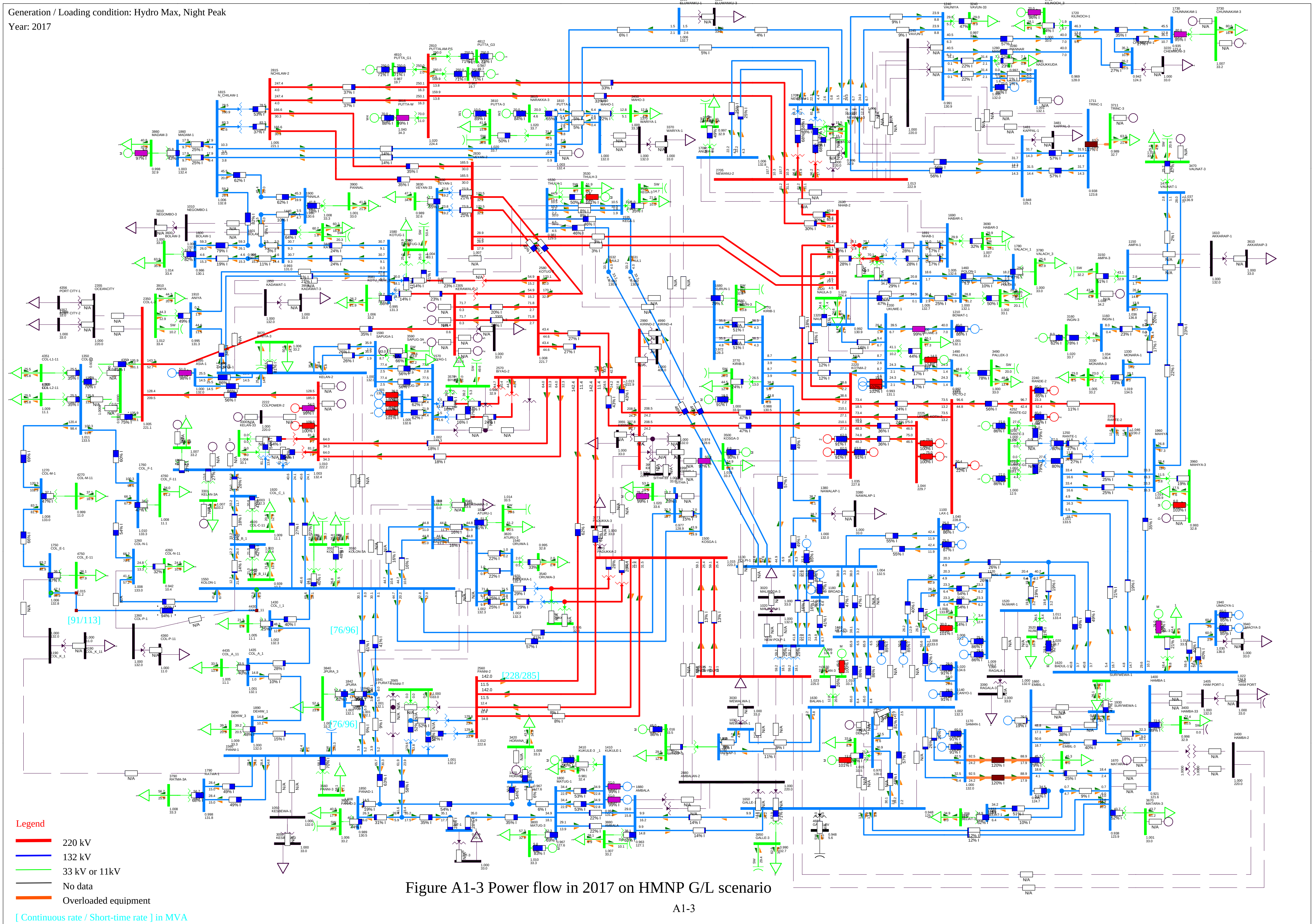
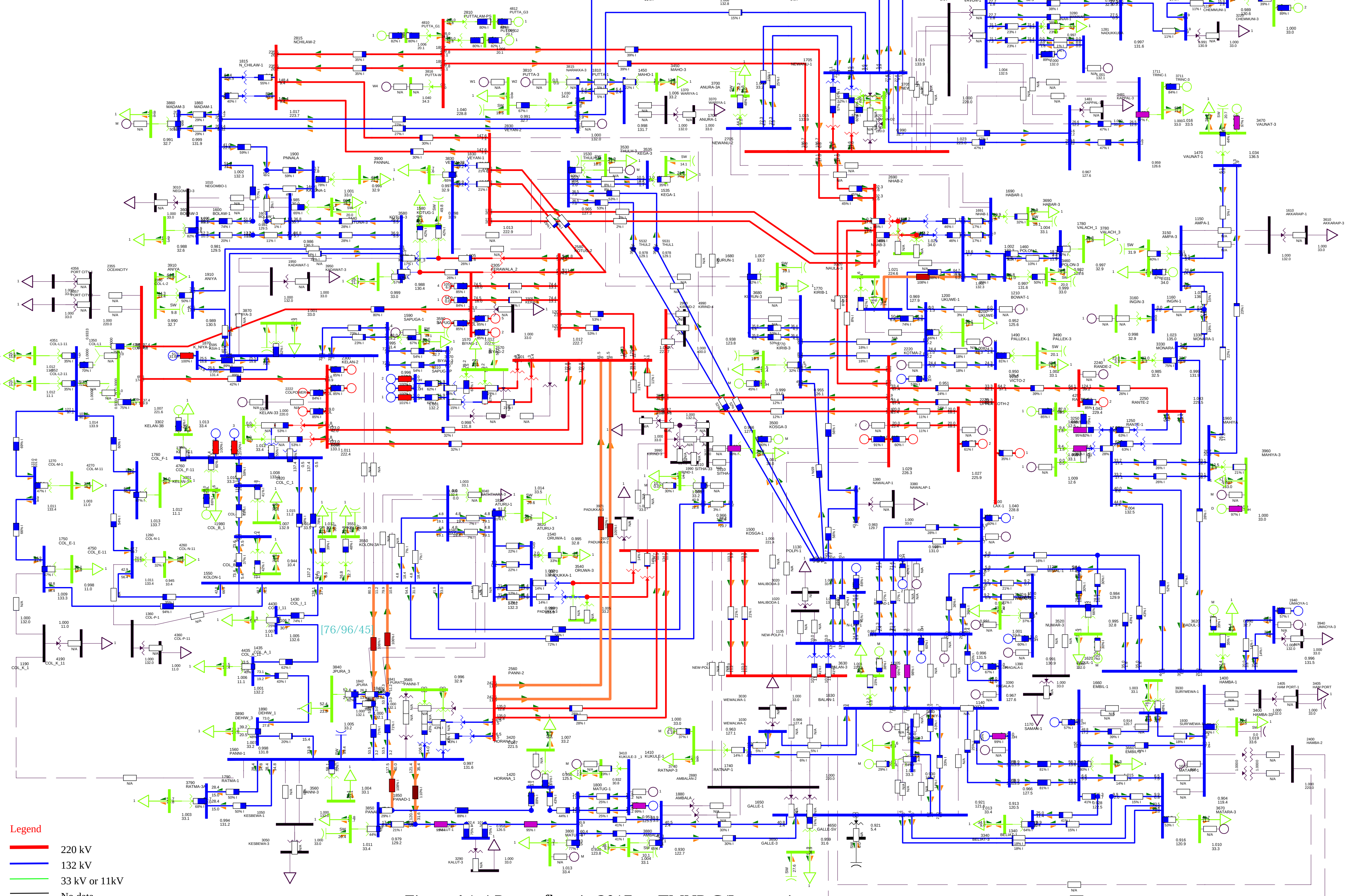


Figure A1-3 Power flow in 2017 on HMNP G/L scenario

Generation / Loading condition: Thermal Max, Night Peak

Year: 2017



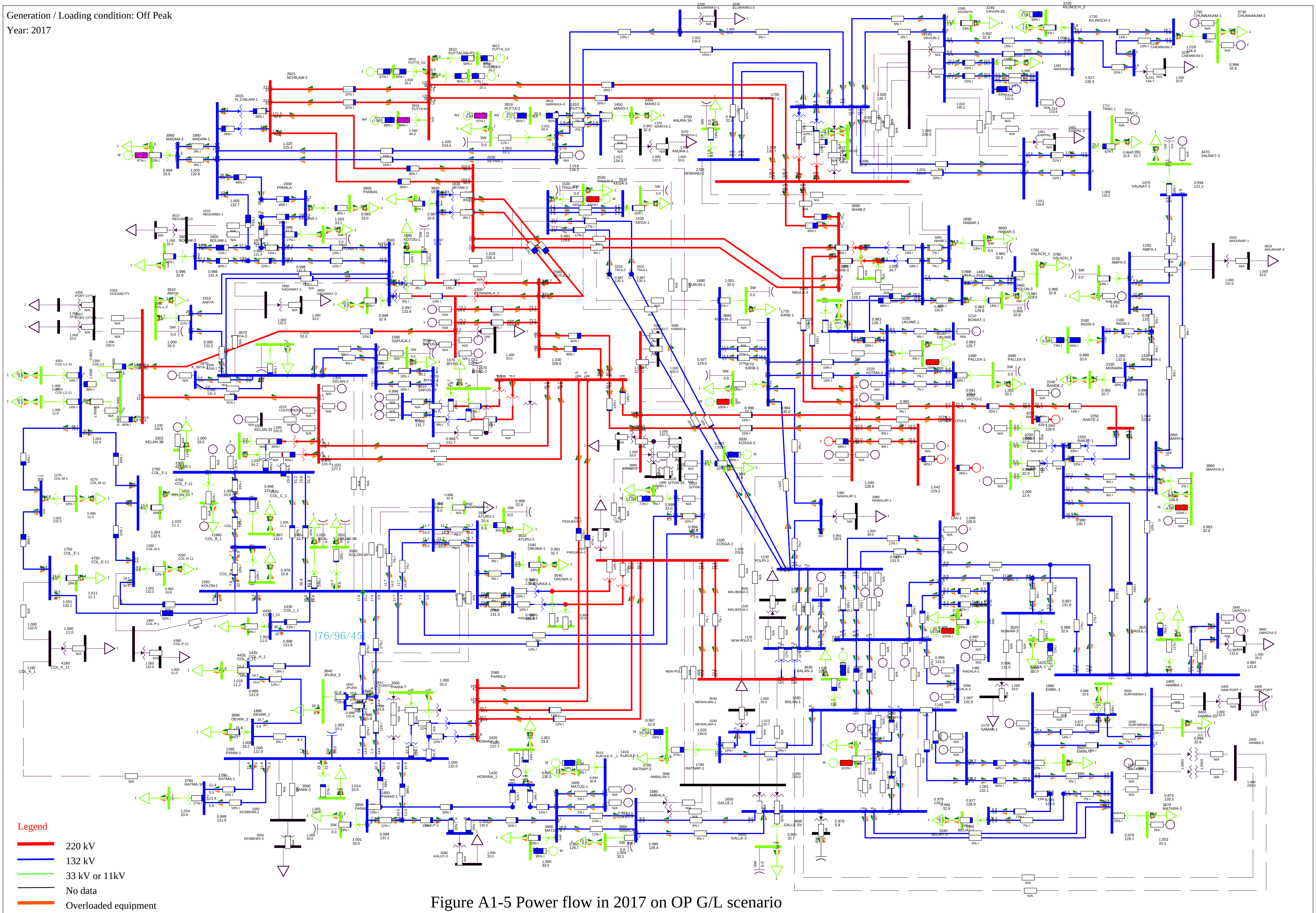
Legend

- 220 kV
- 132 kV
- 33 kV or 11kV
- No data
- Overloaded equipment

[Continuous rate / Short-time rate] in MVA

Figure A1-4 Power flow in 2017 on TMNP G/L scenario

Generation / Loading condition: Off Peak
Year: 2017



Legend

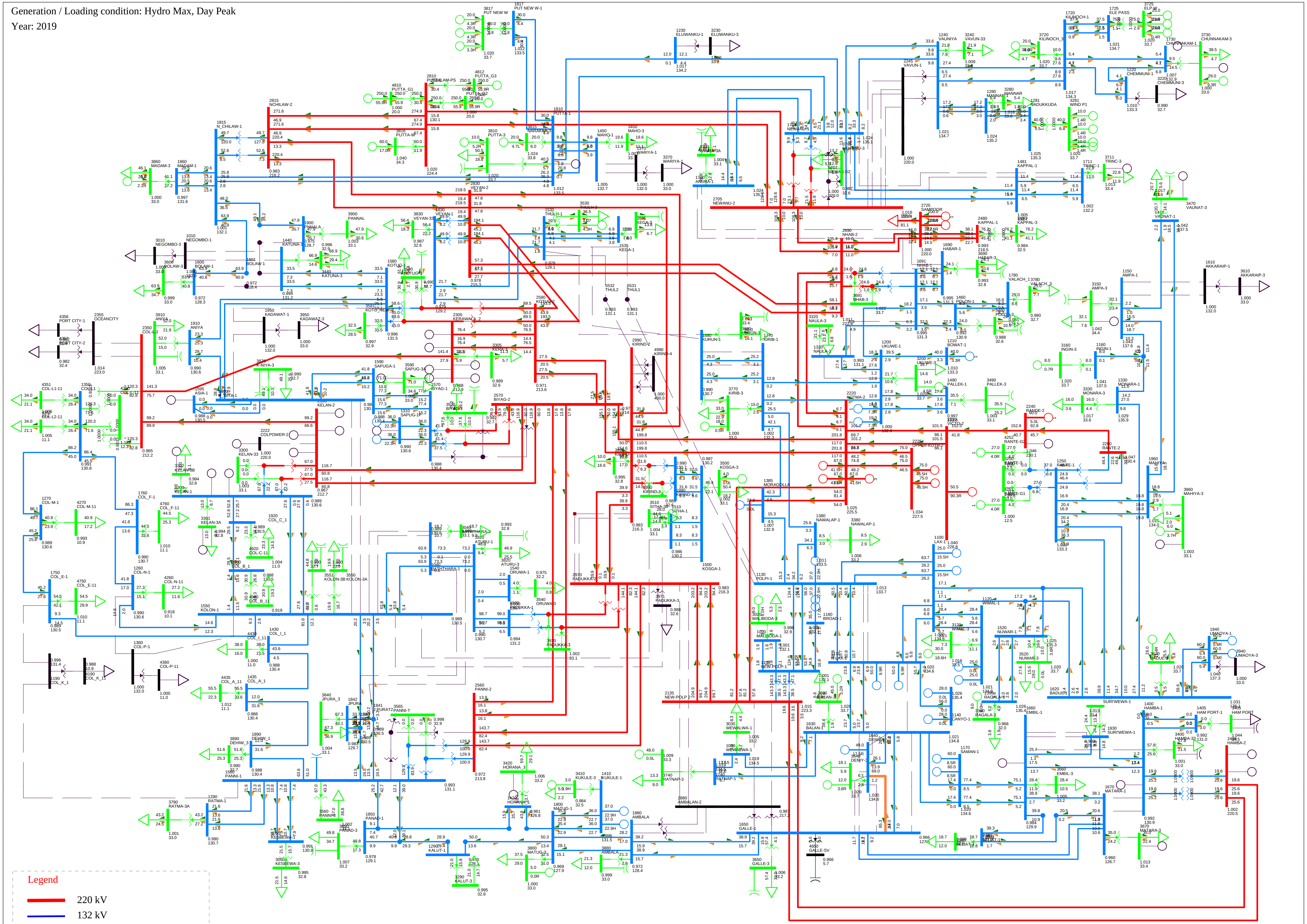
220 kV
132 kV
33 kV or 11kV
No data
Overloaded equipment

[Continuous rate / Short-time rate] in MVA

Figure A1-5 Power flow in 2017 on OP G/L scenario

Generation / Loading condition: Hydro Max, Day Peak

Year: 2019



Legend

220 kV

132 kV

33 kV or 11kV

No data

Overloaded equipment

Figure A1-6 Power flow in 2019 on HMDP G/L scenario

Generation / Loading condition: Thermal Max, Day Peak
Year: 2019

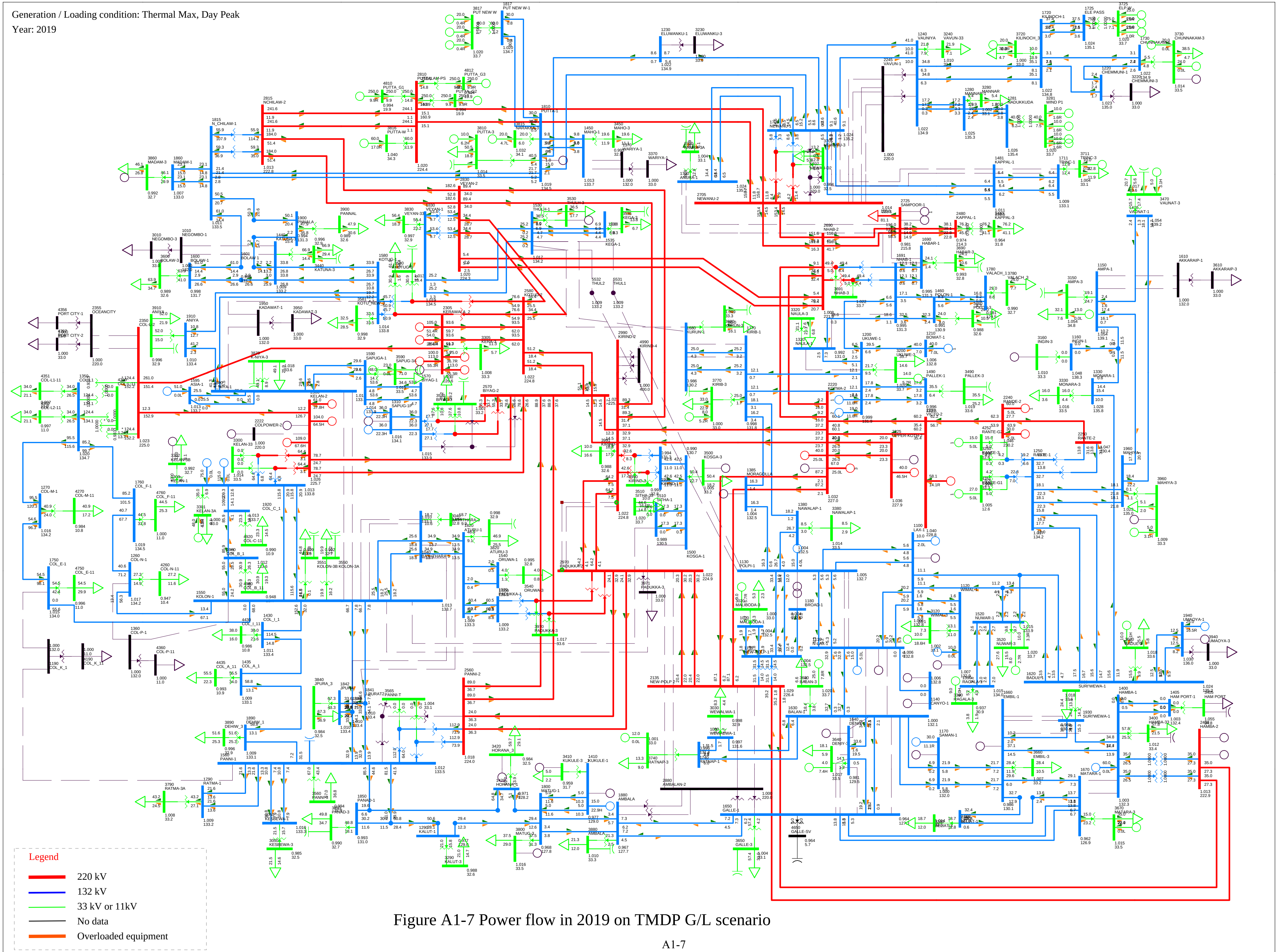


Figure A1-7 Power flow in 2019 on TMDP G/L scenario

Generation / Loading condition: Hydro Max, Night Peak
Year: 2019

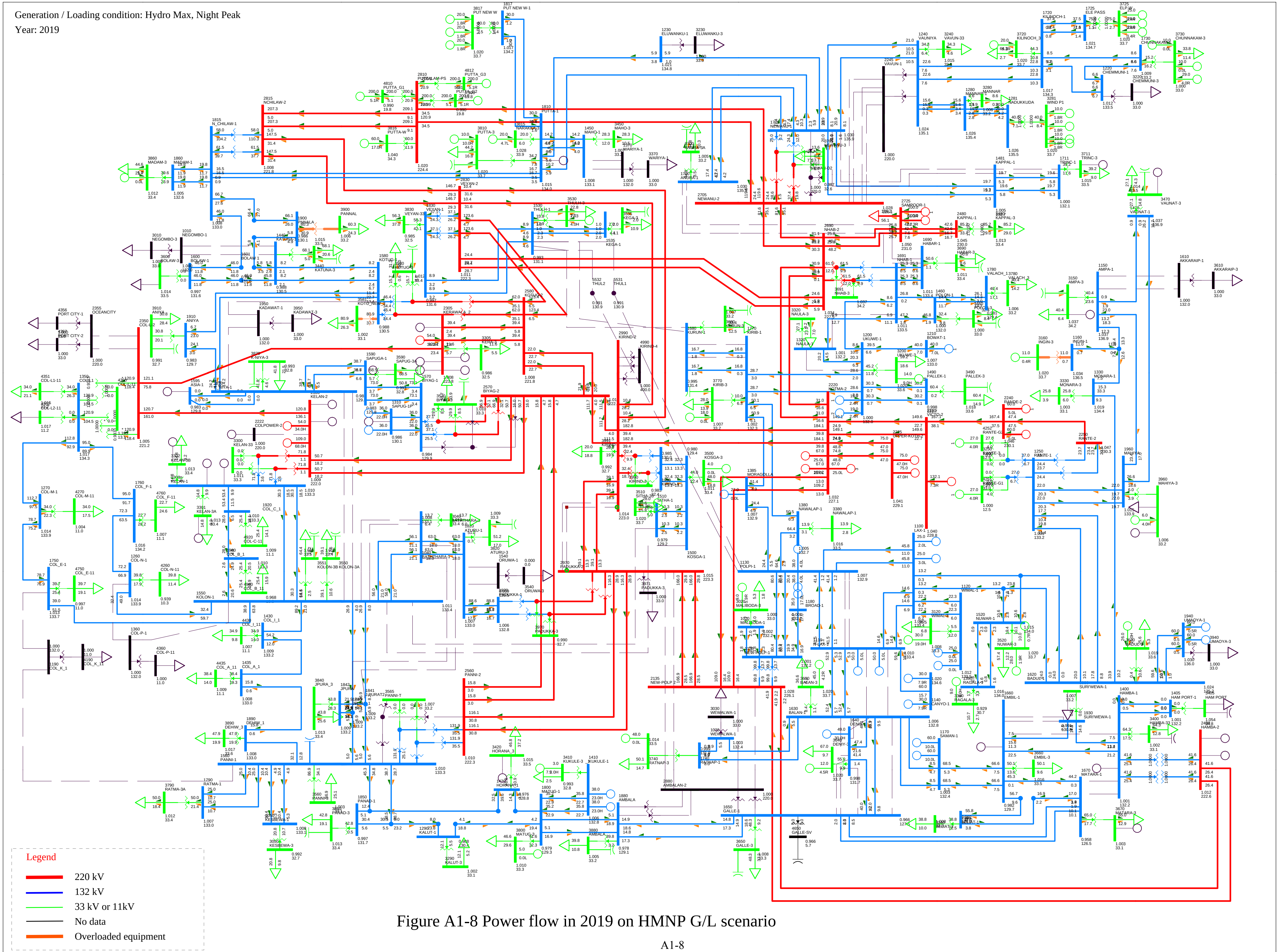


Figure A1-8 Power flow in 2019 on HMNP G/L scenario

Generation / Loading condition: Thermal Max, Night Peak

Year: 2019

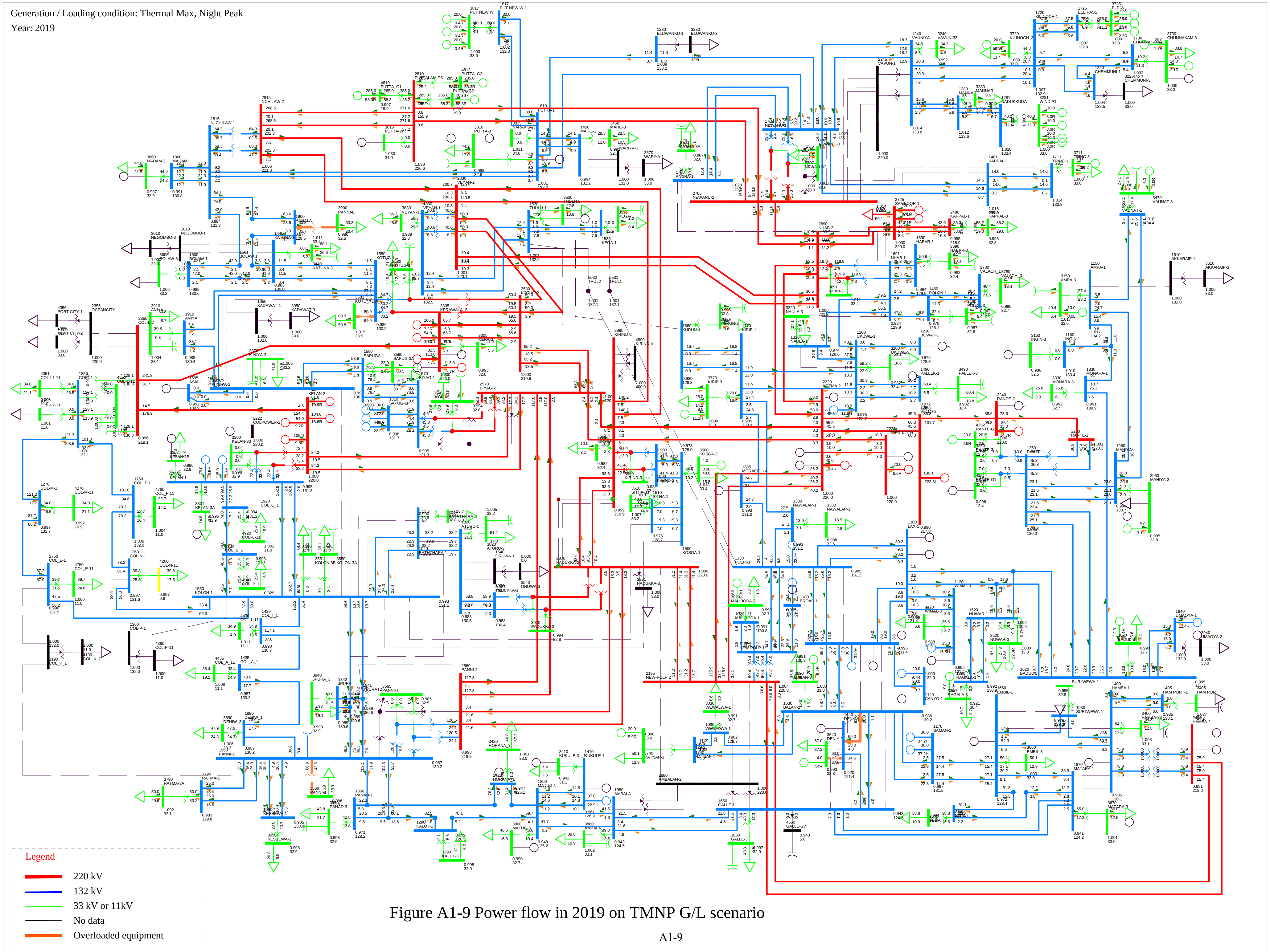


Figure A1-9 Power flow in 2019 on TMNP G/L scenario

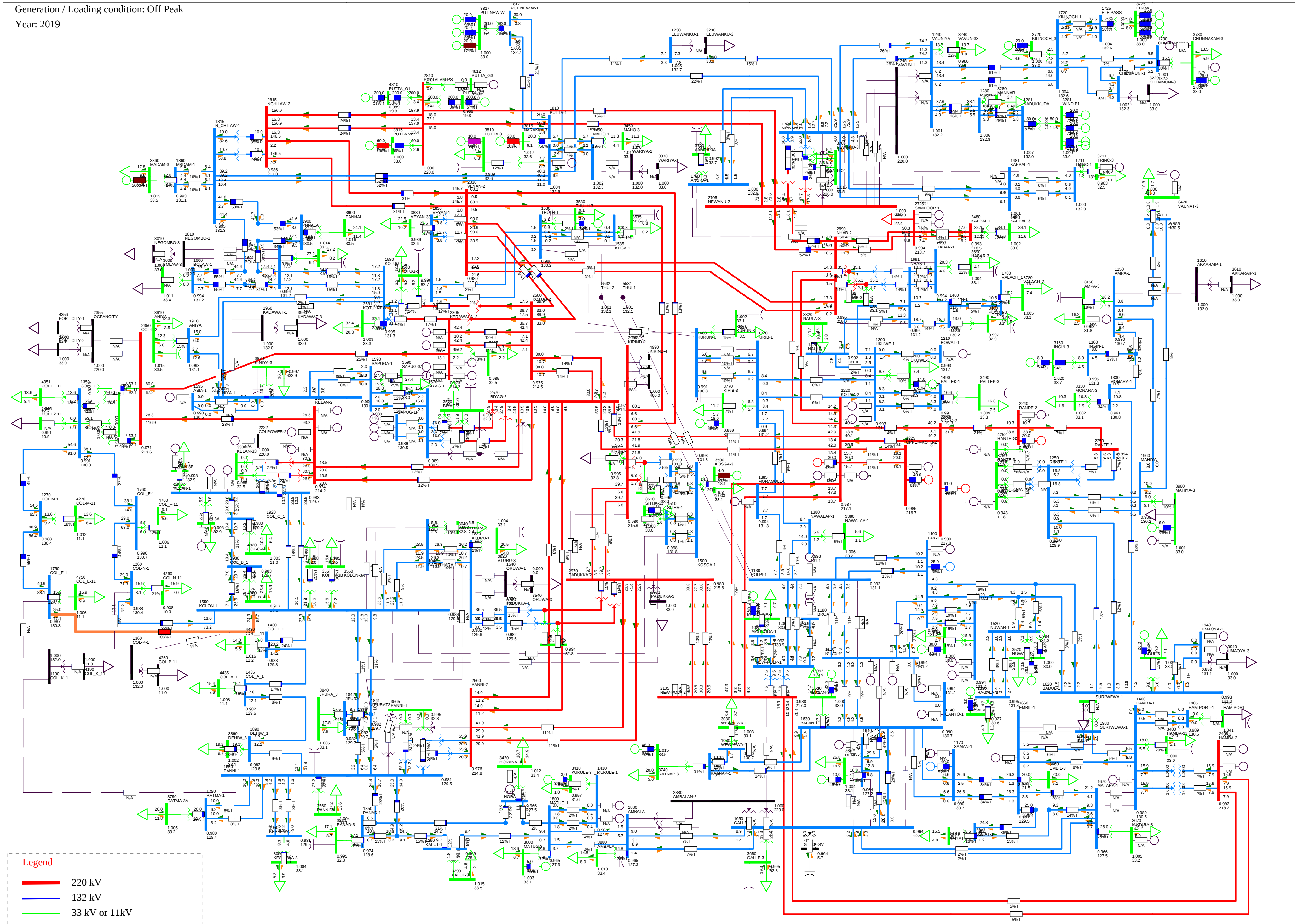
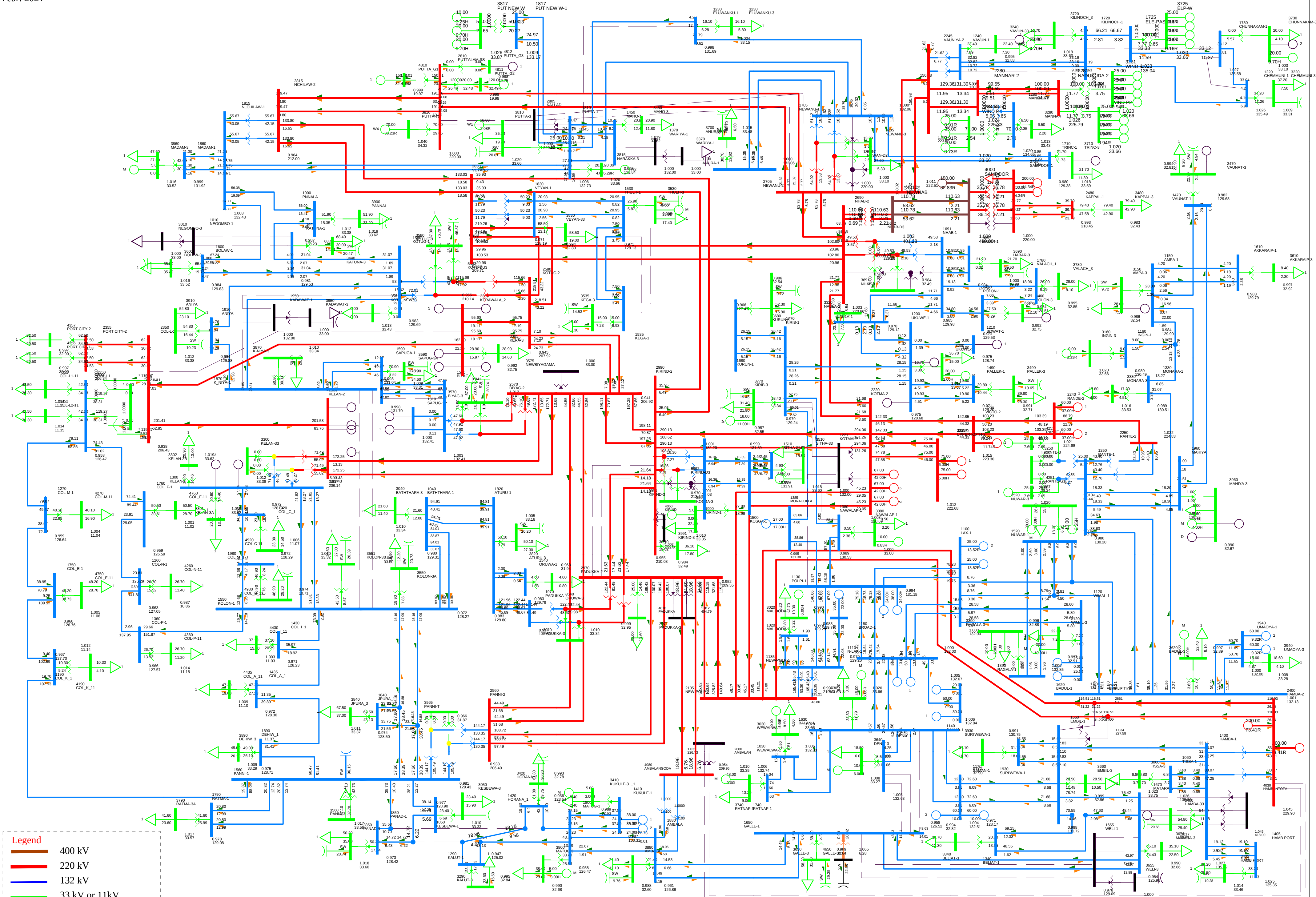


Figure A1-10 Power flow in 2019 on OP G/L scenario

Generation / Loading condition: Hydro Max, Day Peak

Year: 2021



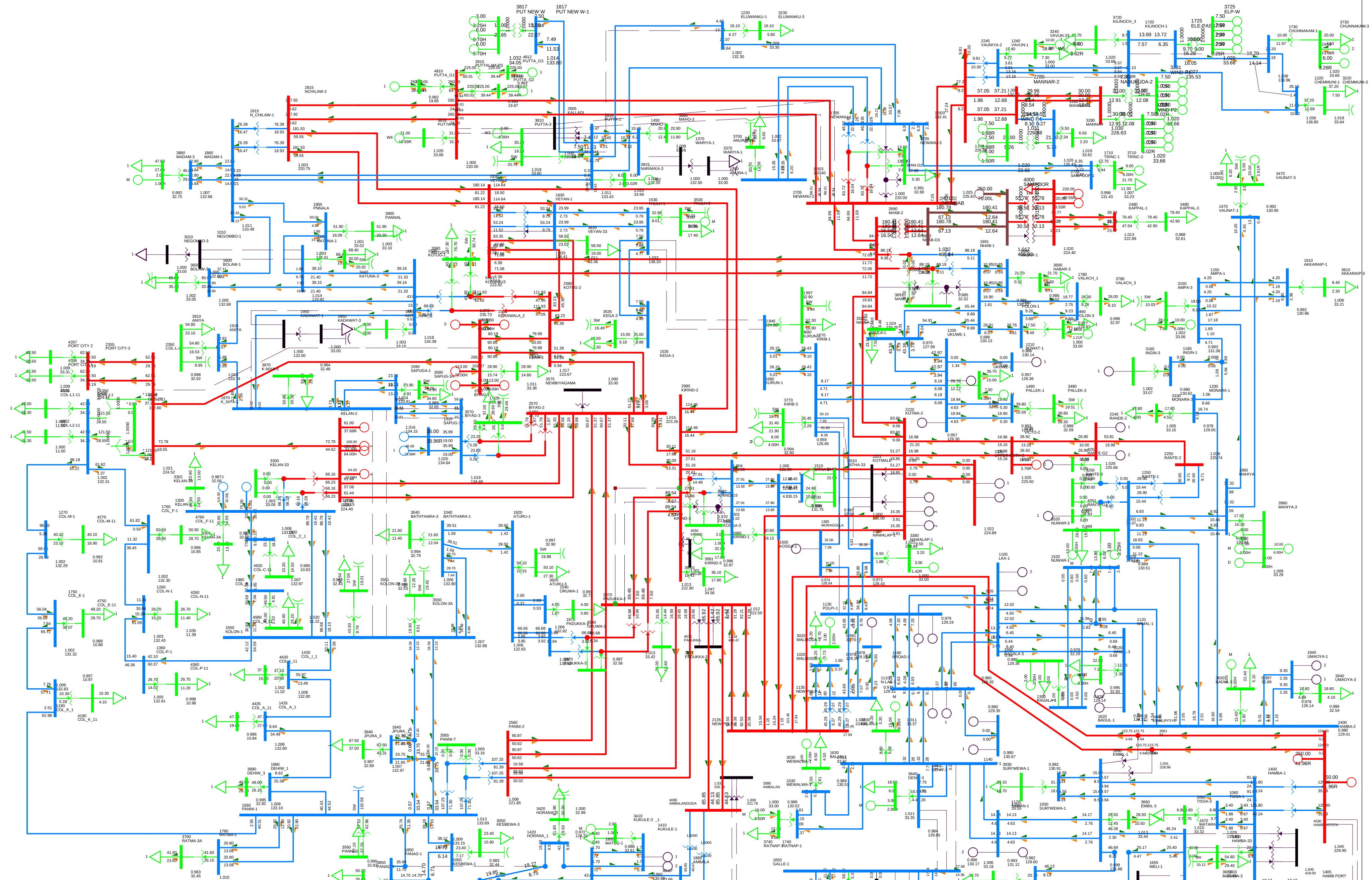
Legend

- 400 kV
- 220 kV
- 132 kV
- 33 kV or 11kV
- No data
- Overloaded equipment

Figure A1-11 Power flow in 2021 on HMDP G/L scenario

Generation / Loading condition: Thermal Max, Day Peak

Year: 2021



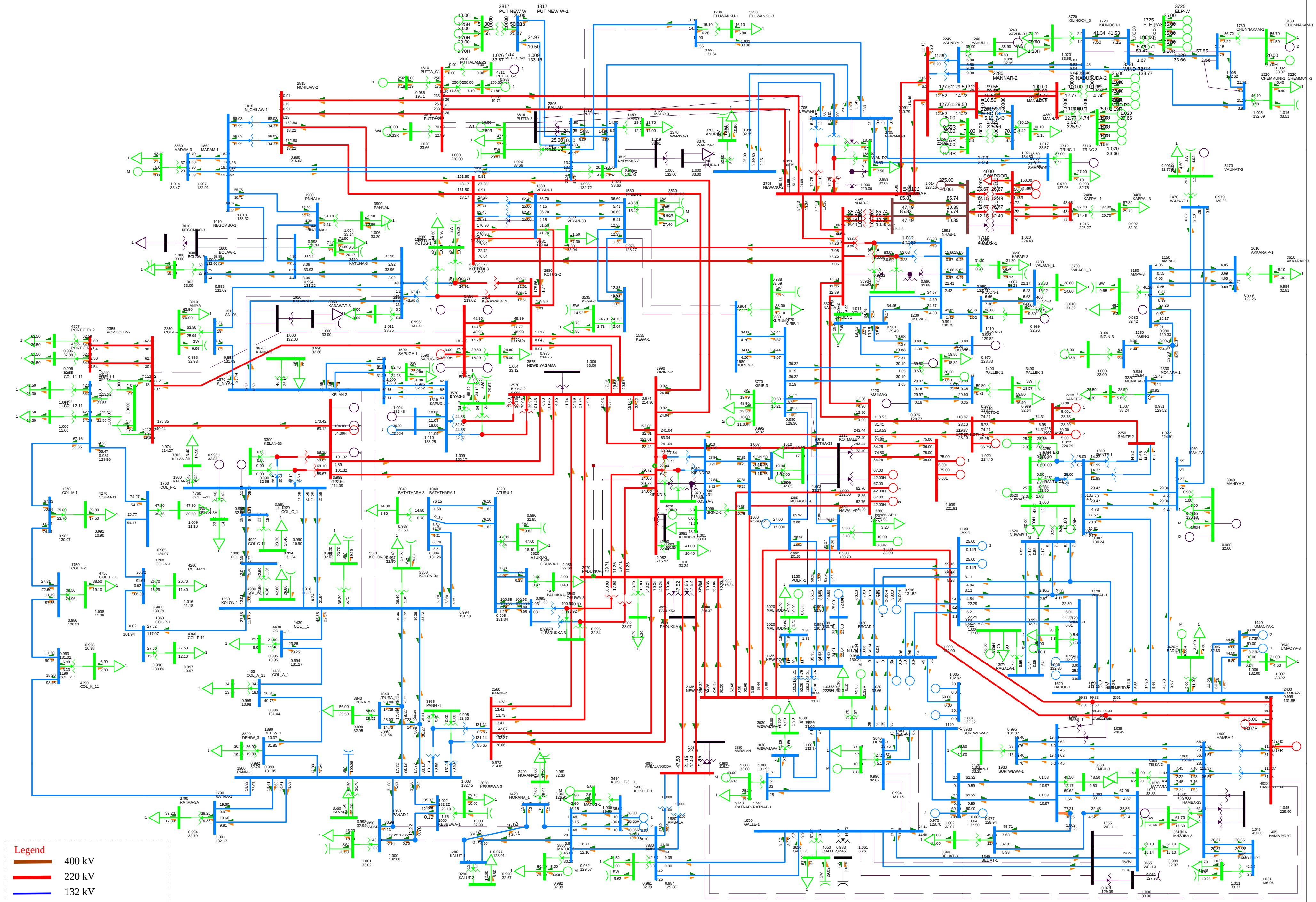
Legend

- 400 kV
- 220 kV
- 132 kV
- 33 kV or 11kV
- No data
- Overloaded equipment

Figure A1-12 Power flow in 2021 on TMDP G/L scenario

Generation / Loading condition: Hydro Max, Night Peak

Year: 2021



Legend

- 400 kV
- 220 kV
- 132 kV
- 33 kV or 11kV
- No data
- Overloaded equipment

Figure A1-13 Power flow in 2021 on HMNP G/L scenario

Generation / Loading condition: Thermal Max, Night Peak
Year: 2021

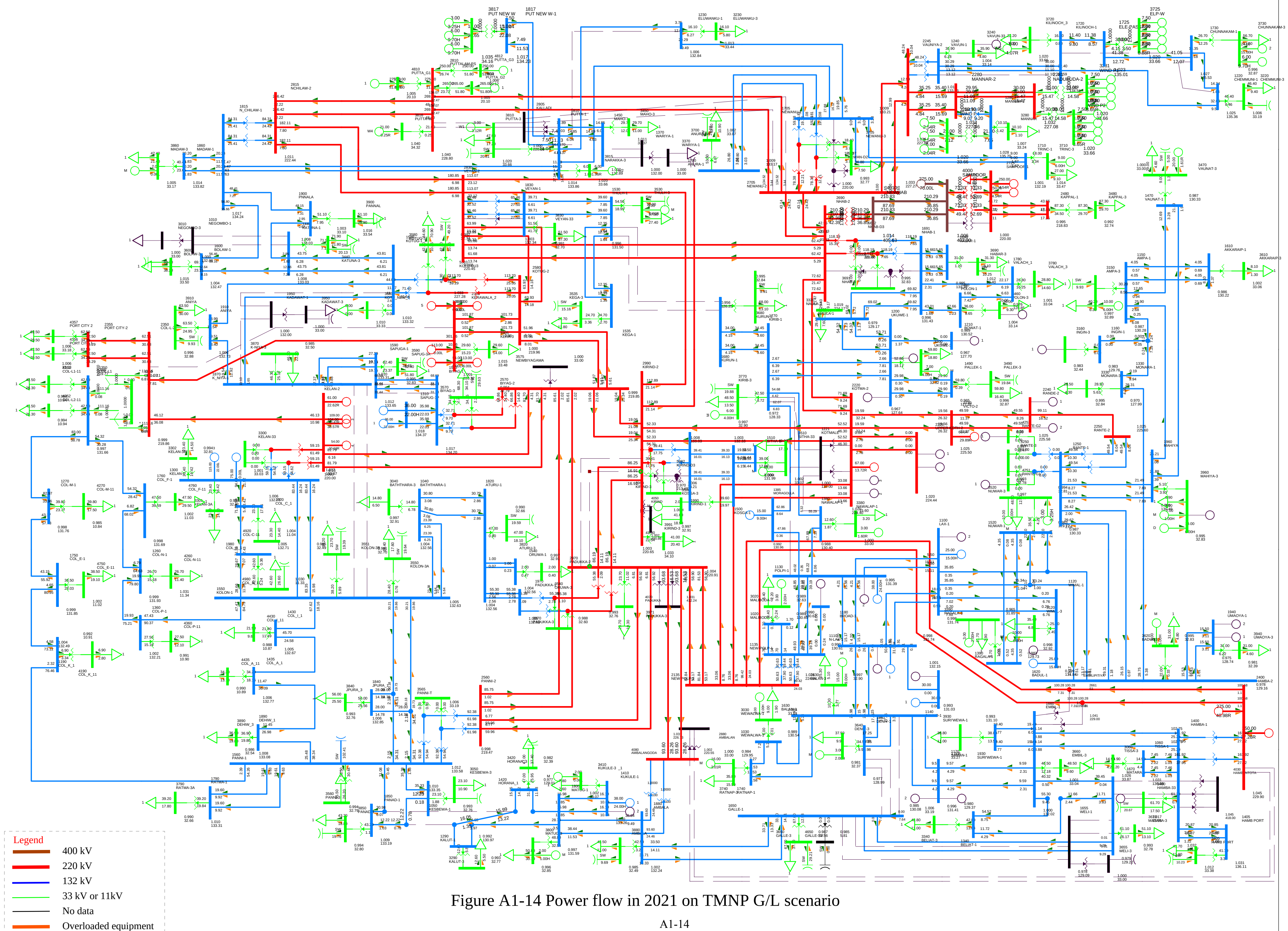
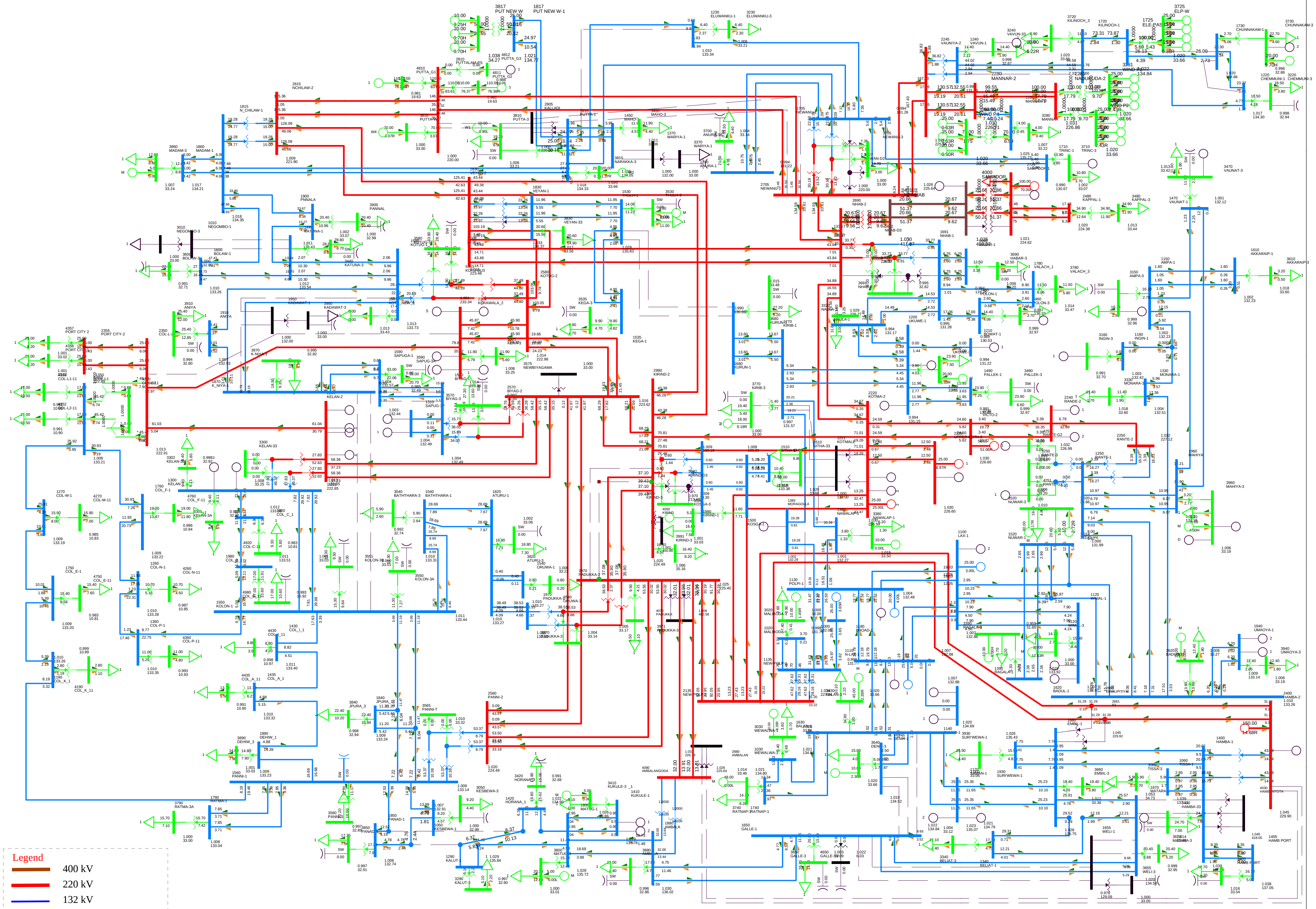


Figure A1-14 Power flow in 2021 on TMNP G/L scenario

Generation / Loading condition: Off Peak

Year: 2021



Legend

- 400 kV
- 220 kV
- 132 kV
- 33 kV or 11kV
- No data
- Overloaded equipment

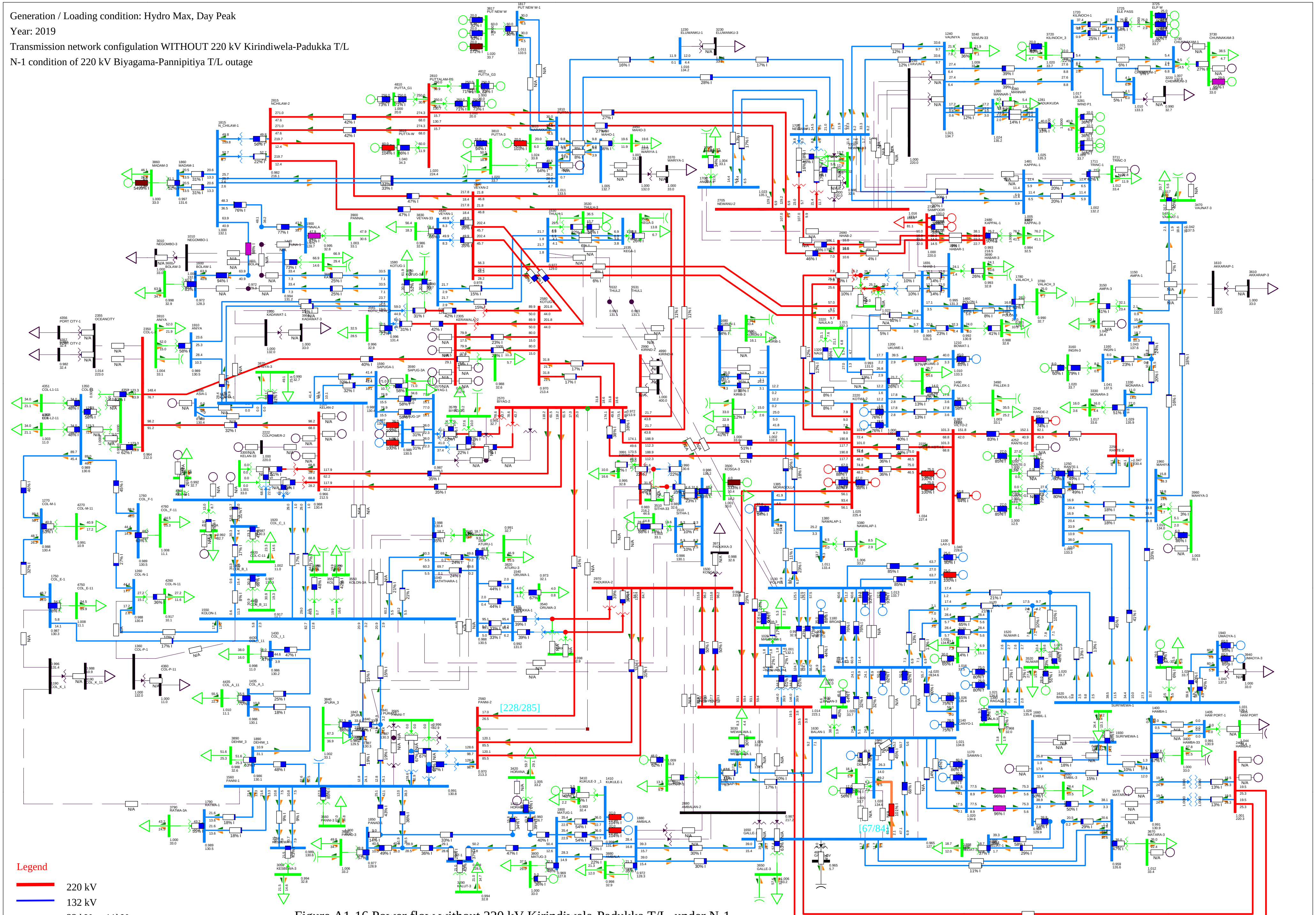
Figure A1-15 Power flow in 2021 on OP G/L scenario

Generation / Loading condition: Hydro Max, Day Peak

Year: 2019

Transmission network configulation WITHOUT 220 kV Kirindiwela-Padukka T/L

N-1 condition of 220 kV Biyagama-Pannipitiya T/L outage



Legend

220 kV

132 kV

33 kV or 11kV

No data

Overloaded equipment

[Continuous rate / Short-time rate] in MVA

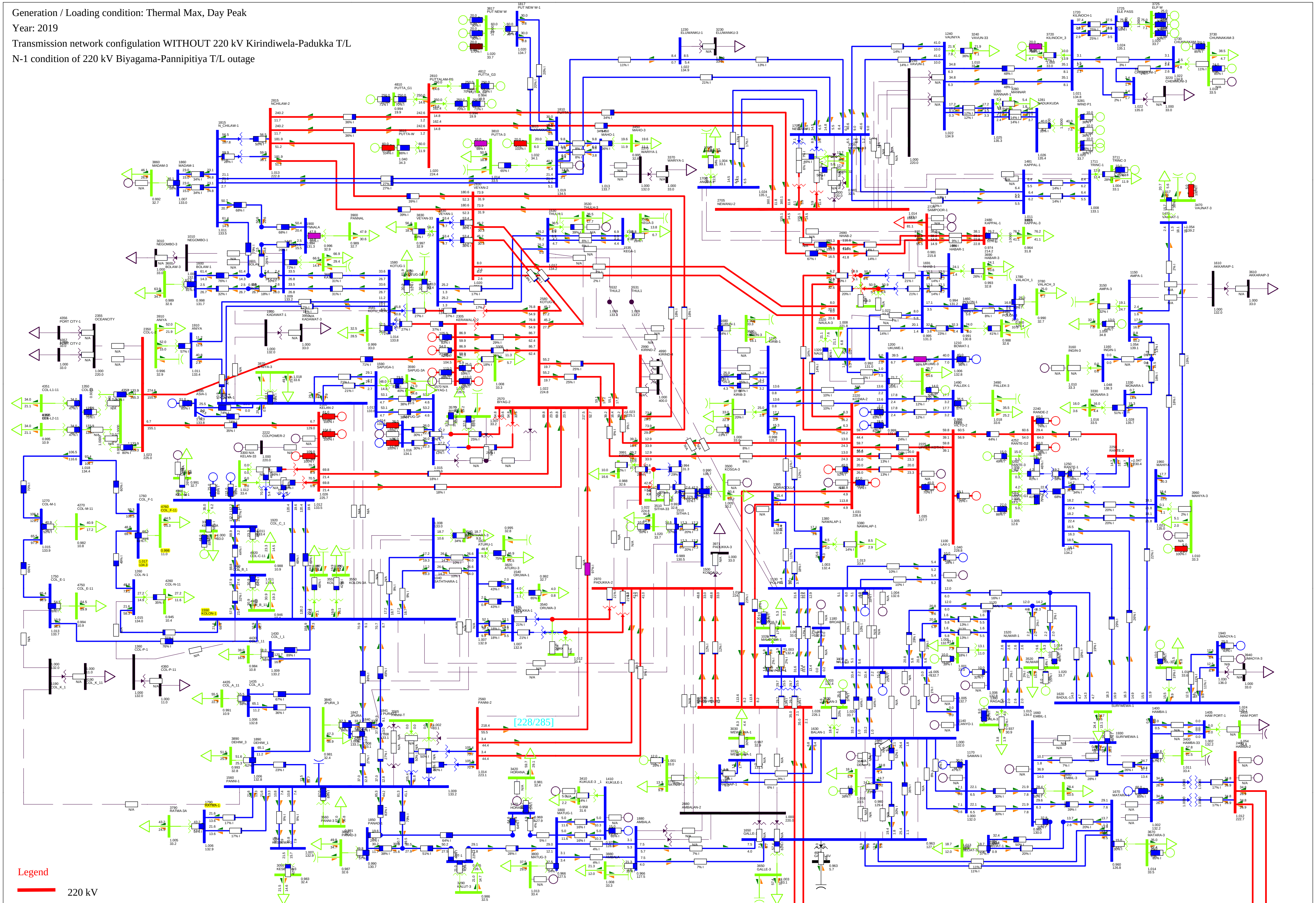
Figure A1-16 Power flow without 220 kV Kirindiwela-Padukka T/L, under N-1 condition of 220 kV Biyagama-Pannipitiya T/L outage in 2019 on HMDP G/L scenario

Generation / Loading condition: Thermal Max, Day Peak

Year: 2019

Transmission network configulation WITHOUT 220 kV Kirindiwela-Padukka T/L

N-1 condition of 220 kV Biyagama-Pannipitiya T/L outage



Legend

- 220 kV
- 132 kV
- 33 kV or 11kV
- No data
- Overloaded equipment

[Continuous rate / Short-time rate] in MVA

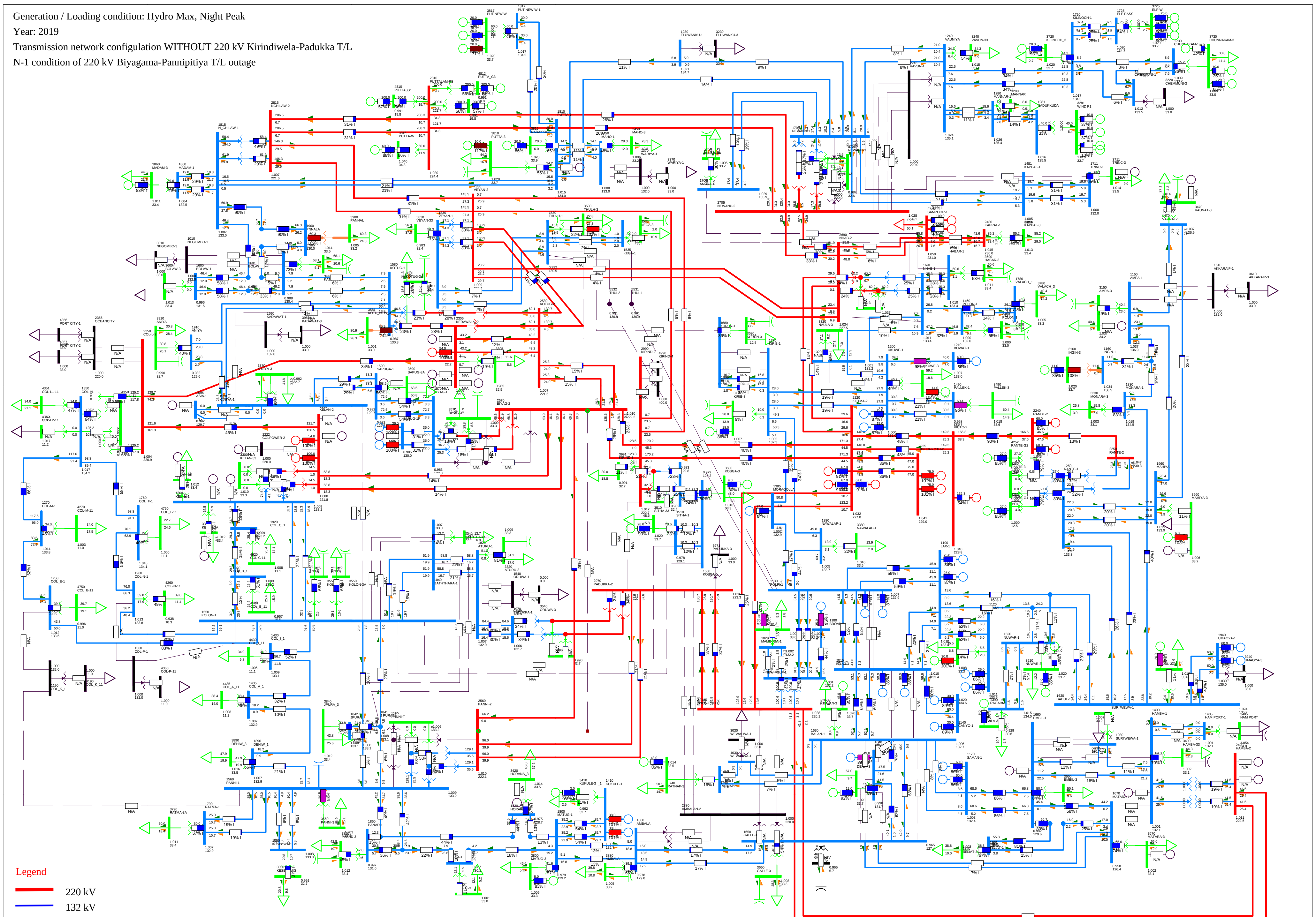
Figure A1-17 Power flow without 220 kV Kirindiwela-Padukka T/L, under N-1 condition of 220 kV Biyagama-Pannipitiya T/L outage in 2019 on TMDP G/L scenario

Generation / Loading condition: Hydro Max, Night Peak

Year: 2019

Transmission network configulation WITHOUT 220 kV Kirindiwela-Padukka T/L

N-1 condition of 220 kV Biyagama-Pannipitiya T/L outage



Legend

220 kV

132 kV

33 kV or 11kV

No data

Overloaded equipment

[Continuous rate / Short-time rate] in MVA

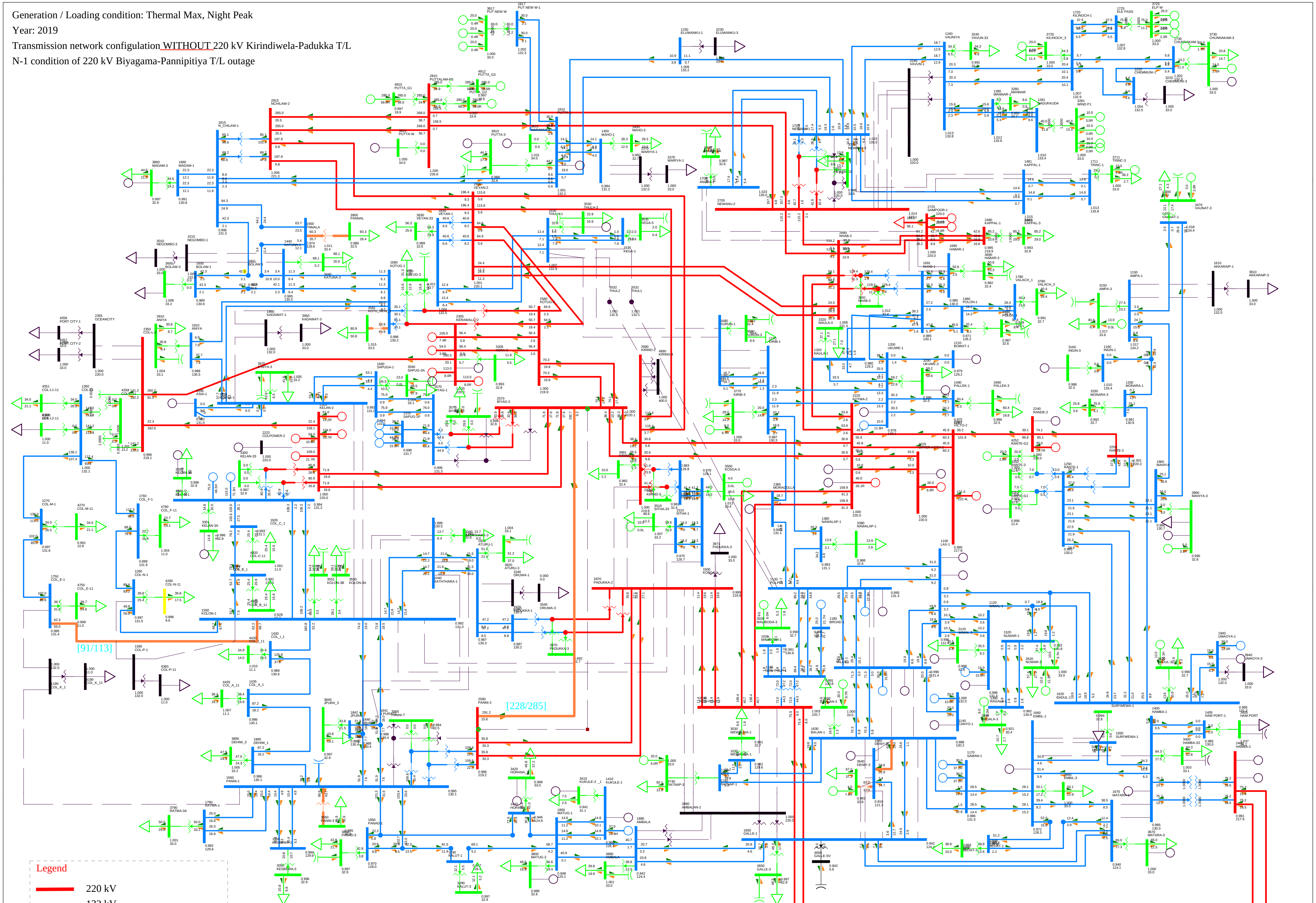
Figure A1-18 Power flow without 220 kV Kirindiwela-Padukka T/L, under N-1 condition of 220 kV Biyagama-Pannipitiya T/L outage in 2019 on HMNP G/L scenario

Generation / Loading condition: Thermal Max, Night Peak

Year: 2019

Transmission network configulation WITHOUT 220 kV Kirindiwela-Padukka T/L

N-1 condition of 220 kV Biyagama-Pannipitiya T/L outage



Legend

- 220 kV
- 132 kV
- 33 kV or 11kV
- No data
- Overloaded equipment

[Continuous rate / Short-time rate] in MVA

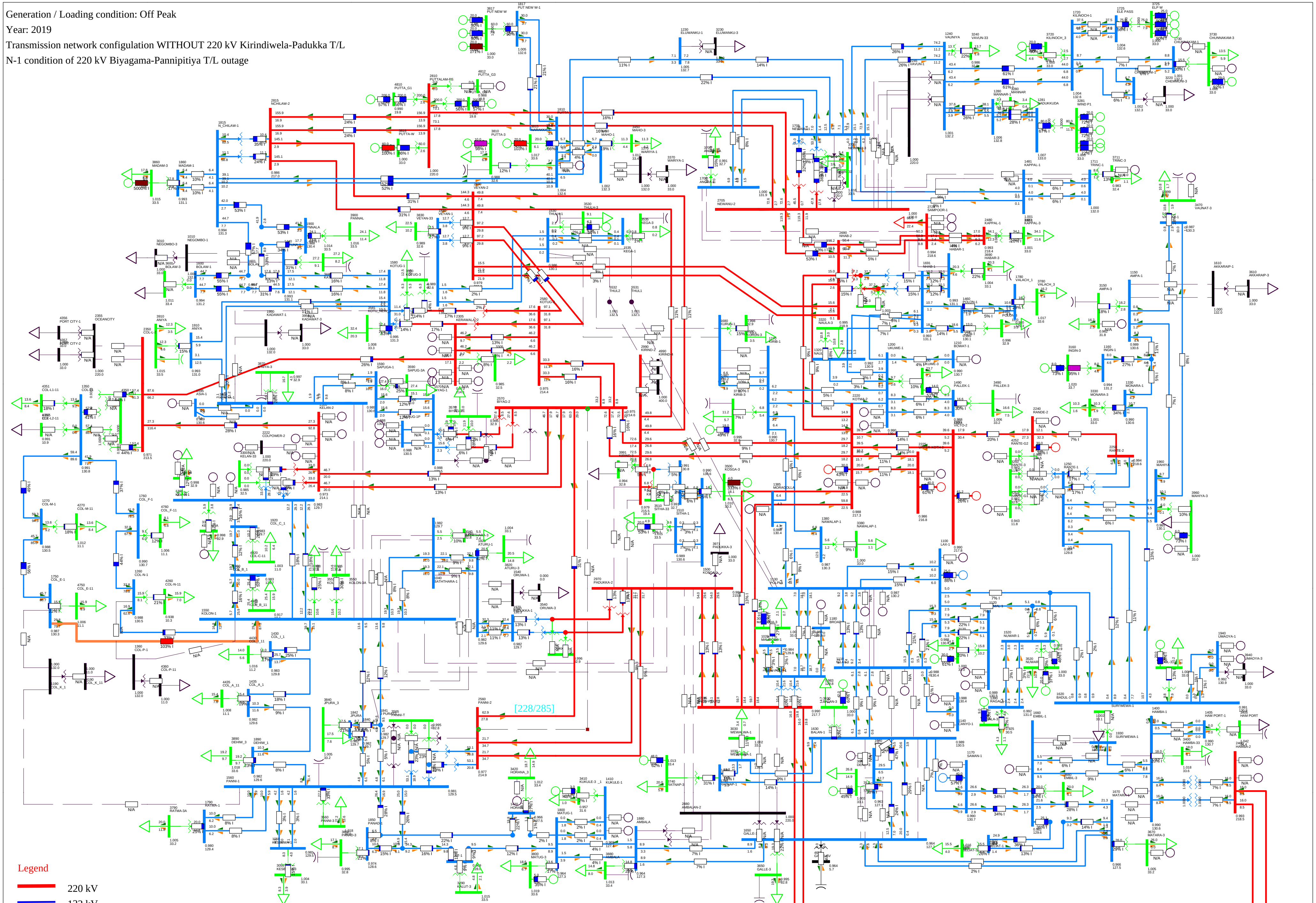
Figure A1-19 Power flow without 220 kV Kirindiwela-Padukka T/L, under N-1 condition of 220 kV Biyagama-Pannipitiya T/L outage in 2019 on TMNP G/L scenario

Generation / Loading condition: Off Peak

Year: 2019

Transmission network configulation WITHOUT 220 kV Kirindiwela-Padukka T/L

N-1 condition of 220 kV Biyagama-Pannipitiya T/L outage



Legend

- 220 kV
- 132 kV
- 33 kV or 11kV
- No data
- Overloaded equipment

[Continuous rate / Short-time rate] in MVA

Figure A1-20 Power flow without 220 kV Kirindiwela-Padukka T/L, under N-1 condition of 220 kV Biyagama-Pannipitiya T/L outage in 2019 on OP G/L scenario

Generation / Loading condition: Thermal Max, Night Peak
Year: 2019
Transmission network configulation WITH Kirindiwela-Padukka T/L
N-1 condition of 220 kV Biyagama-Pannipitiya T/L outage

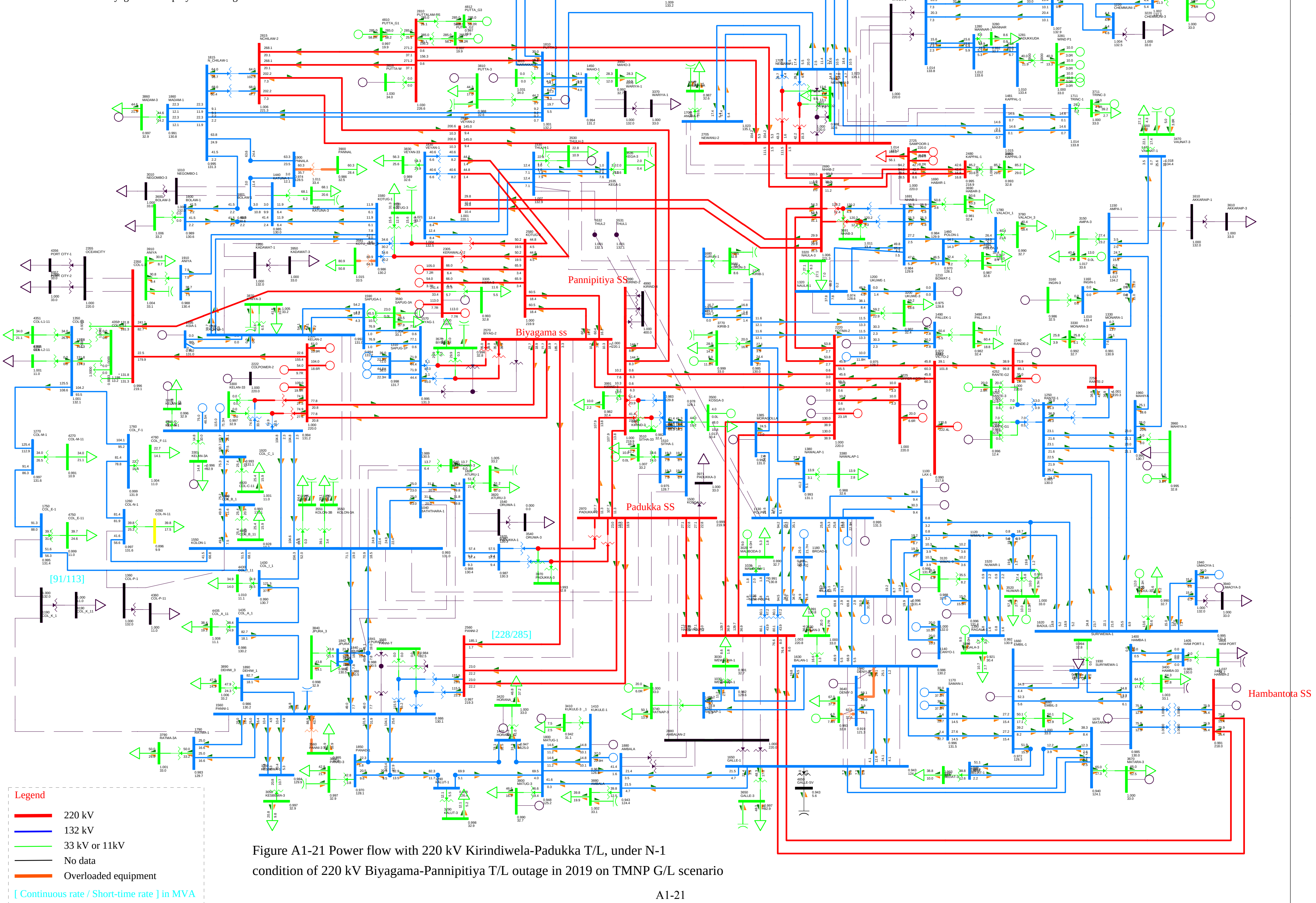


Figure A1-21 Power flow with 220 kV Kirindiwela-Padukka T/L, under N-1 condition of 220 kV Biyagama-Pannipitiya T/L outage in 2019 on TMNP G/L scenario

Generation / Loading condition: Hydro Max, Day Peak

Year: 2017

132 kV Kolonnawa-Sri J'Pura T/L outage

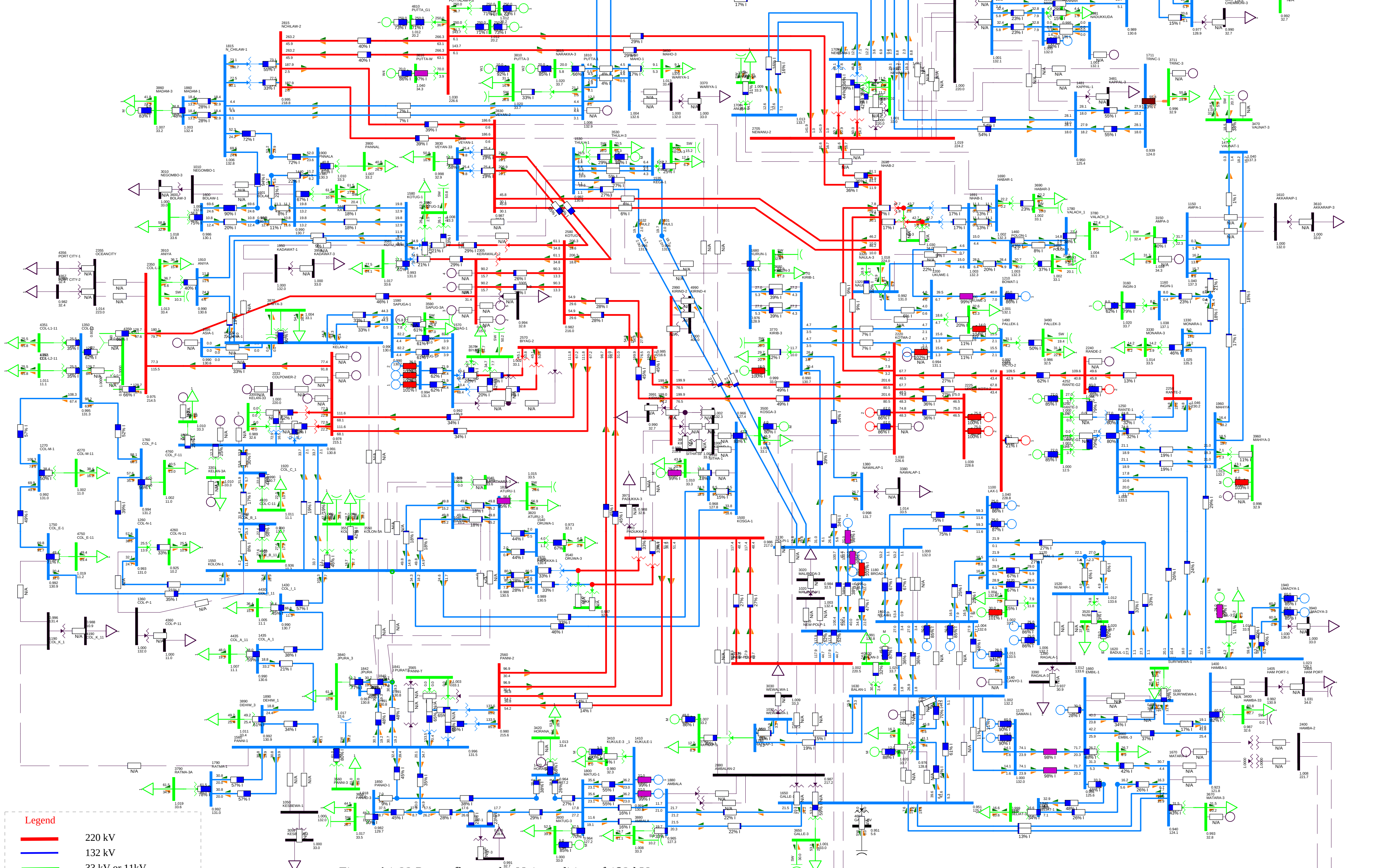


Figure A1-22 Power flow under N-1 condition of 132 kV Kolonnawa-Sri J'Pura T/L outage in 2017 on HMDP G/L scenario

Generation / Loading condition: Thermal Max, Day Peak
Year: 2017
132 kV Kolonnawa-Sri J'Pura T/L outage

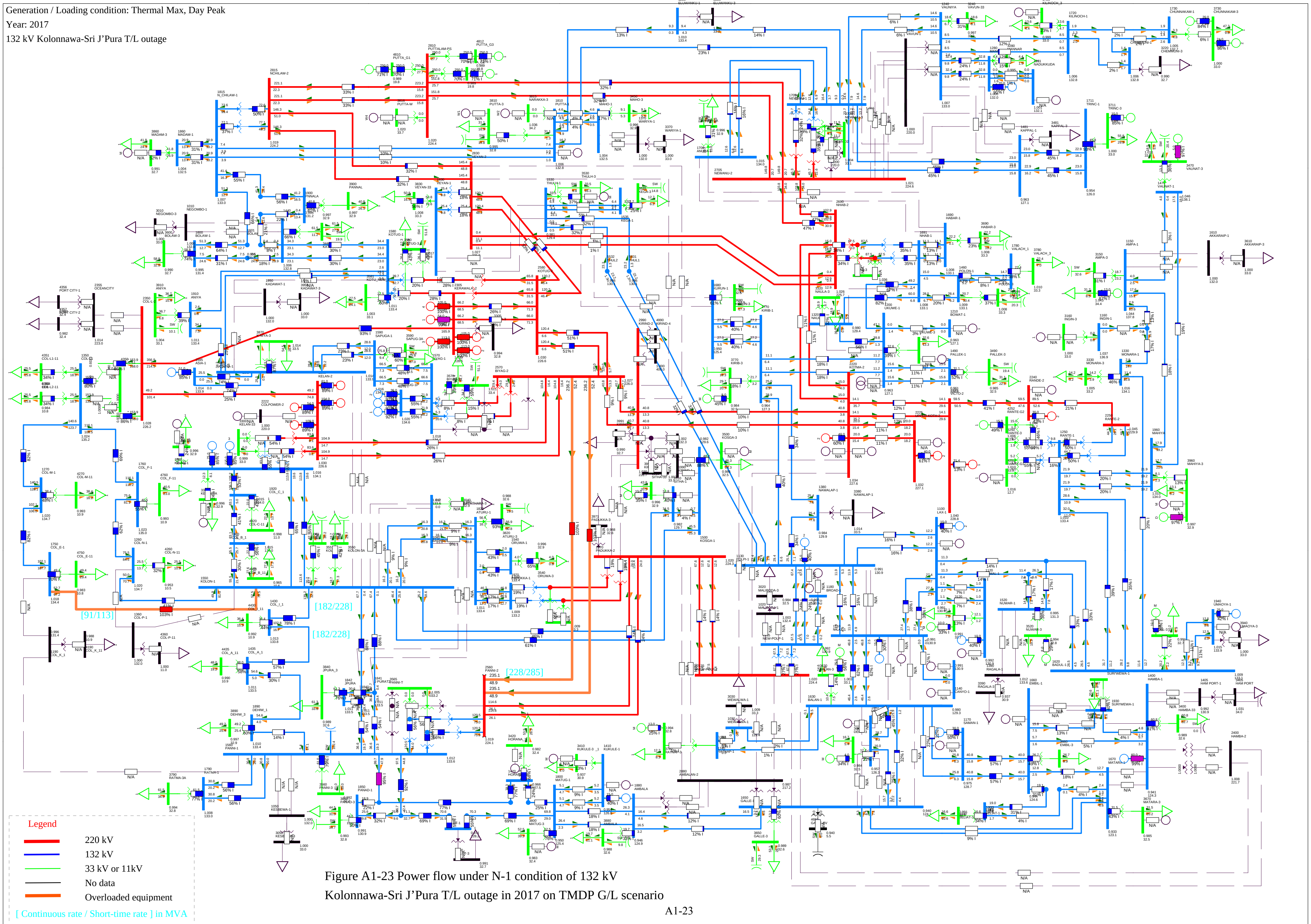
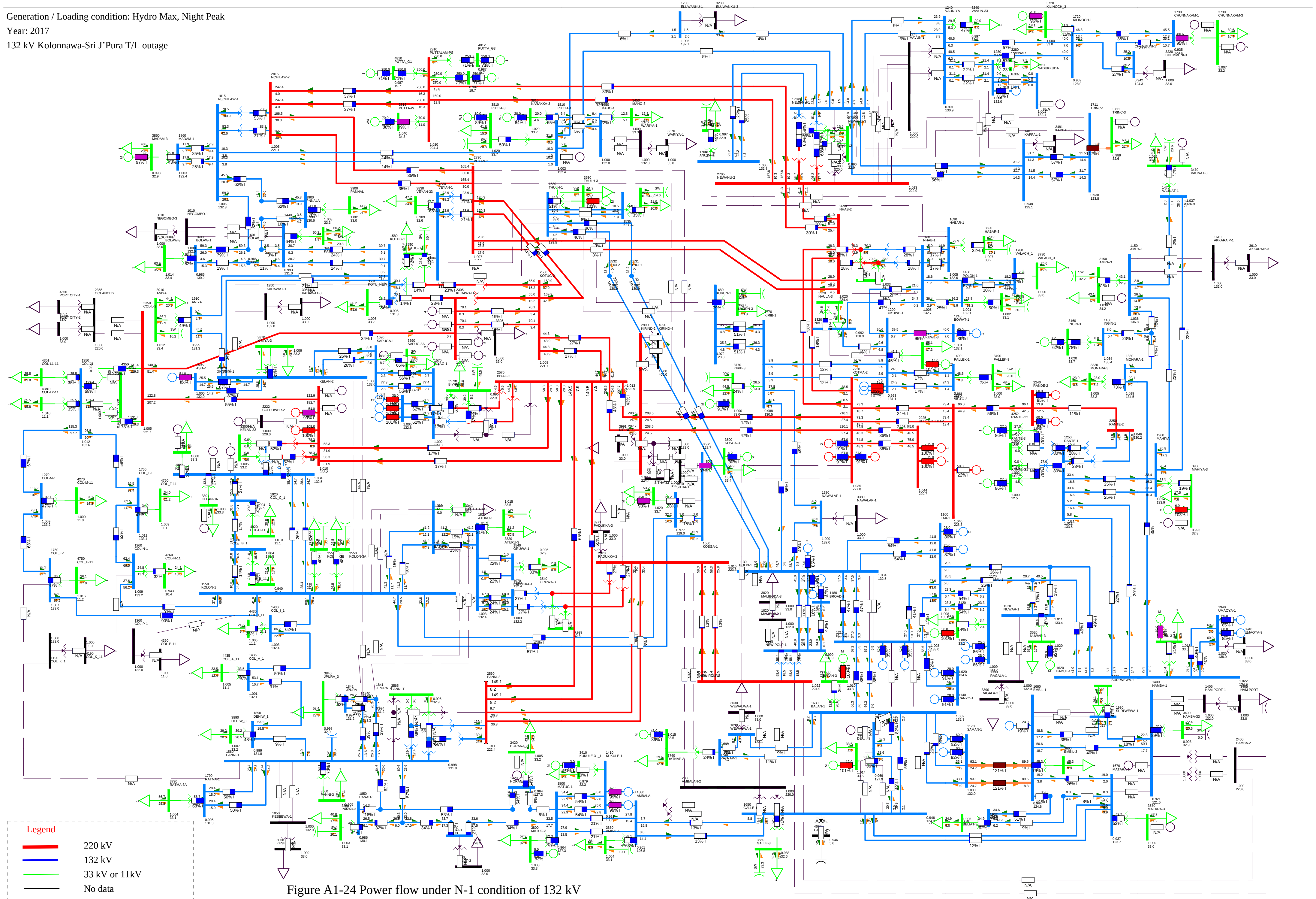


Figure A1-23 Power flow under N-1 condition of 132 kV Kolonnawa-Sri J'Pura T/L outage in 2017 on TMDP G/L scenario

Generation / Loading condition: Hydro Max, Night Peak

Year: 2017

132 kV Kolonnawa-Sri J'Pura T/L outage



Legend

220 kV

132 kV

33 kV or 11kV

No data

Overloaded equipment

[Continuous rate / Short-time rate] in MVA

Figure A1-24 Power flow under N-1 condition of 132 kV Kolonnawa-Sri J'Pura T/L outage in 2017 on HMNP G/L scenario

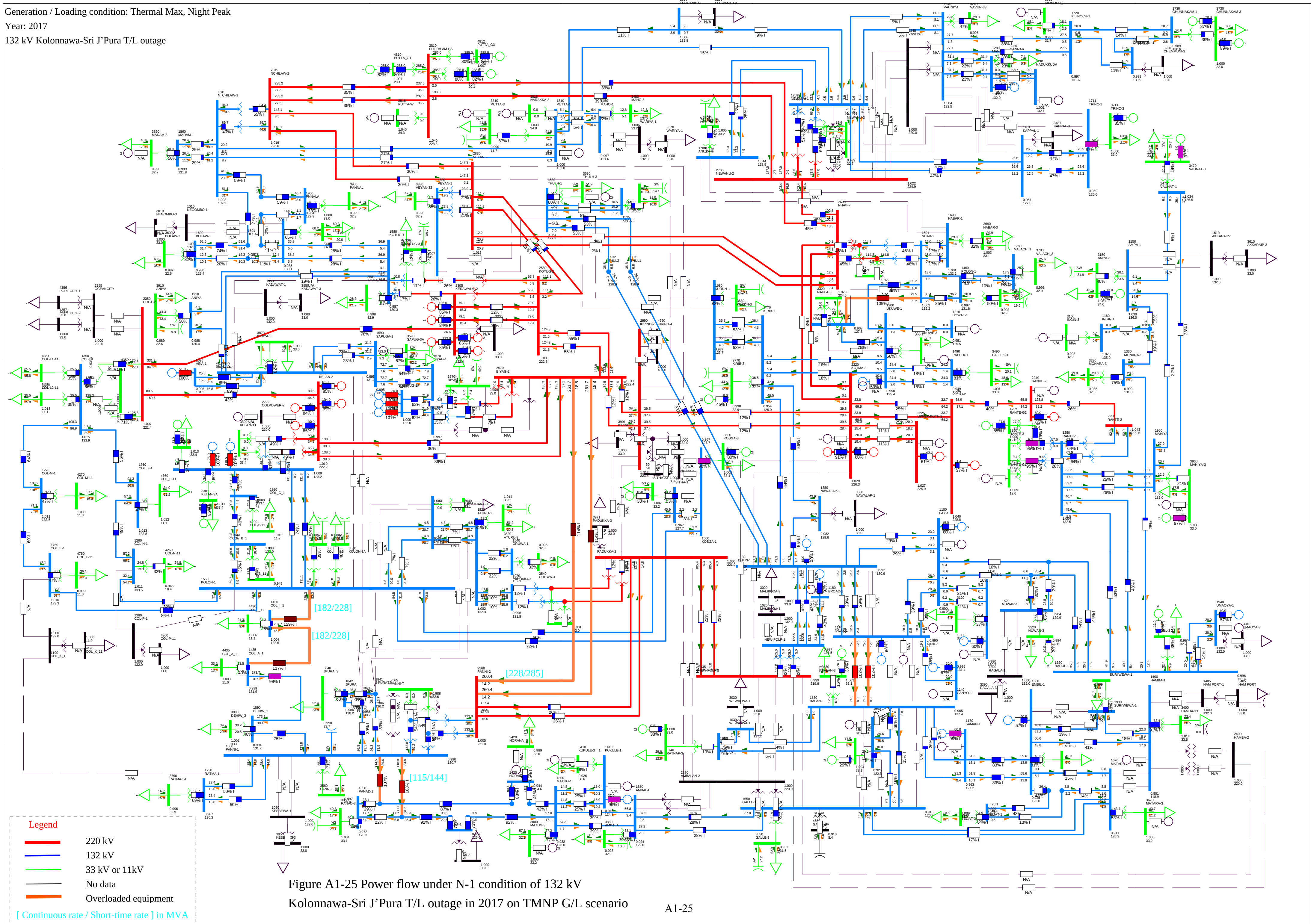
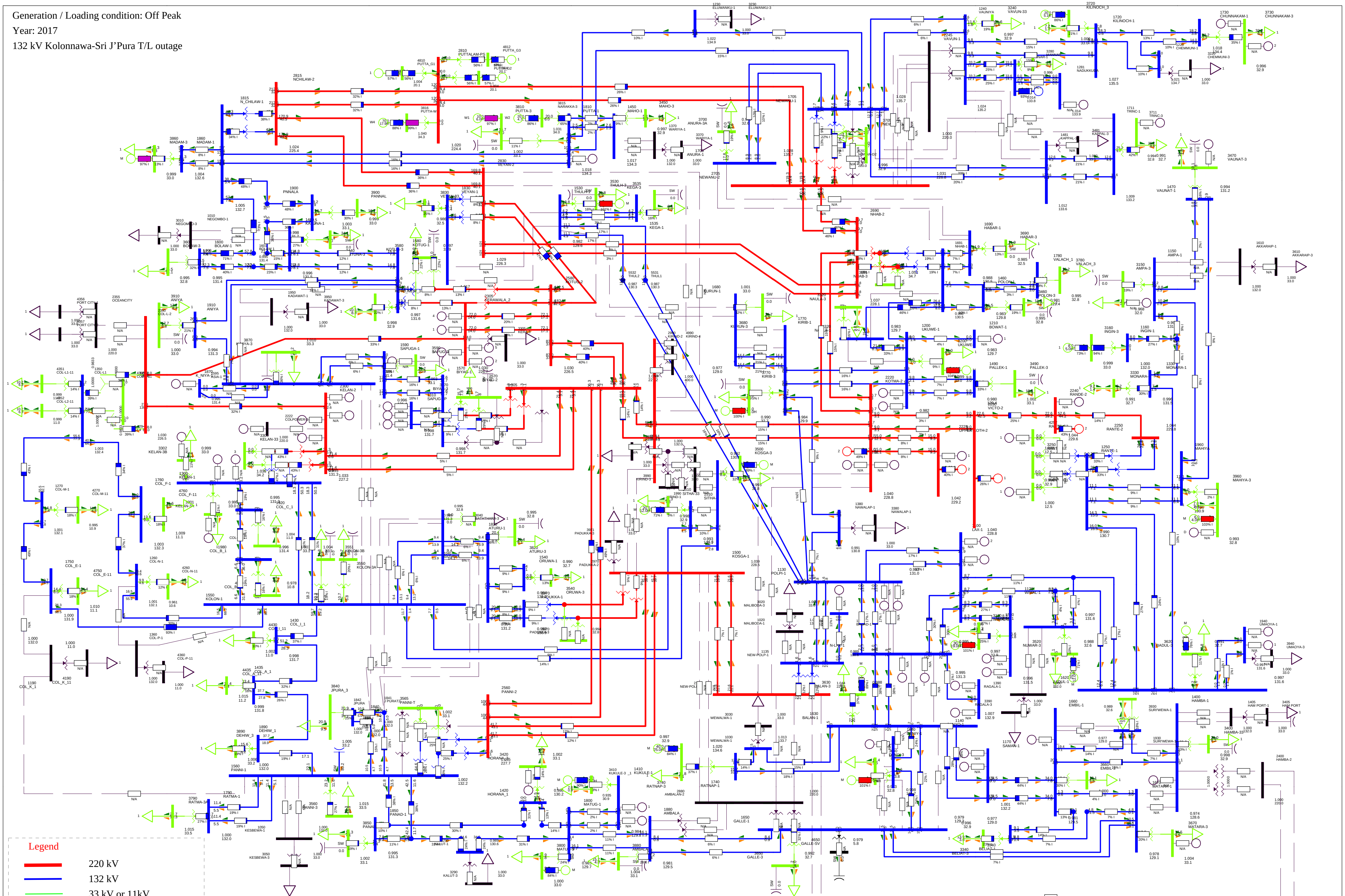


Figure A1-25 Power flow under N-1 condition of 132 kV Kolonnawa-Sri J'Pura T/L outage in 2017 on TMNP G/L scenario

Generation / Loading condition: Off Peak

Year: 2017

132 kV Kolonnawa-Sri J'Pura T/L outage



Legend

	220 kV
	132 kV
	33 kV or 11kV
	No data
	Overloaded equipment

[Continuous rate / Short-time rate] in MVA

Figure A1-26 Power flow under N-1 condition of 132 kV Kolonnawa-Sri J'Pura T/L outage in 2017 on OP G/L scenario

Generation / Loading condition: Hydro Max, Day Peak

Year: 2017

132 kV Pannipitiya-Sri J'Pura T/L outage

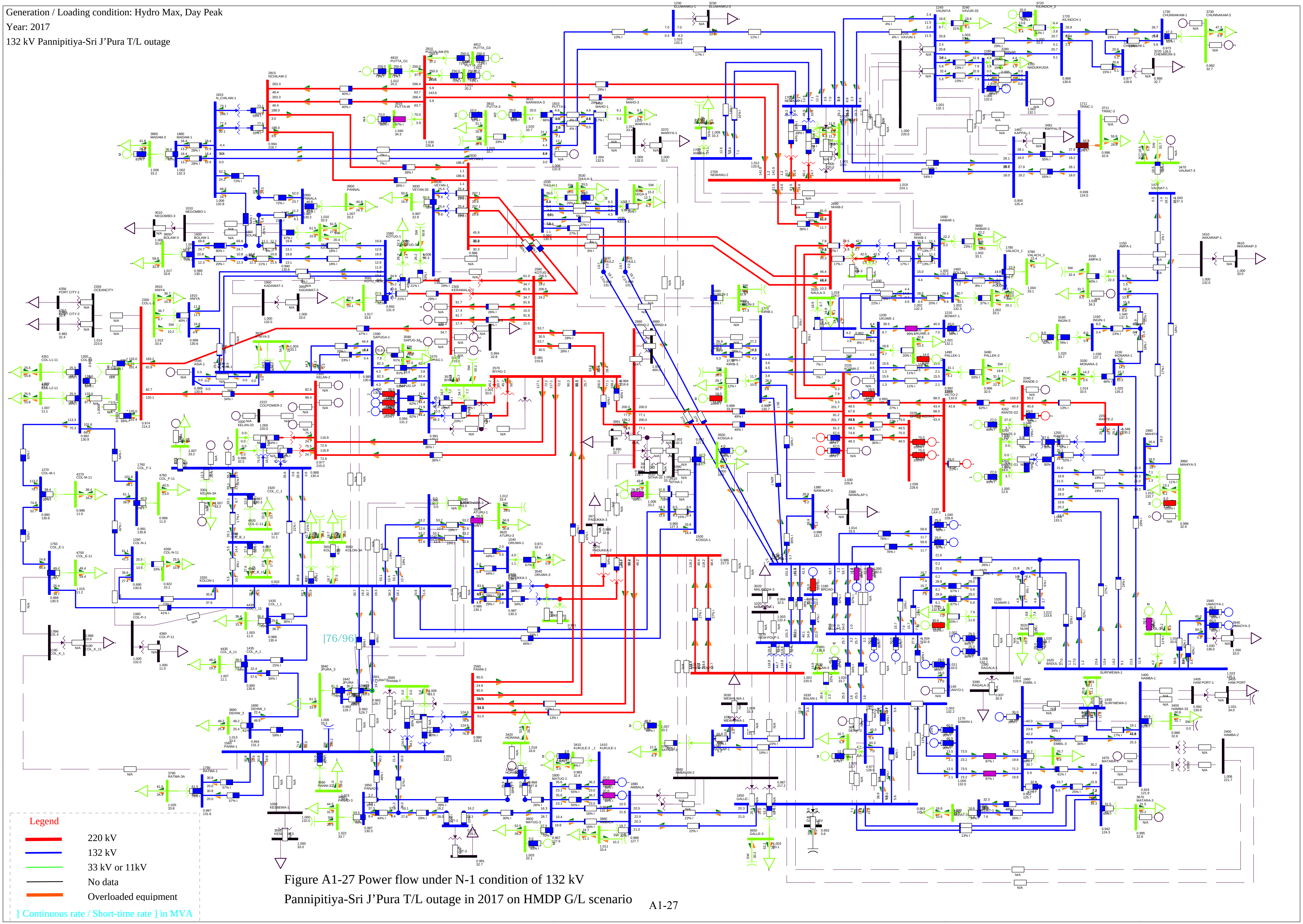
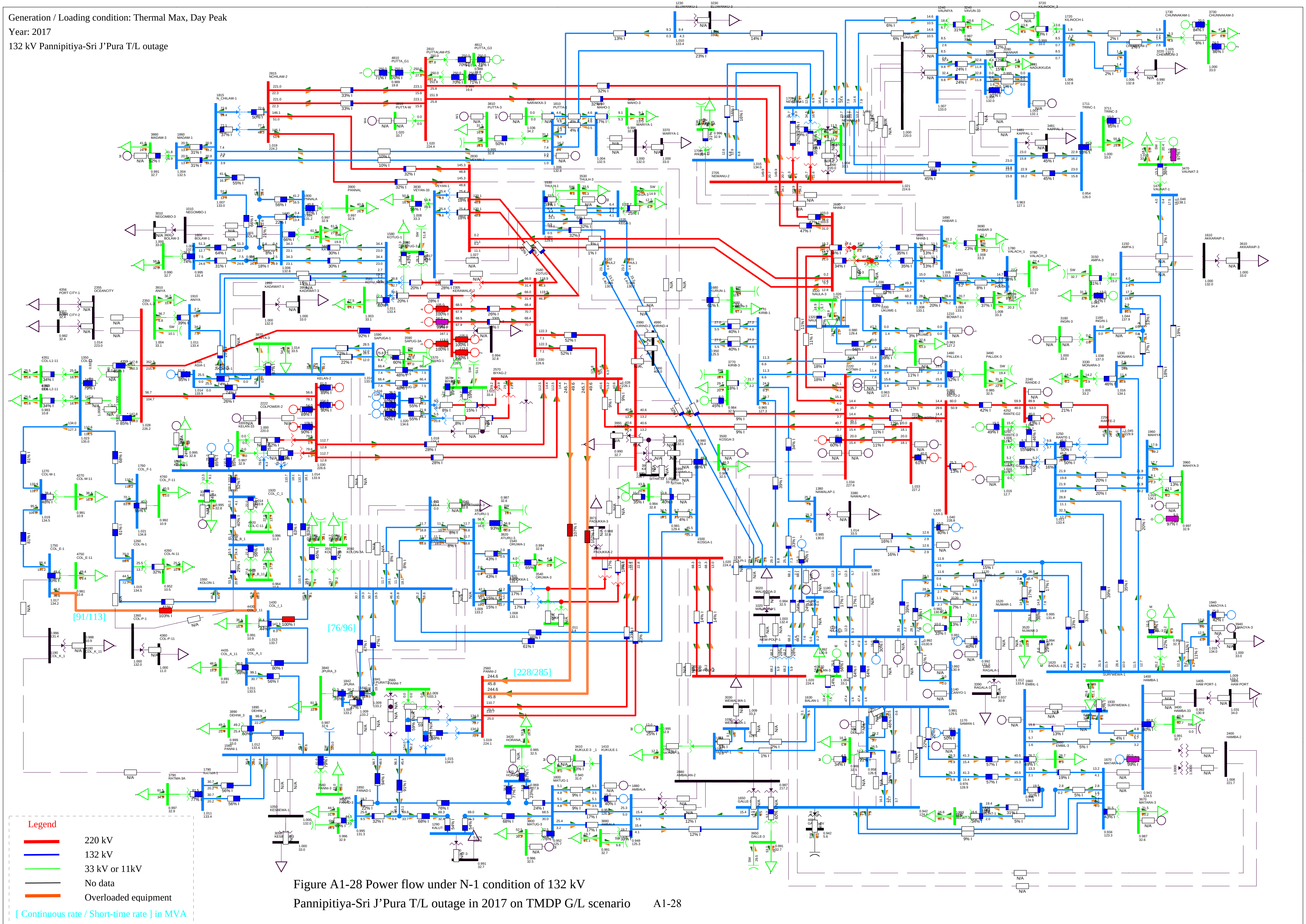


Figure A1-27 Power flow under N-1 condition of 132 kV Pannipitiya-Sri J'Pura T/L outage in 2017 on HMDP G/L scenario

Generation / Loading condition: Thermal Max, Day Peak

Year: 2017

132 kV Pannipitiya-Sri J'Pura T/L outage



Legend

220 kV

132 kV

33 kV or 11kV

No data

Overloaded equipment

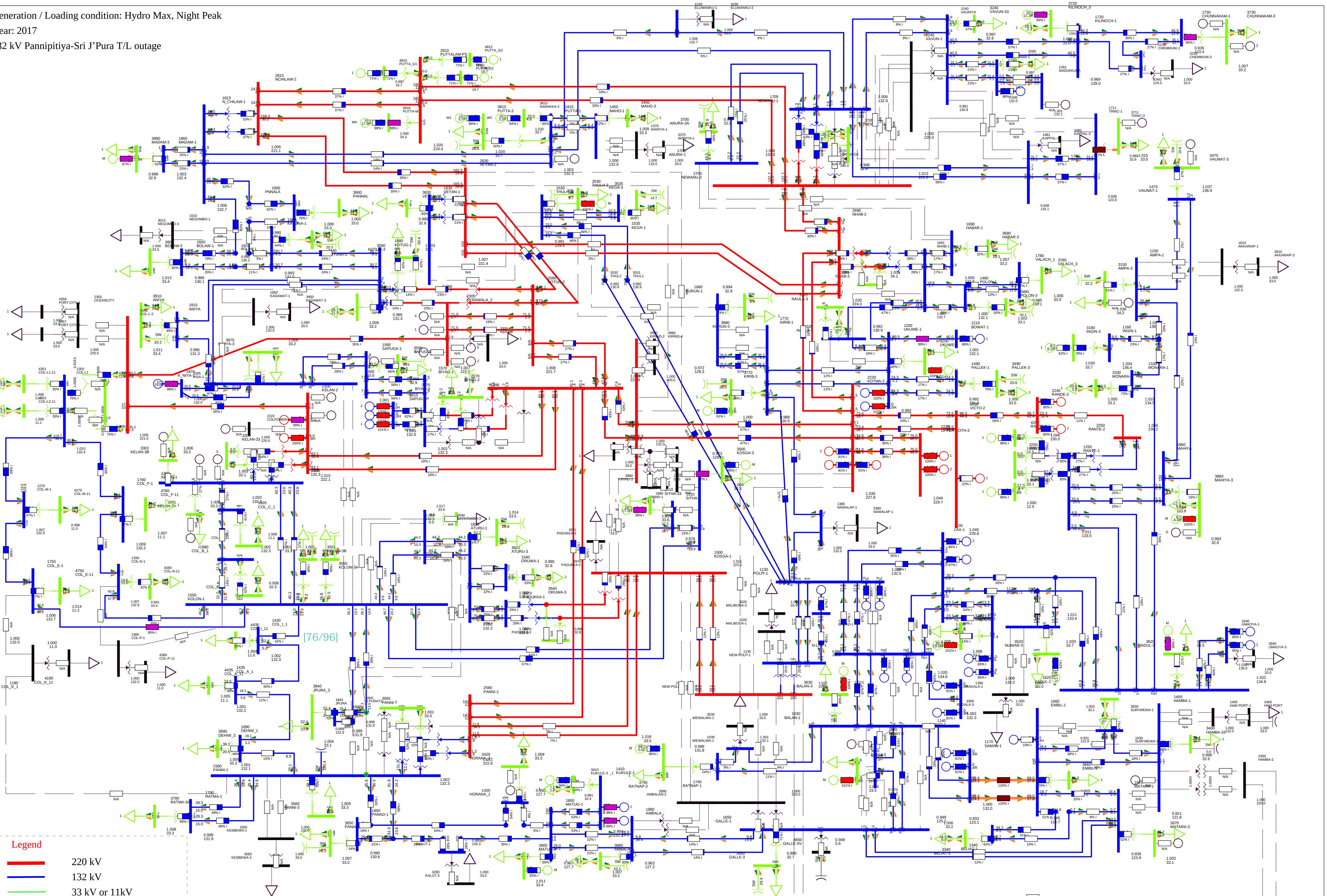
[Continuous rate / Short-time rate] in MVA

Figure A1-28 Power flow under N-1 condition of 132 kV Pannipitiya-Sri J'Pura T/L outage in 2017 on TMDP G/L scenario

Generation / Loading condition: Hydro Max, Night Peak

Year: 2017

132 kV Pannipitiya-Sri J'Pura T/L outage



Legend

220 kV

132 kV

33 kV or 11kV

No data

Overloaded equipment

[Continuous rate / Short-time rate] in MVA

Figure A1-29 Power flow under N-1 condition of 132 kV Pannipitiya-Sri J'Pura T/L outage in 2017 on HMNP G/L scenario

Generation / Loading condition: Thermal Max, Night Peak

Year: 2017

132 kV Pannipitiya-Sri J'Pura T/L outage

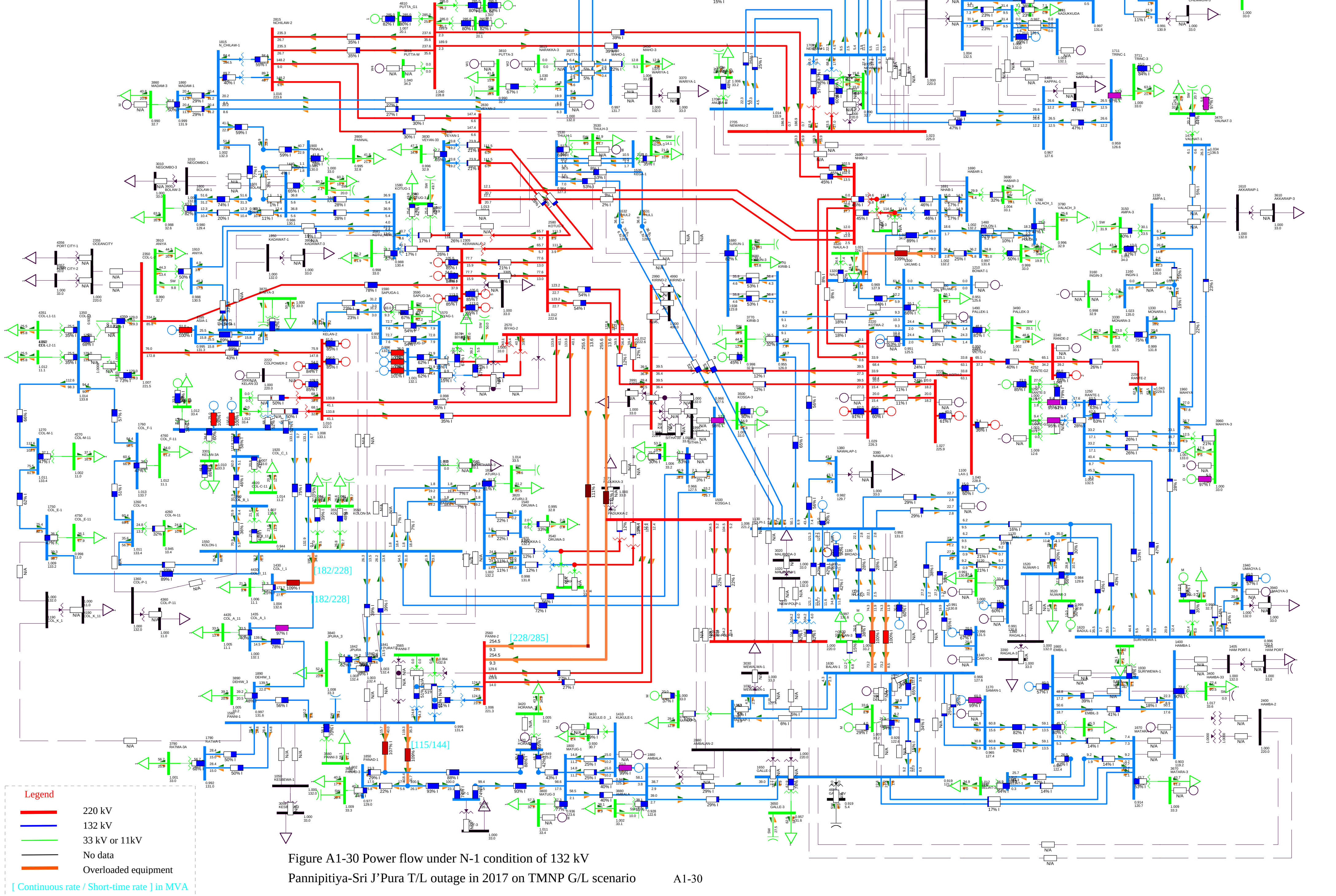


Figure A1-30 Power flow under N-1 condition of 132 kV Pannipitiya-Sri J'Pura T/L outage in 2017 on TMNP G/L scenario

Generation / Loading condition: Off Peak

Year: 2017

132 kV Kolonnawa-Sri J'Pura T/L outage

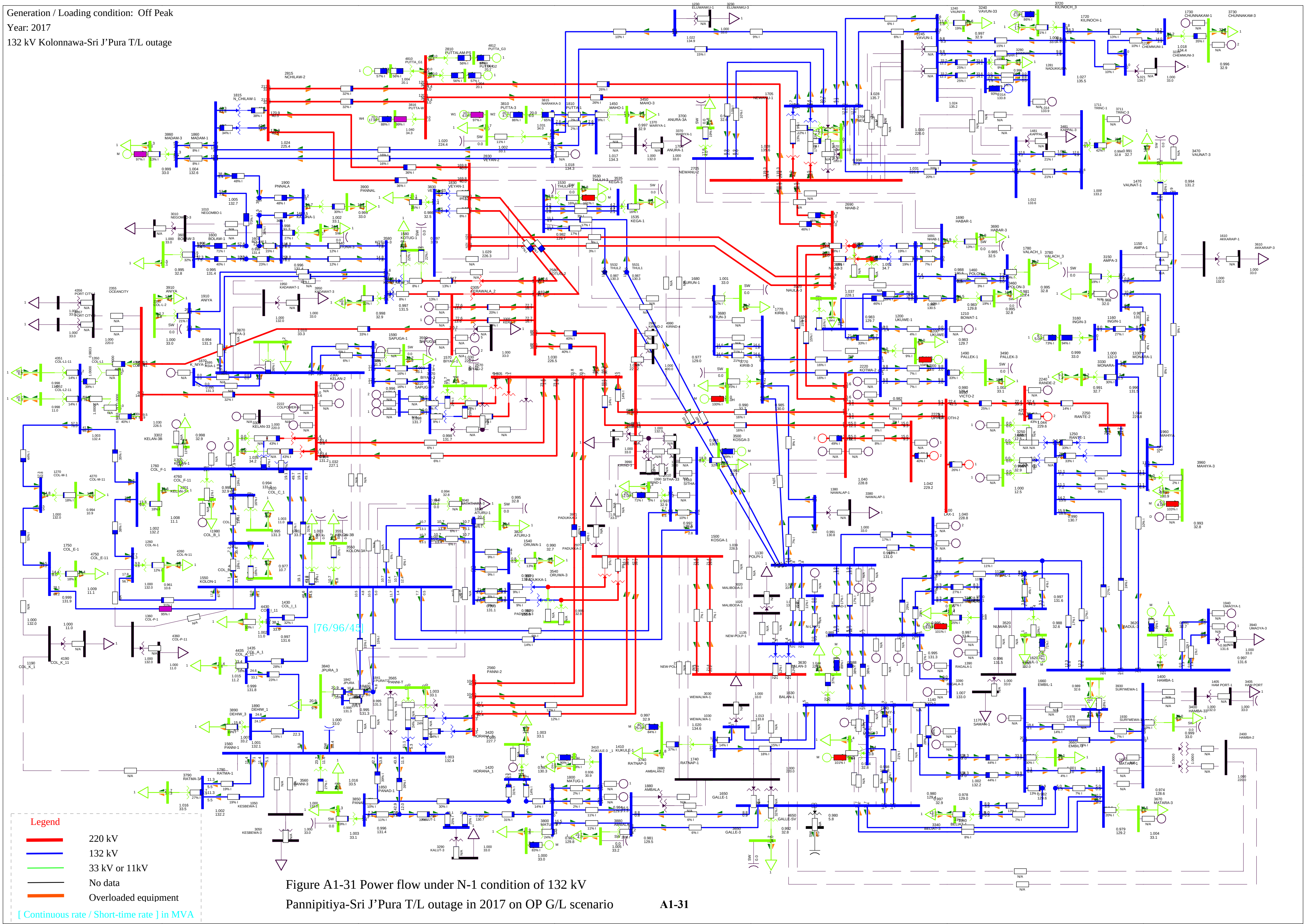


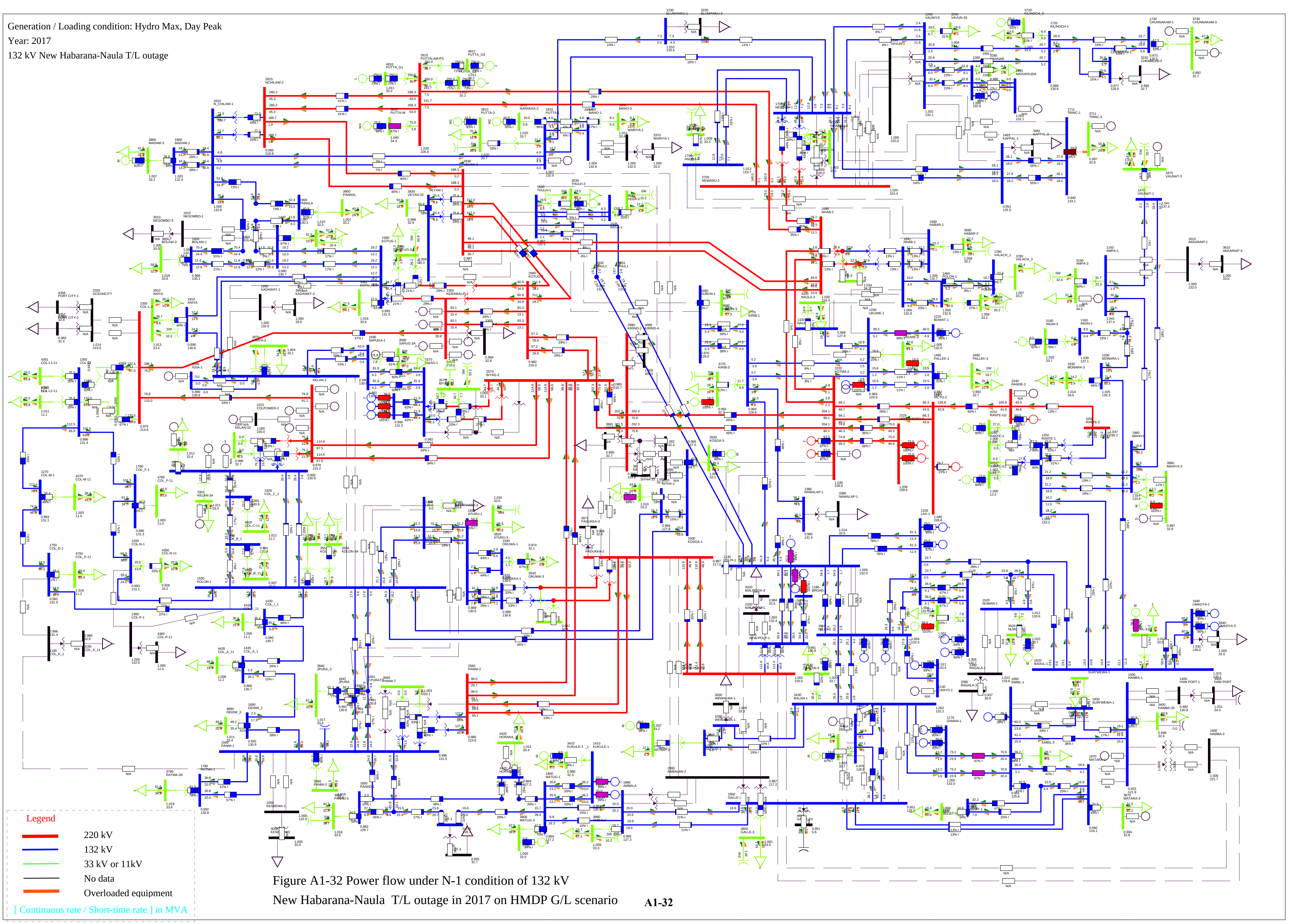
Figure A1-31 Power flow under N-1 condition of 132 kV Pannipitiya-Sri J'Pura T/L outage in 2017 on OP G/L scenario

A1-31

Generation / Loading condition: Hydro Max, Day Peak

Year: 2017

132 kV New Habarana-Naula T/L outage



Legend

220 kV

132 kV

33 kV or 11kV

No data

Overloaded equipment

[Continuous rate / Short-time rate] in MVA

Figure A1-32 Power flow under N-1 condition of 132 kV New Habarana-Naula T/L outage in 2017 on HMDP G/L scenario

Generation / Loading condition: Thermal Max, Day Peak

Year: 2017

132 kV New Habarana-Naula T/L outage

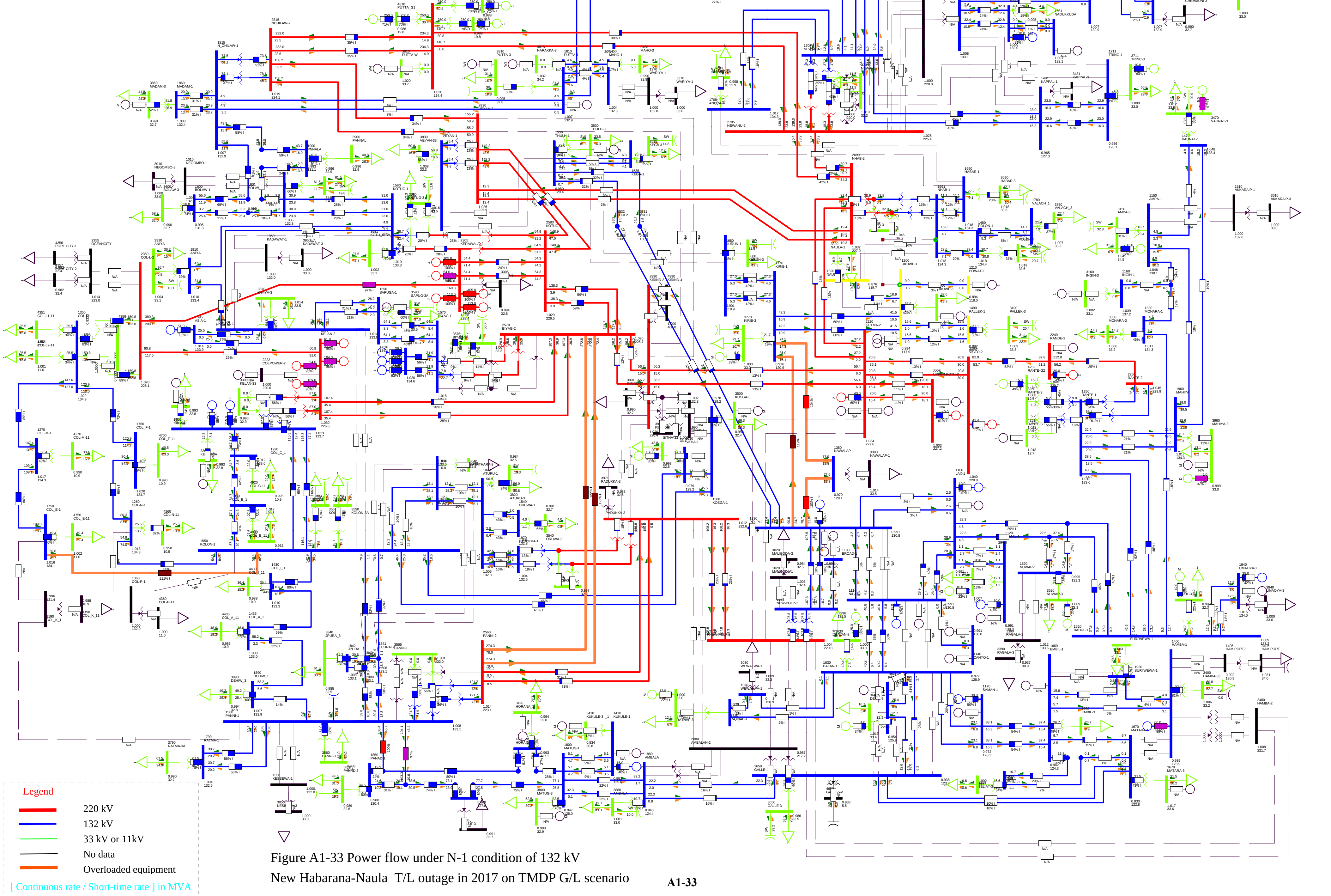


Figure A1-33 Power flow under N-1 condition of 132 kV New Habarana-Naula T/L outage in 2017 on TMDP G/L scenario

Generation / Loading condition: Hydro Max, Night Peak

Year: 2017

132 kV New Habarana-Naula T/L outage

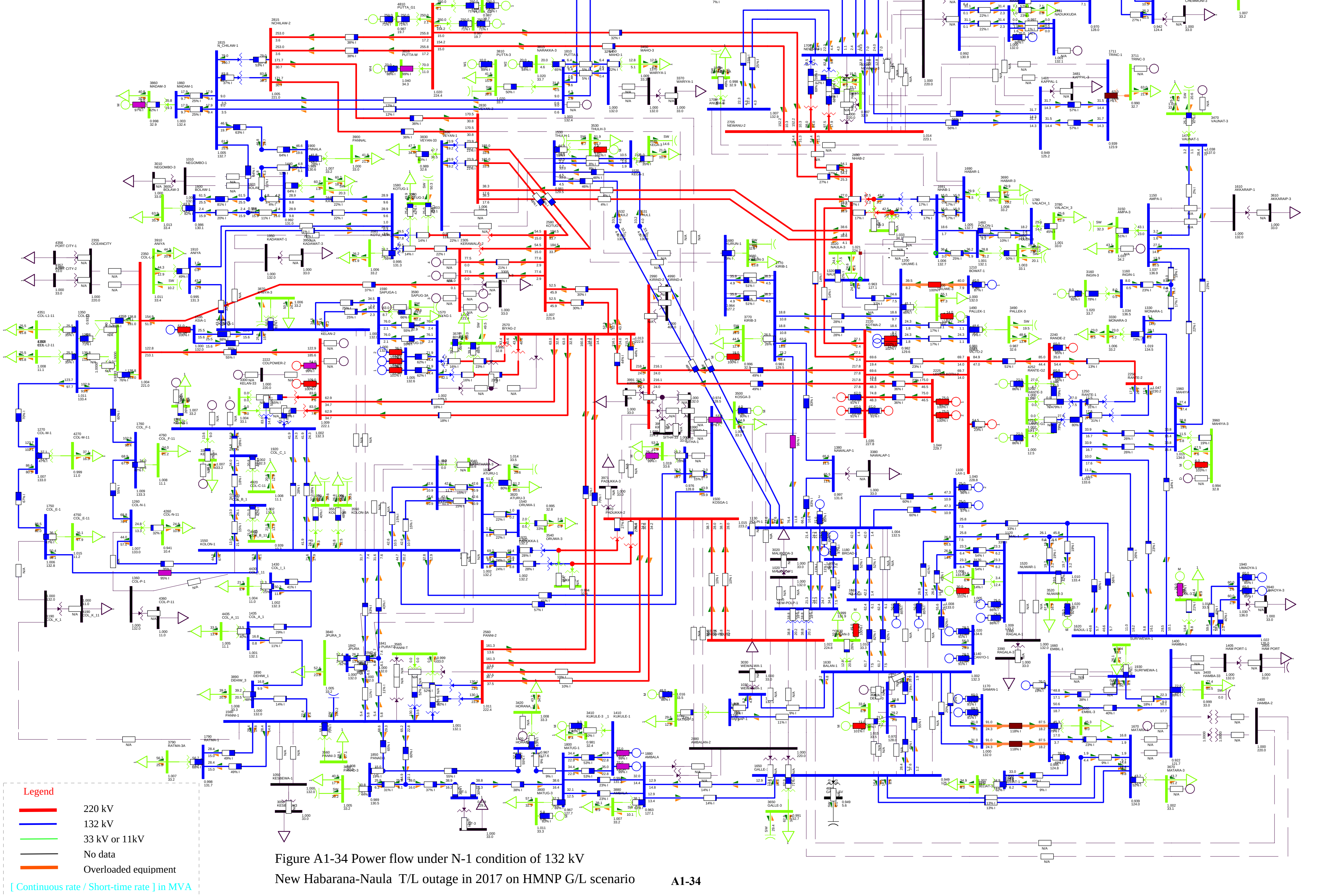


Figure A1-34 Power flow under N-1 condition of 132 kV New Habarana-Naula T/L outage in 2017 on HMNP G/L scenario

Generation / Loading condition: Thermal Max, Night Peak

Year: 2017

132 kV New Habarana-Naula T/L outage

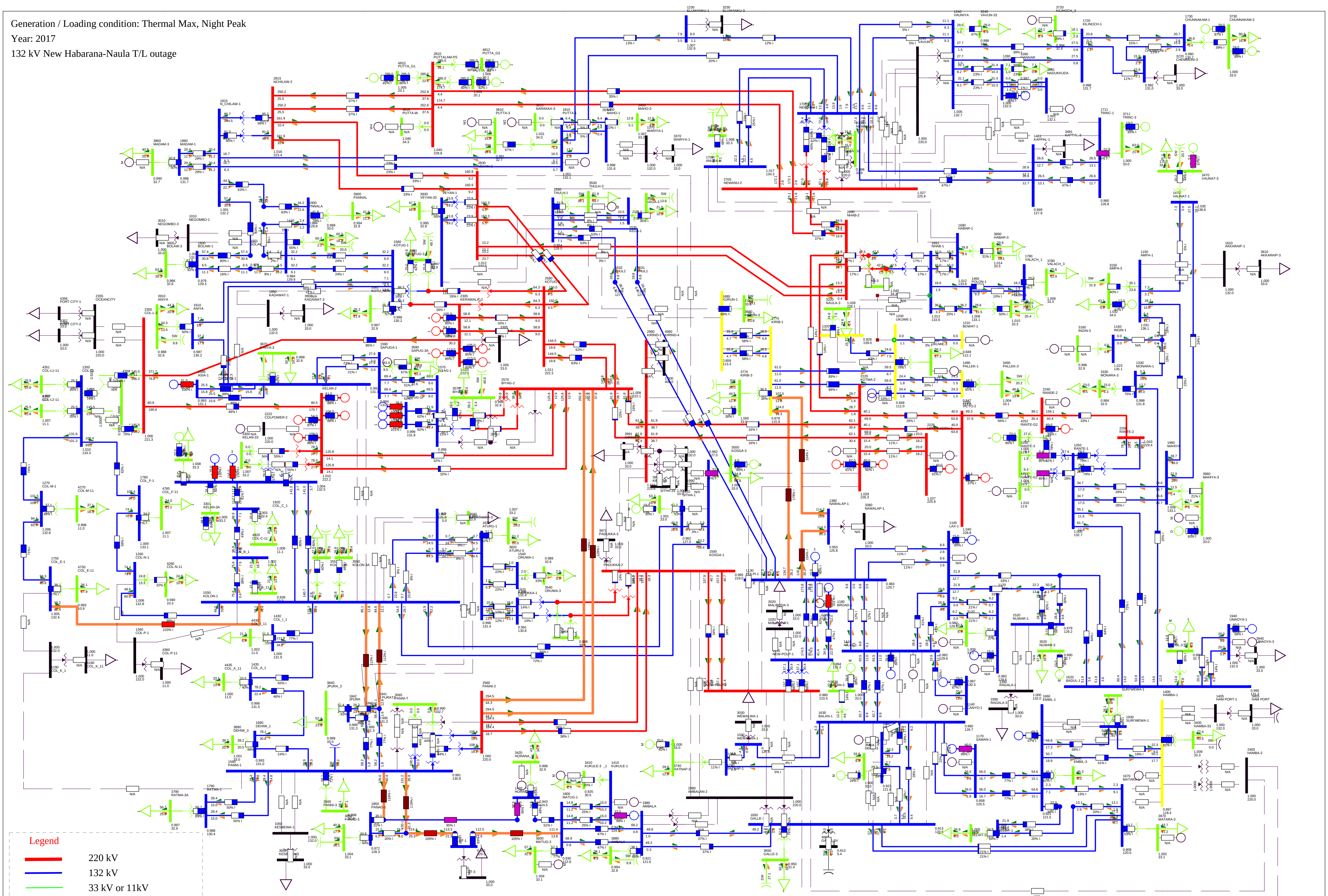
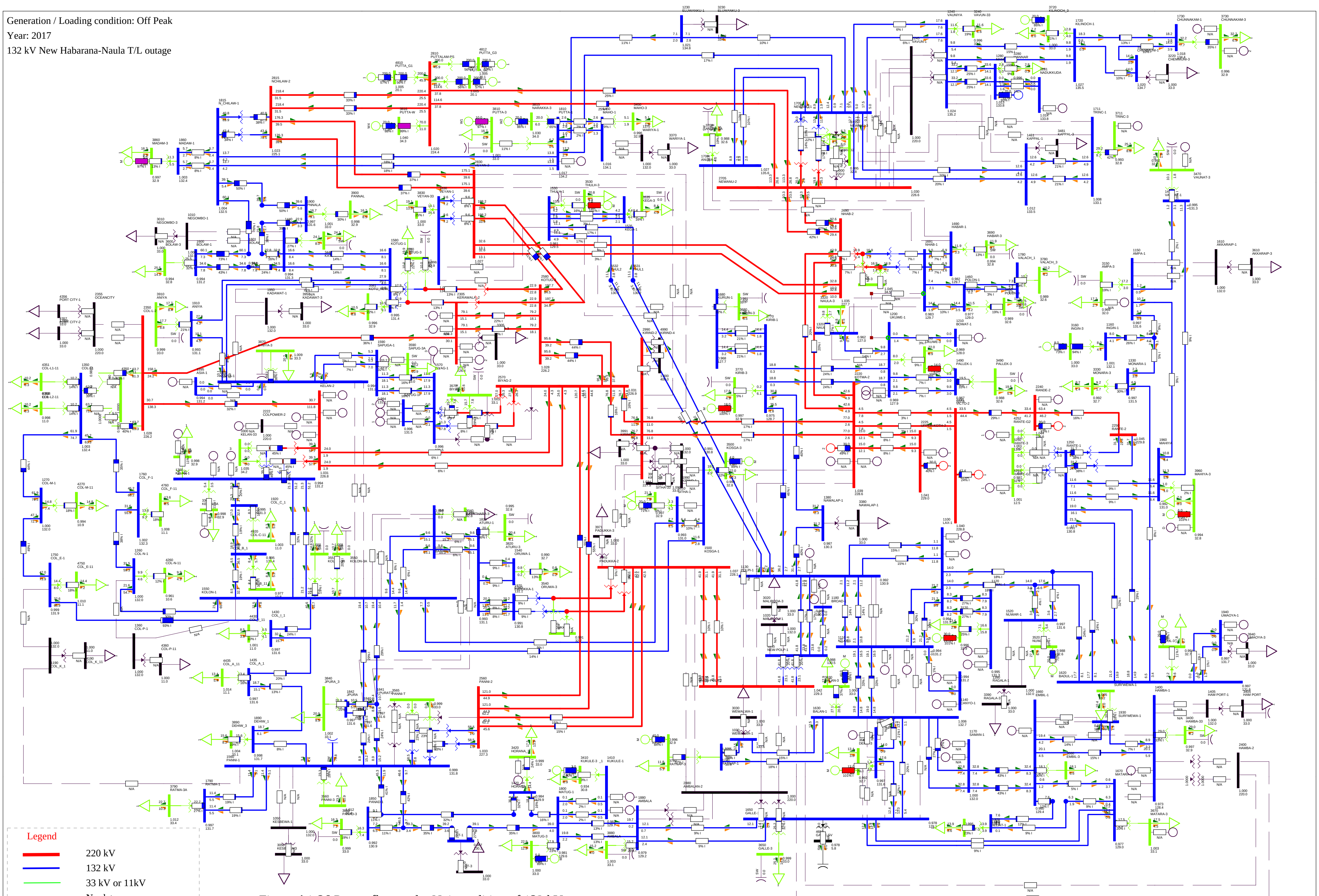


Figure A1-35 Power flow under N-1 condition of 132 kV New Habarana-Naula T/L outage in 2017 on TMNP G/L scenario

Generation / Loading condition: Off Peak

Year: 2017

132 kV New Habarana-Naula T/L outage



Legend

220 kV

132 kV

33 kV or 11kV

No data

Overloaded equipment

[Continuous rate / Short-time rate] in MVA

Figure A1-36 Power flow under N-1 condition of 132 kV New Habarana-Naula T/L outage in 2017 on OP G/L scenario

Generation / Loading condition: Hydro Max, Day Peak

Year: 2017

132 kV Ukuwela-Naula T/L outage

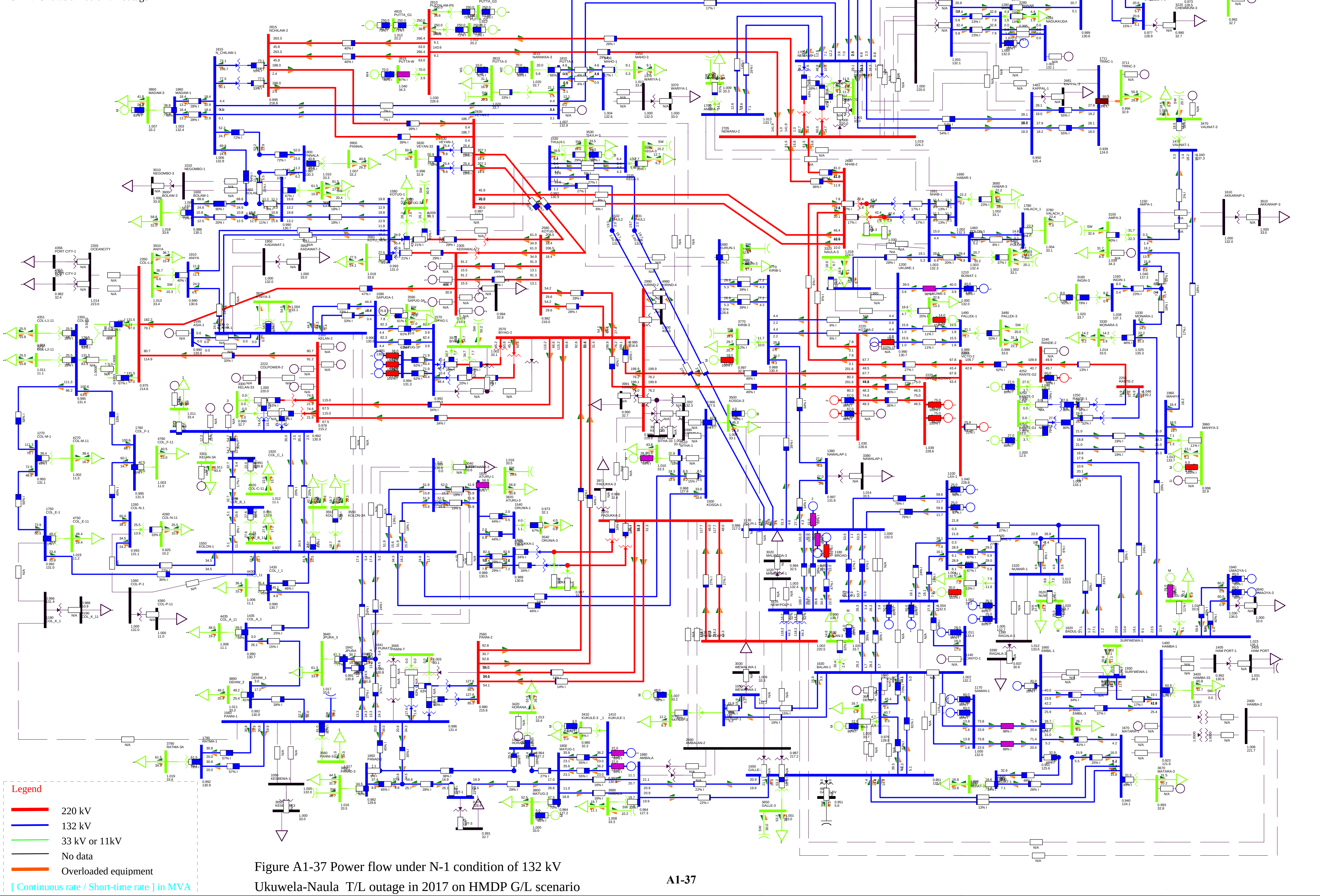


Figure A1-37 Power flow under N-1 condition of 132 kV Ukuwela-Naula T/L outage in 2017 on HMDP G/L scenario

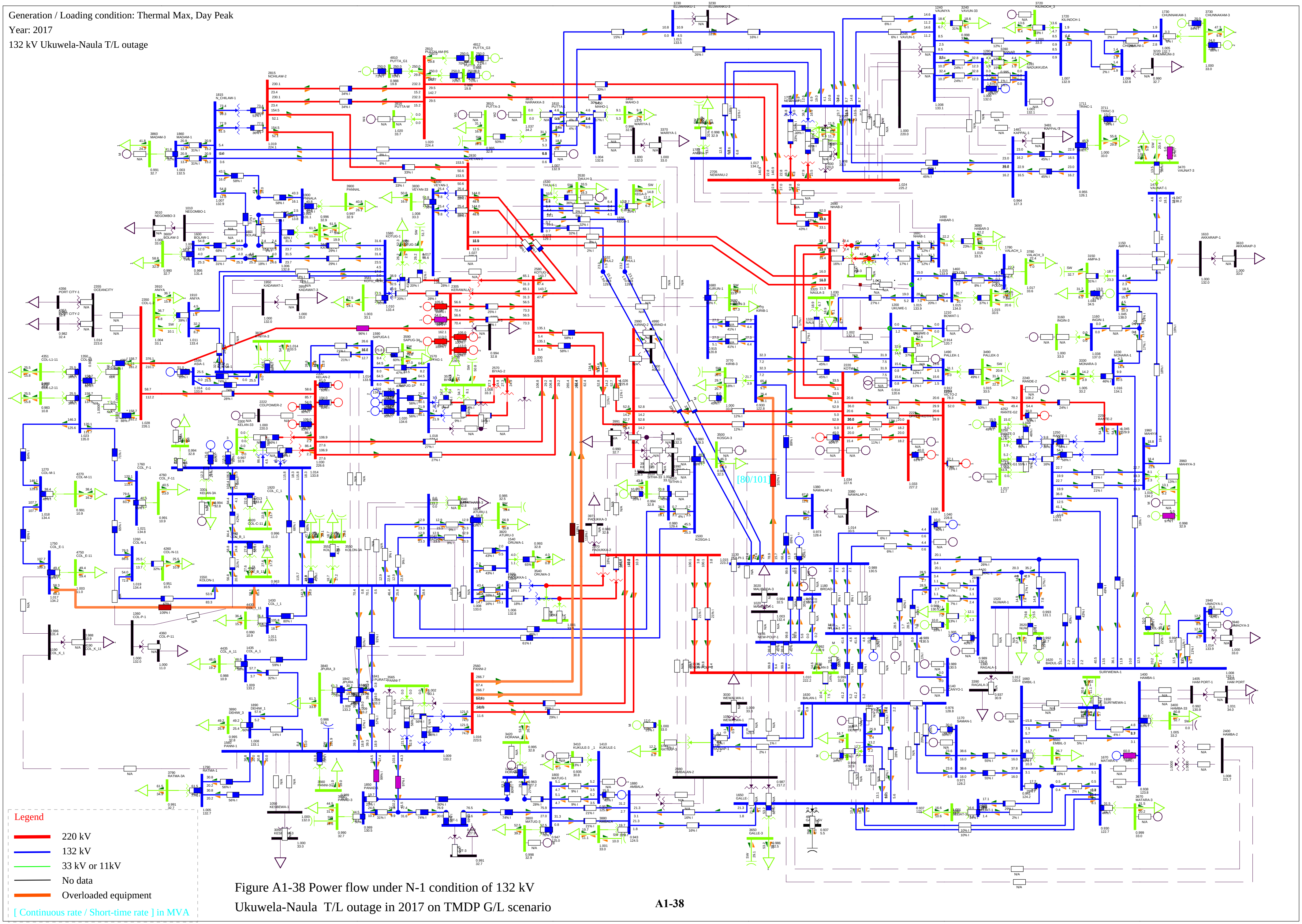


Figure A1-38 Power flow under N-1 condition of 132 kV Ukuwela-Naula T/L outage in 2017 on TMDP G/L scenario

Generation / Loading condition: Hydro Max, Night Peak

Year: 2017

132 kV Ukuwela-Naula T/L outage

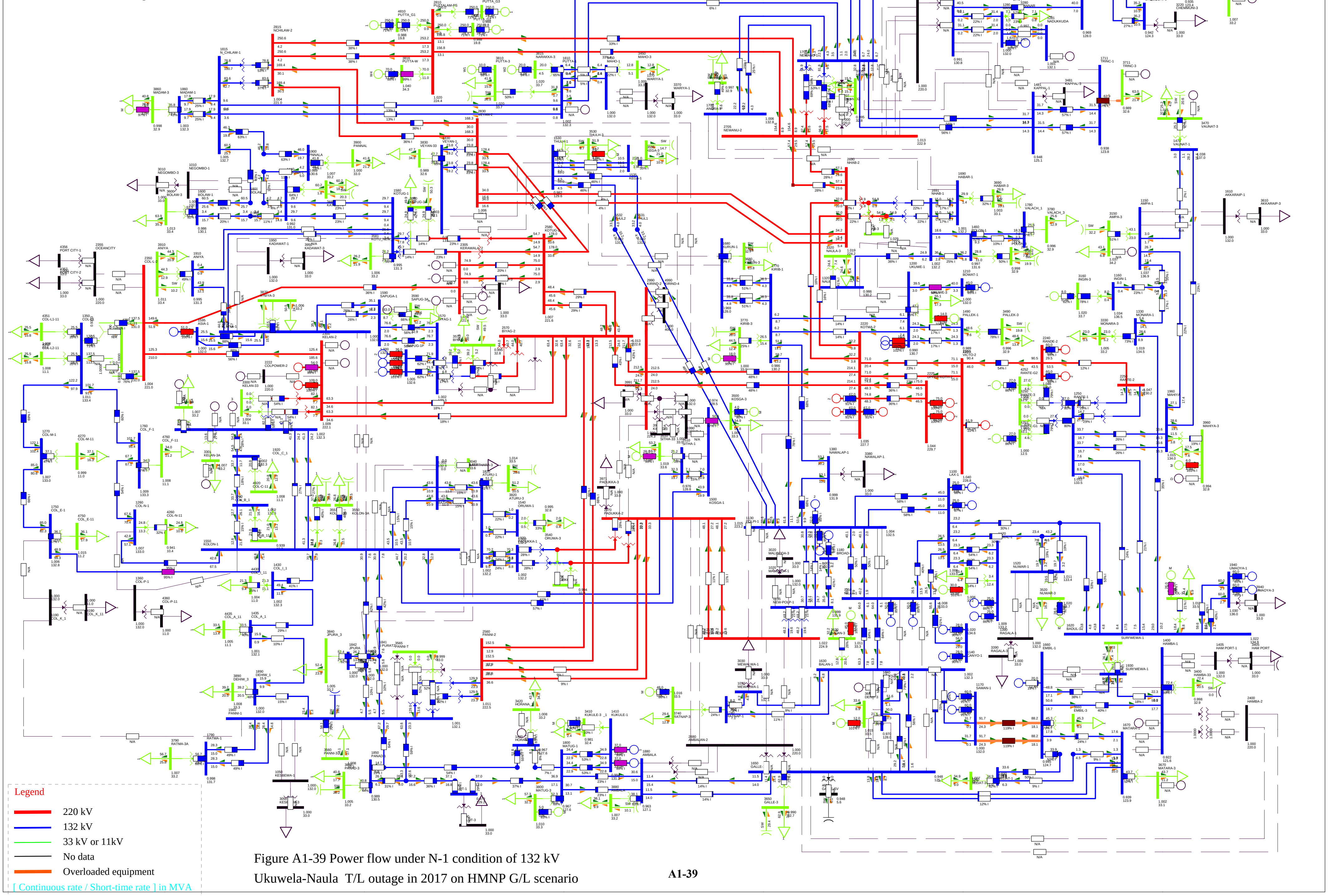


Figure A1-39 Power flow under N-1 condition of 132 kV Ukuwela-Naula T/L outage in 2017 on HMNP G/L scenario

Generation / Loading condition: Thermal Max, Night Peak

Year: 2017

132 kV Ukuwela-Naula T/L outage

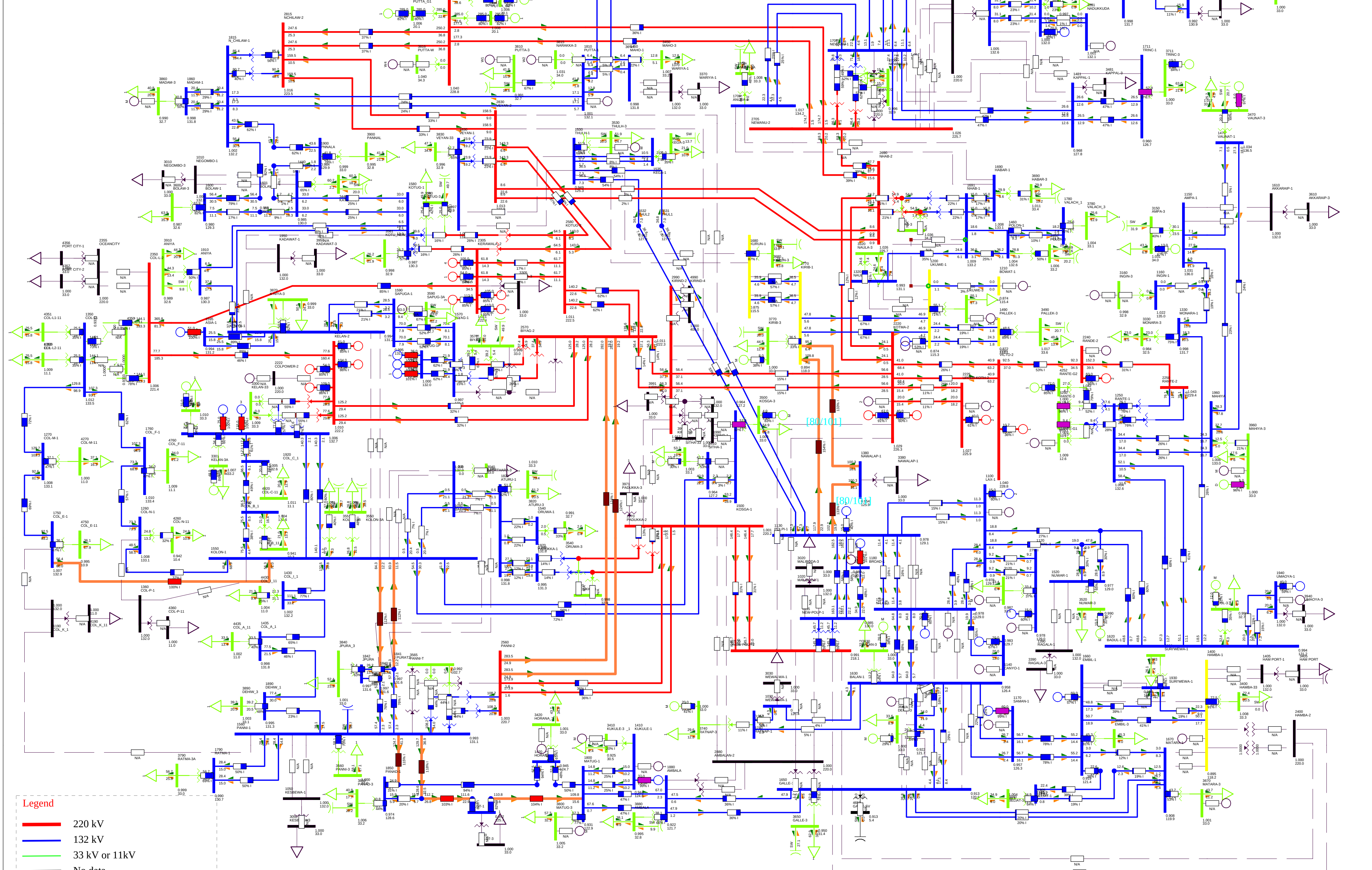
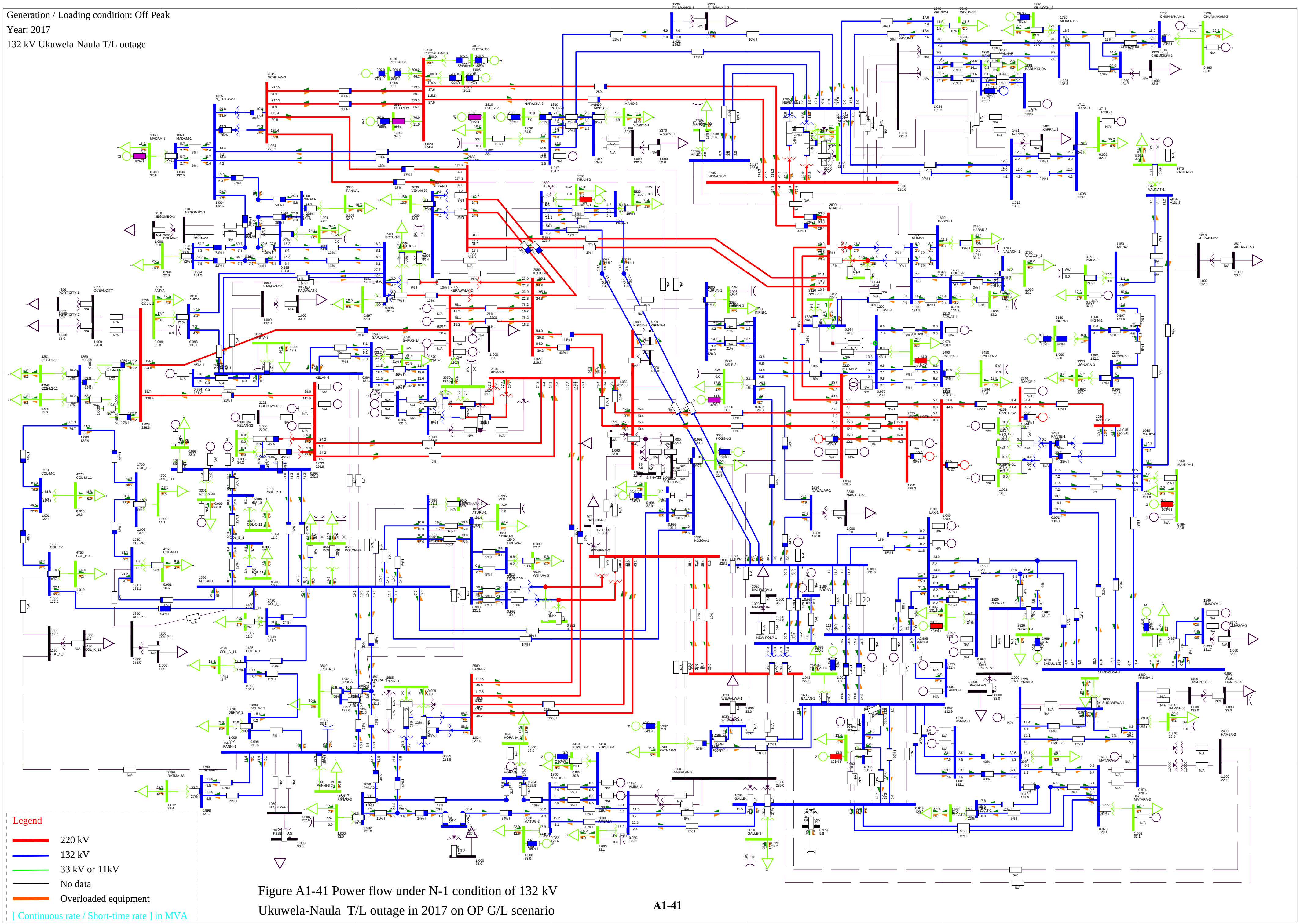


Figure A1-40 Power flow under N-1 condition of 132 kV Ukuwela-Naula T/L outage in 2017 on TMNP G/L scenario

Generation / Loading condition: Off Peak

Year: 2017

132 kV Ukuwela-Naula T/L outage



Legend

220 kV

132 kV

33 kV or 11kV

No data

Overloaded equipment

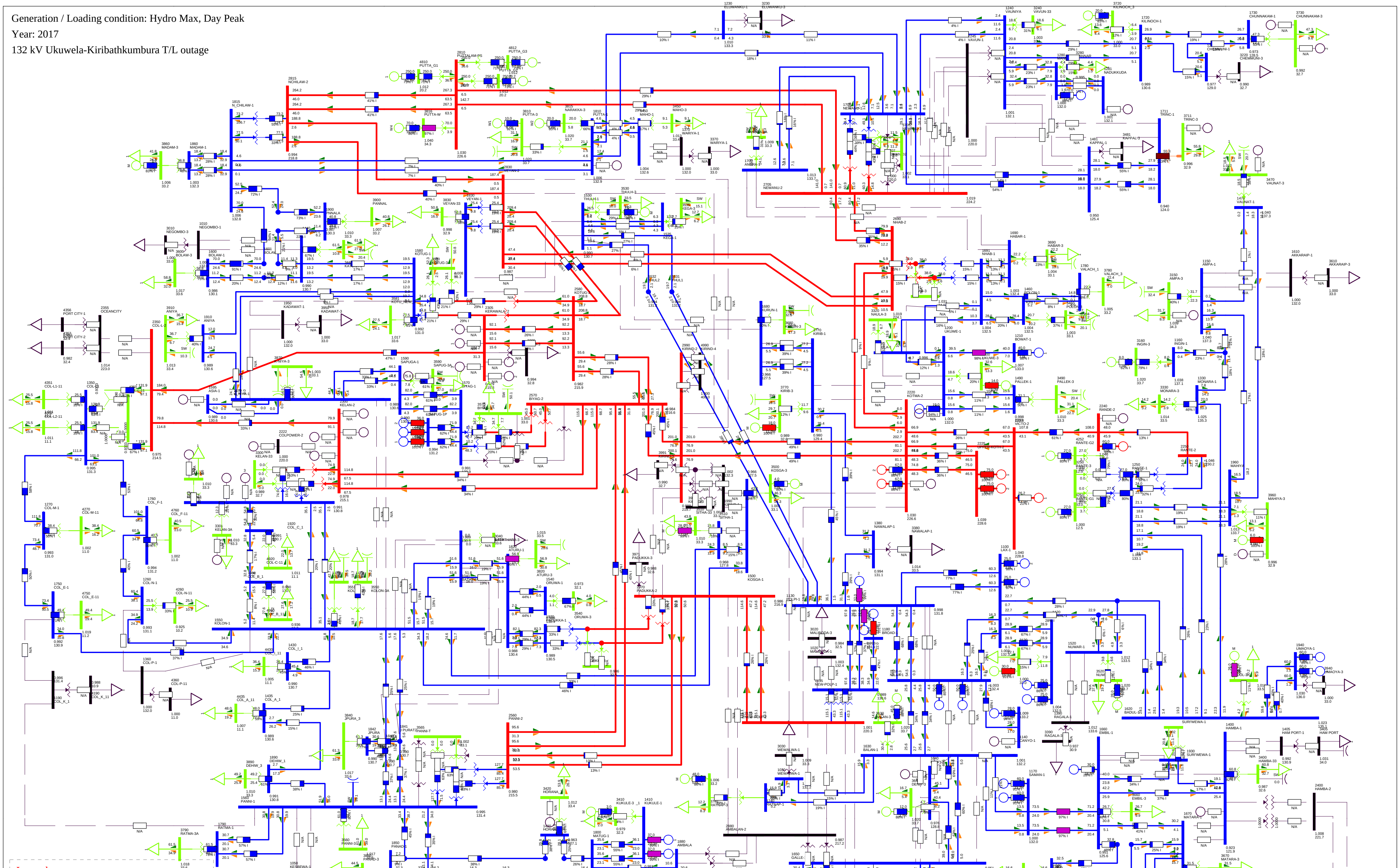
[Continuous rate / Short-time rate] in MVA

Figure A1-41 Power flow under N-1 condition of 132 kV Ukuwela-Naula T/L outage in 2017 on OP G/L scenario

Generation / Loading condition: Hydro Max, Day Peak

Year: 2017

132 kV Ukuwela-Kiribathkumbura T/L outage



Legend

220 kV

132 kV

33 kV or 11kV

No data

Overloaded equipment

[Continuous rate / Short-time rate] in MVA

Figure A1-42 Power flow under N-1 condition of 132 kV Ukuwela-Kiribathkumbura T/L outage in 2017 on HMDP G/L scenario

Generation / Loading condition: Thermal Max, Day Peak

Year: 2017

132 kV Ukuwela-Kiribathkumbura T/L outage

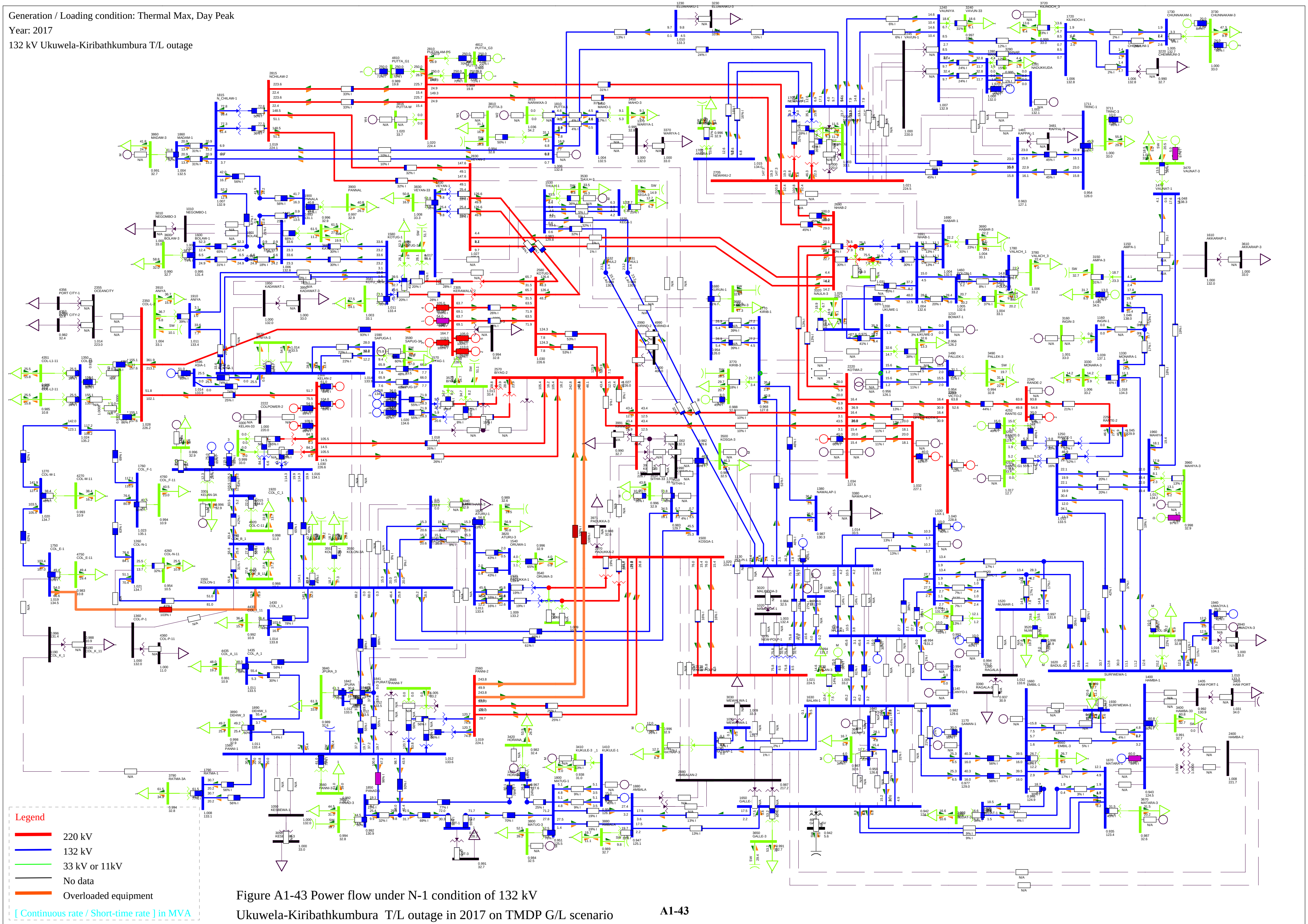
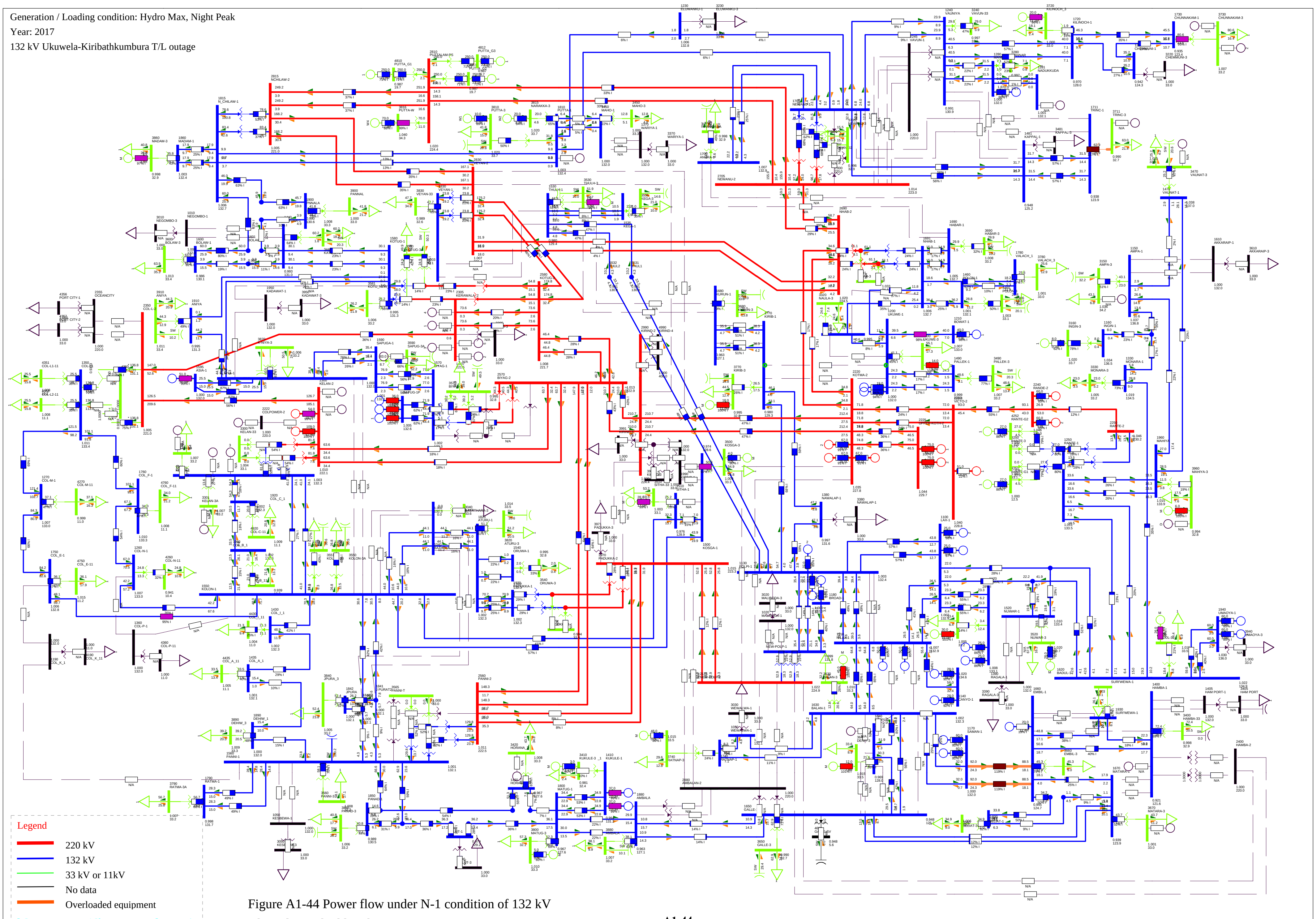


Figure A1-43 Power flow under N-1 condition of 132 kV Ukuwela-Kiribathkumbura T/L outage in 2017 on TMDP G/L scenario

Generation / Loading condition: Hydro Max, Night Peak
Year: 2017
132 kV Ukuwela-Kiribathkumbura T/L outage



Legend

- 220 kV
- 132 kV
- 33 kV or 11kV
- No data
- Overloaded equipment

[Continuous rate / Short-time rate] in MVA

Figure A1-44 Power flow under N-1 condition of 132 kV Ukuwela-Kiribathkumbura T/L outage in 2017 on HMNP G/L scenario

Generation / Loading condition: Thermal Max, Night Peak

Year: 2017

132 kV Ukuwela-Kiribathkumbura T/L outage

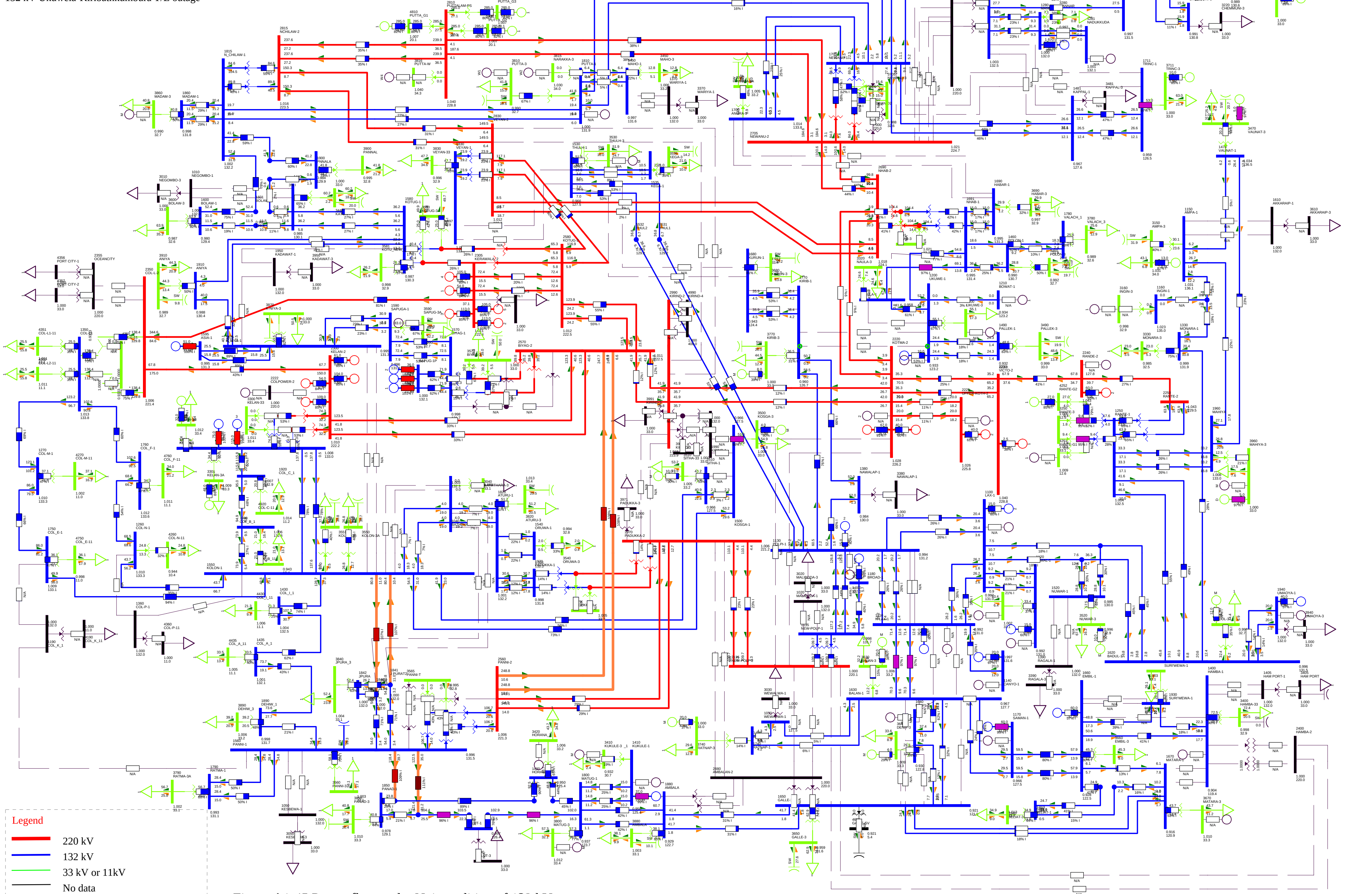
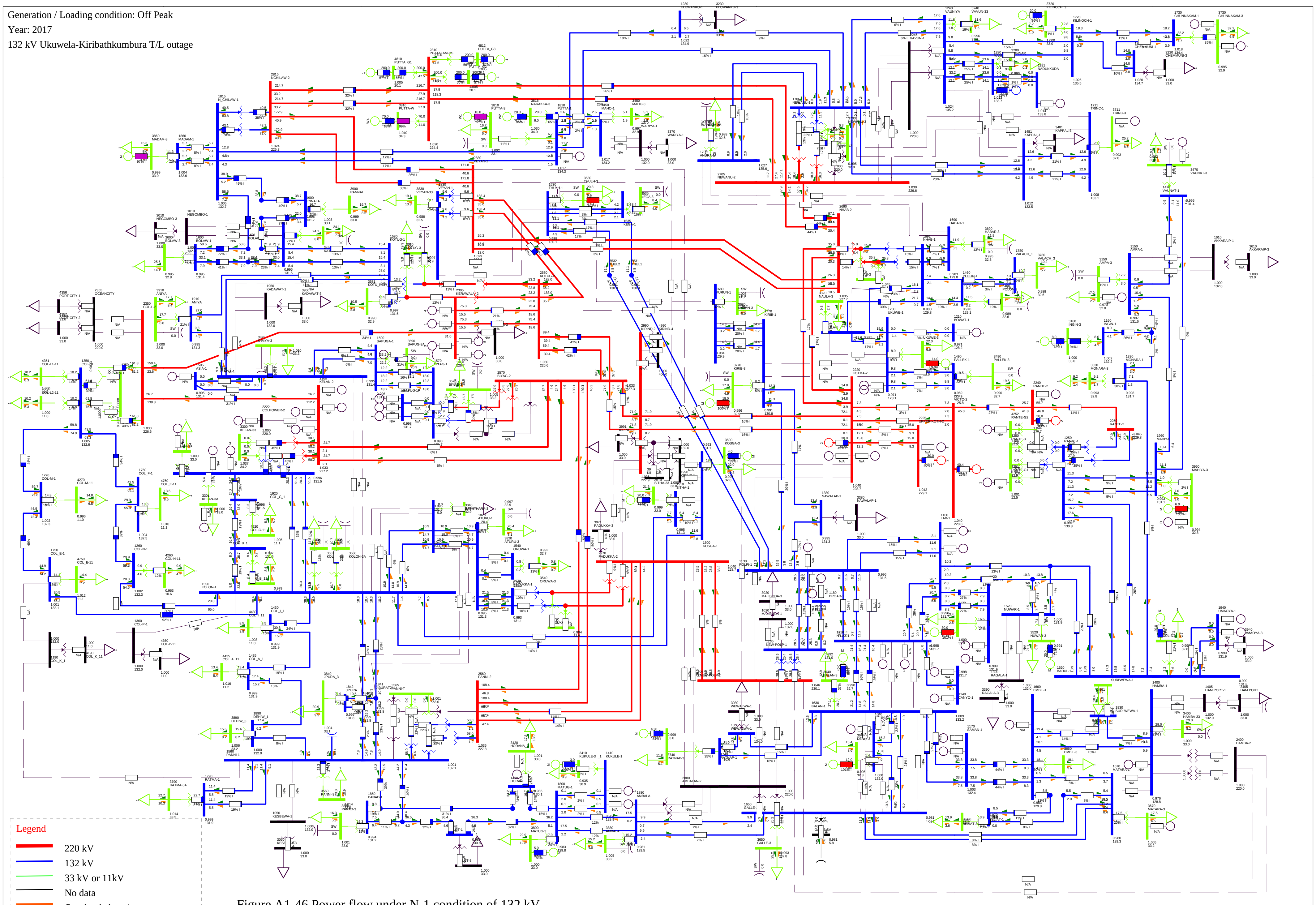


Figure A1-45 Power flow under N-1 condition of 132 kV Ukuwela-Kiribathkumbura T/L outage in 2017 on TMNP G/L scenario

Generation / Loading condition: Off Peak

Year: 2017

132 kV Ukuwela-Kiribathkumbura T/L outage



Legend

220 kV

132 kV

33 kV or 11kV

No data

Overloaded equipment

[Continuous rate / Short-time rate] in MVA

Figure A1-46 Power flow under N-1 condition of 132 kV Ukuwela-Kiribathkumbura T/L outage in 2017 on OP G/L scenario

Generation / Loading condition: Hydro Max, Day Peak

Year: 2017

132 kV Polpitiya-Kiribathkumbura T/L outage

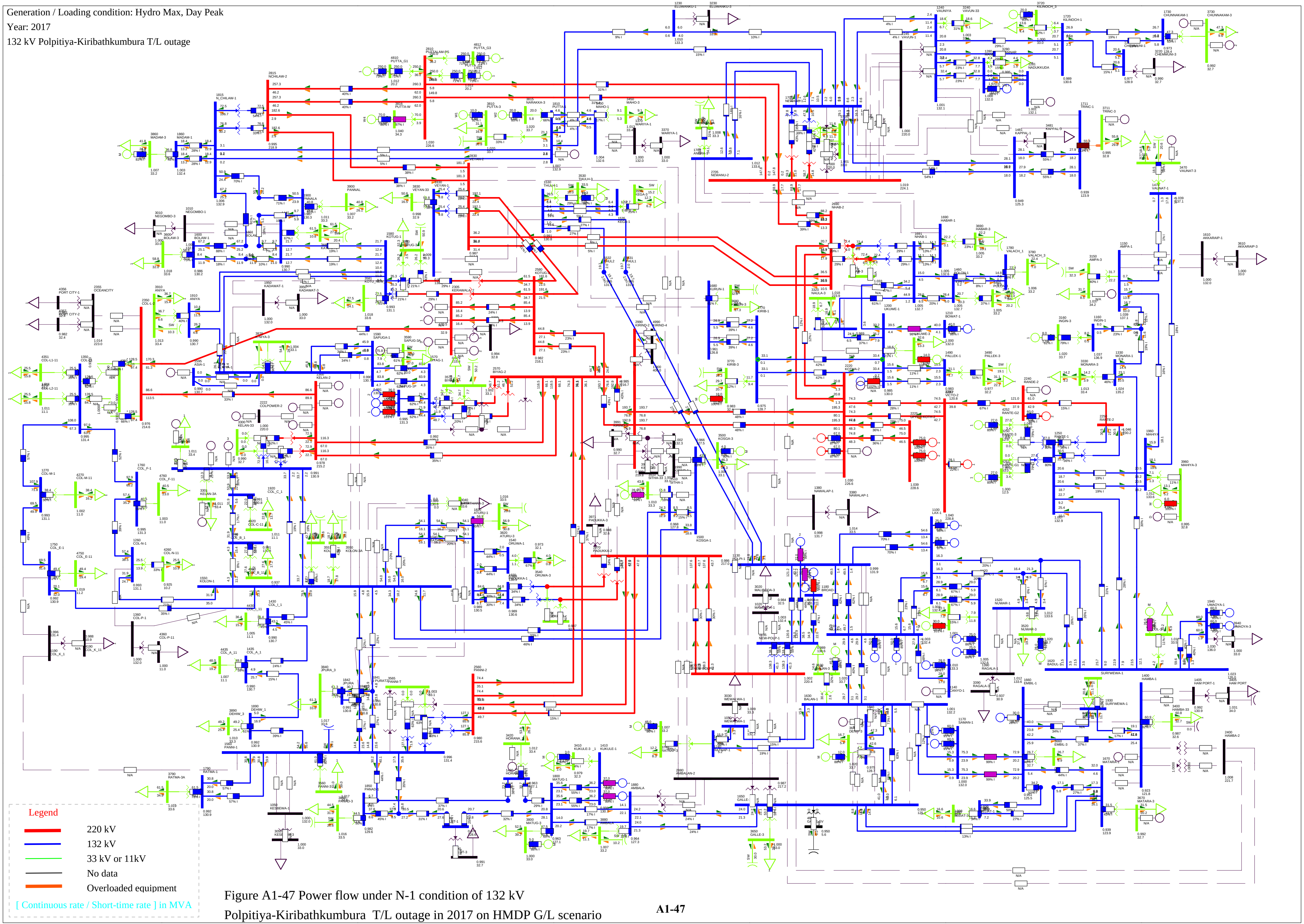
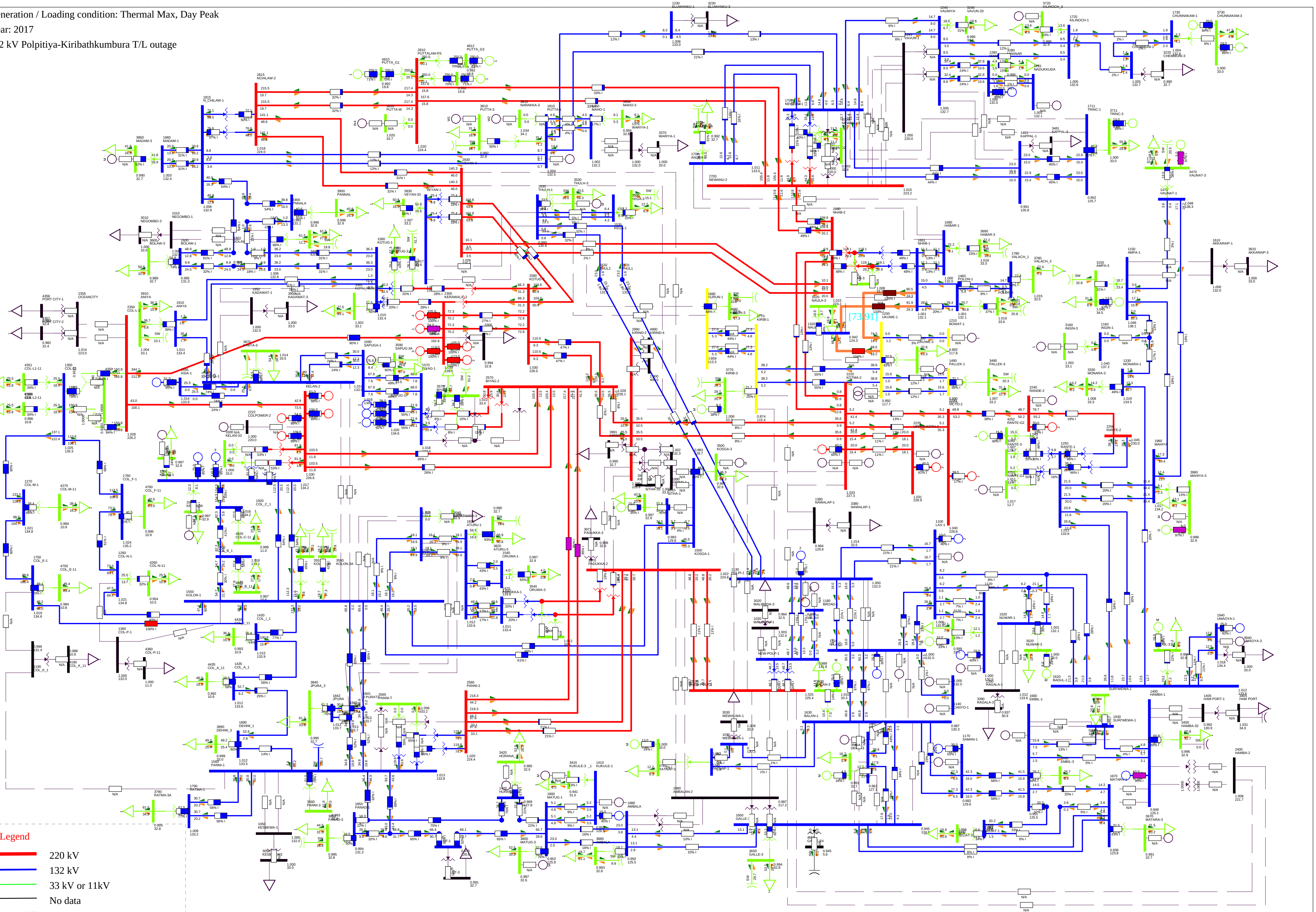


Figure A1-47 Power flow under N-1 condition of 132 kV Polpitiya-Kiribathkumbura T/L outage in 2017 on HMDP G/L scenario

Generation / Loading condition: Thermal Max, Day Peak

Year: 2017

132 kV Polpitiya-Kiribathkumbura T/L outage



Legend

220 kV

132 kV

33 kV or 11kV

No data

Overloaded equipment

[Continuous rate / Short-time rate] in MVA

Figure A1-48 Power flow under N-1 condition of 132 kV Polpitiya-Kiribathkumbura T/L outage in 2017 on TMDP G/L scenario

Generation / Loading condition: Hydro Max, Night Peak

Year: 2017

132 kV Polpitiya-Kiribathkumbura T/L outage

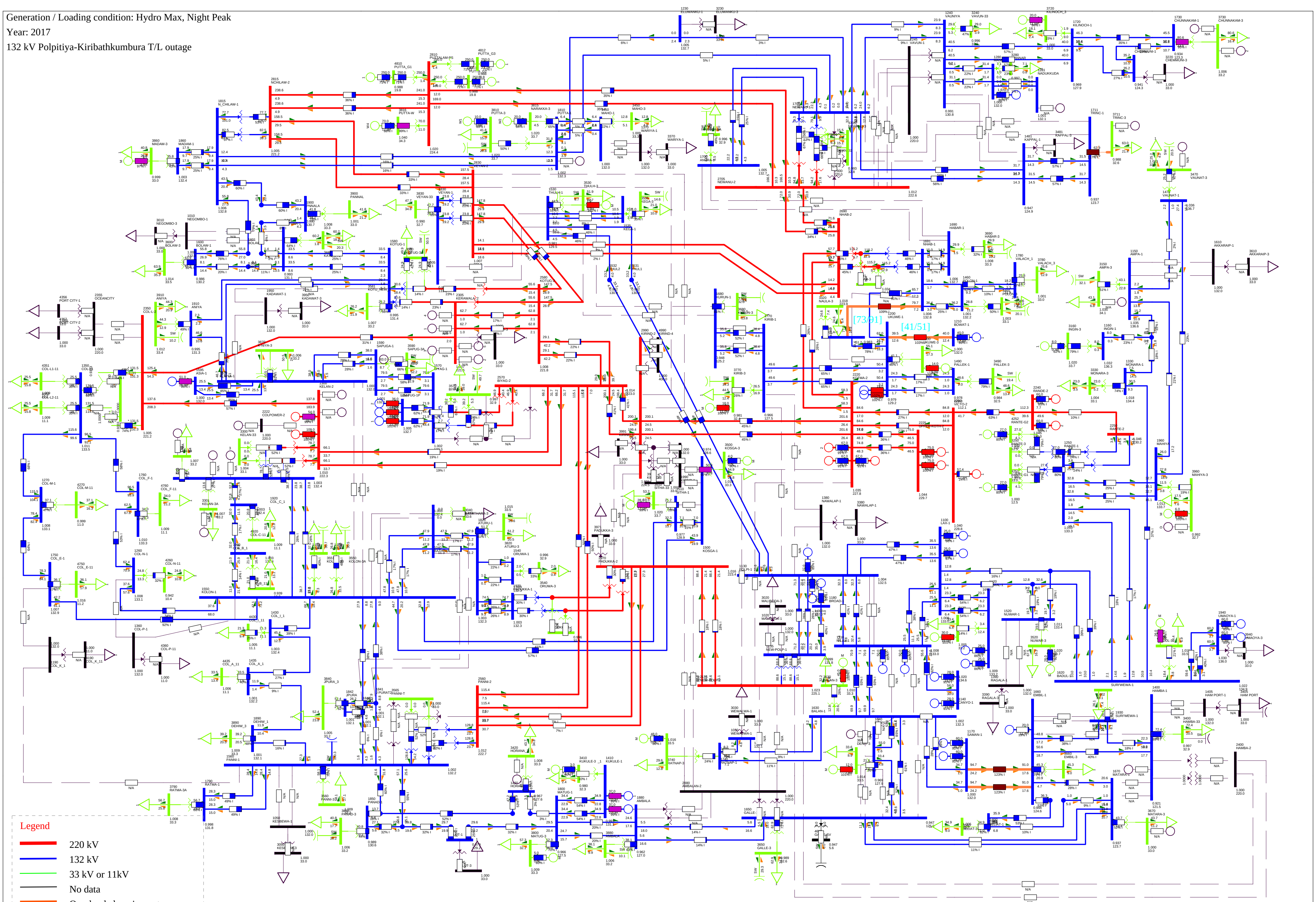
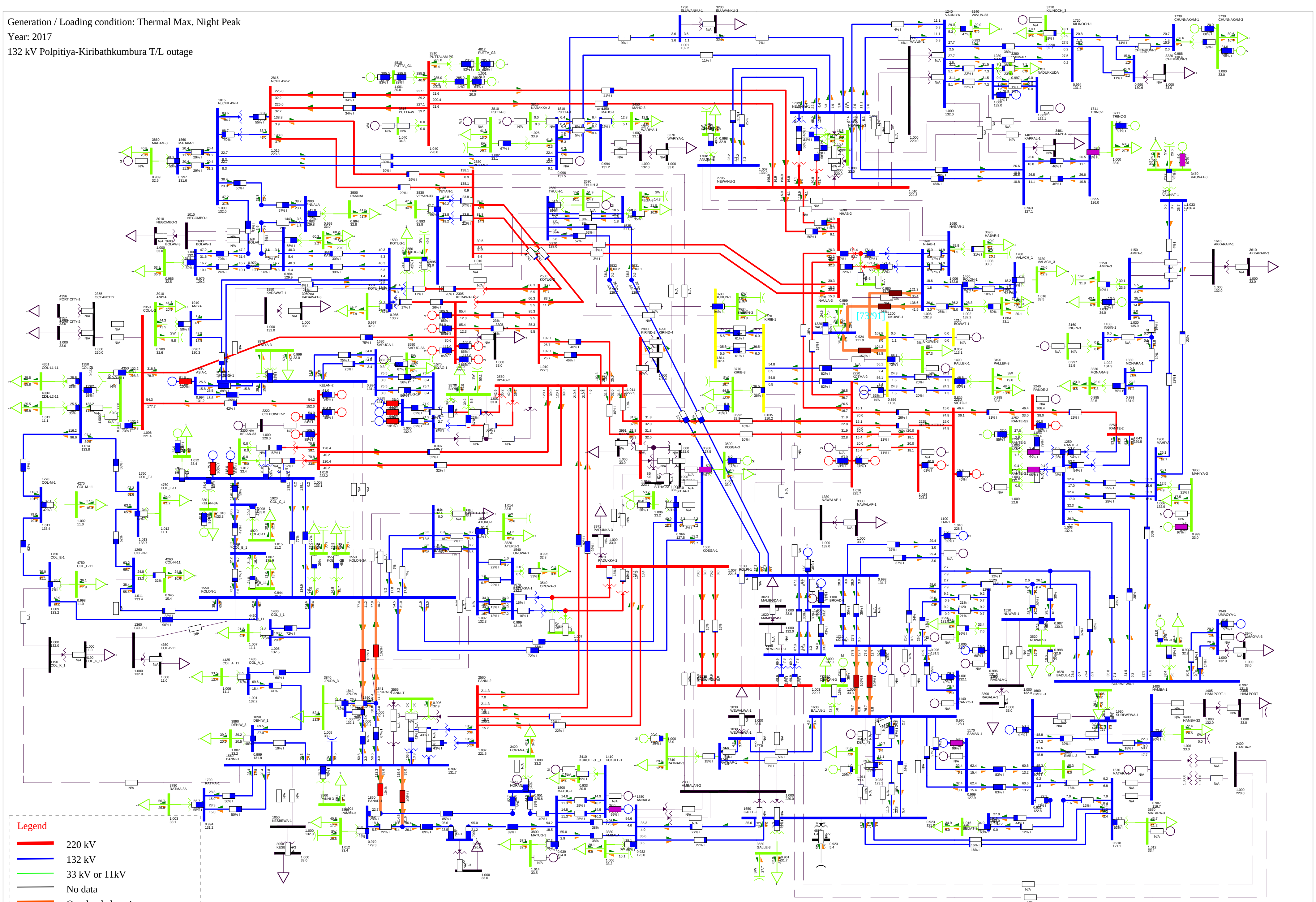


Figure A1-49 Power flow under N-1 condition of 132 kV Polpitiya-Kiribathkumbura T/L outage in 2017 on HMNP G/L scenario

Generation / Loading condition: Thermal Max, Night Peak

Year: 2017

132 kV Polpitiya-Kiribathkumbura T/L outage



Legend

220 kV

132 kV

33 kV or 11kV

No data

Overloaded equipment

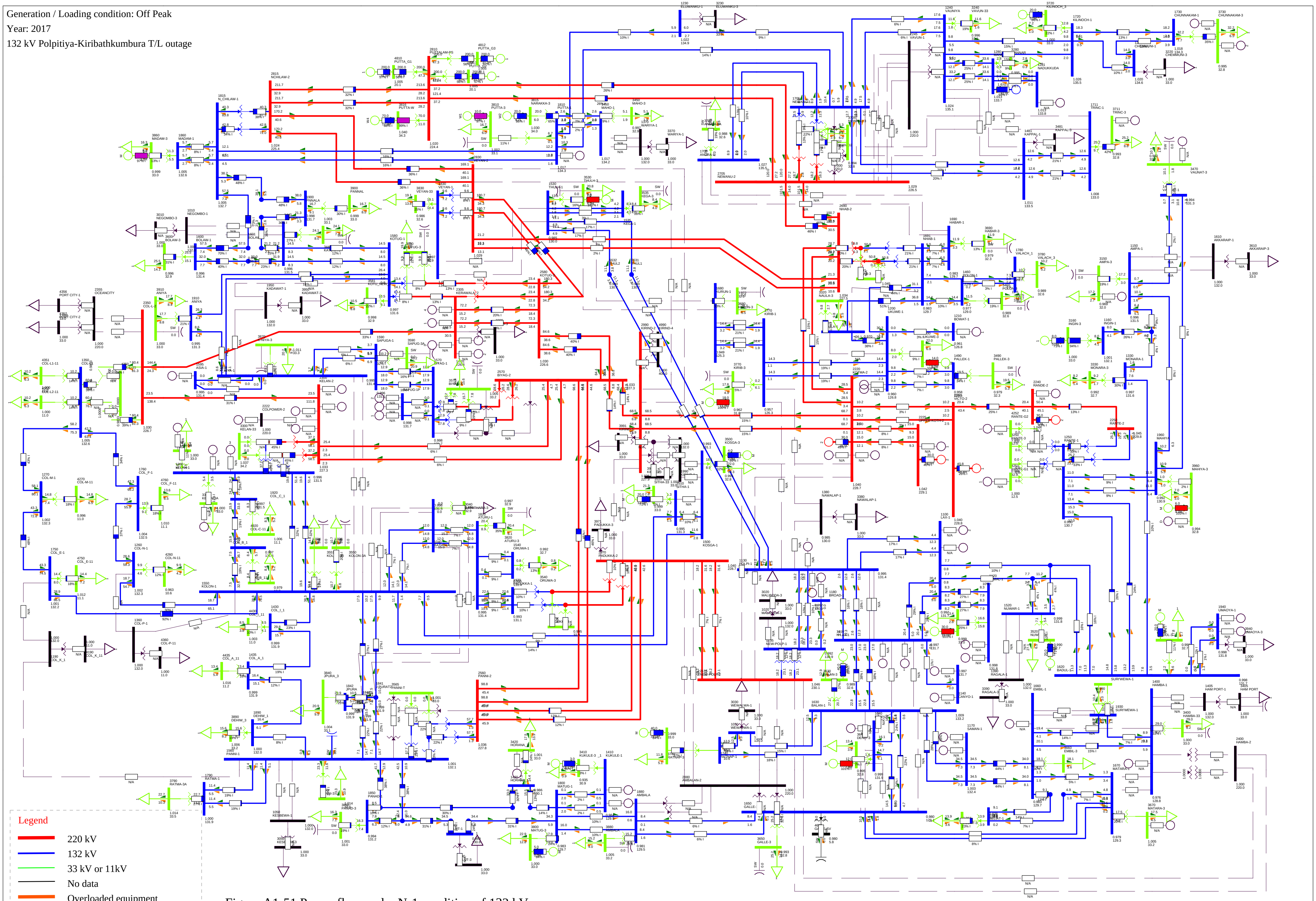
[Continuous rate / Short-time rate] in MVA

Figure A1-50 Power flow under N-1 condition of 132 kV Polpitiya-Kiribathkumbura T/L outage in 2017 on TMNP G/L scenario

Generation / Loading condition: Off Peak

Year: 2017

132 kV Polpitiya-Kiribathkumbura T/L outage



Legend

220 kV

132 kV

33 kV or 11kV

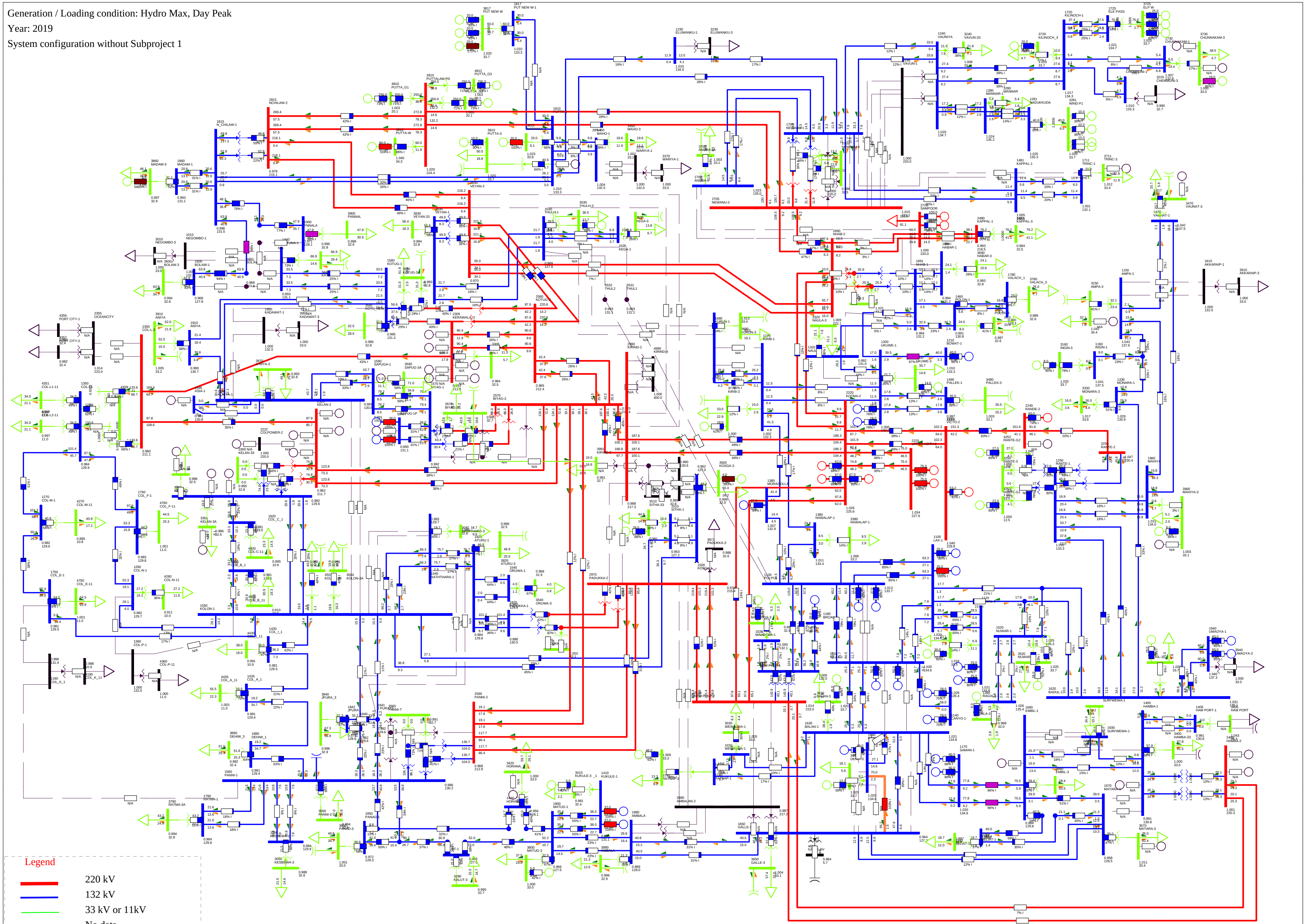
No data

Overloaded equipment

[Continuous rate / Short-time rate] in MVA

Figure A1-51 Power flow under N-1 condition of 132 kV Polpitiya-Kiribathkumbura T/L outage in 2017 on OP G/L scenario

Generation / Loading condition: Hydro Max, Day Peak
Year: 2019
System configuration without Subproject 1



Legend

220 kV
132 kV
33 kV or 11kV
No data
Overloaded equipment

[Continuous rate / Short-time rate] in MVA

Figure A1-52 Power flow without Subproject 1 in 2019 on HMDP G/L scenario

Generation / Loading condition: Thermal Max, Day Peak

Year: 2019

System configuration without Subproject 1

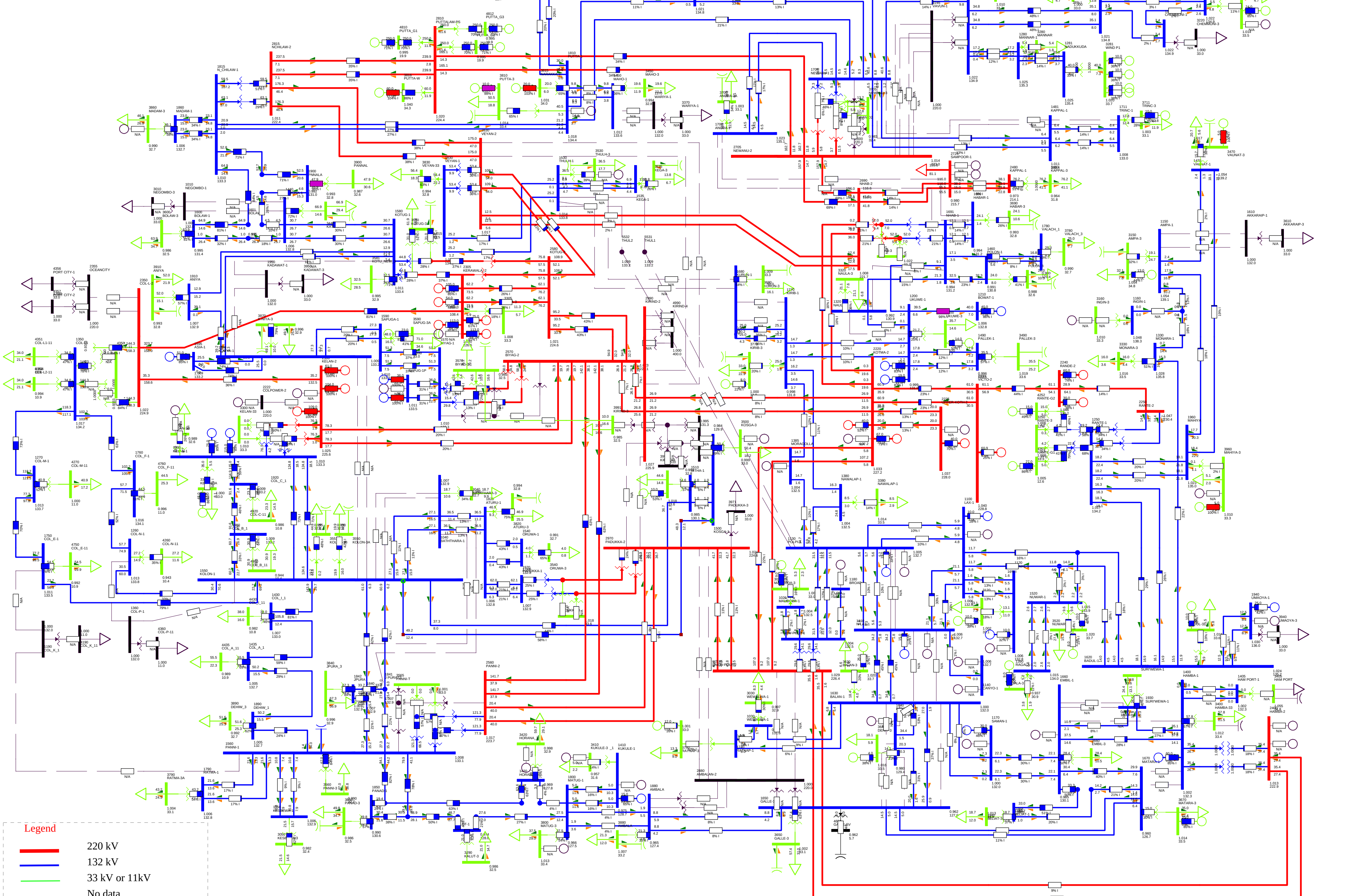
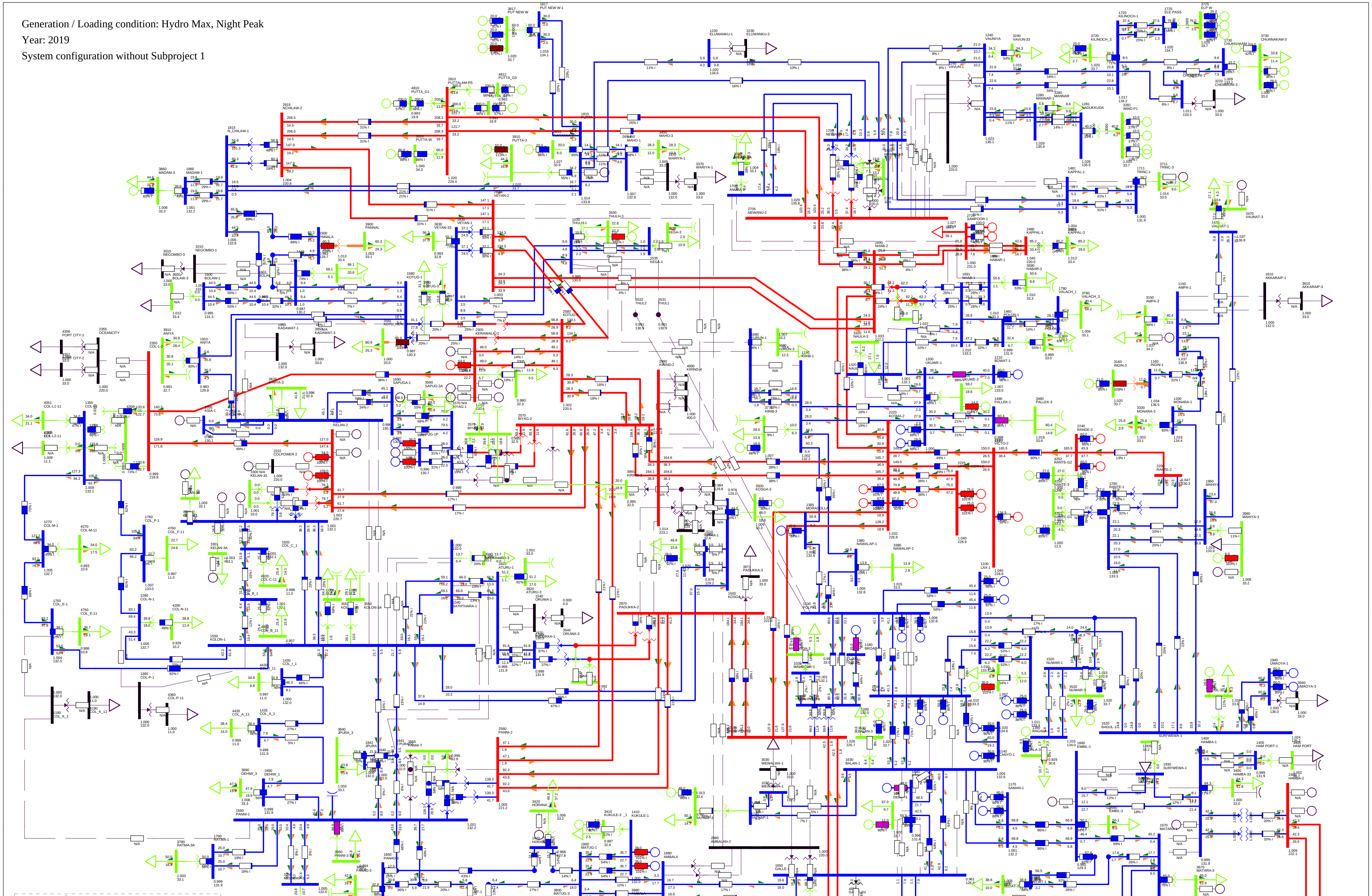


Figure A1-53 Power flow without Subproject 1 in 2019 on TMDP G/L scenario

Generation / Loading condition: Hydro Max, Night Peak

Year: 2019

System configuration without Subproject 1



Legend

220 kV

132 kV

33 kV or 11kV

No data

Overloaded equipment

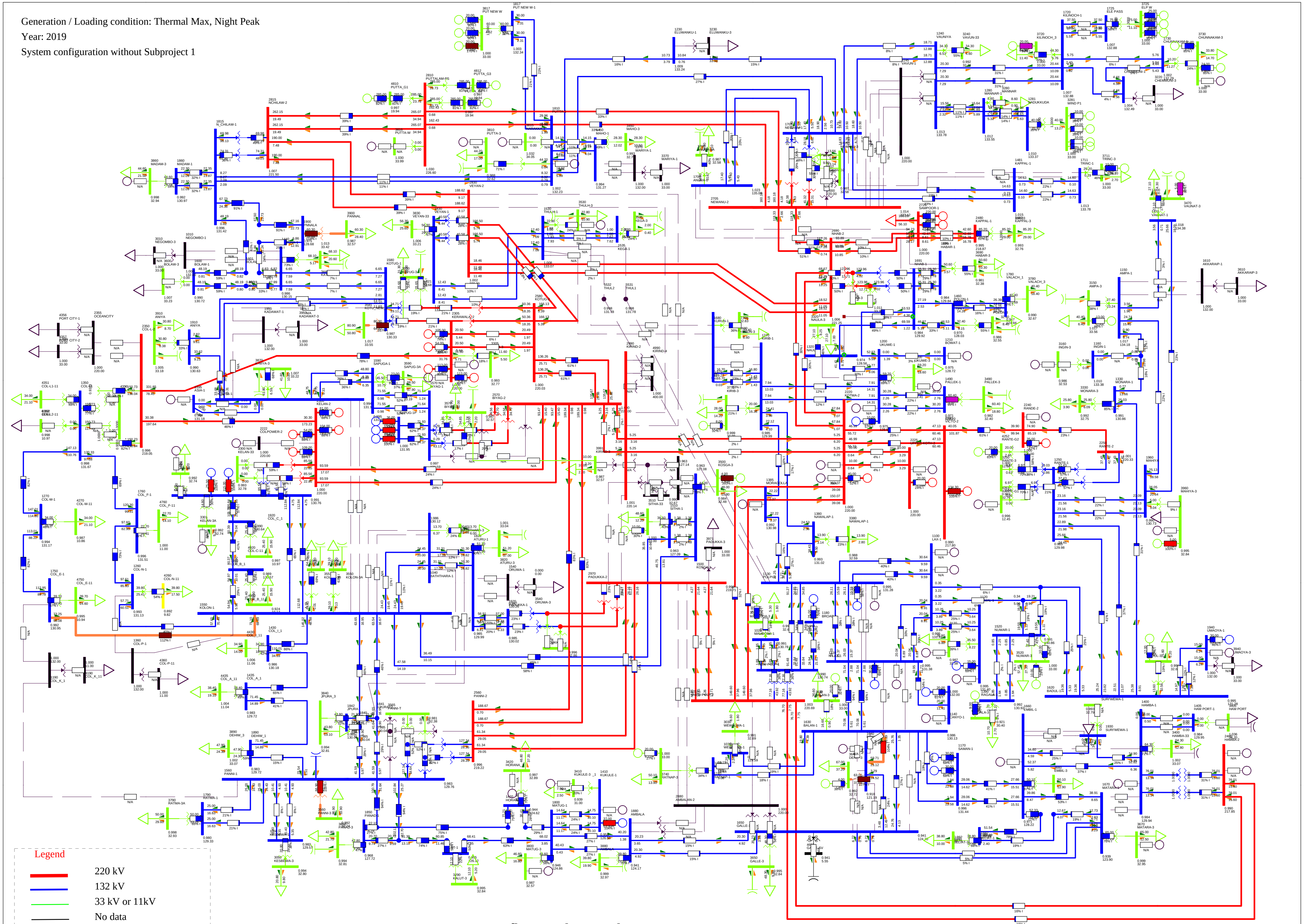
[Continuous rate / Short-time rate] in MVA

Figure A1-54 Power flow without Subproject 1 in 2019 on HMNP G/L scenario

Generation / Loading condition: Thermal Max, Night Peak

Year: 2019

System configuration without Subproject 1



Legend

- 220 kV
- 132 kV
- 33 kV or 11kV
- No data
- Overloaded equipment

[Continuous rate / Short-time rate] in MVA

Figure A1-55 Power flow without Subproject 1 in 2019 on TMNP G/L scenario

Generation / Loading condition: Thermal Off Peak

Year: 2019

System configuration without Subproject 1

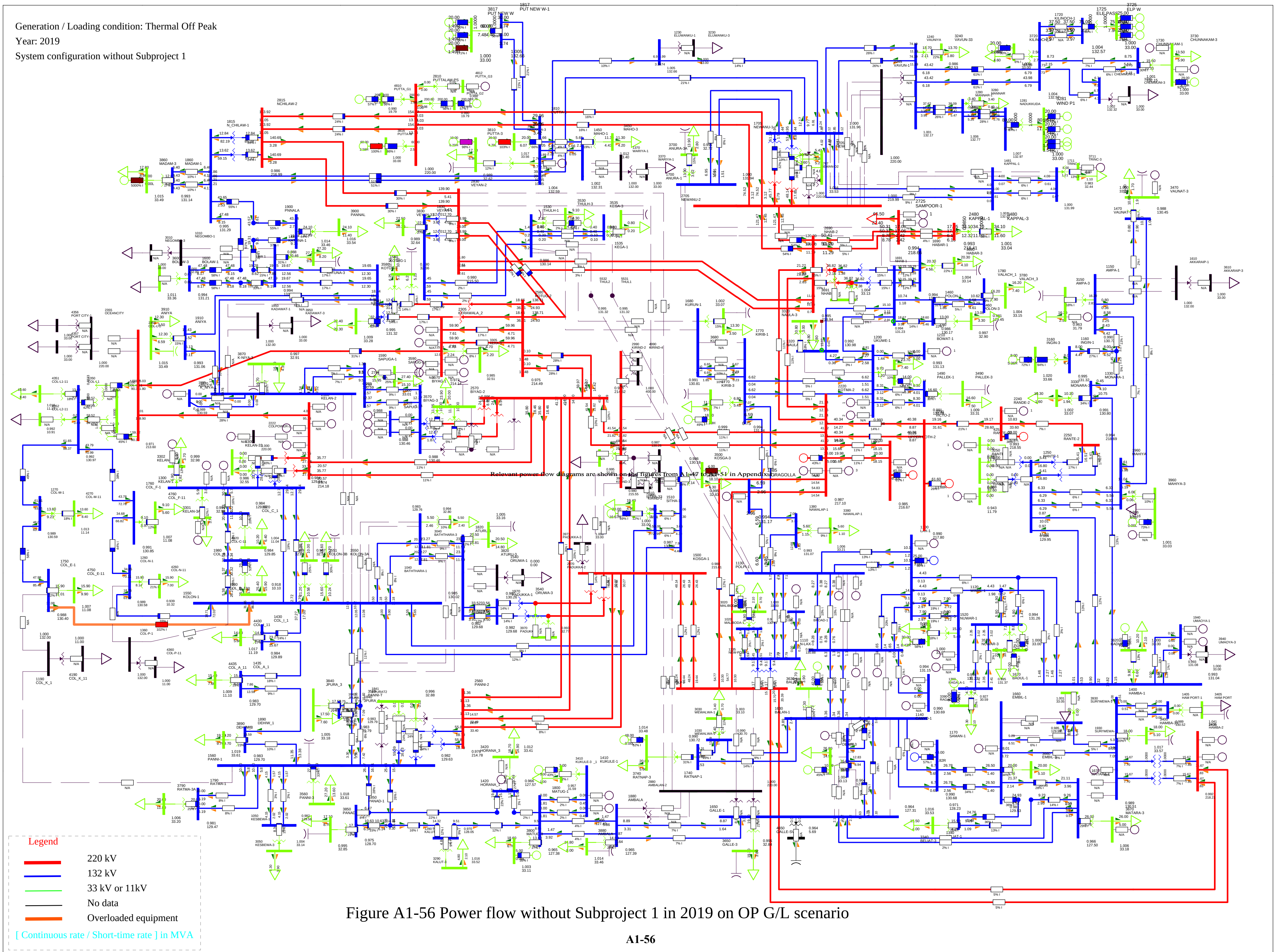


Figure A1-56 Power flow without Subproject 1 in 2019 on OP G/L scenario

Generation / Loading condition: Hydro Max, Day Peak

Year: 2019

System configuration without Subproject 2

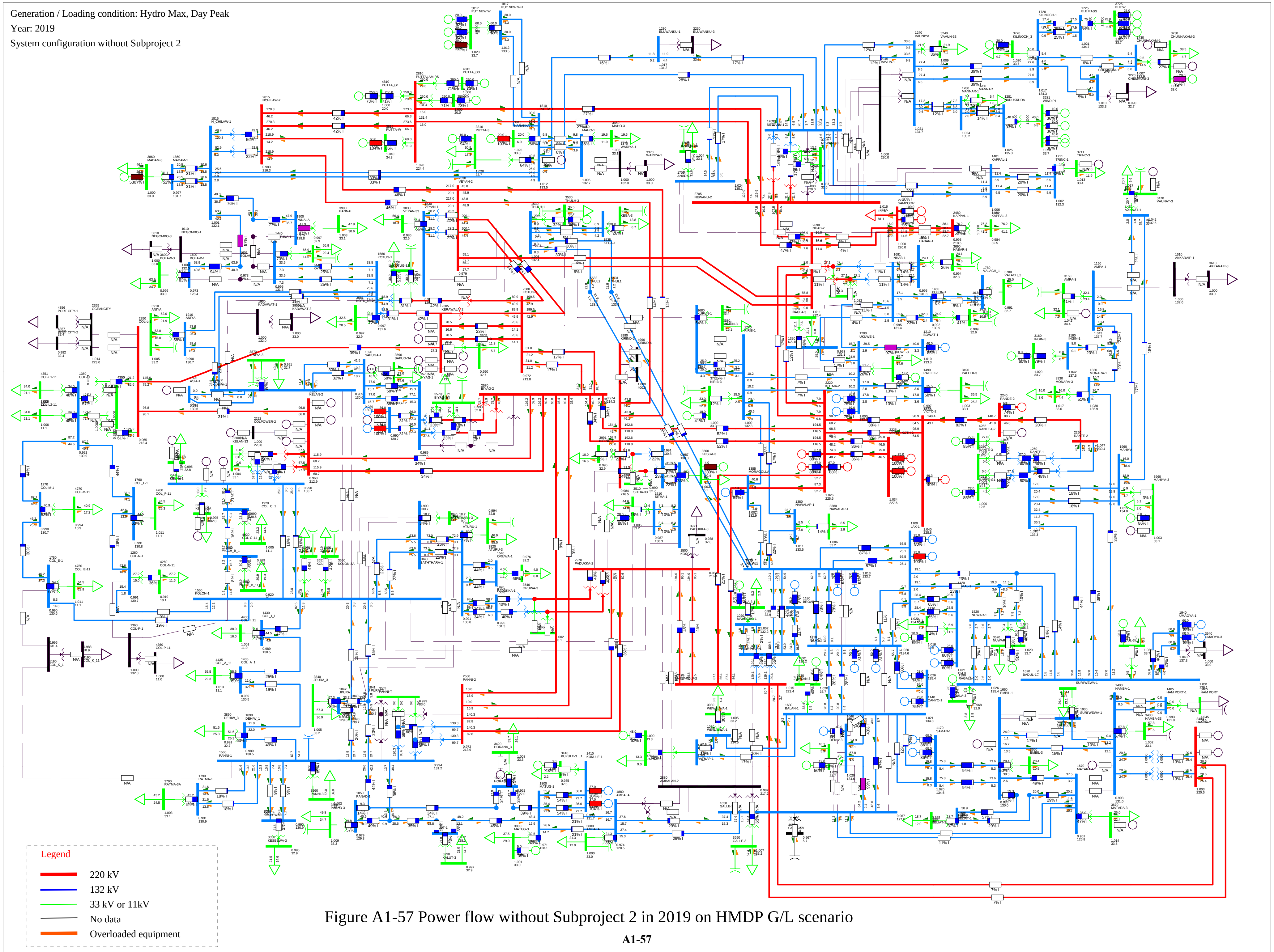


Figure A1-57 Power flow without Subproject 2 in 2019 on HMDP G/L scenario

Generation / Loading condition: Thermal Max, Day Peak

Year: 2019

System configuration without Subproject 2

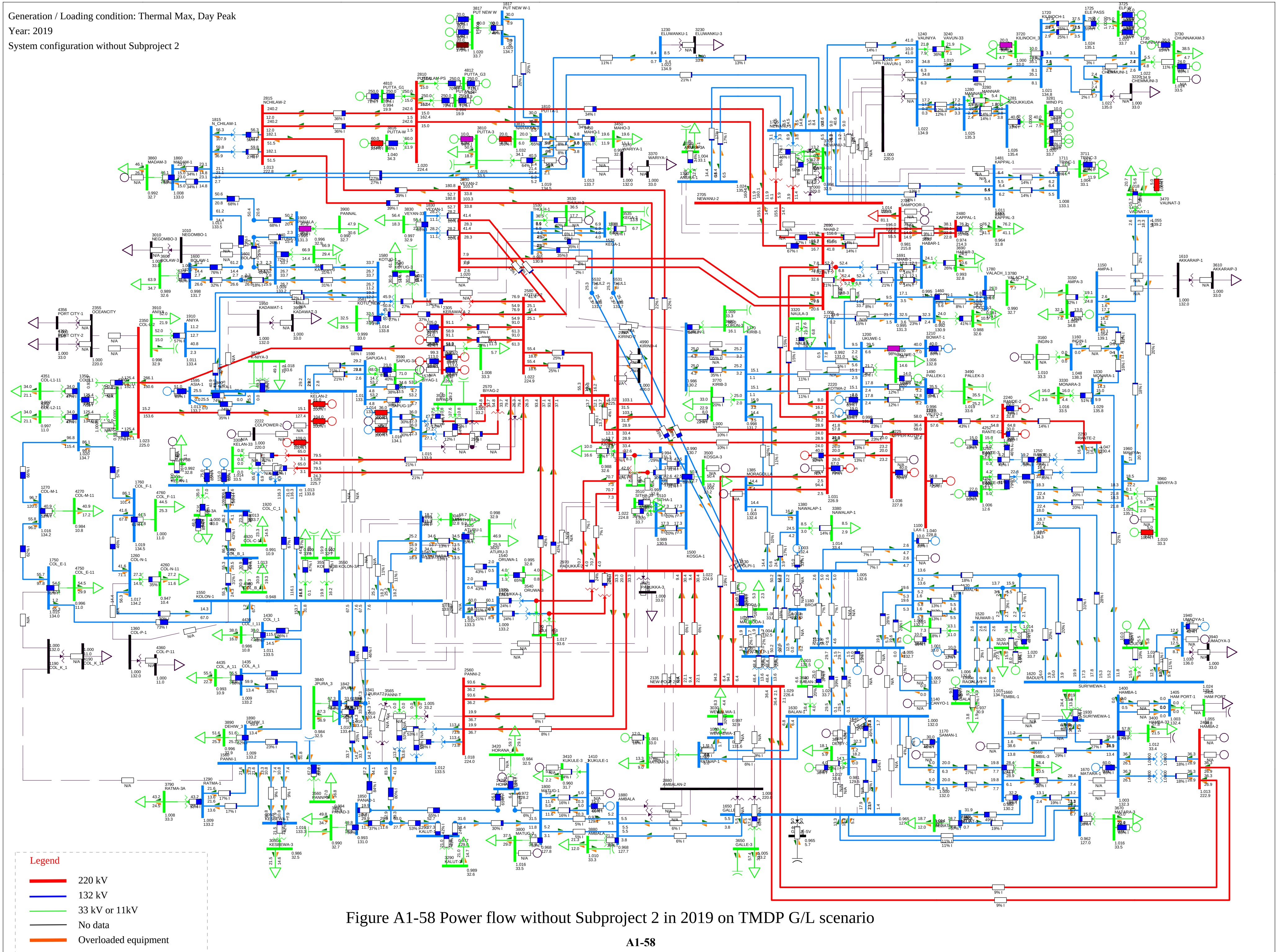
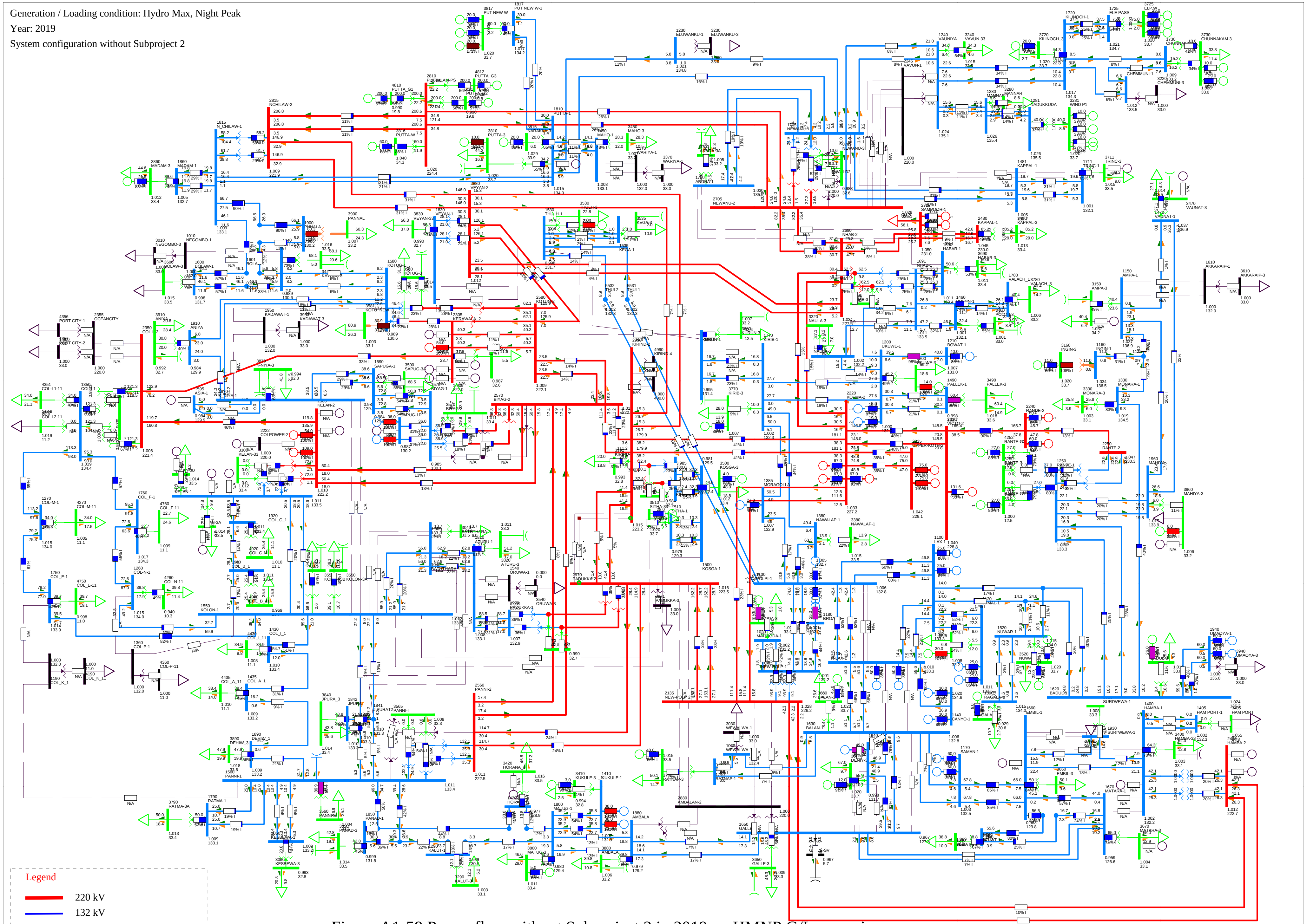


Figure A1-58 Power flow without Subproject 2 in 2019 on TMDP G/L scenario

Generation / Loading condition: Hydro Max, Night Peak

Year: 2019

System configuration without Subproject 2



Legend

- 220 kV
- 132 kV
- 33 kV or 11kV
- No data
- Overloaded equipment

Figure A1-59 Power flow without Subproject 2 in 2019 on HMNP G/L scenario

Generation / Loading condition: Thermal Max, Night Peak

Year: 2019

System configuration without Subproject 2

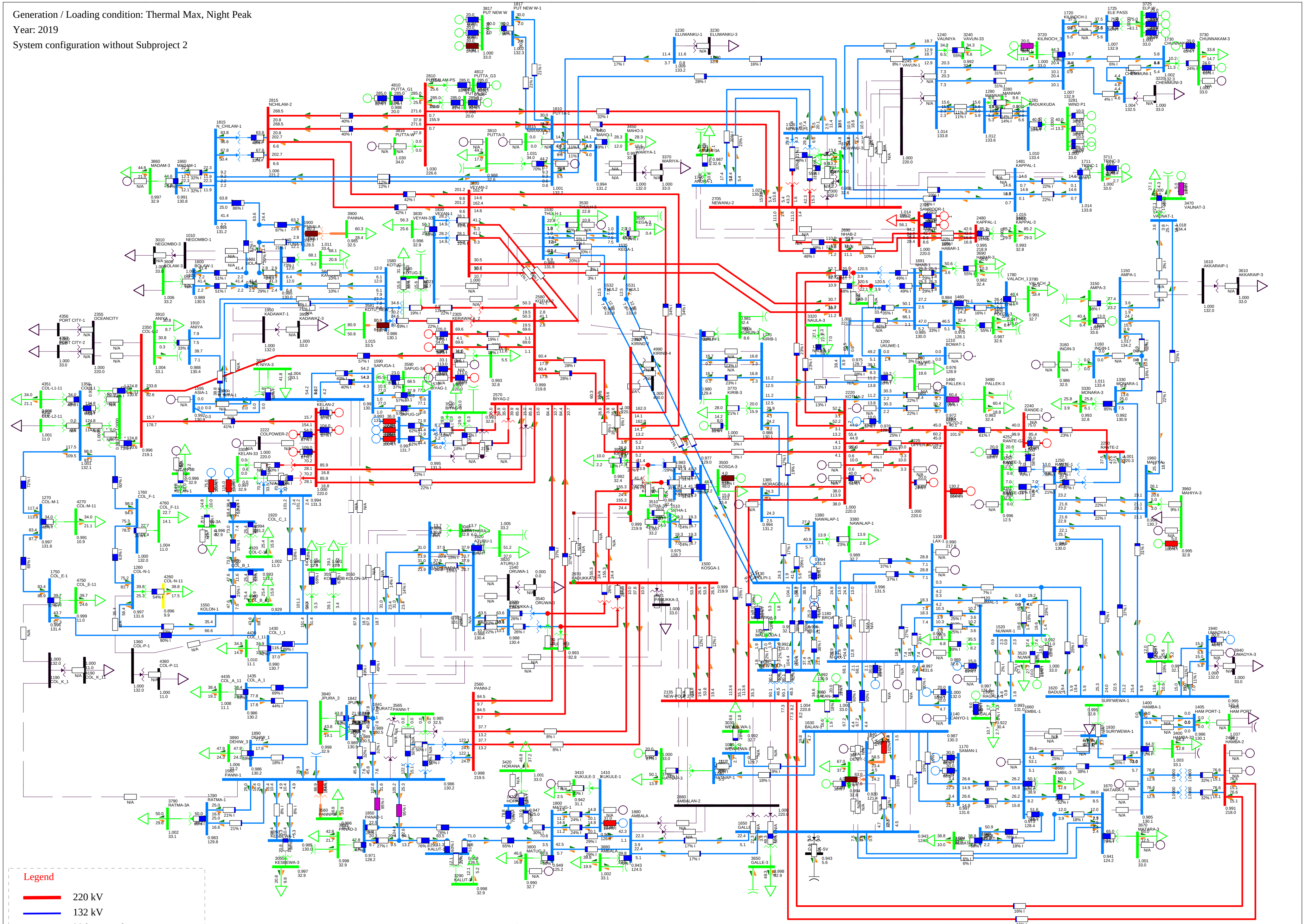
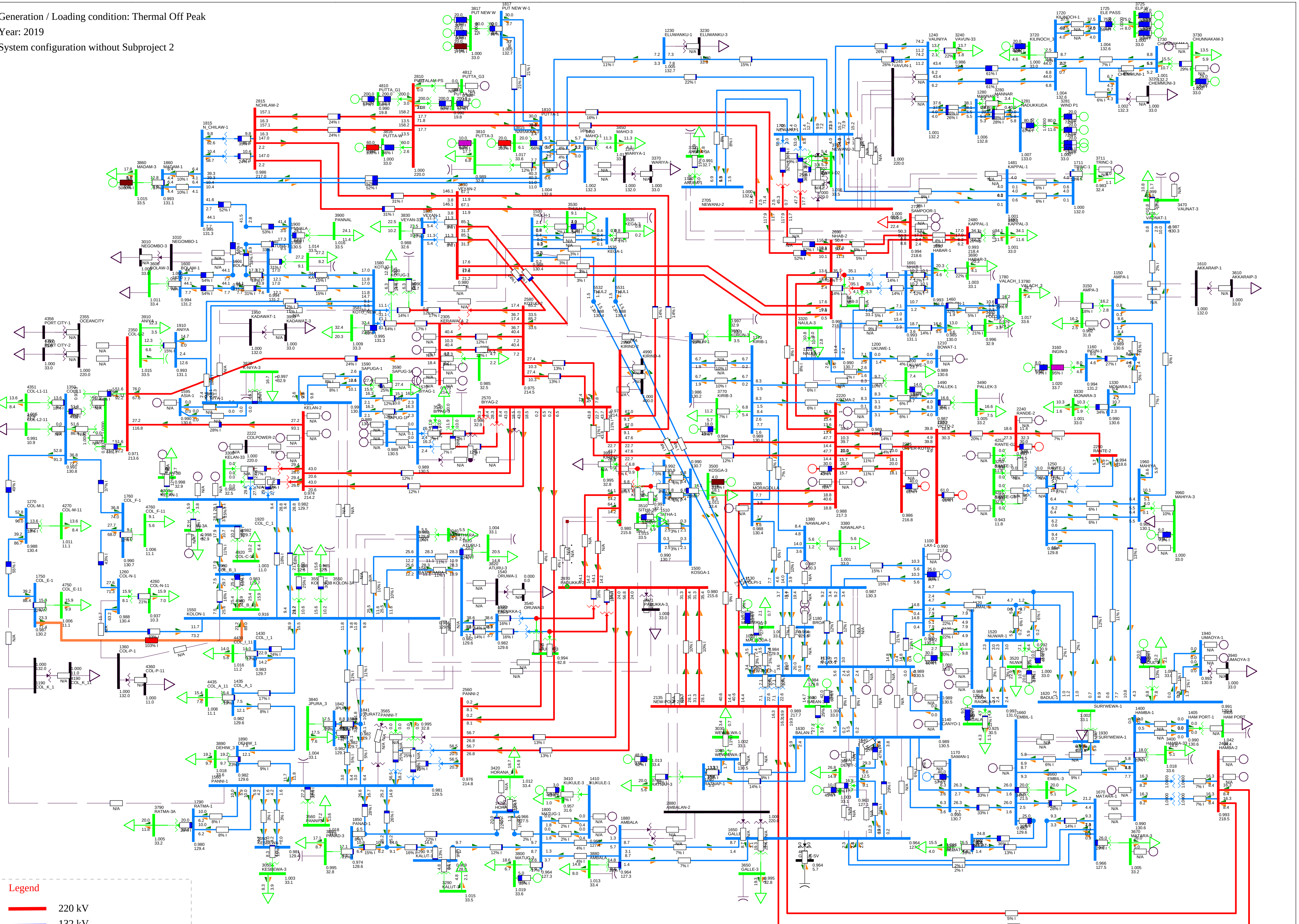


Figure A1-60 Power flow without Subproject 2 in 2019 on TMNP G/L scenario

Generation / Loading condition: Thermal Off Peak

Year: 2019

System configuration without Subproject 2



Legend

- 220 kV
- 132 kV
- 33 kV or 11kV
- No data
- Overloaded equipment

Figure A1-61 Power flow without Subproject 2 in 2019 on OP G/L scenario

Generation / Loading condition: Hydro Max, Day Peak
Year: 2019
System configuration without Subproject 3

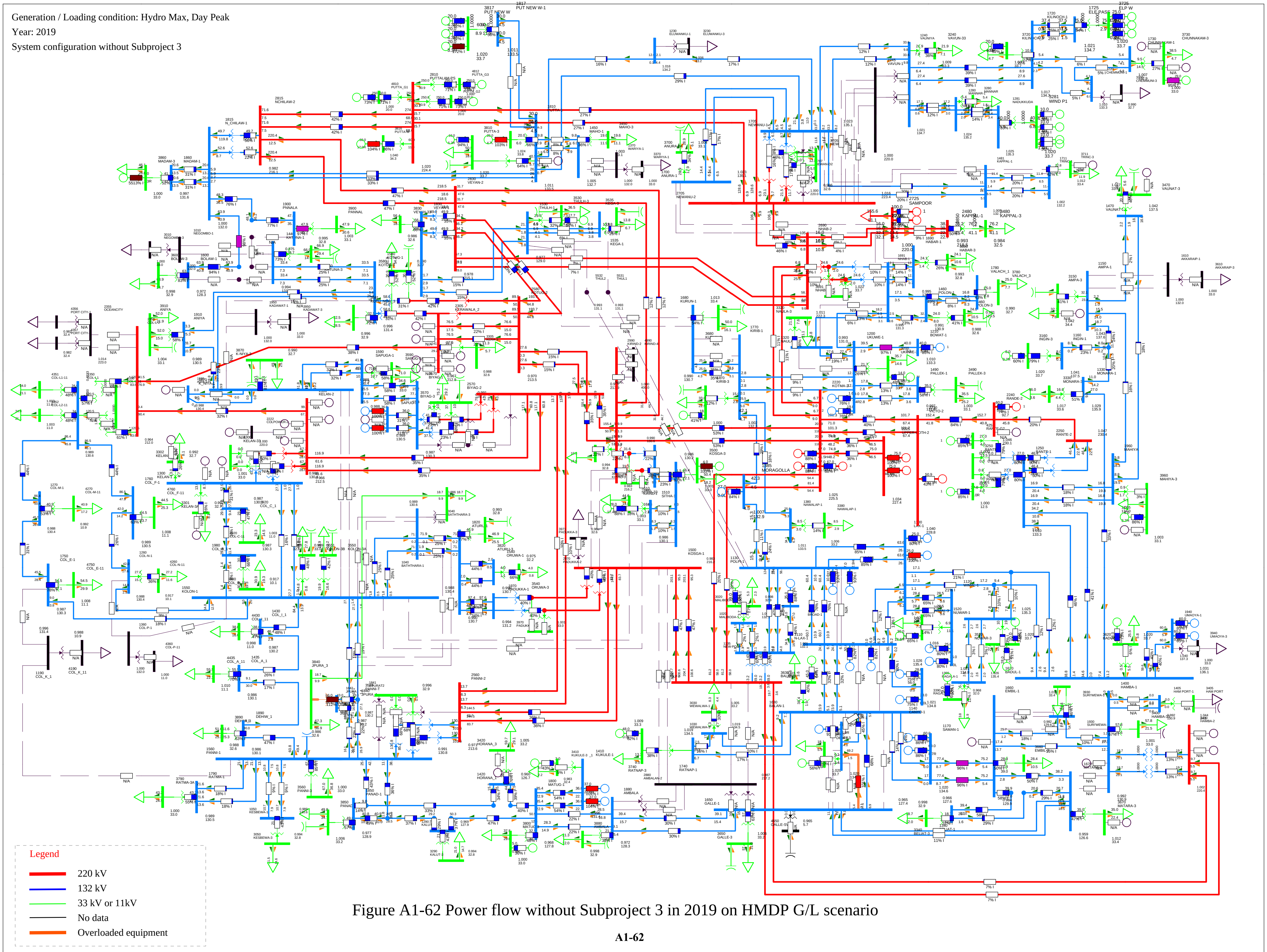


Figure A1-62 Power flow without Subproject 3 in 2019 on HMDP G/L scenario

Generation / Loading condition: Thermal Max, Day Peak

Year: 2019

System configuration without Subproject 3

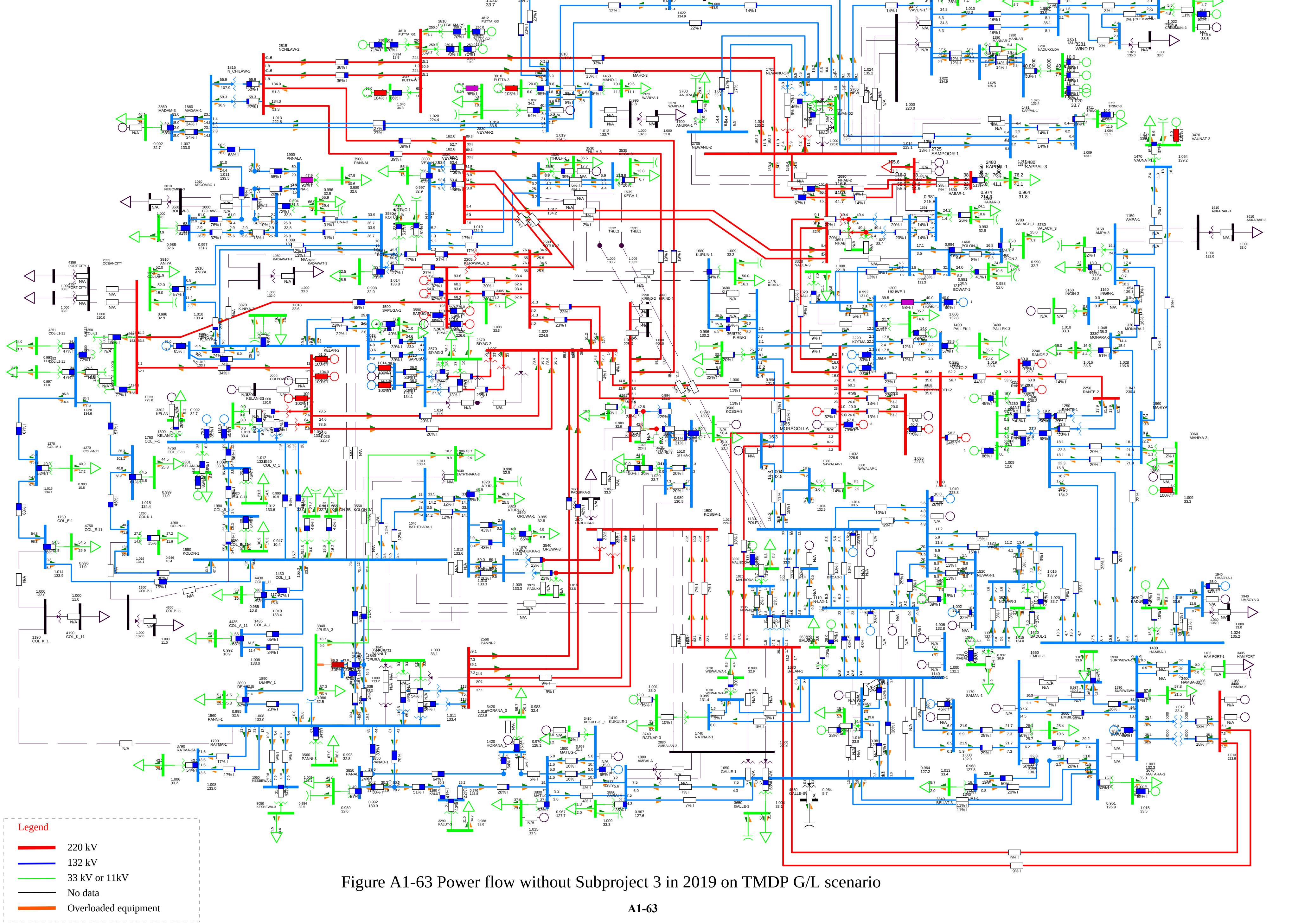


Figure A1-63 Power flow without Subproject 3 in 2019 on TMDP G/L scenario

Generation / Loading condition: Hydro Max, Night Peak

Year: 2019

System configuration without Subproject 3

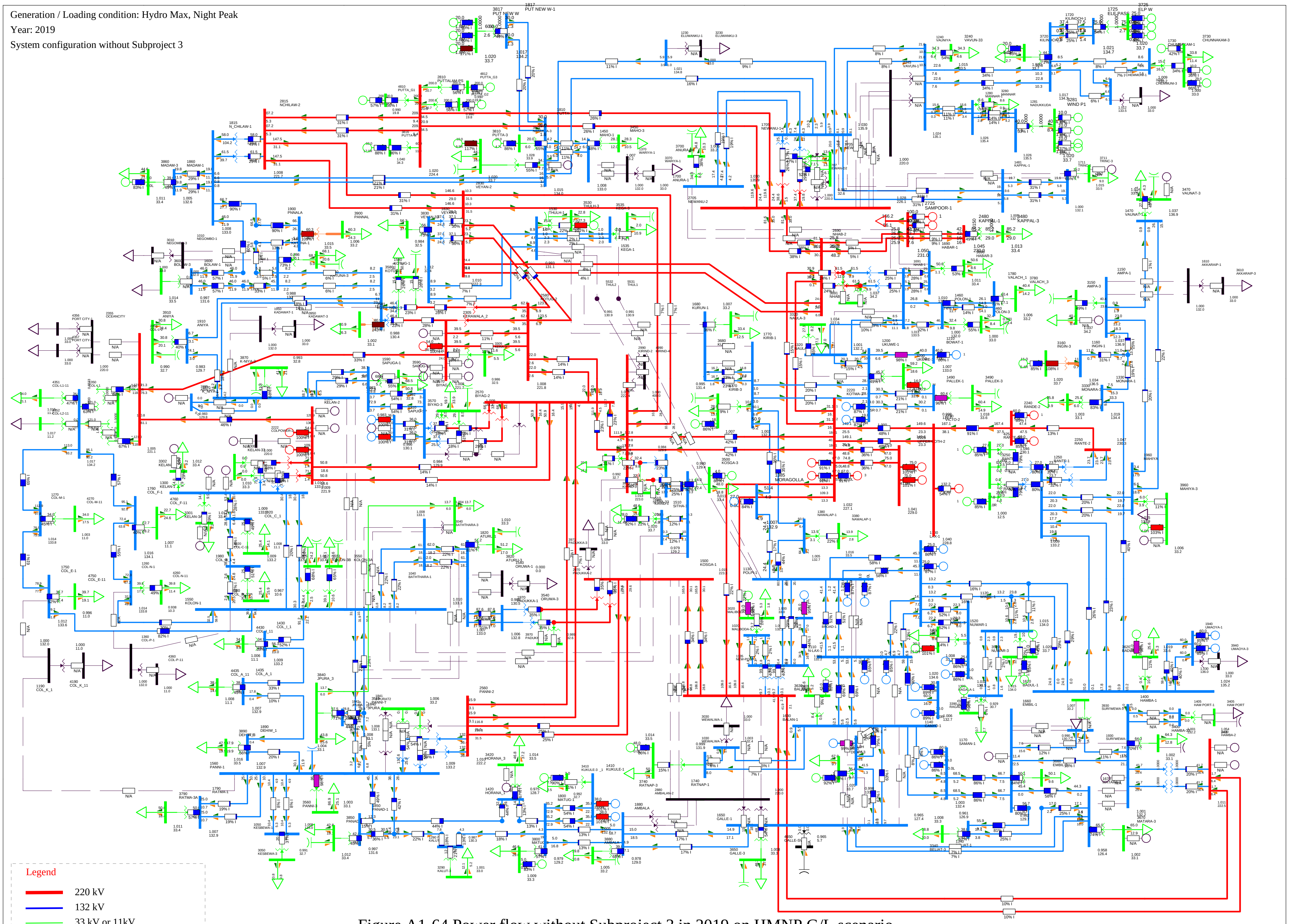
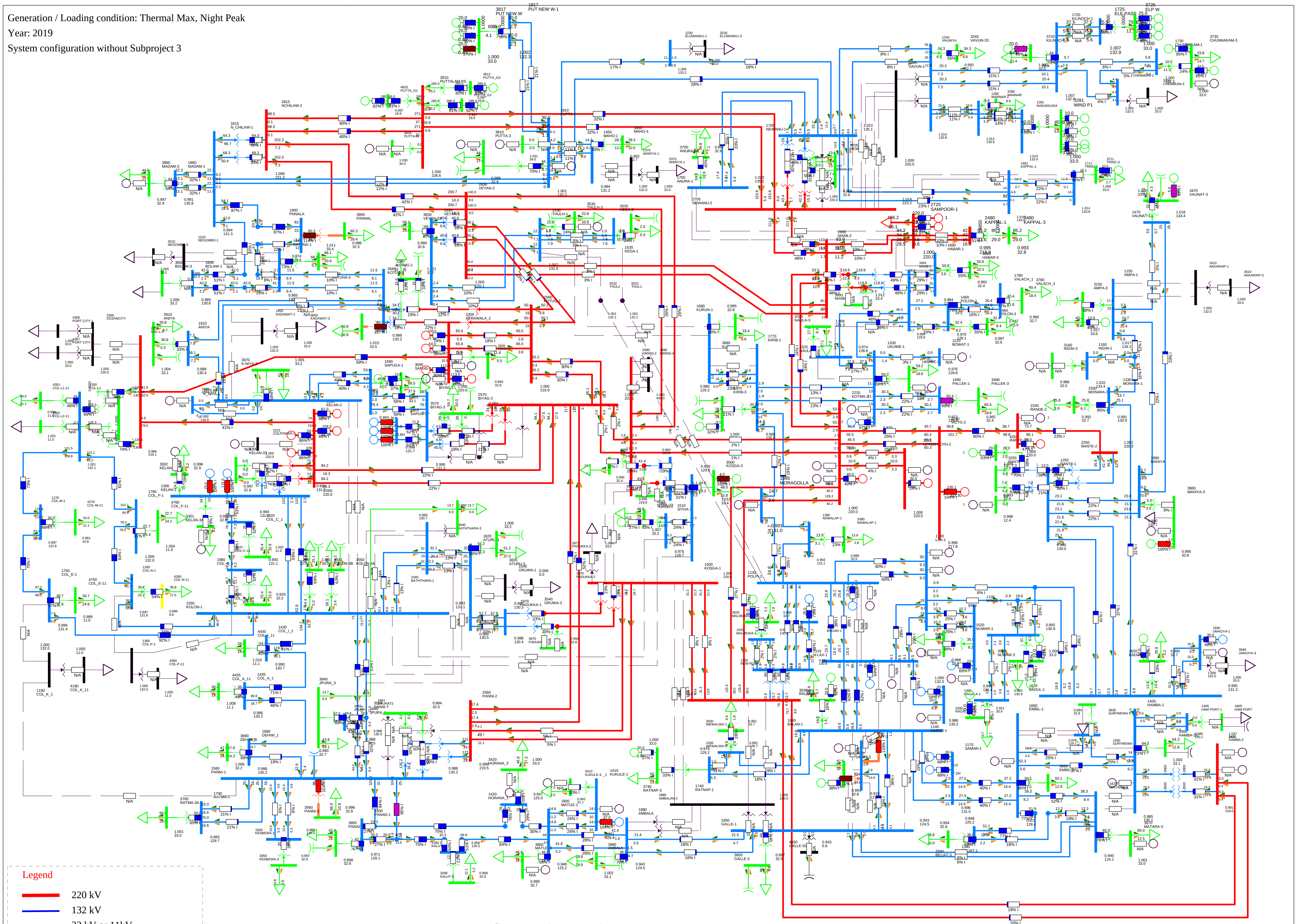


Figure A1-64 Power flow without Subproject 3 in 2019 on HMNP G/L scenario

Generation / Loading condition: Thermal Max, Night Peak

Year: 2019

System configuration without Subproject 3



Legend

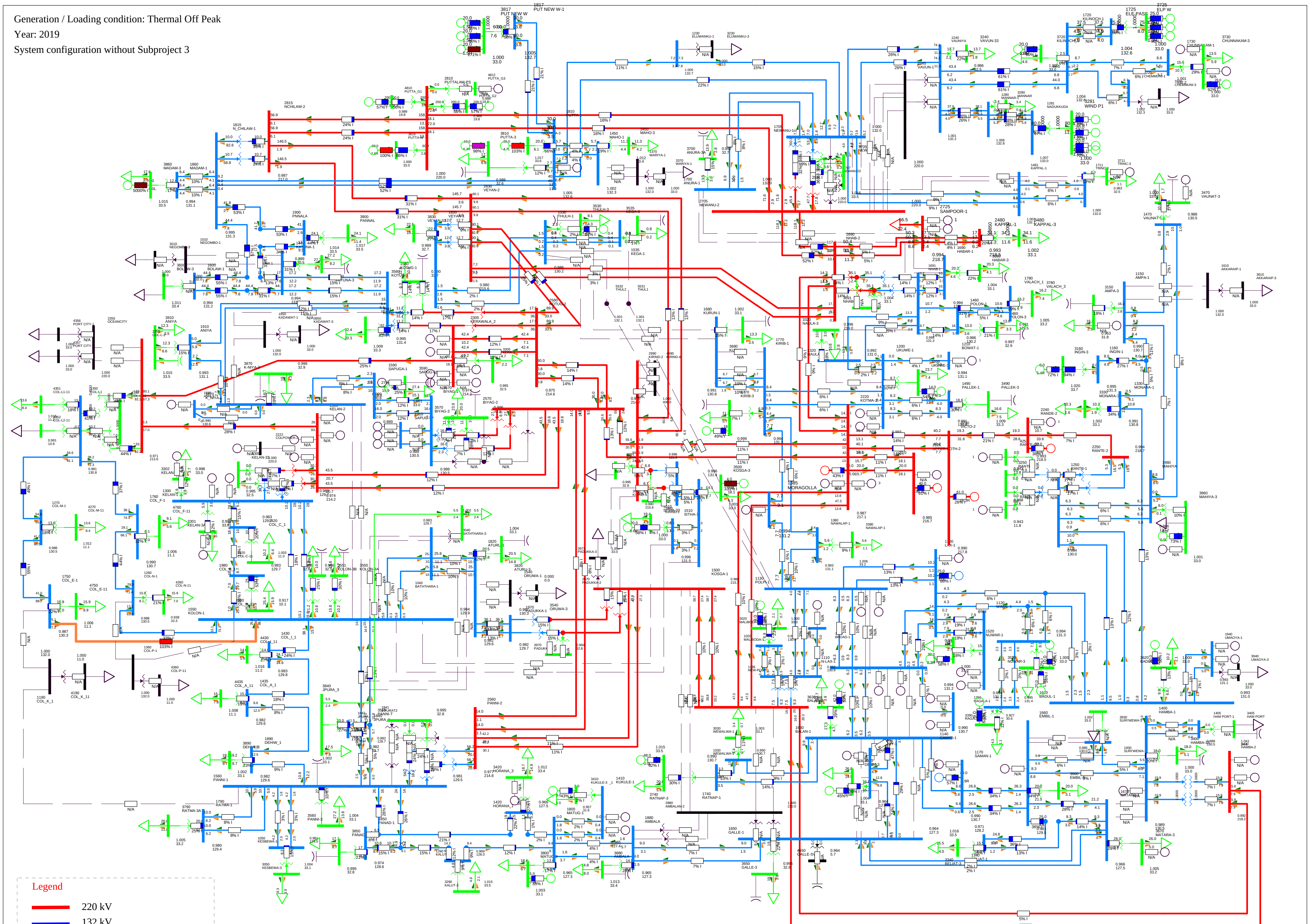
- 220 kV
- 132 kV
- 33 kV or 11kV
- No data
- Overloaded equipment

Figure A1-65 Power flow without Subproject 3 in 2019 on TMNP G/L scenario

Generation / Loading condition: Thermal Off Peak

Year: 2019

System configuration without Subproject 3



Legend

- 220 kV
- 132 kV
- 33 kV or 11kV
- No data
- Overloaded equipment

Figure A1-66 Power flow without Subproject 3 in 2019 on OP G/L scenario

Generation / Loading condition: Hydro Max, Day Peak

Year: 2019

System configuration without subproject 4

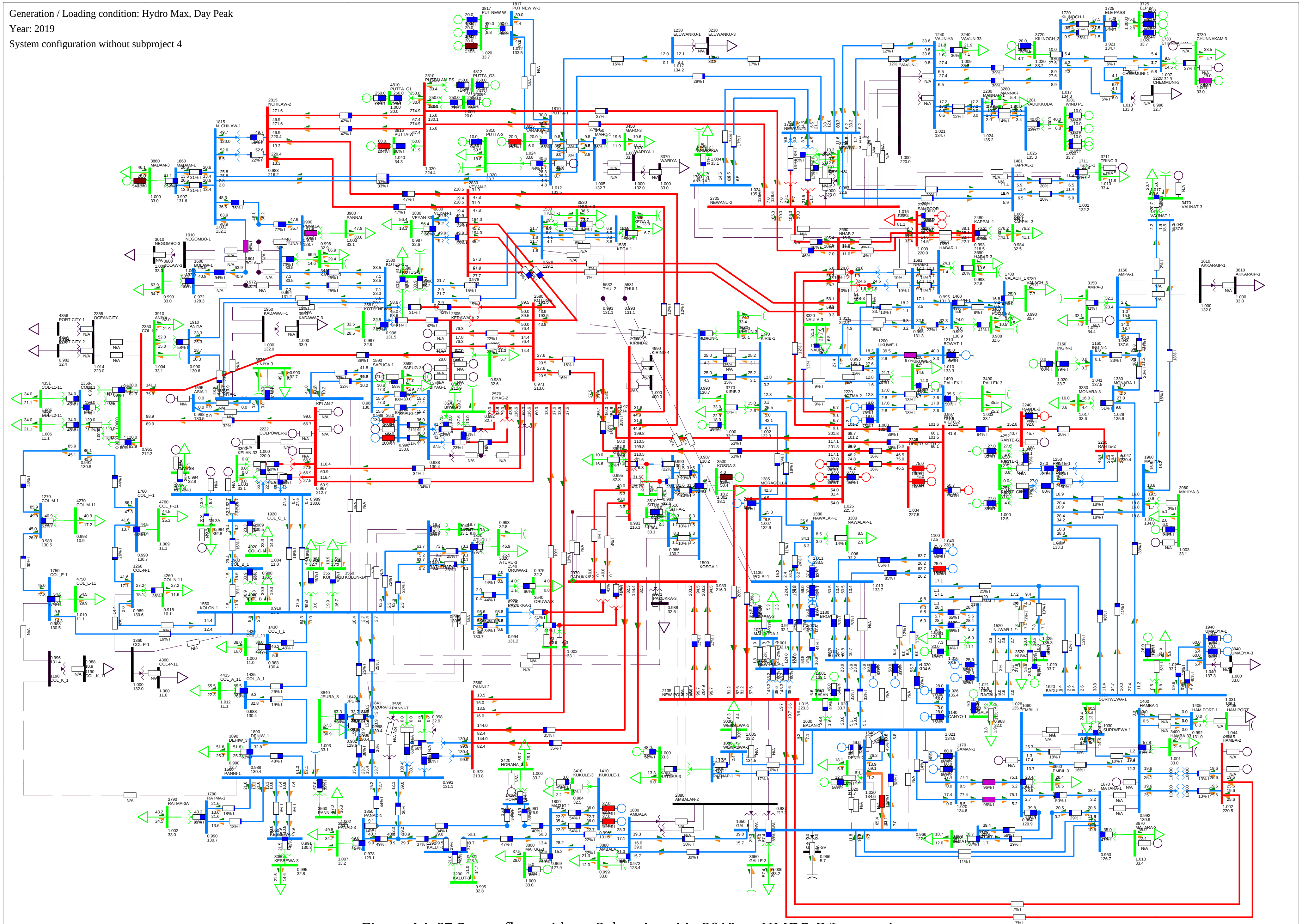


Figure A1-67 Power flow without Subproject 4 in 2019 on HMDP G/L scenario

Generation / Loading condition: Thermal Max, Day Peak

Year: 2019

System configuration without subproject 4

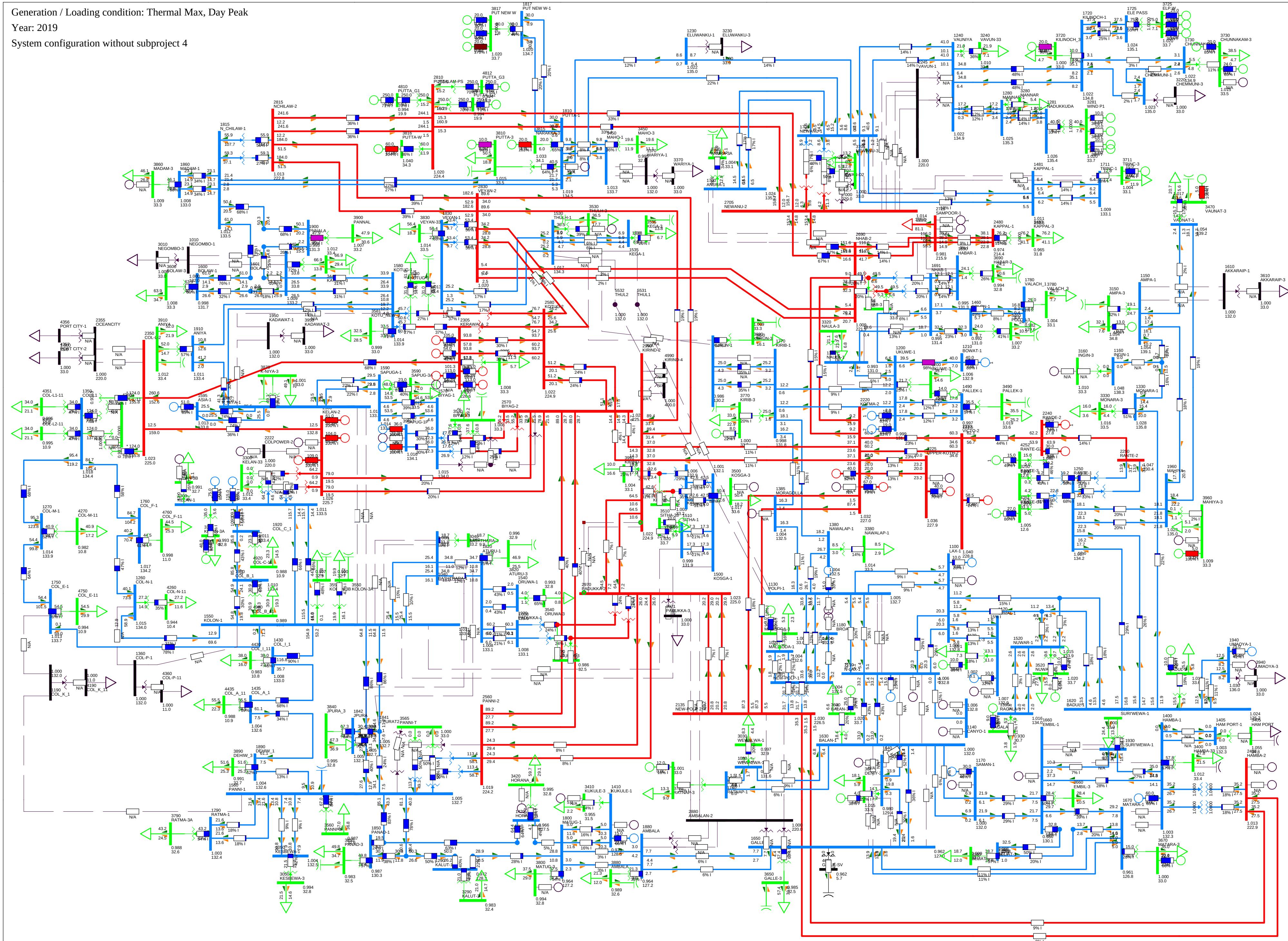


Figure A1-68 Power flow without Subproject 4 in 2019 on TMDP G/L scenario

Generation / Loading condition: Hydro Max, Night Peak

Year: 2019

System configuration without subproject 4

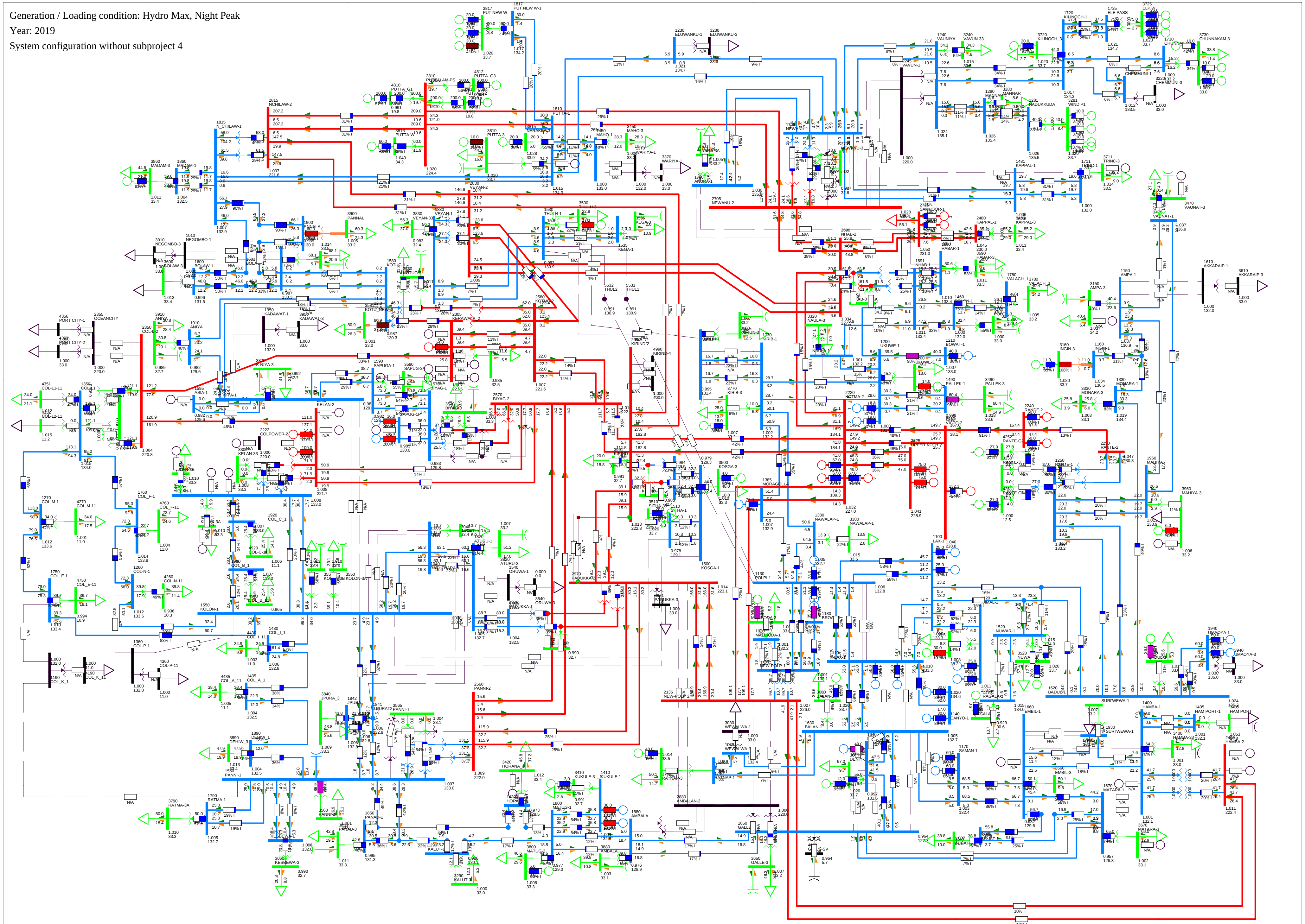


Figure A1-69 Power flow without Subproject 4 in 2019 on HMNP G/L scenario

Generation / Loading condition: Thermal Max, Night Peak
Year: 2019
System configuration without subproject 4

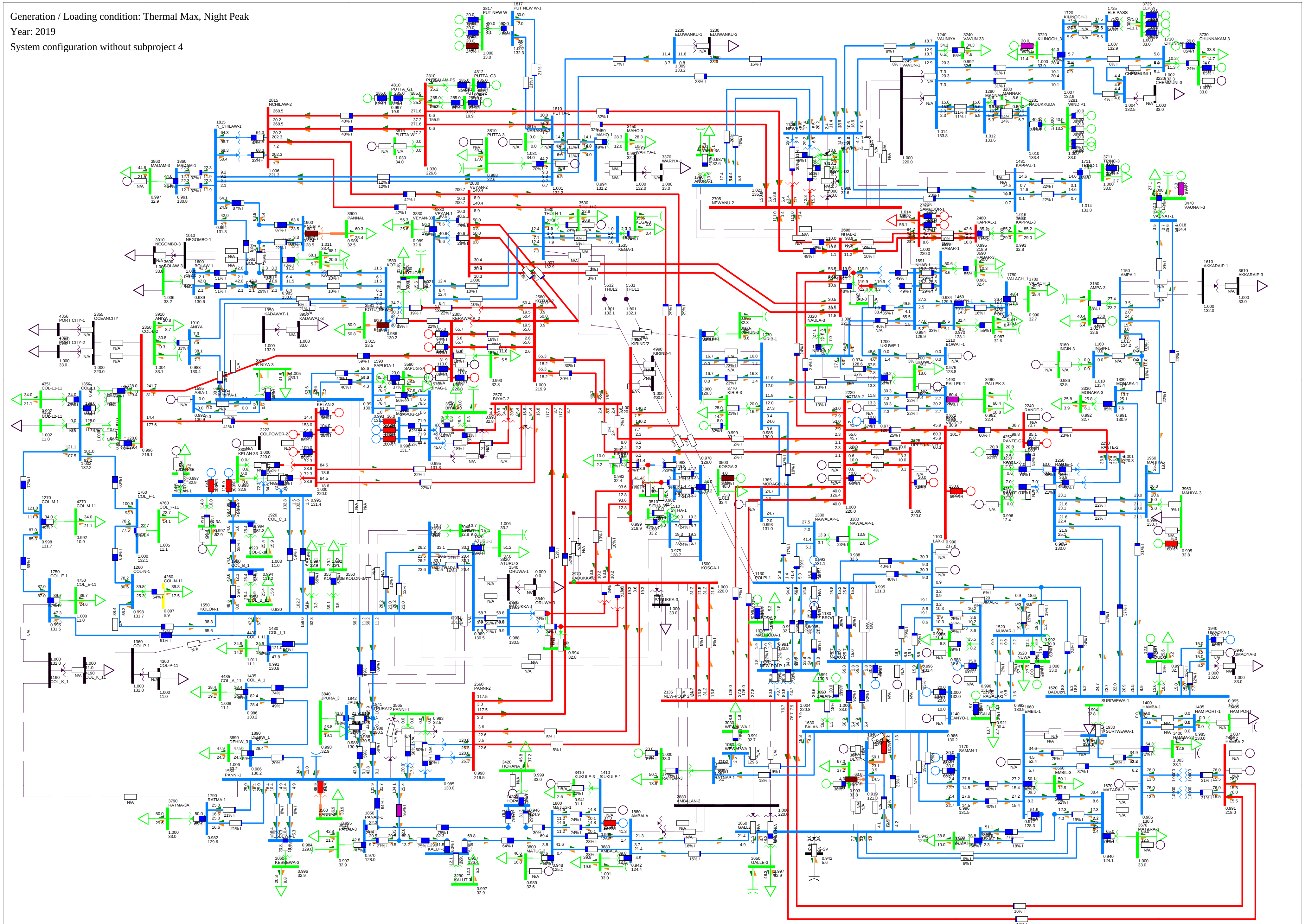


Figure A1-70 Power flow without Subproject 4 in 2019 on TMNP G/L scenario

Generation / Loading condition: Thermal Off Peak

Year: 2019

System configuration without Subproject 4

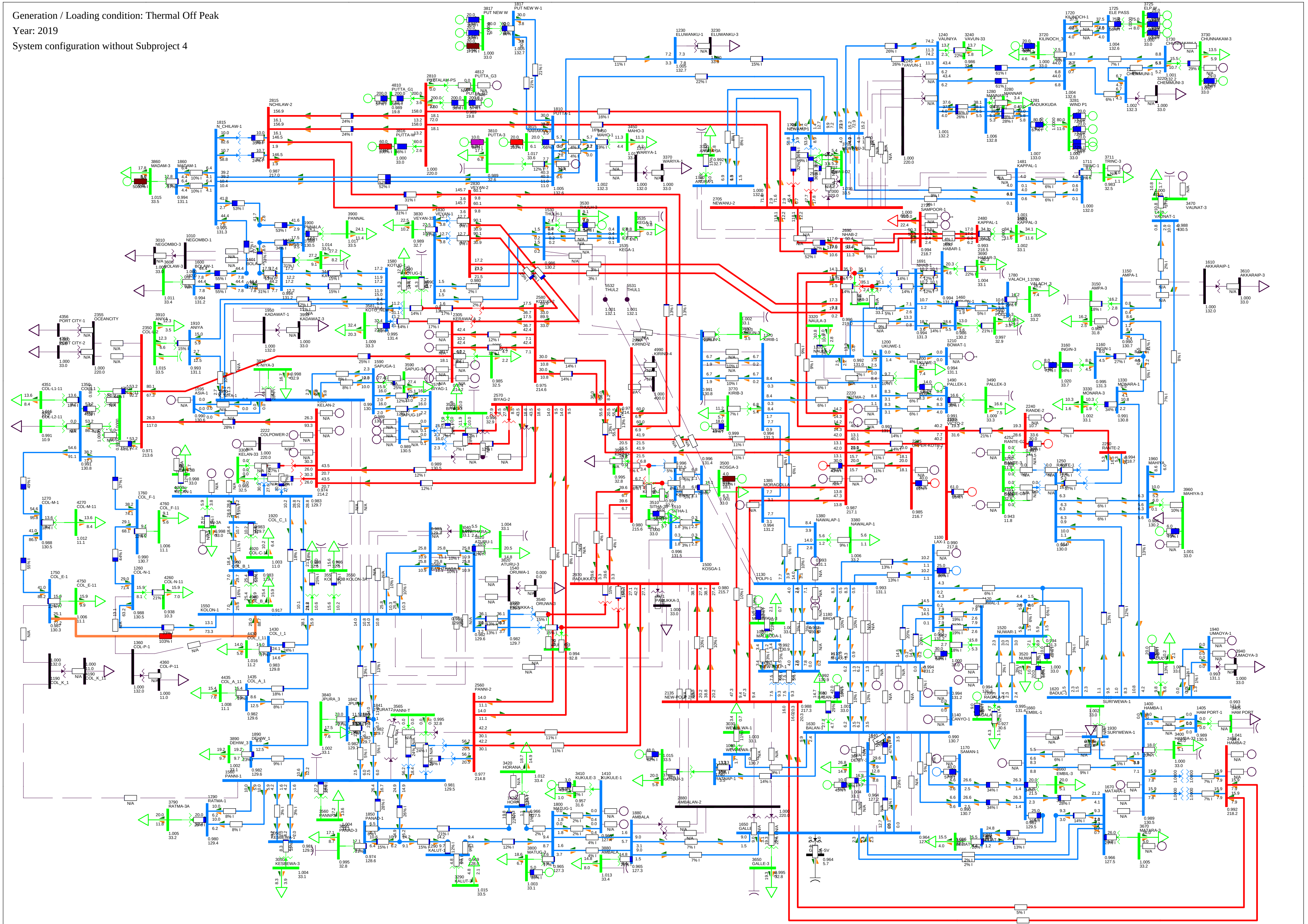


Figure A1-71 Power flow without Subproject 4 in 2019 on OP G/L scenario

Generation / Loading condition: Hydro Max, Day Peak

Year: 2019

System configuration without Subproject 5

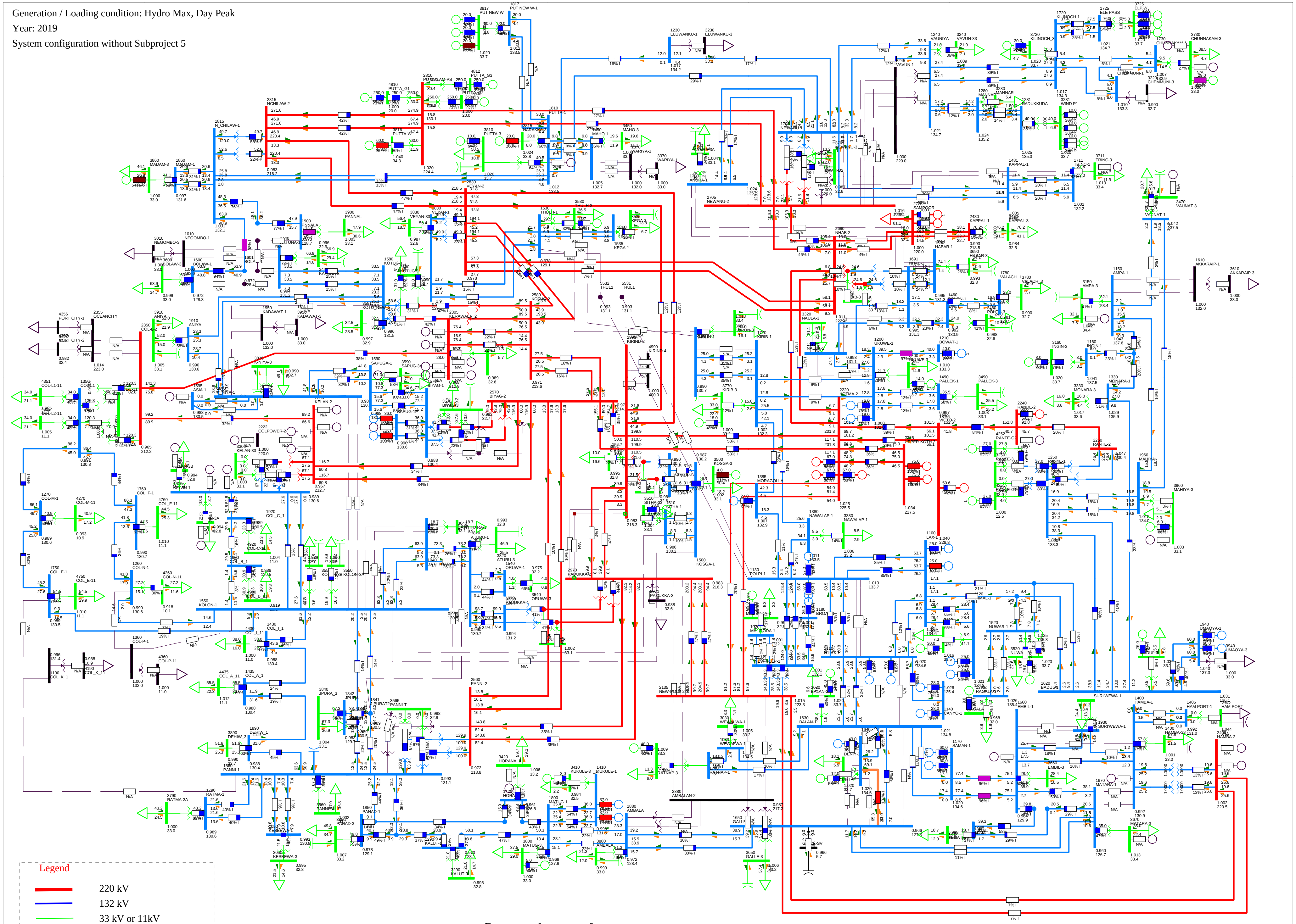
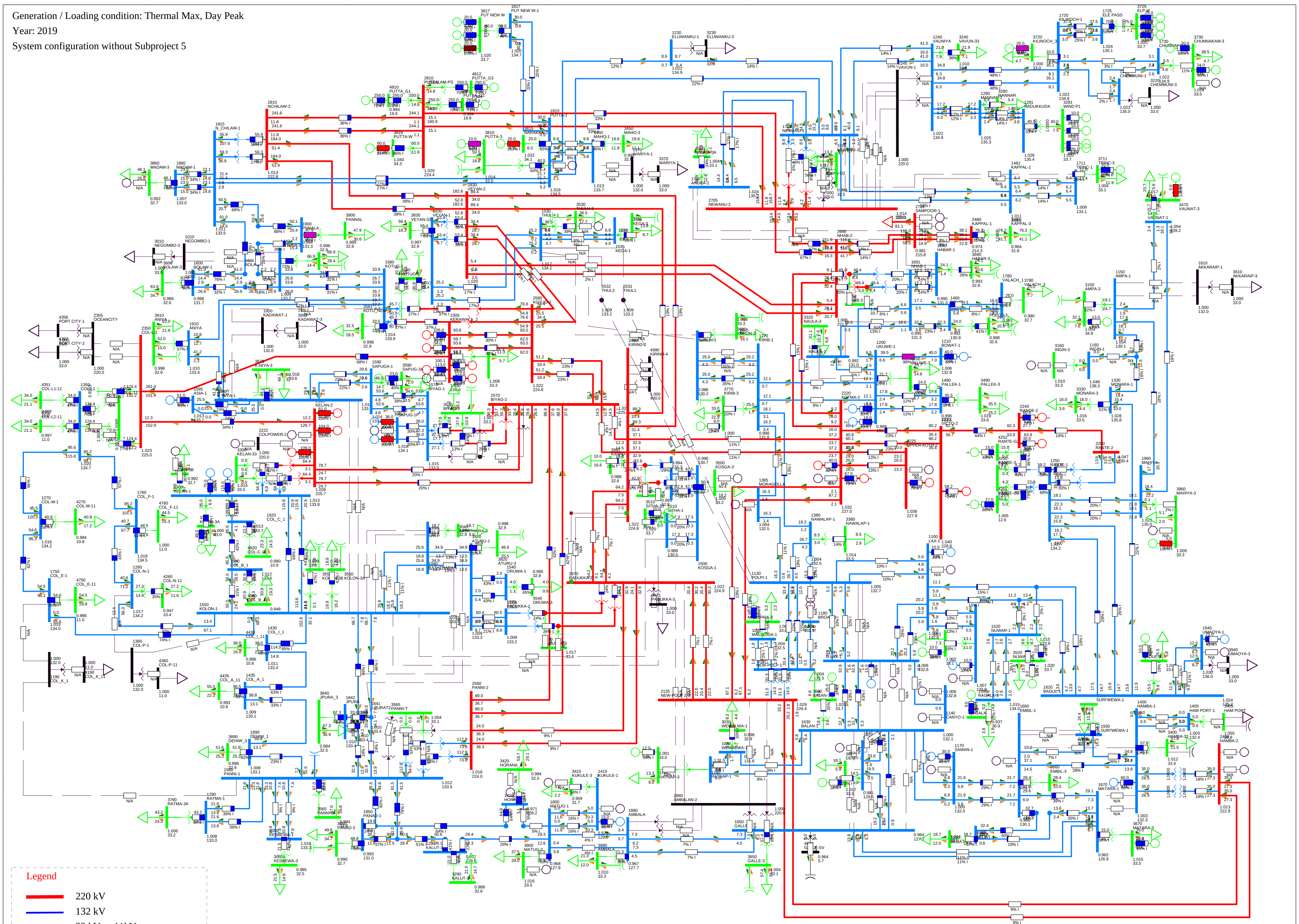


Figure A1-72 Power flow without Subproject 5 in 2019 on HMDP G/L scenario

Generation / Loading condition: Thermal Max, Day Peak

Year: 2019

System configuration without Subproject 5



Legend

- 220 kV
- 132 kV
- 33 kV or 11kV
- No data
- Overloaded equipment

Figure A1-73 Power flow without Subproject 5 in 2019 on TMDP G/L scenario

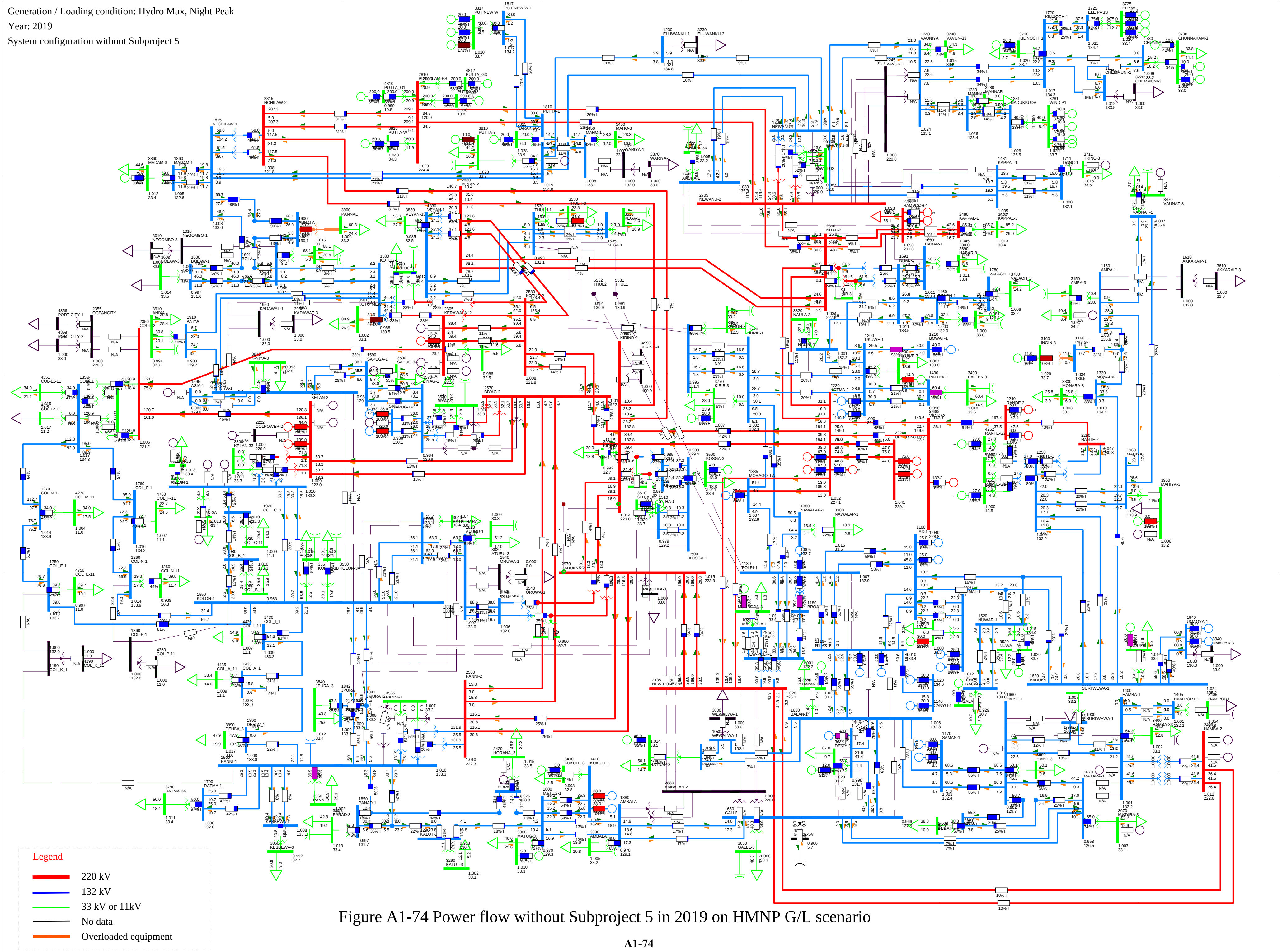
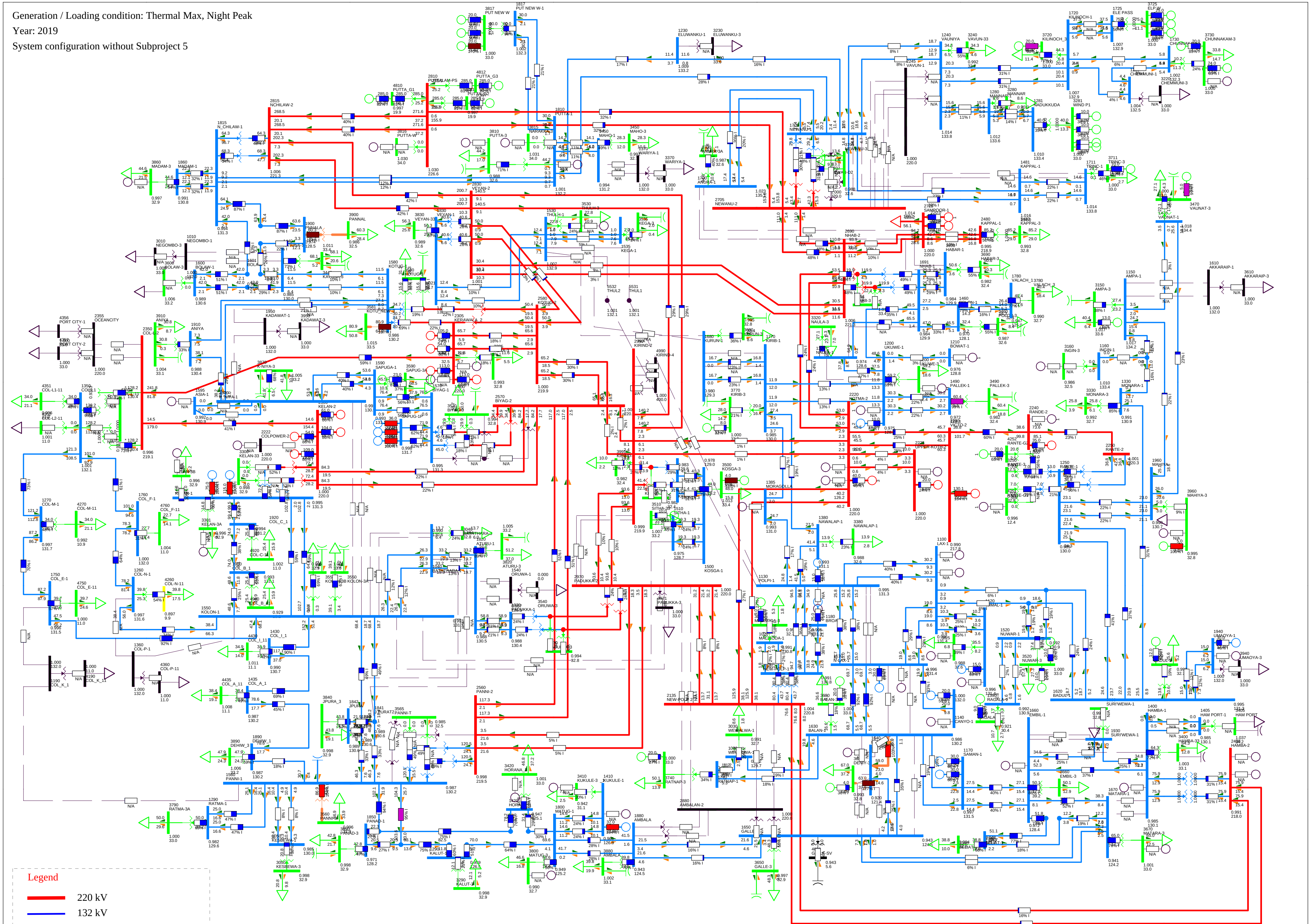


Figure A1-74 Power flow without Subproject 5 in 2019 on HMNP G/L scenario

Generation / Loading condition: Thermal Max, Night Peak

Year: 2019

System configuration without Subproject 5



Legend

- 220 kV
- 132 kV
- 33 kV or 11kV
- No data
- Overloaded equipment

Figure A1-75 Power flow without Subproject 5 in 2019 on TMNP G/L scenario

Generation / Loading condition: Thermal Off Peak

Year: 2019

System configuration without Subproject 5

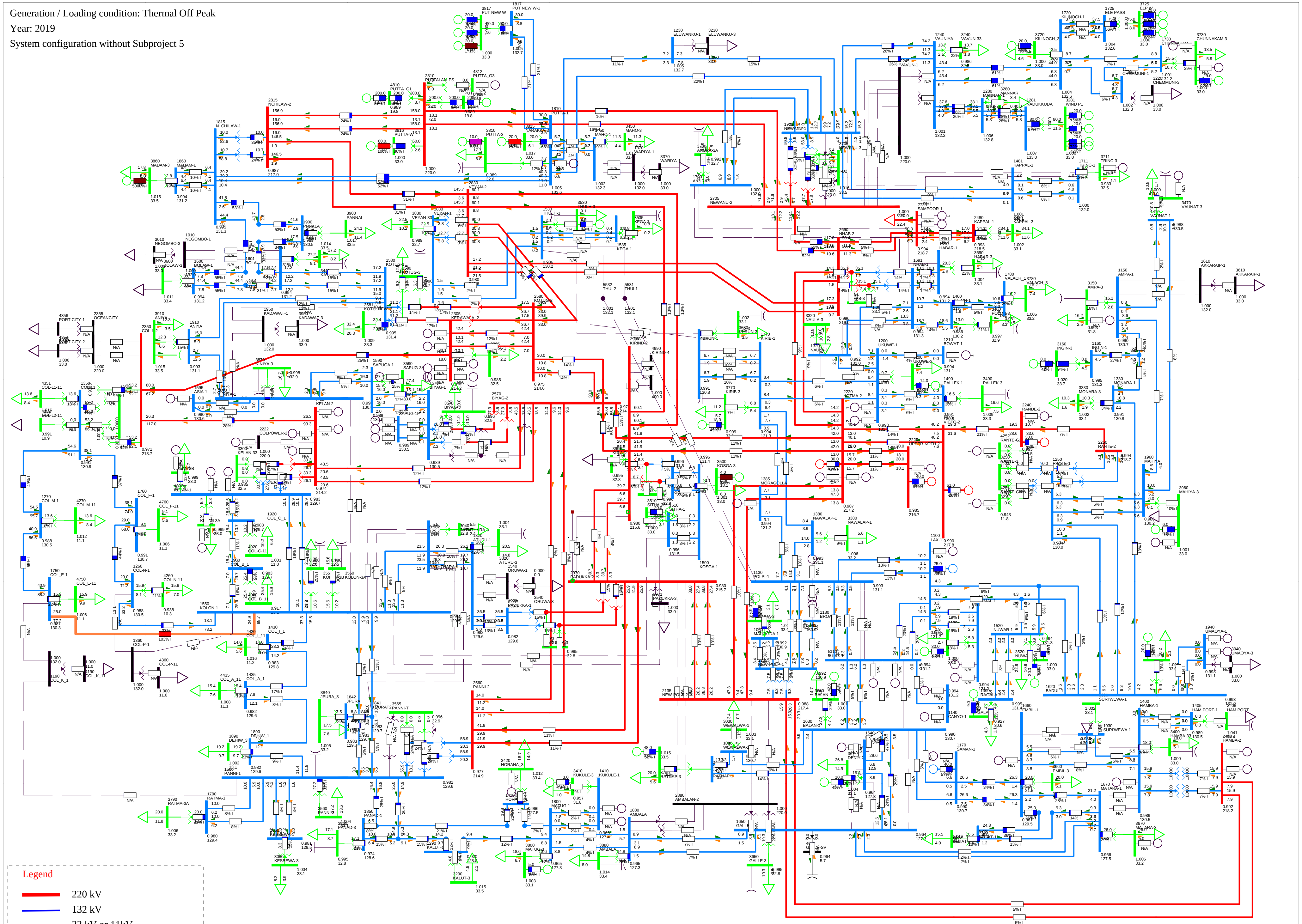


Figure A1-76 Power flow without Subproject 5 in 2019 on OP G/L scenario

Generation / Loading condition: Hydro Max, Day Peak
Year: 2019
System configuration without Subproject 6

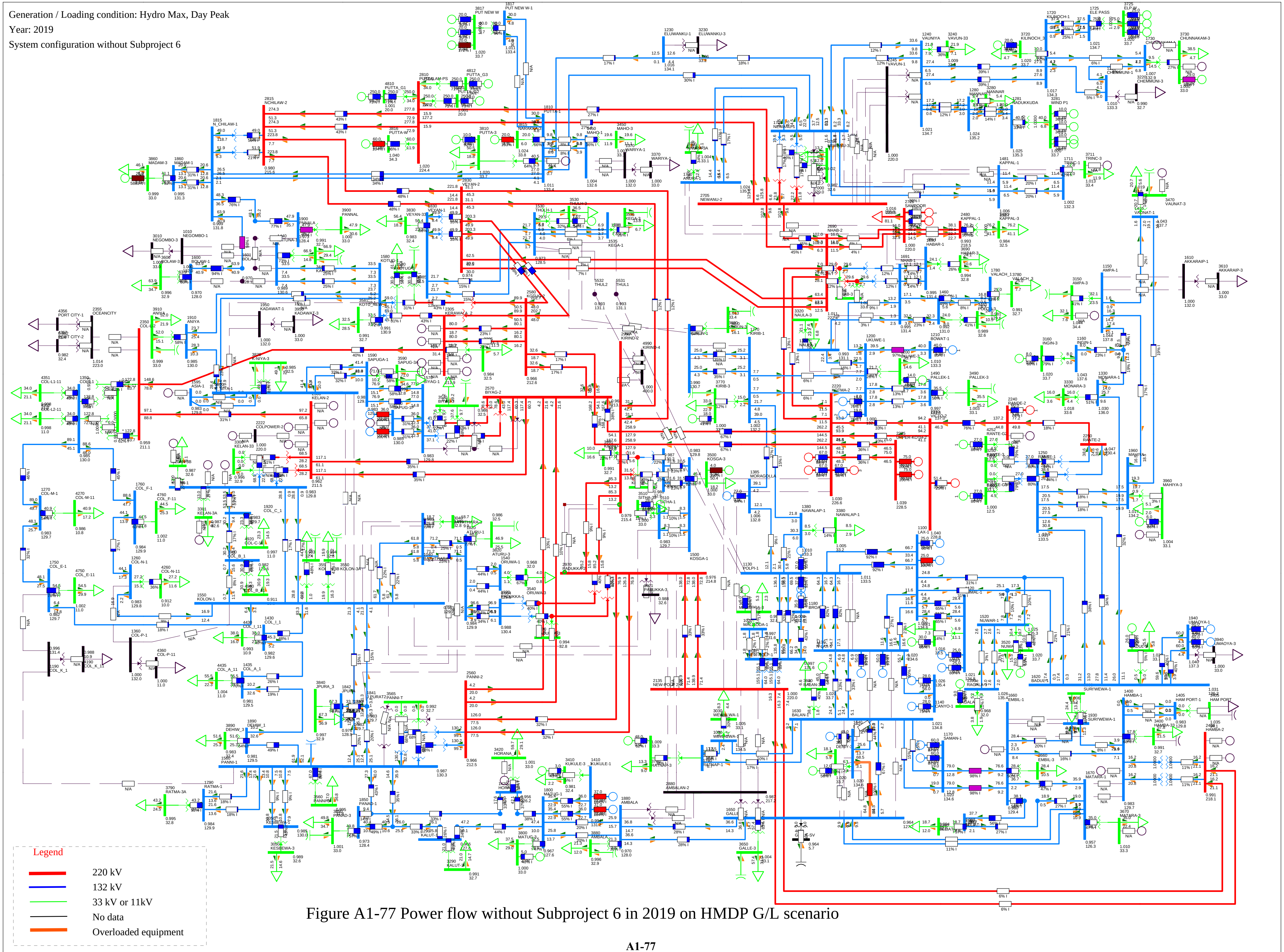


Figure A1-77 Power flow without Subproject 6 in 2019 on HMDP G/L scenario

Generation / Loading condition: Thermal Max, Day Peak

Year: 2019

System configuration without Subproject 6

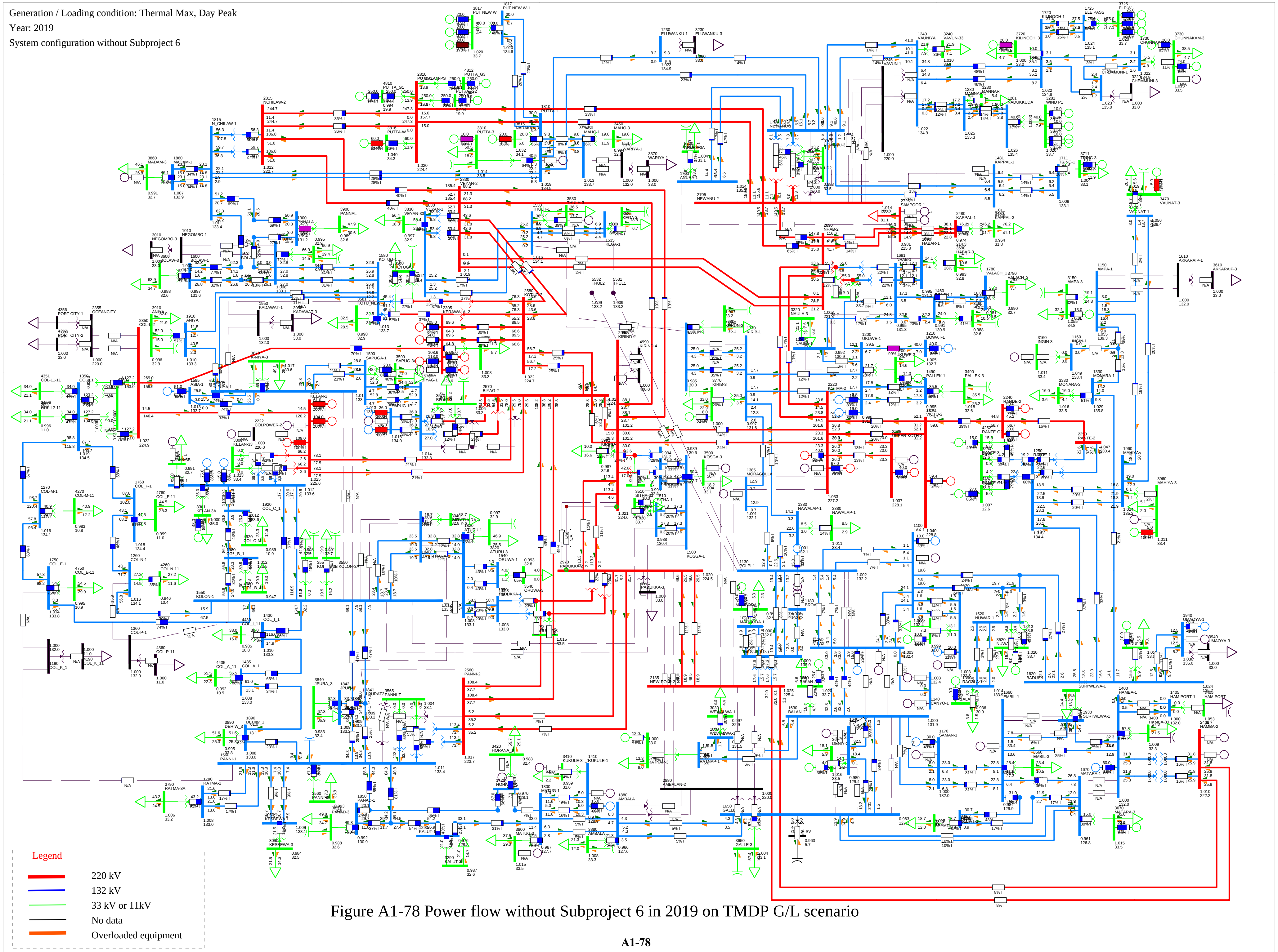
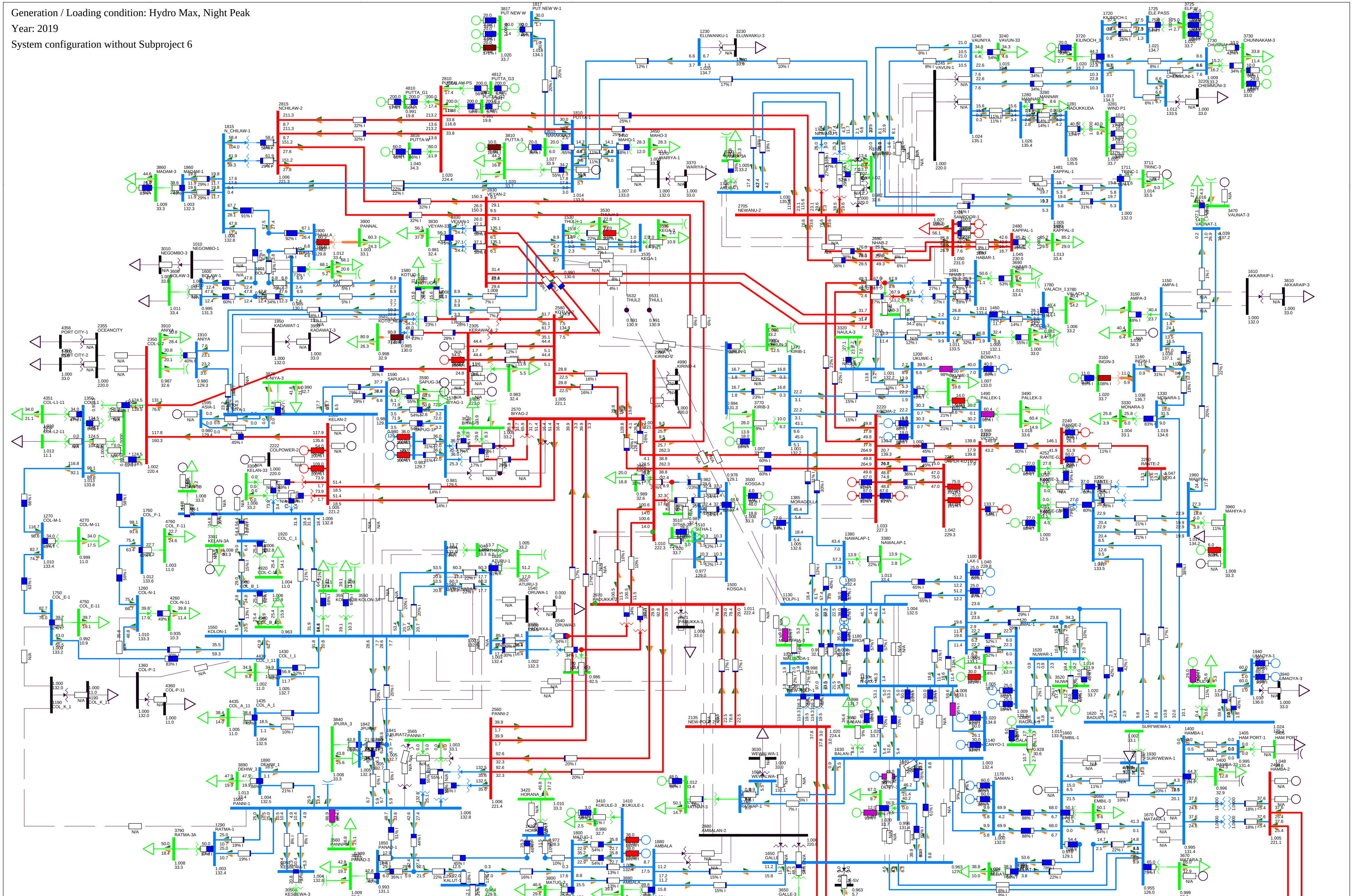


Figure A1-78 Power flow without Subproject 6 in 2019 on TMDP G/L scenario

Generation / Loading condition: Hydro Max, Night Peak

Year: 2019

System configuration without Subproject 6



Legend

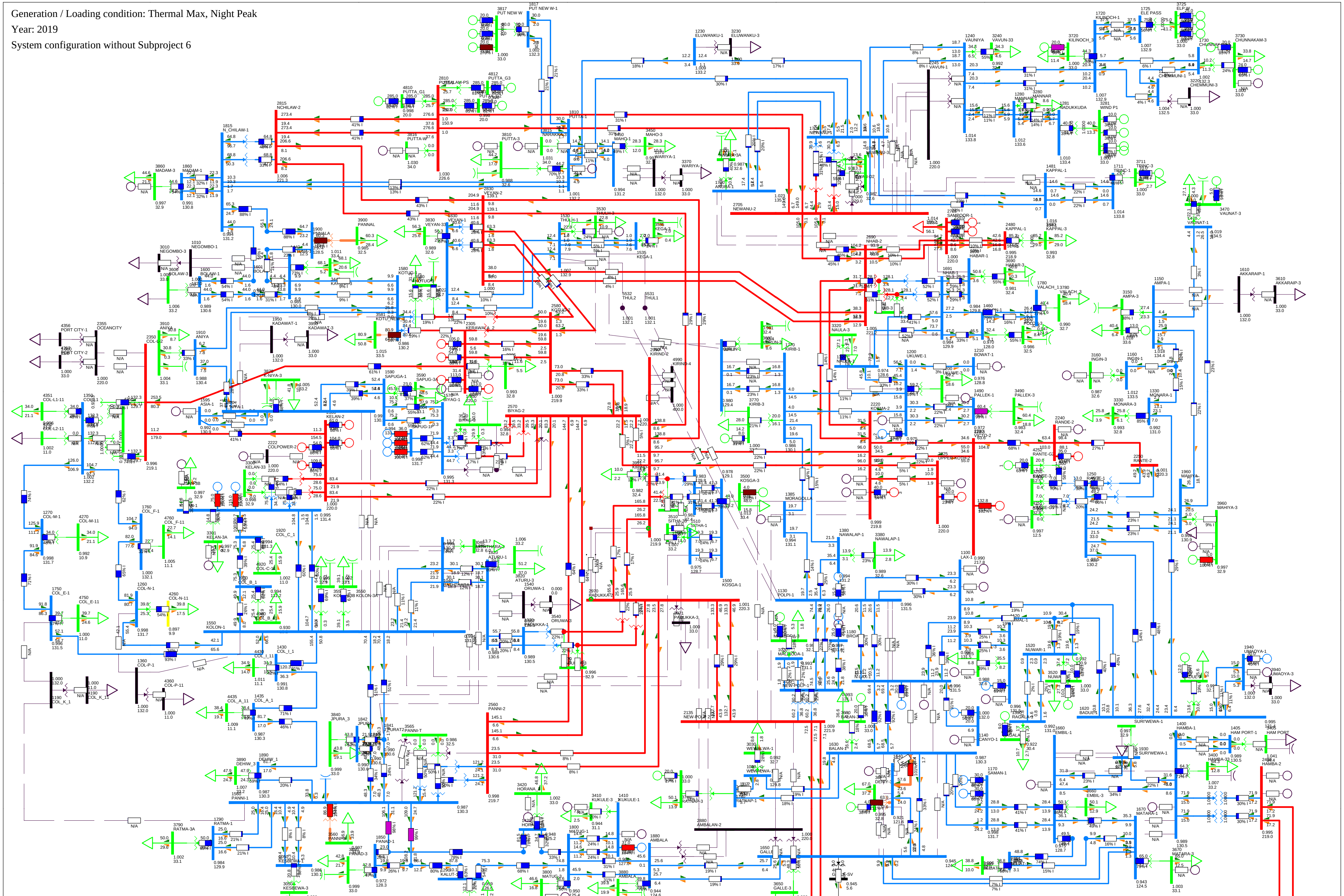
- 220 kV
- 132 kV
- 33 kV or 11kV
- No data
- Overloaded equipment

Figure A1-79 Power flow without Subproject 6 in 2019 on HMNP G/L scenario

Generation / Loading condition: Thermal Max, Night Peak

Year: 2019

System configuration without Subproject 6

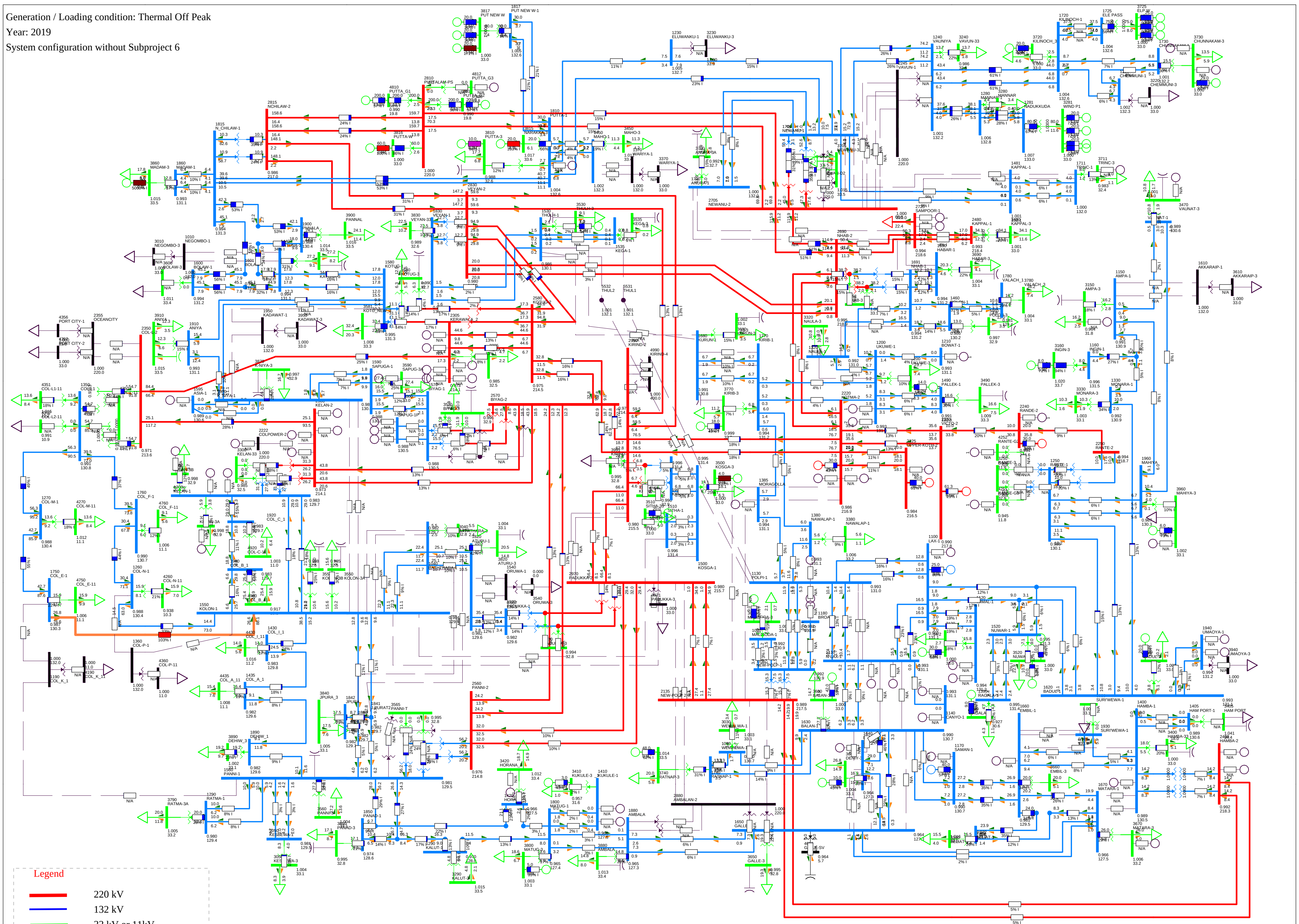


Legend

(red line)	220 kV
(blue line)	132 kV
(green line)	33 kV or 11kV
(black line)	No data
(orange line)	Overloaded equipment

Figure A1-80 Power flow without Subproject 6 in 2019 on TMNP G/L scenario

Generation / Loading condition: Thermal Off Peak
Year: 2019
System configuration without Subproject 6



Legend

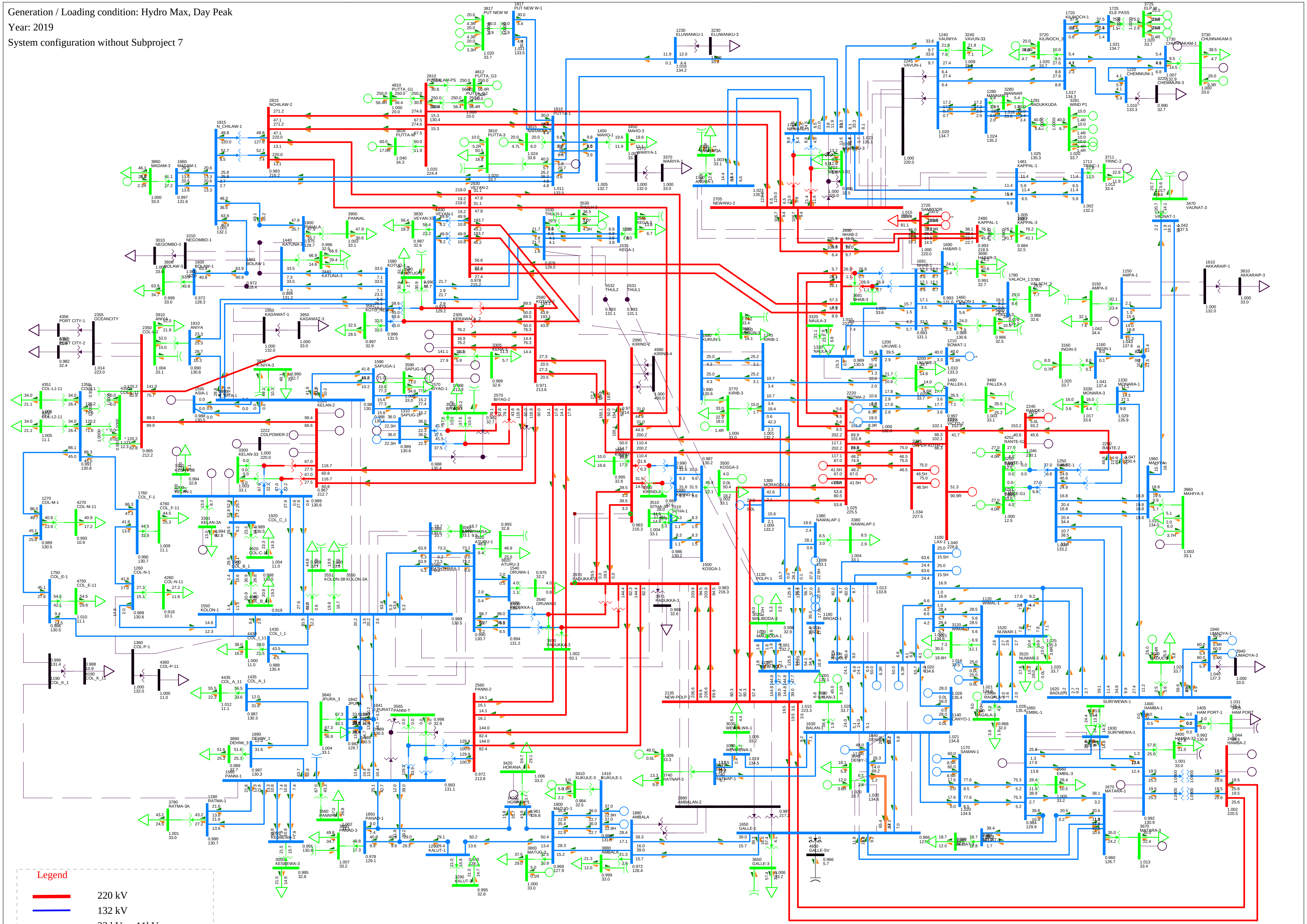
- 220 kV
- 132 kV
- 33 kV or 11kV
- No data
- Overloaded equipment

Figure A1-81 Power flow without Subproject 6 in 2019 on OP G/L scenario

Generation / Loading condition: Hydro Max, Day Peak

Year: 2019

System configuration without Subproject 7



Legend

220 kV

132 kV

33 kV or 11kV

No data

Overloaded equipment

Figure A1-82 Power flow without Subproject 7 in 2019 on HMDP G/L scenario

Generation / Loading condition: Thermal Max, Day Peak
Year: 2019
System configuration without Subproject 7

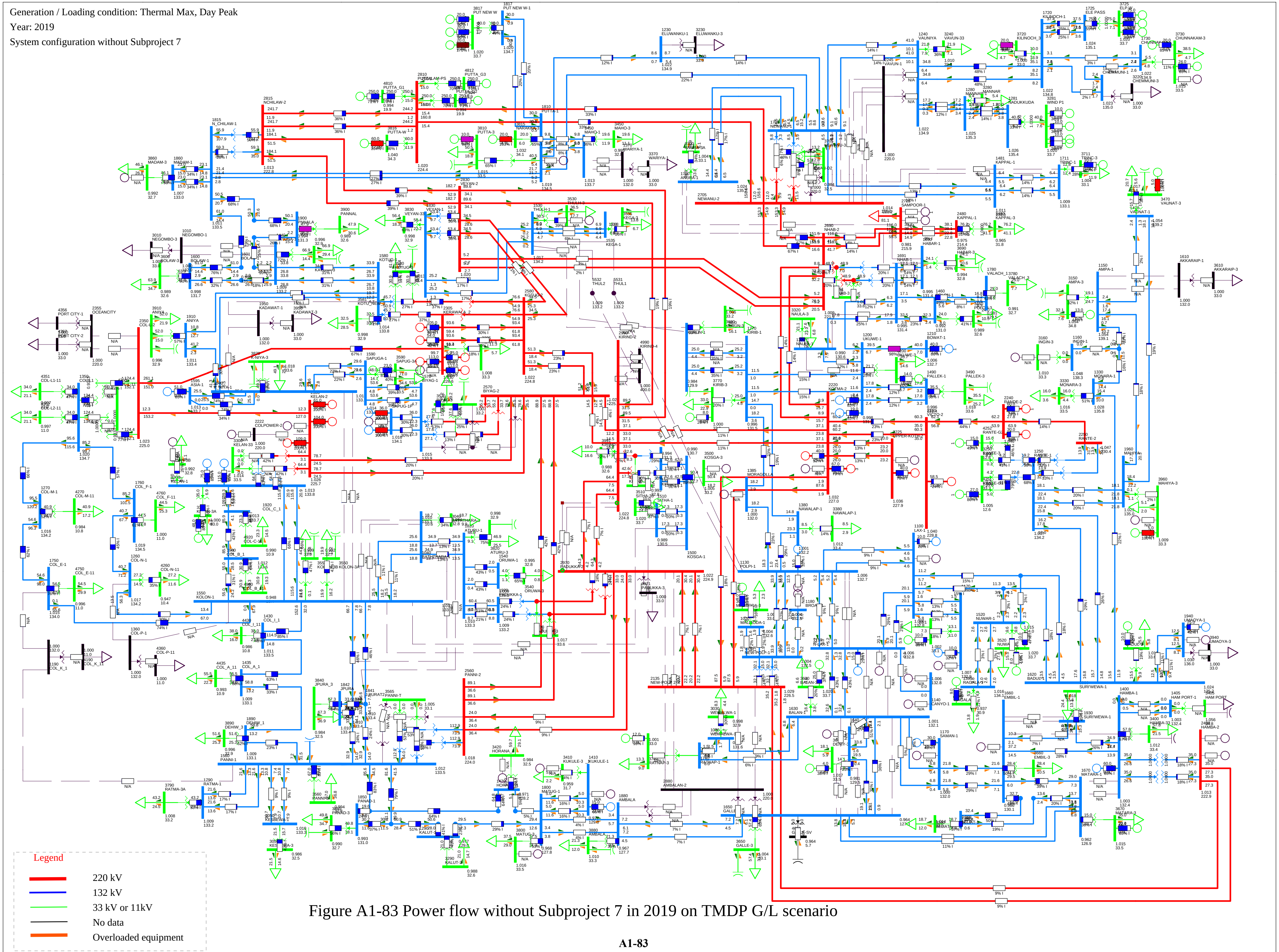
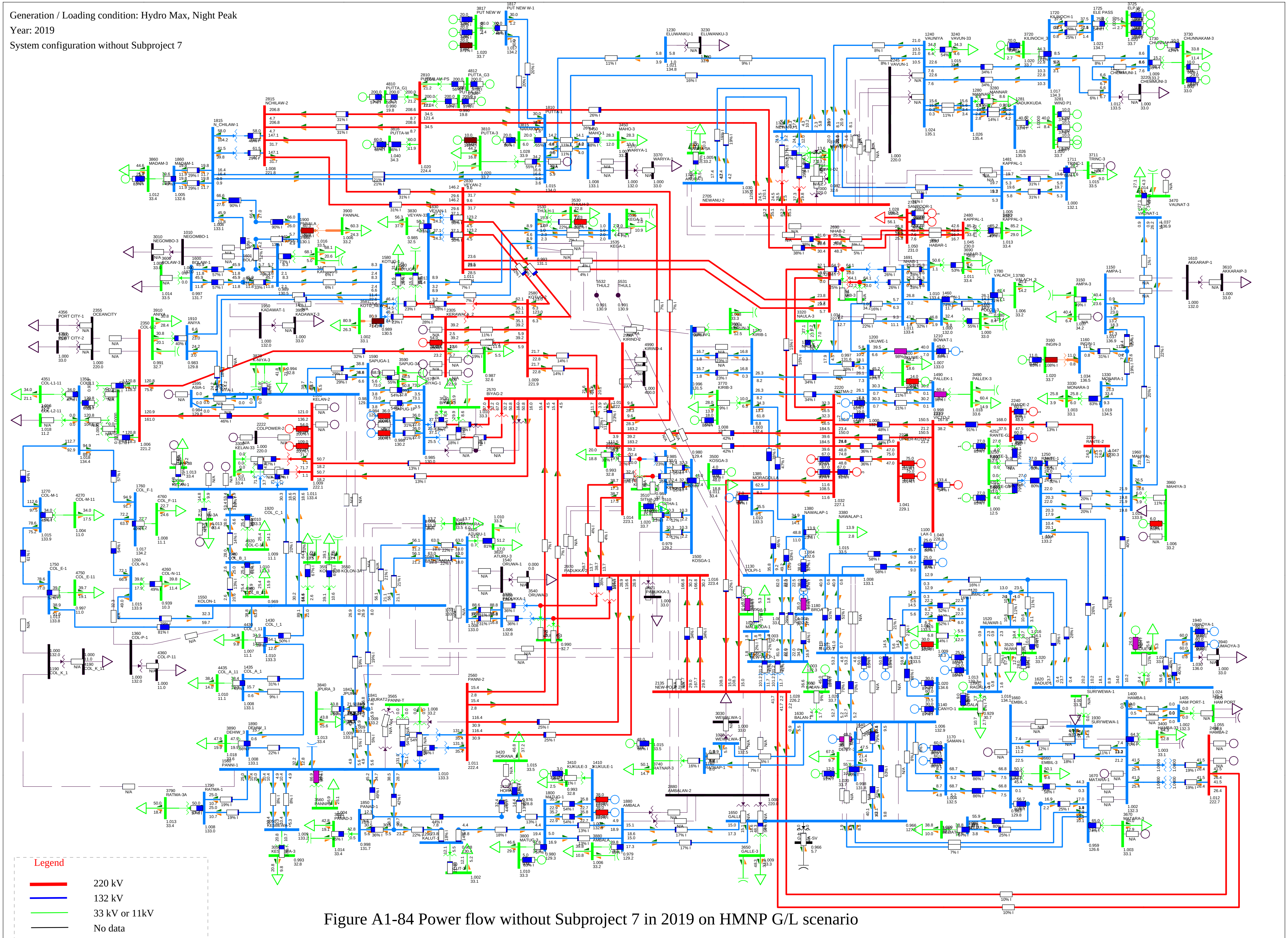


Figure A1-83 Power flow without Subproject 7 in 2019 on TMDP G/L scenario

Generation / Loading condition: Hydro Max, Night Peak
Year: 2019
System configuration without Subproject 7



Legend

220 kV
132 kV
33 kV or 11kV
No data
Overloaded equipment

Figure A1-84 Power flow without Subproject 7 in 2019 on HMNP G/L scenario

Generation / Loading condition: Thermal Max, Night Peak

Year: 2019

System configuration without Subproject 7

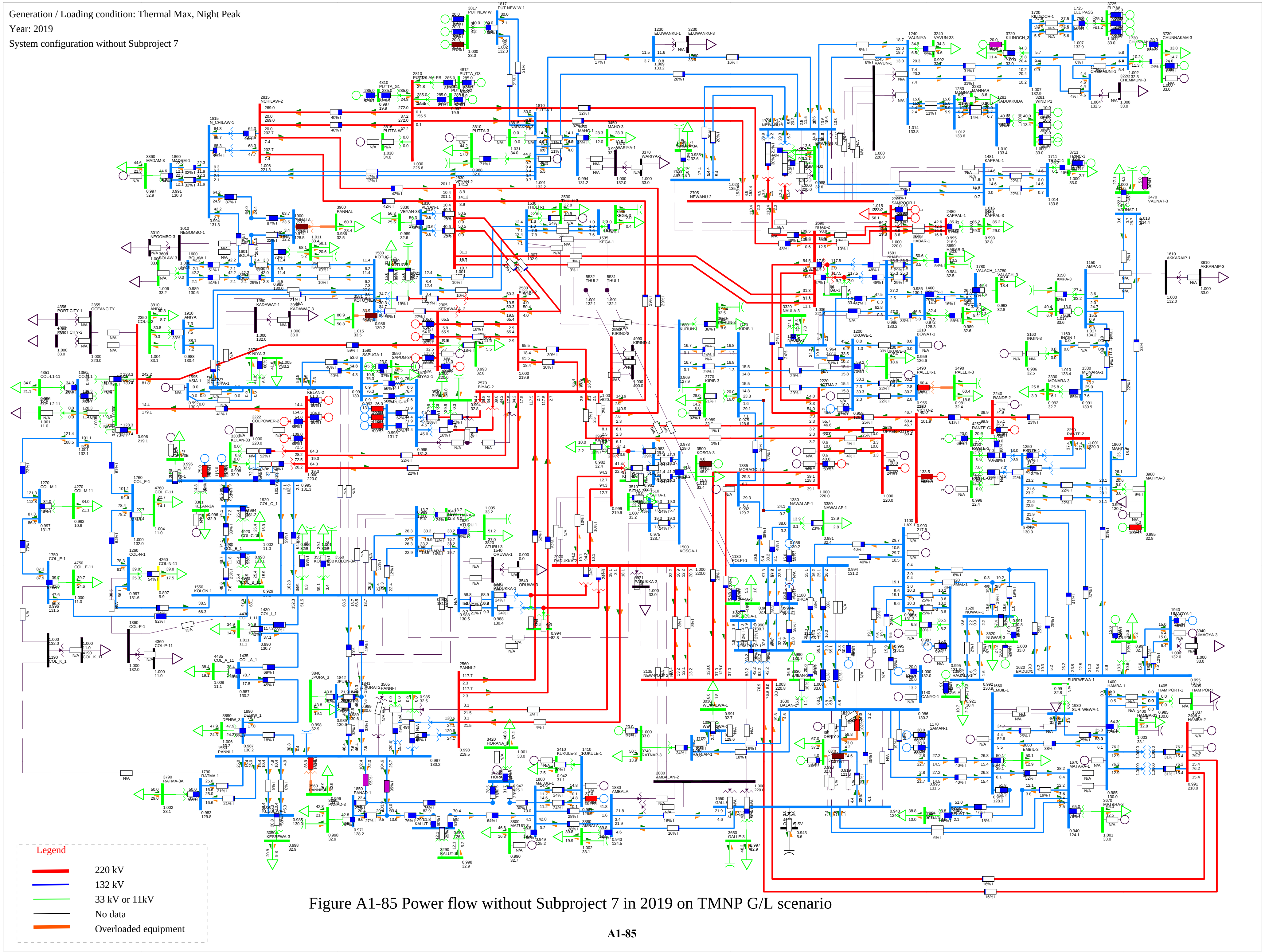
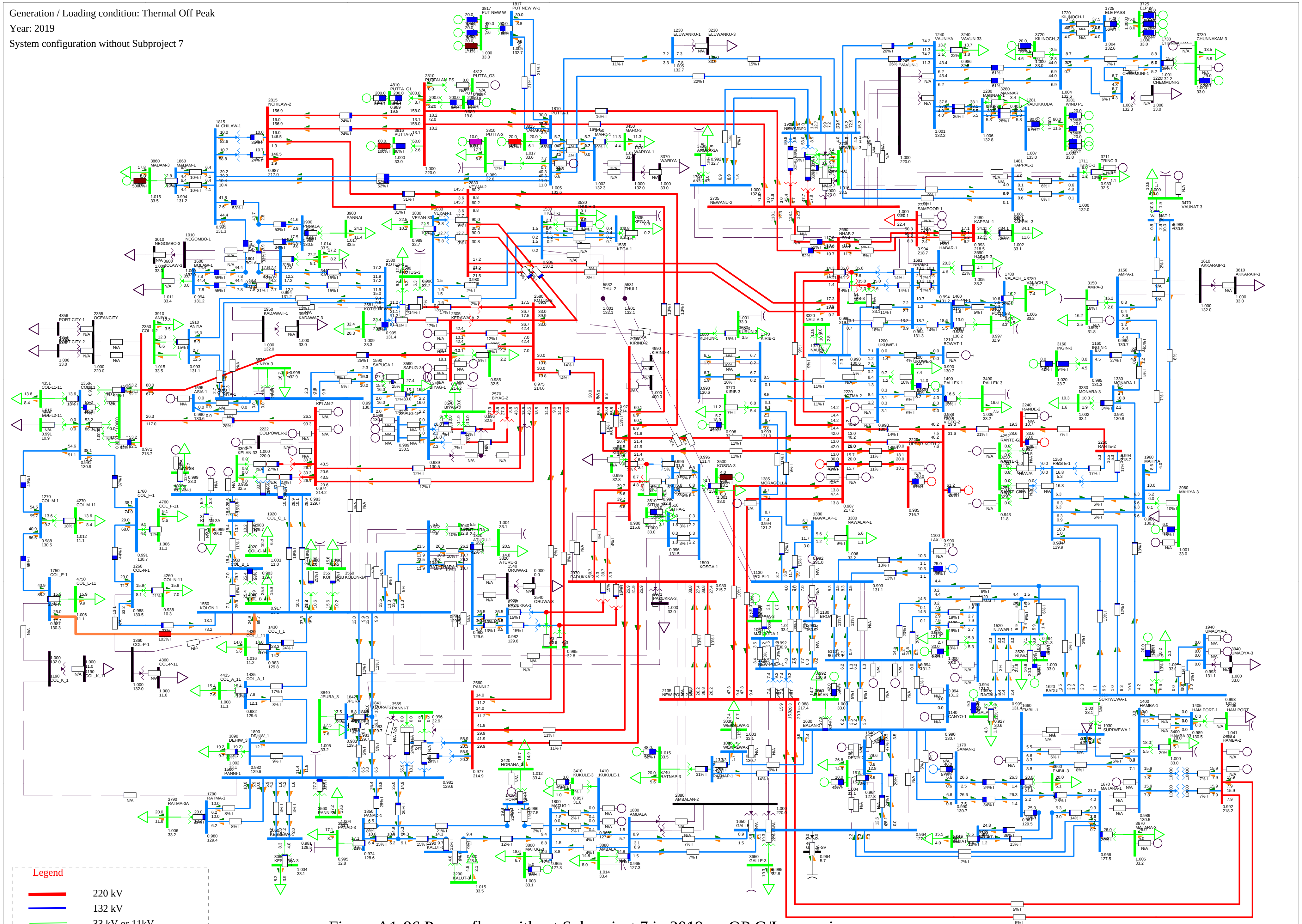


Figure A1-85 Power flow without Subproject 7 in 2019 on TMNP G/L scenario

Generation / Loading condition: Thermal Off Peak

Year: 2019

System configuration without Subproject 7



Legend

- 220 kV
- 132 kV
- 33 kV or 11kV
- No data
- Overloaded equipment

Figure A1-86 Power flow without Subproject 7 in 2019 on OP G/L scenario

Site Survey Report for Project 1

1. Date

September 25 – 30, 2014

2. Location

220/132/33kV Kirindiwela GS (New)

220/132/33kV Padukka GS (Under construction)

220/132/33kV Veyangoda GS (Existing)

220/132kV Biyagama GS (Existing)

220/132kV Kothmale GS (Existing)

132/33kV Kosgama GS (Existing)

132/33kV Seethawaka GS (Existing)

3. Surveyor

CEB Engineers

Mr. Tada (TEPSCO)

Mr. Minagawa (TEPSCO)

4. Method of Survey

Visual check Survey from the ground

5. Site condition

5.1. 220/132/33kV Kirindiwela GS

Planned area is being used for banana plantation at the moment. Field is almost flat and ground seems to be good condition. There is much area to construct a future 400kV GS as well.

An access road to the substation is narrow, and therefore it needs to expand.

Planned area (Banana plantation)

Access road to planned substation site

5.2. Padukka GS

The construction of this substation under ADB project is yet to be started at the moment. It is scheduled to be completed and commissioned by the end of 2017 as per CEB. This area is forest, and ground condition seems to be good.

Planning area (Forest)

5.3. 220/132kV Biyagama GS

CEB plans that 220kV TL protection facility for new Kirindiwela GS will be replaced to match with the opposite end i.e. Kirindiwela GS, however the existing control panels will be used.

Existing 220kV TL Protection facility to be replaced

5.4. 220/132kV Veyangoda GS

There is not enough space for additional 220kV bays and gantry of 220kV Kirindiwela – Veyangoda lines. To construct the bays and gantry, land acquisition is needed in south area of GS.

There are old un-used 132kV towers in the area for new 220kV line and bays. Therefore tower (inside and outside GS) needs to be removed.

Area for new 220kV bay extension (Old 132kV tower are center and back)

Same scale gantries and tower (Double Zebra) will be constructed.

Enough space for protection and control facility for the 220kV TL bays for Kirindiwela GS are available.
Interface with the existing SAS (SAC (China) make) is required.

5.5. 220/132kV Kothmale GS (Modification of TL protection and control for Kirindiwela GS)

Modification to the existing 220kV TL protection and control facility for Biyagama GS will be made to protect a new 220kV Kirindiwela TL.
Interface with the existing SAS is required.

5.6. 132/33kV Kosgama GS

132kV gantries are located at North of GS, but there are some houses at north area. So to construct transmission line and connect to GS from north is difficult. And there are some 33kV and 132kV transmission/ distribution line at south and east of GS. And further 132kV Kolonnawa / Polpitiya line come from south of GS and go through over the transformer.
In design stage of the 132kV Kirindiwela – Kosgama line, consideration needs to be made about clearance from these existing T/Ls. Also during construction period, it needs some special measures for safety.
Space for additional two 132kV TL bays for Kirindiwela GS is available in both side of the existing 132kV switchyard.
Space for additional protection and control facility for two nos. of 132kV TL bay switchgear for Kirindiwela GS is available in the existing control room.
DC 110V battery and charger will be Ni-Cd (1.2V x 92 cells 300Ah@5Ah) and a switchboard (ATS) will be necessary for redundancy.

CEB proposed, as additional scope of work, the followings items:

a) Replacement of existing protection facilities,
b) Installation of New SAS facility including IED for 132kV system
(The existing 132kV direct control panel will not be used and will be removed.)

North west side of GS (33kV T/L and private house around GS)
Space for additional 132kV bay for JICA project

Existing 132kV Koronnawa / Polipitiya line comes from south of GS and cross over transformer

Existing 132kV T/L switch backed and connected to north faced gantry. (New T/L is planned in the same connection style)

Some 33kV and two 132kV existing T/L are located on south area of GS (New T/L will come from this direction)

Existing 132kV switchgear to be replaced

Existing 33kV switchgear (DS, DE/ES) to be replaced

5.7. 132/33kV Seethawaka GS

CEB originally plans to install a bus-coupler under JICA project.

CEB proposed, as additional scope of work, the following item:

a) Addition of the second 132kV bus-bar since it is necessary for system operation,

b) Replacement of existing TL protection facility to match with one in the Kosgama GS.

132kV Switchyard

(End)

Site Survey Report for Project 2

1. Date

September 24 – 30, 2014

2. Location

220/132/33kV Veyangoda GS (Existing)

132/33kV Thulhiriya GS (Existing)

3. Surveyor

CEB Engineers

Mr. Tada (TEPSCO)

Mr. Minagawa (TEPSCO)

4. Method of Survey

Visual check Survey from the ground

5. Site condition

5.1. 220/132/33kV Veyangoda GS (Existing 132kV switchyard)

Spare two 132kV bays will be used for 132kV Veyangoda – Thulhiriya lines. The gantries for these lines are located west of 132kV bay, and therefore the line must come from west. But new 220kV TL bays (Kirindiwela – Veyangoda line) will be constructed in west area of this bay, and therefore new 132kV line has to come from south side of GS. Further to this condition, there is a house in south of GS. Therefore CEB plans to construct 132kV Veyangoda – Thulhiriya line dead-end tower at south boundary area of GS near a private house and connect to existing gantry.

The CT needs to be replaced to match with the new TL power flow. This work will be additional scope of JICA project.

The TL protection and control facility for Thulhiriya GS needs to be modified to match with the Thulhiriya GS.

Existing 132kV spare TL bays for Thulhiriya line (Right-end and 3rd from right, front area of these bays will be used for 220kV new bay)

West direction view from 132kV bay (The old 132kV towers needs to be removed and New two 220kV bays will be extended)

Private house at south side of GS.

5.2. 132/33kV Thulhiriya GS

The existing 132kV Polpitiya / Aturugiriya in-out line go over the GS and are connected to the dead-end tower. The gantries for 132kV T/L are not arranged in ordinary way.

CEB is planning to connect 132kV Thulhiriya – Kegalle line. (ADB project) Tow towers will be constructed at west area (Apparel factory's baseball ground now) of GS to connect its line in its project.

In this JICA project, CEB plan to use these towers to connect 132kV Polpitiya / Aturugiriya in-out line and remove existing dead-end tower and gantry.

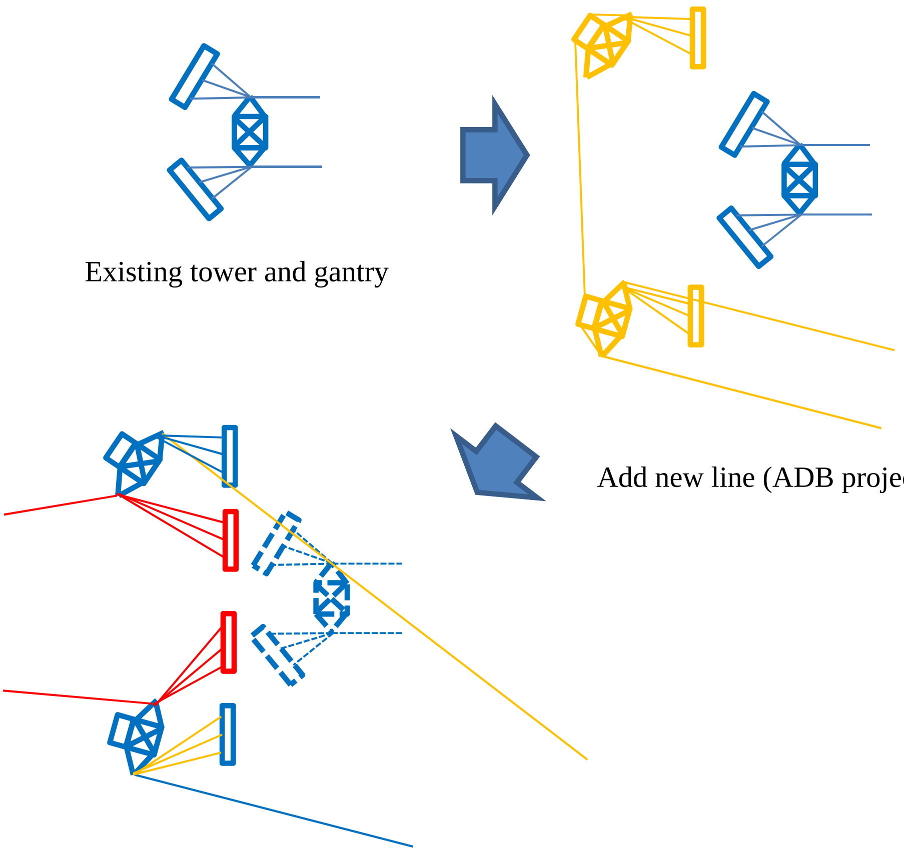
CEB originally plans to replace 132kV switchgears such as DS, DS/ES.

As an additional scope work of JICA project, the followings will be incorporated:

a) Two nos. of 132kV gantries for new transmission line in-take,
b) Replacement of 132kV CT for transmission line,
c) Modification of 132kV TL protection and control facility.

Existing 132kV Polpitiya / Aturugiriya in-out line and gantry

Apparel factory's baseball ground



Add new line and gantry and remove existing tower and gantry (This project)

132kV Switchgear equipment to be replaced

(End)

Site Survey Report for Project 3

1. Date
September 23, 2014

2. Location
132/33kV Battaramulla GS (New)
132/33kV Kolonnawa GS (Existing)
133/33kV Aturugiriya GS (Existing)

3. Surveyor
CEB Engineers
Mr. Tada (TEPSCO)
Mr. Minagawa (TEPSCO)

4. Method of Survey
Visual check Survey from the ground

5. Site condition

5.1. 132/33kV Battaramulla GS

132kV Kolonnawa – Aturugiriya line goes under 220kV T/L. To cross the 220kV T/L, this 132kV T/L uses gantry. CEB plans to construct new Battaramulla GS around the gantry. This gantry is located in a field where used to be a paddy field but not being cultivated at the moment. CEB doesn't have soil data of this area at present, and therefore geological investigation is needed during detailed design stage.

Existing 132kV Kolonnawa – Aturugiriya lines go under 220kV T/L

The planned area for Battaramulla GS

5.2. 132/33kV Kolonnawa GS

CEB plans to modify the existing line protection & control facility to match with the opposite end i.e. new Battaramulla GS.

132kV TL Protection facility to be modified

5.3. 133/33kV Athurugiriya GS

CEB plans to modify the existing line protection & control facility to match with the opposite end i.e. new Battaramulla GS.

132kV TL Protection facility to be modified

(End)

Site Survey Report for Project 4

1. Date

September 23, 2014

2. Location

132/33kV Kolonnawa GS (Existing)

132/33kV Pannipitiya GS (Existing)

132kV Kolonnawa – Pannipitiya T/L

3. Surveyor

CEB Engineers

Mr. Tada (TEPSCO)

Mr. Minagawa (TEPSCO)

4. Method of Survey

Visual check Survey from the ground

5. Site condition

5.1. 132/33kV Kolonnawa GS

Kolonnawa GS is located near Colombo and dead-end tower is located in Colombo 9. CEB plans to use the same gantry for 132kV Kolonnawa – Pannipitiya line. The gantry looks good condition.

Existing 132kV Kolonnawa– Pannipitiya line and gantry

Existing 132kV Kolonnawa– Pannipitiya line (No2 and No3 tower are seen)

5.2. 132/33kV Pannipitiya GS

As same as Kolonnawa GS, this transmission line is old but in good condition. According to CEB plan, the existing gantry will be used for new Kolonnawa – Pannipitiya line.

For the portion of substation work , please refer to the Site Survey Report on Project 5.

Existing 132kV Kolonnawa– Pannipitiya line (Dead end tower)

5.3. 132kV Kolonnawa – Pannipitiya T/L

This line goes through density area. There is no area to construct another new line, and so CEB plans to make new line on the same place because there are some difficulties to acquire new RoW.

The tower No.2 to No.6 are located in the most density area. Some towers are located in private houses. At the time of re-construction, removal of those personal owned structures (Store-house, shop, etc.) is required. Especially No.3 tower must be considered because a house may have been constructed on the tower foundation. CEB plans to construct new tower at other place which is under existing T/L because new RoW can't acquire.

Existing 132kV Kolonnawa– Pannipitiya line and ambient area

Existing 132kV Kolonnawa No.3 tower

(Private store-house has been constructed on tower area and house (Green house in picture and left white house in the 3rd picture) has been on the tower foundation)

Existing 132kV Kolonnawa No.4 tower

(The tower is located inside a private garden.)

Existing 132kV Kolonnawa line goes along with Diyawanna Lake.

(End)

Site Survey Report for Project 5

1. Date

September 23, 2014

2. Location

132/33kV Pannipitiya GS (Existing)

132/33kV Ratmalana GS (Existing)

132kV Pannipitiya – Ratmalana line

3. Surveyor

CEB Engineers

Mr. Tada (TEPSCO)

Mr. Minagawa (TEPSCO)

4. Method of Survey

Visual check Survey from the ground

5. Site condition

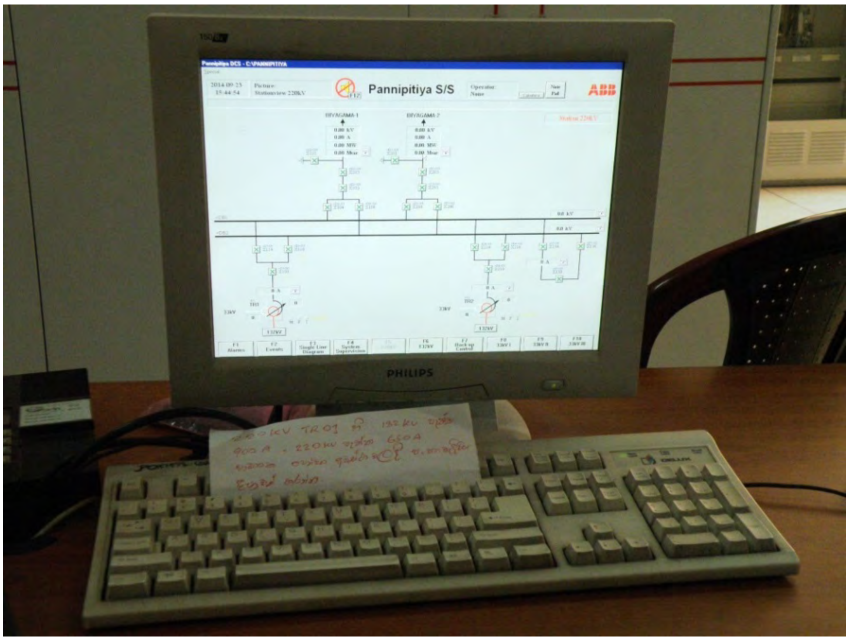
5.1. 132/33kV Pannipitiya GS

According to CEB, this substation has been constructed and commissioned in 1983, and therefore most of the equipment used more than 30 years and aged enough.

CEB originally plans to replace the existing 132kV switchgear including CB, VT, 132kV protection and control facility and substation automation system (SAS).

As an additional scope to JICA project, 132kV CTs for the 132kV TL for Kolonnawa and Ratmalana will be replaced to match with the new power flow.

Existing 132kV switchgear (CB, CT and VT) to be replaced



Existing SAS system to be replaced by JICA Project

5.2. 132/33kV Ratmalana GS

As same as Kolonnawa GS, this line is old but in good condition. According to CEB plan, the existing gantry will be used for new Kolonnawa – Pannipitiya line.

According to CEB this substation has constructed and commissioned in 1960s, and therefore most of the equipment used more than 45 years and aged enough.
CEB originally plans to replace 132kV switchgears such as CB, DS, 33kV DS/ES, substation common items and to supply substation automation system (SAS)

It is confirmed that the existing 132kV CT for Pannipitiya line needs to be replaced because the rated primary current is not suitable. This replacement work will be an additional scope of work of JICA Project.
CEB plans to construct a new control building under JICA project as an additional scope.

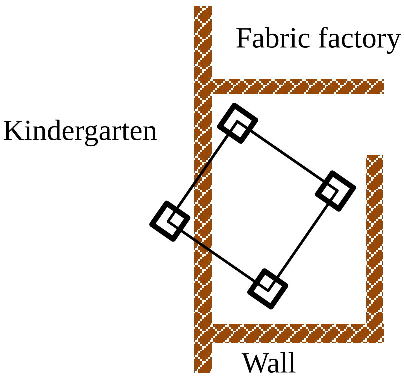
Existing 132kV Ratmalana dead-end tower (It is plan to be removed) and 132kV switchgear to be replaced (CB, DS, CT)

Existing 132kV Protection & control facility to be replaced

5.3. 132kV Pannipitiya – Ratmalana line

Almost all of this line goes through rural area. But some towers are at residential area (No17 – No20). It is difficult to construct new line because new line must avoid any house under T/L. Then CEB plans to use same RoW in this area.

This T/L is about 42 years old, and some towers are not well maintained. Some members are stolen, fixed incorrectly, and welded.



Existing 132kV Ratmalana No20 tower (One main post stands at kindergarten and the others stand at fabric factory. Wall will have to remove at re-construction time)

Existing 132kV Ratmalana No.17 tower

(According to CEB information, this tower is the most worst condition tower because atmosphere of this area coming from garbage station. But members were painted and not have corrosion in bottom part. Some members are stolen and one member is bent.)

Existing 132kV Ratmalana No.11 tower

(Some members are welded. Strange structures and incorrectly fixed members are there. This tower doesn't have planned strength.)

(End)

Site Survey Report for Project 6

1. Date

September 25, 2014

2. Location

220kV Kotmale PS (Existing)

220kV Kotmale - New Polpitiya T/L (Future)

3. Surveyor

CEB Engineers

Mr. Tada (TEPSCO)

Mr. Minagawa (TEPSCO)

4. Method of Survey

Visual check Survey from the ground

5. Site condition

5.1. 220kV Kotmale PS

It is found that a space for two nos. of 220kV transmission lines for New Polpitiya GS is not available in the existing 220kV switchyard.

Under the circumstance CEB plans to construct the additional 220kV TL bays in the existing 132kV switchyard which is presently not in operation and make connection line to the existing 220kV bus bars considering transmission line accessibility to the Switchyard.

Existing 220kV Switchyard

Existing SAS system for 220kV Switchyard

5.2. 132kV Kothmale - New Polpitiya T/L

New line will go through rural area. There is some area to construct new line. Almost all of area for new tower has no rode to access, so they need temporally rode.

New T/L goes along with existing 132kV line here


New T/L goes along with the river here (Near Ulapane town)

(End)

Site Survey Report for Project 7

1. Date

September 25 - 26, 2014

2. Location

132kV Polpitiya PS (Existing)

132/33kV Kiribathkumbura GS (Existing)

132/33kV Ukuwela GS (Existing)

132/33kV Naula GS (Existing)

220/132/33kV New Habarana GS (Feature)

3. Surveyor

CEB Engineers

Mr. Tada (TEPSCO)

Mr. Minagawa (TEPSCO)

4. Method of Survey

Visual check Survey from the ground

5. Site condition

5.1. 132kV Polpitiya PS

CEB plans to use the existing 132kV bays for new transmission lines. The bay is now used for Kothmale 1 and 2 line. There are some T/L coming in and out around Polpitiya PS, and so new T/L will have difficulty to connect PS.

As an additional scope to JICA project, 132kV CTs for the 132kV TL for Kiribathkumbura GS will be replaced to match with the power flow.

Existing 132kV bay (1^{st} and 2^{nd} bay from near side is for new line)

Existing T/L in front of GS


Existing T/L in front of GS

5.2. 132/33kV Kiribathkumbura GS

CEB plans to use existing 132kV bay. As same as Polpitiya GS, there are some existing T/Ls, and so new line has to cross these lines.

Existing 132kV bay will be used for new T/L

5.3. 132/33kV Ukuwela GS

CEB plan to use existing 132kV bay to connect new line to Ukuwela GS.

As an additional scope to JICA project, 132kV CTs for the 132kV TL for Kiribathkumbura and Habarana GS will be replaced to match with the power flow.

Existing 132kV Kiribathkumbura / Habarana dead-end tower (Remove existing tower and construct new tower)

5.4. 132/33kV Naula GS

This GS is a new substation. The GS is connected to Naula and Habarana by single in-out connection. The existing in-out line and 132kV bay will be used for new line.

As an additional scope to JICA project, 132kV CTs for the 132kV TL for Ukuwela Habarana GS will be replaced to match with the power flow.

Existing 132kV Naula / Habarana in-out line gantry

Existing 132kV Naula / Habarana in-out dead-end and second dead-end tower will be used for the new line.

5.5. 220/132/33kV New Habarana GS

There is enough area to construct GS and no obstacle for T/L. A big road goes in front of the planed area. The area is generally flat and condition of the soil seems good.

The area to construct New Habarana GS

Big road in front of the planed area

(End)

Site Survey Report Project 8

1. Date

October 1 – 3, 2014

2. Location

Dehiwala GSS

Attidiya PSS

Calubowila PSS

Dehiwala PSS

Kirulapana PSS (CEB Colombo city office Area)

Council Lane PSS (DD4 Chief engineer office)

Mt. Lavinia Bus Station PSS (Tentative name)

Alubogahawatta RSS

kohuwala 1 RSS

kohuwala 2 RSS

Station Rd. RSS

Frazer Avenue RSS

Telecom RSS

Connecting point the F 1 and the F 3 of Dehiwara GSS for council lane PSS

Connecting point the F 6 and the F 8 of Dehiwara GSS for Mt. Lavinia Bus Station PSS

Switch Station

Existing Pad-mount Transformer

3. Surveyors

CEB DD4 : Ms. Indu, Mr. Sabry, Mr. Janaka Ms. Dinusha,

JICA survey team : Mr. Iwama

4. Method of Survey

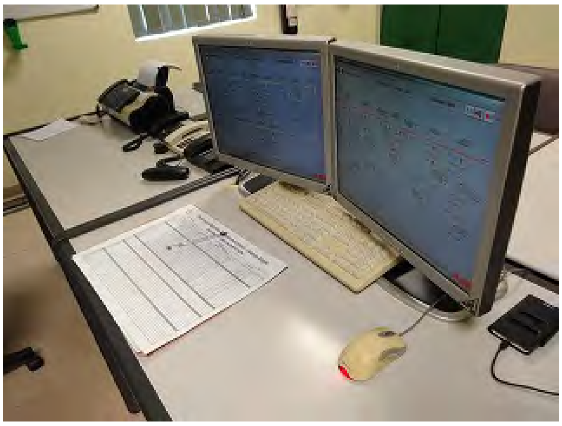
Visual check

5. Site condition

5.1. Grid Substation (GSS)

a) Dehiwala GSS

	
132/ 33kVTransformer 31.5MVA×2 ABB	33kV Feeding Point (Spare for two circuit)
	
33kV Feeder Panel Confirmed two spare circuit for new feeder of the PJ	Back said of the 33kV Feeder Panel
	
The Spare space for expansion of new feeder.	132kV SW controller(ABB) 132kV GIS will install in 2016

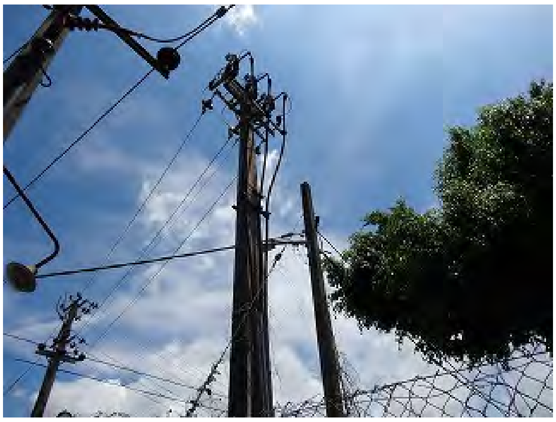
132/ 33 kV 31.5MVA Transformer will install in 2016 (Tentative)	(Tentative)
	
Back side of 133kV GIS	SCADA System

- There will connect two new 33kV feeders (33 kV UG cable) at JICA project.
- Existing Grid substation have two 33kV spare circuits.

5.2. Primary Substation (PSS)

a) Attidiya PSS (out of JICA Project scope)

	
Appearance (33/ 11 kV 20MVA)	33/ 11 kV 10MVA Transformer × 2
	

Switch Gear of 33kV (ABB) (SF_6 Gas Insulated)	Switch Gear of 11kV Existing 2 circuit for spare
	
33kV Incoming side	11kV Outgoing feeder
	
Arial work platform	

- Attidiya PSS was in the scope by an original plan. Because CEB changed a design of cable route during this survey period, it became out of a scope
- Land size (20m by 30m Appr.), Building size : 25m×14m (Appr.) Transformer Bay 7m x 5m (Appr.)
- 11 kV Over Current Relay setting: 225A (Out going Cable size 185 mm^2 , OH line ACSR 91.5mm^2 (Raccoon)).

b) Calubowila PSS

	
Appearance (33/ 11 kV 20MVA)	33kV Incoming feeder connecting Point
	
33/ 11 kV 10MVA Transformer	33kV Bus control Panel
	
33kV Panel	Back side of 33kV Panel

	
11kV Panel Total 6 outgoing feeder (full use)	Back side of 11kV Panel
	
Remote controller	11kV Switch gear (VCB)

- New connection three 11kV under ground feeder
- 11kV Switch Gear has total six out going feeder (without spare feeder.)
- connected feeders capacity's loading rate is low.
- For two by one rearrange the feeder of six, to make three spares for new feeder
- Proposed Distribution SCADA (Distribution Control Center) will be installed in 1st floor (upstairs) of this PSS building.
- Building size: 13m × 10m, Tr. Bay (33/ 11kV 10MVA×2): 13m× 7m.

c) Dehiwala PSS

	
Appearance	33kV Incoming feeder
	
33/ 11 kV 10MVA Transformer ×2	33/ 11 kV 10MVA Transformer
	
33kV Panel	11kV Panel

	
11kV Outgoing feeder	

- New connection two 11kV under ground feeder and replace one 11kV under ground cable line.
- 11kV Switch Gear has total six out going feeders (one spare feeder.)
- For two by one reallocate the feeder of two, to make a spare for new feeder.
  * reallocate a low feeder of the load factor.

d) Kirulapana PSS (CEB Colombo city office Area)

	
Appearance	33kV Panel
	

11kV Panel	11 kV panel with WHM (EDMI)

- Under the control of CEB Colombo city office
- Spare for three 11kV outgoing feeder.
- Have permission from the CEB Colombo city office.

e) Council Lane PSS (DD4 Chief engineer office)

	
Appearance	33kV Panel
	
11kV Panel	11 kV panel with WHM (EDMI)

- New PSS.
- Vacant land of the DD4 Chief Engineer office (Council lane)
- Using CEB Loan build new office and substation building.
- Substation facilities will use JICA Loan.
- Have permission from the CEB Colombo city office.
- Dimension of space: D24m × W25m. *no problems
- Close to Apartment.
- CEB said that EIR report is not required. *should be confirmed

f) Mt. Lavinia Bus Station PSS (Tentative name)

	
Appearance	PSS Space
	
The windows of next house	Remote controllable LBS

- Transformer space of the CEB.
- Dimension of space: (D)9.5m × (W)8m (Appr.).
- Enough space for one 33/ 11kV 5M×1 Transformer.
- If a new building for switches is built, the windows of the next house would be blocked/ covered.

5.3. Radial Substation (RSS)

a) Alubogahawatta RSS

	
Appearance 1	Appearance 2
	
Appearance 3	LV switch panel of existing facility

- CEB's prepared transformer space.
- (D)7m ×(W) 7m
- No problem

b) Kohuwala 1 RSS

Appearance 1	Existing transformer
	
Existing transformer	Existing transformer
	
Existing Switch operation rod	Existing Switch
	
Exiting MV line	Exiting MV line

	
Exiting MV line	

- CEB's prepared transformer and MV switches space.
- (D)7m ×(W) 4m, (D)4m ×(W) 4.5m the steps are existing between CEB land.
- CEB will replace that step.
- No problem

c) Kohuwala 2 RSS

	
Existing transformer	Existing transformer
	

Existing transformer	

- CEB's prepared space.
- (D)7.2m ×(W) 3m.
- CEB will replace that step.
- No problem

d) Station Rd. RSS

	
Rental room of the existing building (1st floor, upstairs)	Rental room of the existing building
	
Inner rental room	From inner rental room

	
Building	

- Rental room of the existing building(1st floor) *near the Dahiwala station.
- CEB's space.
- (D)7.2m ×(W) 3m.
- No problem

e) Frazer Avenue RSS

	
Land of the library (movement)	Land of the library (movement)

- parking of the library.
- gravamen land.
- CEB will acquire permission on Oct./ Nov. 2014
- No problem

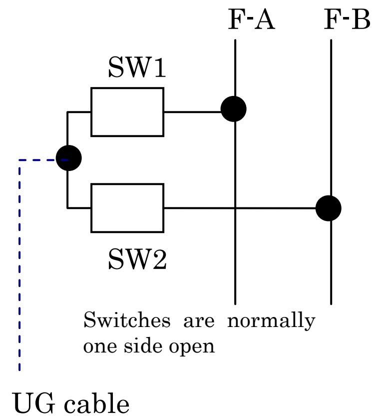
f) Telecom RSS

	
Installed Transformer	Installed 11kV UG cable (goes to transformer of Mt. Lavinia Bus Stop)

- CEB's land.
- gravamen land.
- (D)3m ×(W) 12m (Aprr.).
- No problem

5.4. 33kV UG cable connecting (tapping) point

The cable terminal of a UG will connect to existing two OH 33kV line use by two Switches.

	
Connection design	

a) Connecting point the F1 and the F 3 of Dehiwara GSS for council lane PSS

	
A steel tower of new line connecting point	Switch install point and UG cable route

b) Connecting point the F 6 and the F 8 of Dehiwara GSS for Mt. Lavinia Bus Station PSS

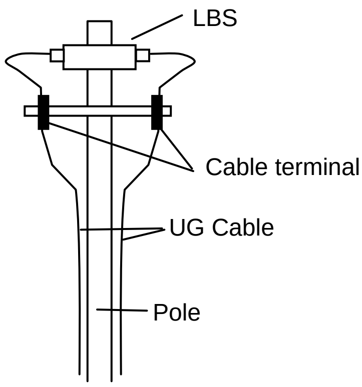
	
Planned new UG line connecting point.	Planned new UG line connecting point.
	
Planned new UG line connecting point.	Planned new UG line connecting point.

5.5. 33kV UG cable Switching station

JICA survey team recommended CEB to install the switch station in case that the total length of the UG cable excess 2.0 km. Because, if once UG cable fault occurs, it is easy to sectionalize faulty section using by switch. And if the cable is long, because the fault point detection signal is attenuated by the impedance of the cable, fault point exploration will be difficult.

Switch Station will be installed in two locations and have three cable routes. One is near the Zoo almost middle point of form Dehiwara GSS to Council lane PSS UG cable route and from F1 and F3 Dehiwara GSS connecting point to Council lane PSS UG cable route, and another is between Kohuwatla 2 and Kirulapana PSS UG cable route on the CEB Colombo Office area.

CEB DD4 planed the switch will be installed on the pole for project cost saving.

	
Switch station install point.	Switch station design (tentative)

- There will install RSS on other PJ.
- Almost middle point of Dehiwala GS to Council lane PS planned site.

5.6. Existing UG Transformer

Pad-mount transformers are installed at the moment along the existing UG cable route of Dehiwara PS to proposed Council lane PS. In this project, the existing UG cable and 10 old RMU* will be replaced to new UG cable and new RMU. On the other hand the existing transformers for UG cable will not be replaced.

	
Existing pad-mount transformer.	Existing UG transformer.
	
Primary (MV 11 kV) RMU side.	RMU operation part
	
Direct burry UG MV cable.	LV power feeding point (LV UG cable from pad-mount Tr along the pole).

(End)

Site Survey Report Project 9

1. Date

29. Sep. 2014

2. Location

Ethulkotte PSS.(Near DD3 Head office)

Navara PSS (Lanca Electric Corporation)

Pelawatta PSS（in CEB DD3 existing PSS）

Koswatta PSS (private land acquisition are proceeding now)

ER1 RSS

KR1 RSS

KR2 RSS

KR3 RSS

PR1 RSS

PR2 RSS

PR3 RSS

Example of Compact Type Transformer establish place

Use of established pole inside of the path

3. Surveyors

CEB DD3 : Mr. Chamira, Ms. Sujani

JICA survey team : Mr. Iwama

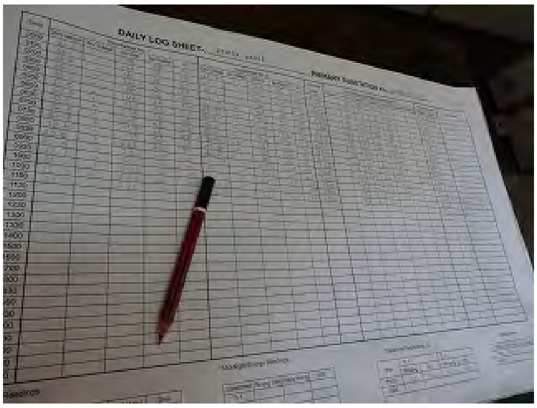
4. Method of Survey

Visual check

5. Site condition

5.1. Proposed PSS Site

a) Ethulkotte PSS.(Near DD3 Head office)

	
Ethulkotte PSS existing system	11kV Feeder Panel
	
Existing 11kV Feeder Panel. A new building will be built before JICA Project by another Project The 11kV Panel will be replaced by JICA PJ	Feeder parameter recording sheet

b) Navara PSS (Lanca Electric Corporation: LECO)

	
Project name Panel (Mein Contractor: SIEMENS INDIA)	Building of PSS
	
Switch Gear of 33kV (SF$_6$ Gas Insulated)	Rear View of 33kV Switch Gear (SF$_6$ Gas Insulated)
	
Switch Gear of 33kV (Vacuum switch)	33kV/ 11KV Transformer bay (10MVA×2)

	
33kV/ 11KV Transformer (10MVA×2)	Transformer Manufacture plate (PT CG POWER SYSTEM, Indonesia)
	
33kV Incoming Disconnector	

・The example of model of building type PSS(Primary substation)

*CEB DD3 proposed to construct the same type building for Pelawatta PSS (by JICA Loan portion)

・The size of the building (D) 7m×(W) 15.3m (App.)

c) Pelawatta PSS（in CEB DD3 existing PSS）

<table>
<tr><td></td><td></td></tr>
<tr><td>Established Transformer (Will replace)</td><td>11kV Switch Panel (will replace)</td></tr>
<tr><td></td><td></td></tr>
<tr><td>J’pura Grid Substation 132kV/33kV (nearby Pelawatta PSS)</td><td></td></tr>
</table>

・The exiting substation are old, and so CEB DD3 proposed to replace the existing substation and to construct new building.
・Planned the same design as Navara PSS (Lanca Electric Corporation).
・There are enough space to construct a new substation.
・CEB DD3 has a new layout plan of Transformers, Switches and 33 kV incoming feeder
・CEB has not yet finished the layout design of substation.

d) Koswatta PSS (private land acquisition are proceeding now)

	
Proposed place (now under acquisition Process) App. 26m×35m	Spare Place

・Under acquisition Process now (Will porches up to November)

・Space (D) 35m×(W) 26m Appr.

・There are no problems.

・They have a substitute plan of the land for new PSS, if they fails to acquisition of the 1st proposed land.

・The DD3 engineer said that the EIA Report is no required.

5.2. Proposed RSS Site

a) ER1 RSS (Radial Substation)

	
ER1 Proposed Place	They will establish the compact type DT on the same land

・Plan to establish the 33kV Switchgear and the 11kV Switchgear in the same building.

・JICA Loan: The building and the 11kV Switchgear
CEB Loan: the 33kV Switchgear.

・In this RSS will not establish 33/ 11 kV Transformers, there no connection 33kV System and

11kV System by 33/ 11 kV Transformer.

・This land have an enough space.

・CEB plans to establish The Compact type DT on the same land.

・The civil work of land leveling have already finished

b) KR1 RSS

	
KR1 Proposed Place	

・Government Land (under approval process)

・To establish the Concrete type building.

・There is an enough space.

c) KR2 RSS

	
KR2 Proposed Place	

・Private land（under land acquisition Process）

・To establish the Concrete type building.

・There is an enough space.

d) KR3 RSS

	
KR3 Proposed Place	

・Government Land (under approval process)

・To establish the Concrete type building.

・There is an enough space.

e) PR1 RSS

	
PR1 Proposed Place	

・Government Land (under approval process)

・To establish the Concrete type building.

・There is an enough space.

f) PR2 RSS

	
PR2 Proposed Place	

・Government Land (under approval process)

・To establish the Concrete type building.

・There an enough space.

・The Illegal occupation building will be removed.

g) PR3 RSS

	
PR3 Proposed Place	

・Government Land (under approval process)

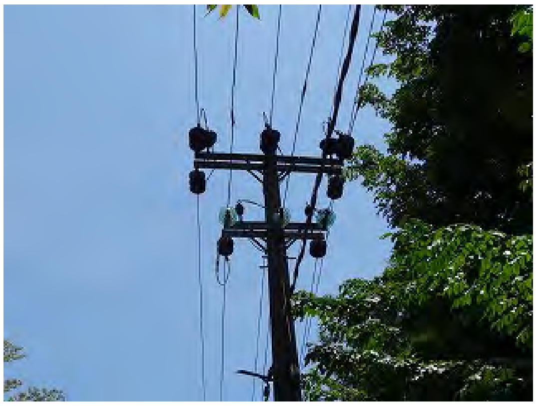
・To establish the Concrete type building.

・There is an enough space.

・The Illegal occupation building will be removed.

5.3.　PJ related site

a)　33 kV UG Cable Connecting (Tapping) point

	
Existing 33 kV OH line	Existing 33 kV OH line

b)　Example of Compact Type Transformer establish place

	
Replace Established Transformer	Proposed place of New Establish Compact Type Substation

・To remove OH transformers and poles on the Project implementation area. And the OH transformers will be replaced with Compact Type Transformers.

・Numbers of the Distribution Substation are 55 (7 are will install inner RSS house: indoor type)。

・Government land: under approval process at the UDA(Urban Development Authority)

*CEB will get approval on Nov. to Dec of this year

・Private land: Under land acquisition process.

c) Use of established pole inside of the path

	
UG Service wire will attach to established pole at path	

・Existing poles on the main load said will remove.

・This project will use the existing poles and the LV line on the inside of the path

(End)

Site Survey Report at CEB Colombo City Office

1. Date

23. September. 2014

2. Location

CEB Colombo City office & Site survey in CEB Colombo City Area

3. Surveyors

CEB Colombo City office: Mr. Harendra,

DD3: Ms. Uplka, Mr. Chamira, Ms. Sujani,

DD4: Ms. Indu, Mr. Sabry, Mr. Janaka, Ms. Dinusha,

JICA survey team: Mr. Iwama,

4. Method of Survey

Visual check

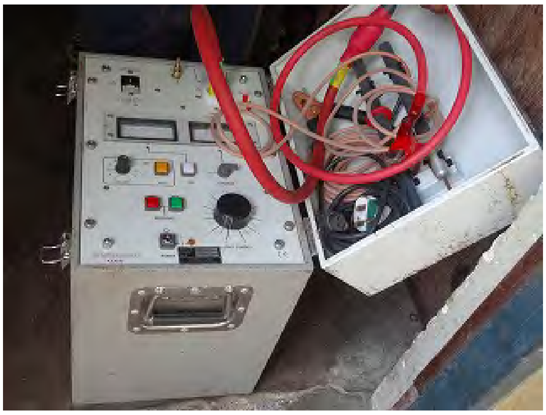
5. Contents/ Site condition

5.1. UG cable measurement equipment/ tools

	
UG Cable Fault detecting Vehicle	Digiphone
	
Cable Route Locator (CSCOPE SG-V)	Cable Route Locator (Megger L1070 & L1071)
	
Cable Route Locator (CSCOPE Cable Avoidance Tester)	Cable Fault Locator (Megger TDR2000/2P)

Testing and Fault Locating Unit (sebaKMT SPG32)

Cable Fault Locator (sebaKMT T30-E)



AC Withstand tester (T&R Test equipment KV30-40)

phase sequence/ rotation indicator (Manufacture unknown)

Energizing Detector (Manufacture unknown)

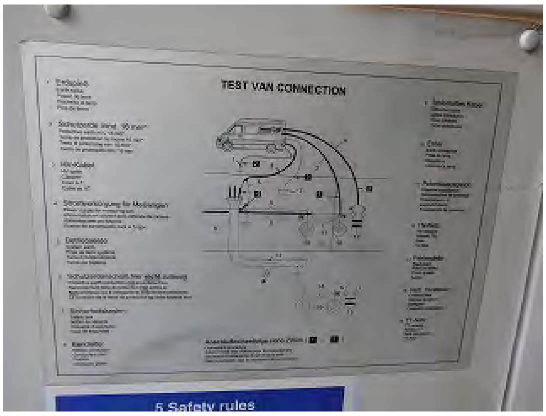
Insulation tester (Megger MIT 1020/2)

Cable Identifier (sebaKMT Transmitter CI TX and LCI TX)

Cable Test Ban

Cable Test Ban (Panel side)

Cable Test Ban (Panel equipment side)



Cable Test Ban Connection

5.2. RSS(Radial Substation: CEB Colombo City Area)

	
RSS building (CEB Colombo City Area) Size: (D)5 m × (W)10m (7m in case of without Tr)	UG Transformer (800kVA) & MV SW Panel
	
RMU Switch Panel (Vacuum Switch: RANHILL POWER BERHAD)	RMU Switch Panel (Circuit Earth fault Relay: Siemens)
	
RMU Switch Panel (Controller: RANHILL POWER BERHAD)	RMU Vacuum switch (RANHILL POWER BERHAD)

	
OIL Insulated RMU	LV Pannel

Building type RSS with equipped SW and Tr

- There is installing 11kV MV Switch panel, Tr, Oil RMU, LV Panel, Communication equipment.
- Building dimensions: (D) 5 m x (W) 10 m(7 m with no Tr)
- Project 8 (DD4) area will install 6 RSS (All of RSS are without Tr type)
- Project 9 (DD3) area will install 7 RSS (with Tr:3, without Tr; 4)
- The manufacture of 11 kV panel (7 circuit type) in this RSS is RANHILL POWER BERHAD (MALAYSIA).
- The manufacture of Oil RMU in this RSS is Lucy (England).
- The 11 KV panel equips the earth fault relay (SIEMENS).
- 11 kV Switches are Vacuum type.
- 1 circuit of 11 kV switch panel are supplying power to Tr via the oil insulated RMU with overload protection fuse.
- Communication equipment are fiber optical cable type (GSM and GPRS type also can adopt for the communication. This RSS is using communication cable of Sri Lanka Telecom.)

5.3. Compact Transformer (CEB Colombo City Area)

	
Compact Transformer (SIEMENS)	Transformer Panel & MV RMU Panel
	
MV RMU Panel	LV Distribution Panel

- Compact Tr (SIEMENS(INDIA)).
- This Compact Tr is equipping the RMU、Tr and LV panel.
- (D)2.5 m x (W) 3 m x (H) 2.5m (approximately).
- The RMU is Equipping 3 circuit by SF6 insulation. 2 circuits are equipping the LBS connected to the trunk line. and 1 circuit is equipping the power fuse connected to Tr.
- Tr capacity can select 630 kVA and 400 kVA.
- Existing the OH MV and the OH LV facilities will use in Project 8 (DD4 area), so there are no use the compact Tr, the Feeder pillar and the Mini feeder Pillar.

5.4. Feeder pillar (CEB Colombo City Area)

Feeder pillar


Feeder pillar Switches

- Divide the LV main trunk line load from the MV / LV Tr.
- (D) 0.3 m x (W) 0.6 m.
- The LV UG cables are direct buried to soil.

5.5. Mini feeder Pillar (CEB Colombo City Area)

Mini feeder Pillar


UG Service wire protection Fuses

- Divide the LV trunk line load from the feeder pillar, and supply power to service line for customers.
- The mini feeder Pillar equipped the LV Fuse for protect service line.

(End)

Site Survey Report of
Existing SCADA in DD3 distribution control center

1. Date

23. September. 2014

2. Location

Distribution Control Center (CEB DD3)

(in CEB DD3 Consumer Service Center (Thelangama))

3. Surveyors

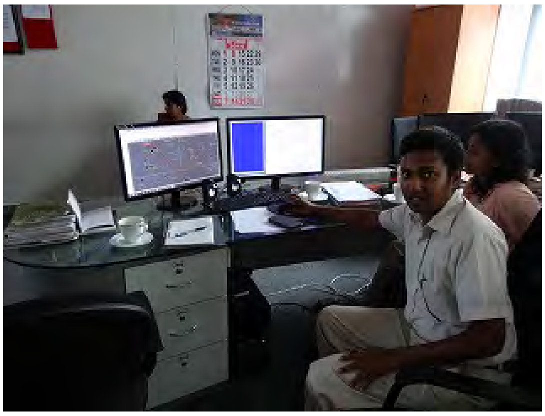
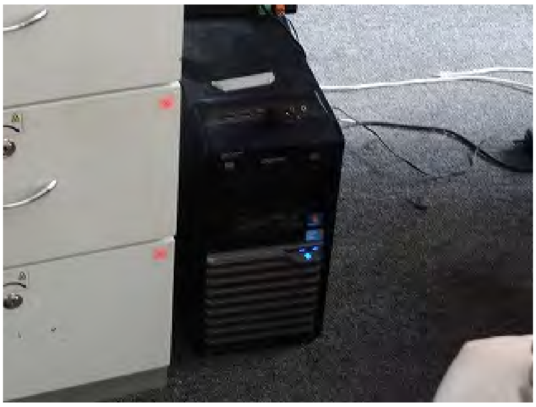
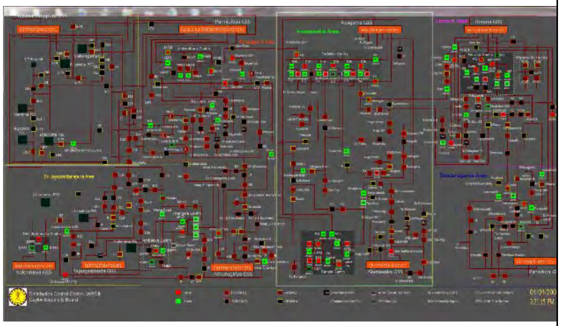
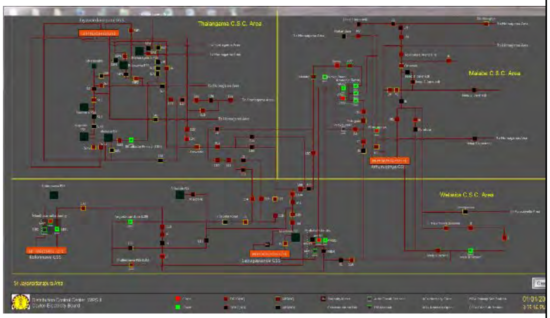
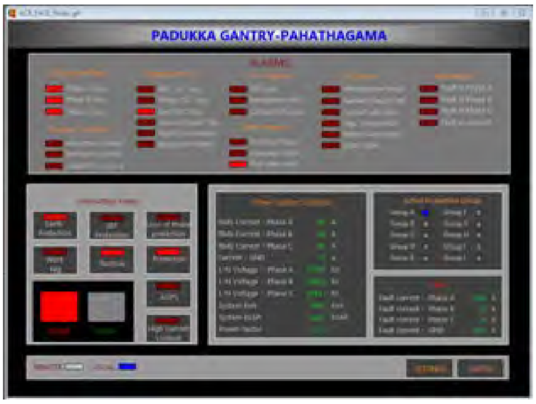
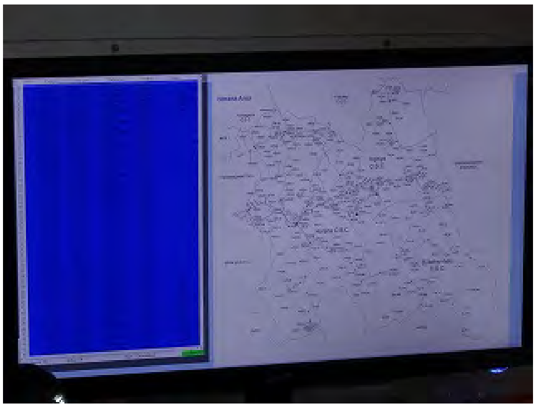
DD3: Mr. Chamira, Ms. Sujani,

JICA Survey team: Iwama

4. Method of Survey

Visual check

5. Site condition

	
SCADA for Distribution Feeder	Computer for SCADA (ACER consumer model)
	
Schematic diagram of the SCADA Controllable Area	Schematic diagram of the Project Supposed Area
	
SCADA monitoring Data at ARCB (iFIX: GE)	Schematic Diagram of Distribution Feeder of GIS

- The Distribution SCADA is using ACER consumer model.
- the Soft Were of SCADA is the iFix5.0 by IBM.
- This control center can acquire the distribution line parameters at the switches and control open/ close of the Switches, in Western Province of the CEB DD3 jurisdiction area. (CEB

DD3 jurisdiction total three provinces, and Western Province is one of these.)

- Western Province has five main area, and Project proposed area is ThaLangama Area of Sri Jayaward hanapura Area.
- There are indicated The Auto Recloser (ARC), the Load Break Switch (LBS), the Air Break Switch (ABS), and the Drop Down Lift Off Switch (DDLO: Power Fuse Type Switch) on the single line diagram of the SCADA, and remote controllable or not is indicated by different color.
- Currently, CEB DD3 is using GPRS method of mobile communication system via modem, if they need monitoring/ contorting switches, should call switches firstly, and after that send control command to switches from computer.
- In case of remote control of the switches, insert the dongle for secure Security to the PC, and communicate.
- SCADA has been installed for about 2 years.
- The GIS data base also installed same PC, but doesn't link to the SCADA system.

  * they said that , have plan to develop the linking software of the SCADA and the GIS
- This SCADA can’t monitor the parameters/ in formations of substation, because it isn’t liking to the substations.

  *Distribution feeders at the substation also can’t monitor.
- They call the sensor equipped ACB on the feeding point of the distribution line near the substation, and get the distribution feeder parameters.

  →There aren’t recoding of distribution parameters currently.
- They said that, are using the GPRS communication between the SCADA and the remote control modems, but system are using the DNP3 communication protocol of the manufacture original, so it has become an obstacle in terms of expandability.

(End)

Calculation for the Application of Low Loss Conductor

1. Calculation Condition

Power Factor	0.9	(from CEB)
Load Factor	0.631	(from Statistical Report 2013)
Loss Load Factor	0.445	
Conductor Resistance		
- ACSR Zebra	0.0814	Ohm/km at 63 deg.
- LL-ASR/14AC 550	0.0621	Ohm/km at 61 deg.
Average electricity cost	17.70	LKR/kWh (from Statistical Report 2013) 1LKR= 0.783 JPY
Unit Price of Conductor		
- ACSR Zebra	620	kJPY/km (fom previous report)
- LL-ASR/14AC 550	870	kJPY/km

2. Calculation Results

Case 1: 400 kV Quad Conductor Votage: 400 kV Bundle: 4

Item	Unit										
Peak loads per cct	MW	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0
Eq. current per conductor	A	20.0	24.1	28.1	32.1	36.1	40.1	44.1	48.1	52.1	56.1
Annual Losses on Zebra per cct	MWh	1.5	2.2	3.0	3.9	5.0	6.1	7.4	8.8	10.3	12.0
Annual Losses on LL-ACSR per cct	MWh	1.2	1.7	2.3	3.0	3.8	4.7	5.6	6.7	7.9	9.1
Annual loss savings	MWh	0.4	0.5	0.7	0.9	1.2	1.5	1.8	2.1	2.5	2.8
Annual cost savings	kLKR	6.4	9.2	12.6	16.4	20.8	25.7	31.1	37.0	43.4	50.3
	eq.kJPY	5.0	7.2	9.8	12.9	16.3	20.1	24.3	28.9	34.0	39.4
Difference of Construction Cost per cct-km	kJPY	3,150.0	3,150.0	3,150.0	3,150.0	3,150.0	3,150.0	3,150.0	3,150.0	3,150.0	3,150.0
Duration for Balance	Year	626.8	435.3	319.8	244.9	193.5	156.7	129.5	108.8	92.7	80.0

Case 2: 220 kV Quad Conductor Votage: 220 kV Bundle: 4

Item	Unit										
Peak loads per cct	MW	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0
Eq. current per conductor	A	36.4	43.7	51.0	58.3	65.6	72.9	80.2	87.5	94.8	102.1
Annual Losses on Zebra per cct	MWh	5.1	7.3	9.9	12.9	16.4	20.2	24.5	29.1	34.2	39.6
Annual Losses on LL-ACSR per cct	MWh	3.9	5.6	7.6	9.9	12.5	15.4	18.7	22.2	26.1	30.2
Annual loss savings	MWh	1.2	1.7	2.3	3.1	3.9	4.8	5.8	6.9	8.1	9.4
Annual cost savings	kLKR	21.2	30.6	41.6	54.3	68.7	84.9	102.7	122.2	143.4	166.3
	eq.kJPY	16.6	23.9	32.6	42.5	53.8	66.5	80.4	95.7	112.3	130.2
Difference of Construction Cost per cct-km	kJPY	3,150.0	3,150.0	3,150.0	3,150.0	3,150.0	3,150.0	3,150.0	3,150.0	3,150.0	3,150.0
Duration for Balance	Year	189.6	131.7	96.7	74.1	58.5	47.4	39.2	32.9	28.0	24.2

Case 3: 220 kV Double Conductor Votage: 220 kV Bundle: 2

Item	Unit										
Peak loads per cct	MW	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0
Eq. current per conductor	A	72.9	87.5	102.1	116.6	131.2	145.8	160.4	175.0	189.5	204.1
Annual Losses on Zebra per cct	MWh	10.1	14.6	19.8	25.9	32.8	40.4	48.9	58.2	68.4	79.3
Annual Losses on LL-ACSR per cct	MWh	7.7	11.1	15.1	19.7	25.0	30.9	37.3	44.4	52.1	60.5
Annual loss savings	MWh	2.4	3.5	4.7	6.1	7.8	9.6	11.6	13.8	16.2	18.8
Annual cost savings	kLKR	42.4	61.1	83.2	108.6	137.5	169.7	205.4	244.4	286.9	332.7
	eq.kJPY	33.2	47.8	65.1	85.1	107.7	132.9	160.8	191.4	224.6	260.5
Difference of Construction Cost per cct-km	kJPY	1,575.0	1,575.0	1,575.0	1,575.0	1,575.0	1,575.0	1,575.0	1,575.0	1,575.0	1,575.0
Duration for Balance	Year	47.4	32.9	24.2	18.5	14.6	11.9	9.8	8.2	7.0	6.0

Case 4: 132 kV Double Conductor Votage: 132 kV Bundle: 2

Item	Unit										
Peak loads per cct	MW	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0
Eq. current per conductor	A	24.3	48.6	72.9	97.2	121.5	145.8	170.1	194.4	218.7	243.0
Annual Losses on Zebra per cct	MWh	1.1	4.5	10.1	18.0	28.1	40.4	55.0	71.9	91.0	112.3
Annual Losses on LL-ACSR per cct	MWh	0.9	3.4	7.7	13.7	21.4	30.9	42.0	54.9	69.4	85.7
Annual loss savings	MWh	0.3	1.1	2.4	4.3	6.7	9.6	13.1	17.0	21.6	26.6
Annual cost savings	kLKR	4.7	18.9	42.4	75.4	117.9	169.7	231.0	301.7	381.9	471.5
	eq.kJPY	3.7	14.8	33.2	59.1	92.3	132.9	180.9	236.3	299.0	369.2
Difference of Construction Cost per cct-km	kJPY	1,575.0	1,575.0	1,575.0	1,575.0	1,575.0	1,575.0	1,575.0	1,575.0	1,575.0	1,575.0
Duration for Balance	Year	426.6	106.7	47.4	26.7	17.1	11.9	8.7	6.7	5.3	4.3

Case 5: 132 kV Single Conductor Votage: 132 kV Bundle: 1

Item	Unit										
Peak loads per cct	MW	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0
Eq. current per conductor	A	48.6	97.2	145.8	194.4	243.0	291.6	340.2	388.8	437.4	486.0
Annual Losses on Zebra per cct	MWh	2.2	9.0	20.2	36.0	56.2	80.9	110.1	143.8	182.0	224.7
Annual Losses on LL-ACSR per cct	MWh	1.7	6.9	15.4	27.4	42.9	61.7	84.0	109.7	138.8	171.4
Annual loss savings	MWh	0.5	2.1	4.8	8.5	13.3	19.2	26.1	34.1	43.2	53.3
Annual cost savings	kLKR	9.4	37.7	84.9	150.9	235.7	339.5	462.1	603.5	763.8	943.0
	eq.kJPY	7.4	29.5	66.5	118.1	184.6	265.8	361.8	472.5	598.1	738.3
Difference of Construction Cost per cct-km	kJPY	787.5	787.5	787.5	787.5	787.5	787.5	787.5	787.5	787.5	787.5
Duration for Balance	Year	106.7	26.7	11.9	6.7	4.3	3.0	2.2	1.7	1.3	1.1

3. Determination of LL-Conductor

Transmission Line	Line Length (km)	Peak Load in 2019	Duration of Balance (Year)	Result	Annual Loss Savings (MWh/cct)	Notes
Project 1: 400kV Paduka - Kirindwela TL (quad)	20.0	93.6	178.9	Conventional	1.3	
Project 1: 220kV Paduka - Kirindwela TL (quad)	20.0	93.6	54.1	Conventional	4.2	
Project 1: 220kV Paduka - Kirindwela TL (double)	20.0	93.6	13.5	LL-ACSR	8.4	
Project 1: 220kV Veyangoda - Kirindwela TL (double)	17.5	140.5	6.0	LL-ACSR	18.9	
Project 1: 132kV Kirindiwela - Kosgama TL (single)	10.0	42.6	5.9	LL-ACSR	9.7	
Project 2: 132kV Veyangoda - Thulhiriya TL (double)	28.0	25.2	67.2	Conventional	1.7	
Project 4: 132kV Kolonnawa - Sri J Pura TL (single)	6.0	68.4	2.3	LL-ACSR	24.9	
Project 4: 132kV Sri J Pura - Panipitiya TL (single)	6.9	46.3	5.0	LL-ACSR	11.4	
Project 5: 132kV Ratmalana - Panipitiya TL (single)	7.0	25.0	17.1	LL-ACSR	3.3	
Project 6: 220kV Kothmale - New Polpitiya TL (double)	23.0	126.2	7.4	LL-ACSR	15.3	
Project 7: 132kV Polpitiya - Nawalapitiya TL (single)	7.0	64.6	2.6	LL-ACSR	22.2	
Project 7: 132kV Polpitiya - Moragolla TL (single)	16.5	24.8	17.3	LL-ACSR	3.3	
Project 7: 132kV Nawalapitiya - Kiribathkumbura TL (single)	45.0	50.5	4.2	LL-ACSR	13.6	
Project 7: 132kV Moragolla - Kiribathkumbura TL (single)	45.3	51.4	4.0	LL-ACSR	14.1	
Project 7: 132kV Kiribathkumbura - Ukuwela TL (single)	30.0	28.7	12.9	LL-ACSR	4.4	
Project 7: 132kV Ukuwela - Naula TL (single)	45.0	37.8	7.5	LL-ACSR	7.6	
Project 7: 132kV Ukuwela - New Habarana TL (single)	80.0	49.5	4.4	LL-ACSR	13.1	
Project 7: 132kV Naula - Habarana TL (single)	34.0	65.5	2.5	LL-ACSR	22.9	

Location Map of the Project

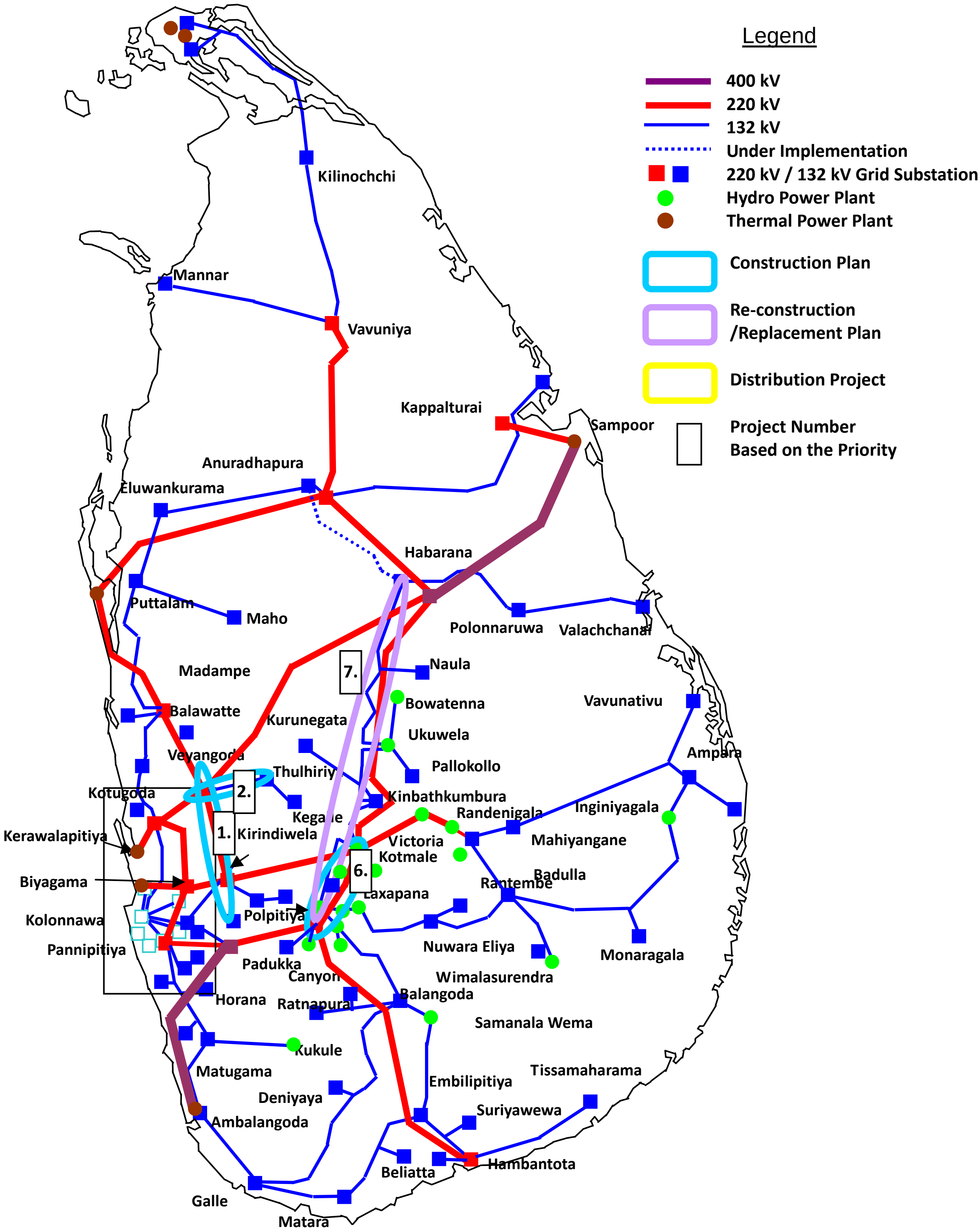


Figure 1: Locations of High Prioritized Projects on Expected 2022 system

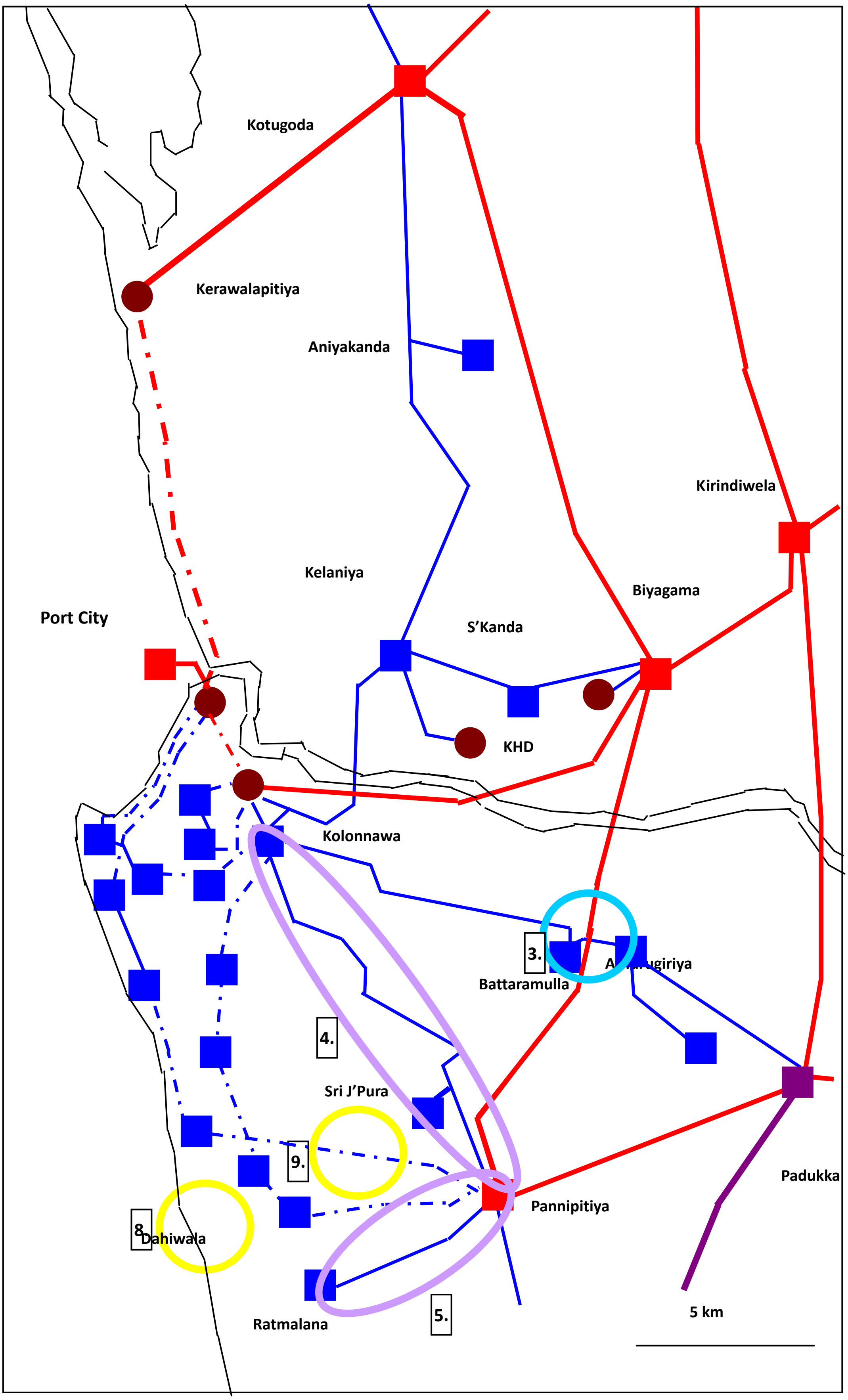
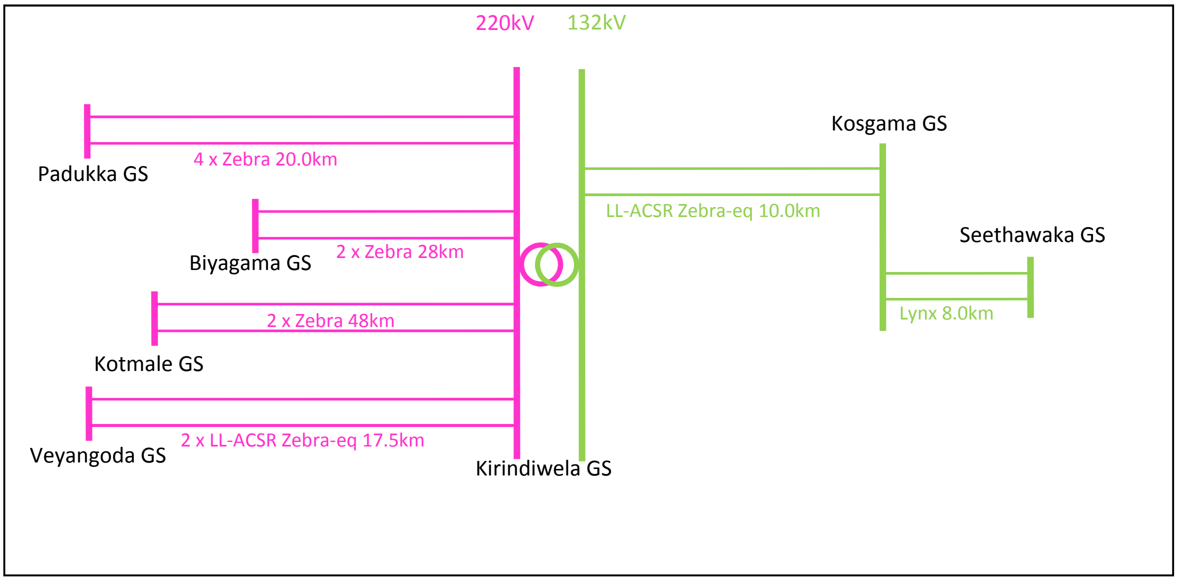


Figure 2: Locations of High Prioritized Projects on Expected 2022 system (surrounding Colombo)

Appendix 5

Scope of the Project (Transmission & Substation)

Project 1: Construction of 220/132kV Kirindiwela SS and 220/33kV Kirindiwela GS with related 132kV and 220kV TLs



Detailed Scope of Project 1:

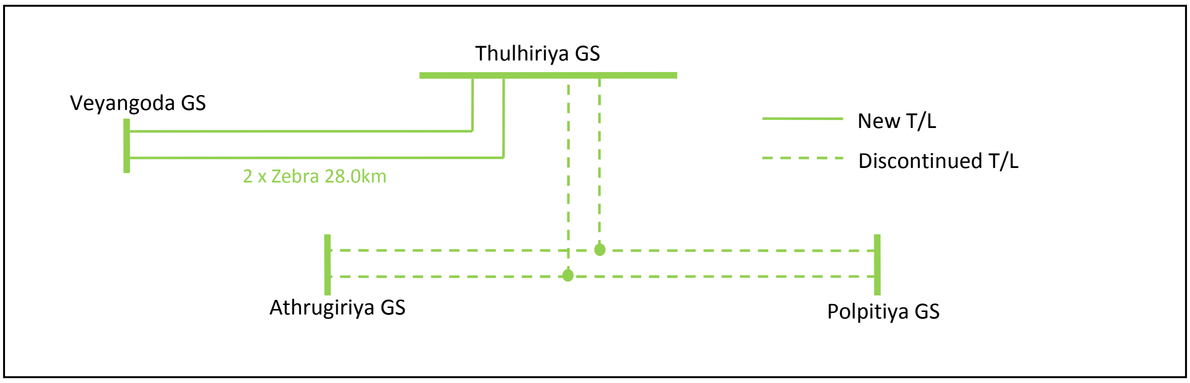
- Construction of 220/132kV Kirindiwela SS
  - 220/132 kV Transformer 2x150MVA, E. Tr., and Aux. Tr.
  - 220kV double bus bar arrangement including bus coupler, 2 transformer bays and 8 transmission line bays
  - 132kV double bus bar arrangement including bus coupler, 2 transformer bays and 2 transmission line bays
  - Substation common items
  - Substation Automation System
  - Spare parts
- Construction of 220/33kV Kirindiwela GS
  - 220/33 kV Transformer 2x45MVA, E. Tr., and Aux. Tr.
  - 220kV 2 transformer bays
  - 33kV single bus bar arrangement including bus section, 2 transformer bays and 12 feeder bays
  - Substation common items
  - Substation Automation System
  - Spare parts
- Double In & Out Connection from 220kV Biyagama - Kotmale TL, 1km, 2cct, 2xZebra
- Modification of Existing 220kV Protection and Control Facilities at Biyagama and Kotmale GSs
- Construction of 220kV Veyangoda - Kirindiwela TL 17.5km, 2cct, 2xLL-ACSR Zebra-eq
- Demolish of the existing 2 x 132kV un-used transmission line towers including foundation in Veyangoda GS
- 220kV 2 transmission line bays at Veyangoda GS
- Construction of 132kV Kirindiwela - Kosgama TL 10km, 2cct, 1xLL-ACSR Zebra-eq

- Augmentation of 132kV/33kV Kosgama GS
  - 132kV S/B TL bay
  - 132kV bus section bay
  - 132kV CB, DS/ES, DS
  - 33kV S/B BB arrangement with bus section bay
  - 33kV DE/ES, DS,
  - DC110V Battery and battery charger
  - AVR relay for transformer
  - Protection & control facility for 132kV TL bays and transformer bays
  - Substation Automation System (SAS)
- Augmentation of 132kV/33kV Seethawaka GS
  - 132kV second bus bar including Bus Coupler
  - Protection & control facility for 132kV TL bays
- Construction of 400kV Kirindiwela – Padukka TL, 20km, 2cct, 4 x Zebra
- Extension of 2 x 220kV DB transmission line bays at Padukka GS.

Note:

- Conductor was changed from CEB planed Zebra to LL-ACSR Zebra-eq on TL construction project of 220kV Veyangoda - Kirindiwela TL, 132kV Kirindiwela - Kosgama TL and 132kV Kirindiwela - Kosgama TL because of economic efficiency.
- Demolish of existing TL towers are added to CEB original plan because they are located in the place where new 220kV Veyangoda – Kirindiwela TL bay will be extend.

Project 2: Construction of 132kV Thulhiriya - Veyangoda TL



Detailed Scope of Project 2:

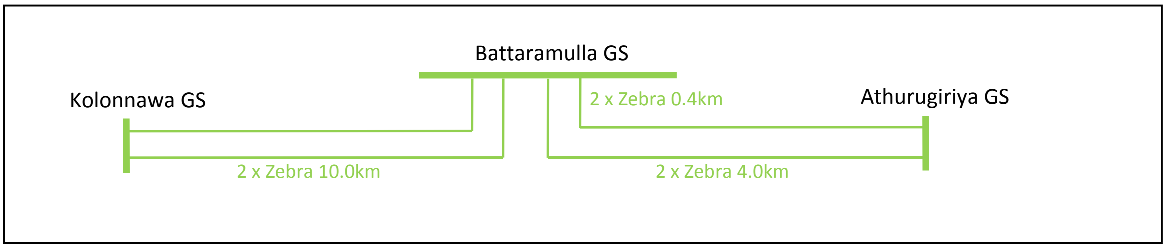
- Construction of 132kV Thulhiriya - Veyangoda TL, 28km, 2cct, 2xZebra
- Augmentation of 132/33 Thulhiriya GS
  - Equipment replacement of 132kV DE/ES, DS, CT, protection & control panels for 132 kV line bays
  - 132kV gantries for line termination
  - Removal/ demolish of 132kV gantries for line termination
  - Removal/ demolish of 132kV line tower

- Augmentation of Veyangoda GS
  - 2 x 132kV CTs
  - 2 x Protection & control facility for 132 kV line bays

Note:

- Construction of 132kV gantries on Thulhiriya GS are added to CEB original plan because existing gantries don’t fit to new 132 kV Thulhiriya - Veyangoda TL.
- Demolish of existing gantries and TL towers at Thulhiriya GS are added to CEB original plan because they don’t fit to new 132 kV Thulhiriya - Veyangoda TL.

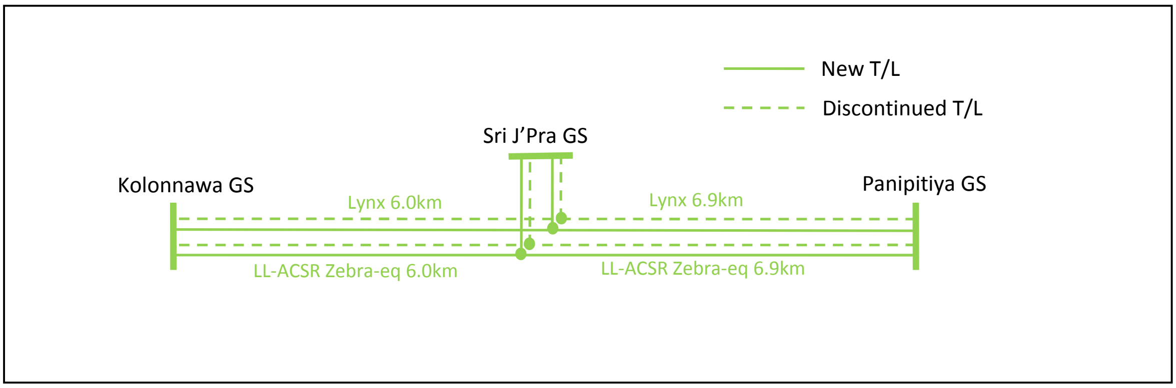
Project 3: Construction of 132/33kV Battaramulla GS



Detailed Scope of Project 3:

- Construction of 132kV/33kV Battaramulla GS
  - 132/33kV Transformer 2x45MVA and E.Tr, & Aux. Tr.
  - 132kV single bus bar arrangement including 2 indoor transformer bays, 4 indoor transmission line bays and 1 bus section (GIS)
  - 33kV single bus bar arrangement including 2 indoor transformer bays, 12 indoor feeder bays and 1 indoor bus section bay (GIS)
  - Substation common items
  - Substation Automation System (SAS)
  - Spare parts
- Double In & Out Connection from 132kV Kolonnawa - Athurugiriya TL, 0.4km, 2cct, 2xZebra
- Modification of Existing 132kV TL Protection and Control Facilities at Kolonnawa and Athurugiriya GSs

Project 4: Capacity Enhancement of 132kV Kolonnawa - Pannipitiya TL



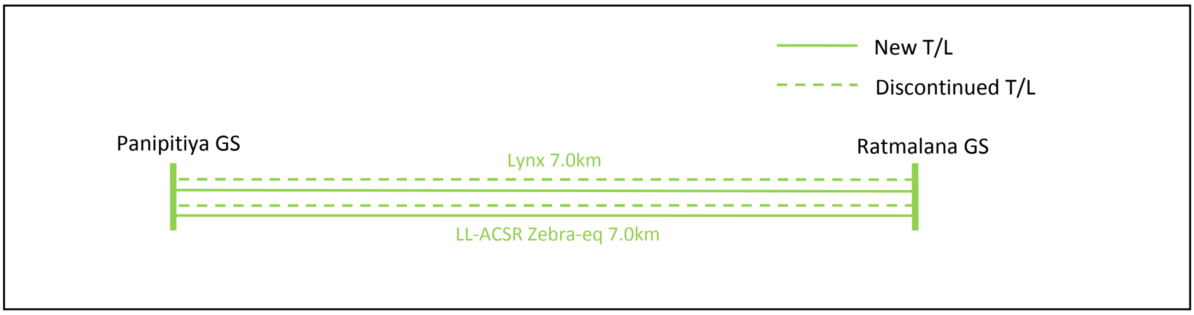
Detailed Scope of Project 4:

- Re-construction of 132kV Kolonnawa – Pannipitiya TL 12.9km, 2cct, 1xLL-ACSR Zebra-eq
- Removal of the existing TL

Note:

- Conductor was changed from CEB planed Zebra to LL-ACSR Zebra-eq on TL re-construction project of 132kV Kolonnawa – Pannipitiya TL because of economic efficiency.

Project 5:   Capacity Enhancement of 132kV Pannipitiya - Ratmalana TL



Detailed Scope of Project 5:

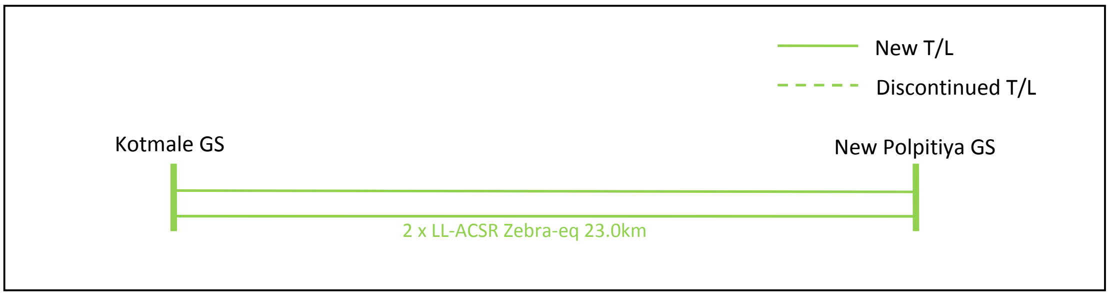
- Re-construction of 132kV Pannipitiya - Ratmalana TL 7km, 2cct, 1xLL-ACSR Zebra-eq
- Removal of the existing TL
- Construction of 132kV 1 x Zebra, 1 cct temporally line
- Removal of 132kV 1 x Zebra, 1 cct temporally line

- Augmentation of 132kV/33kV Ratmalana GS
  - Replacement of 132kV CB, DS, CT, protection & control facility, 33kV DE/ES,
  - Substation Automation System (SAS)
  - Substation common items
  - Spare parts
  -
- Augmentation of 132kV/33kV Pannipitiya GS
  - Replacement of 132kV CB, VT, CT, protection & control facility,
  - Substation Automation System (SAS)
  - Substation common items
  - Spare parts

Note:

- Conductor was changed from CEB planed Zebra to LL-ACSR Zebra-eq on TL re-construction project of 132kV Pannipitiya - Ratmalana TL because of economic efficiency.
- Construction and removal of temporally tower are added to CEB original plan. CEB originaly planned to make tubular tower to re-construction. But it costs high and needs special technique. Temporally TL method is normal way to re-construction, and use existing technology.

Project 6: Construction of 220kV Kothmale – New Polpitiya TL



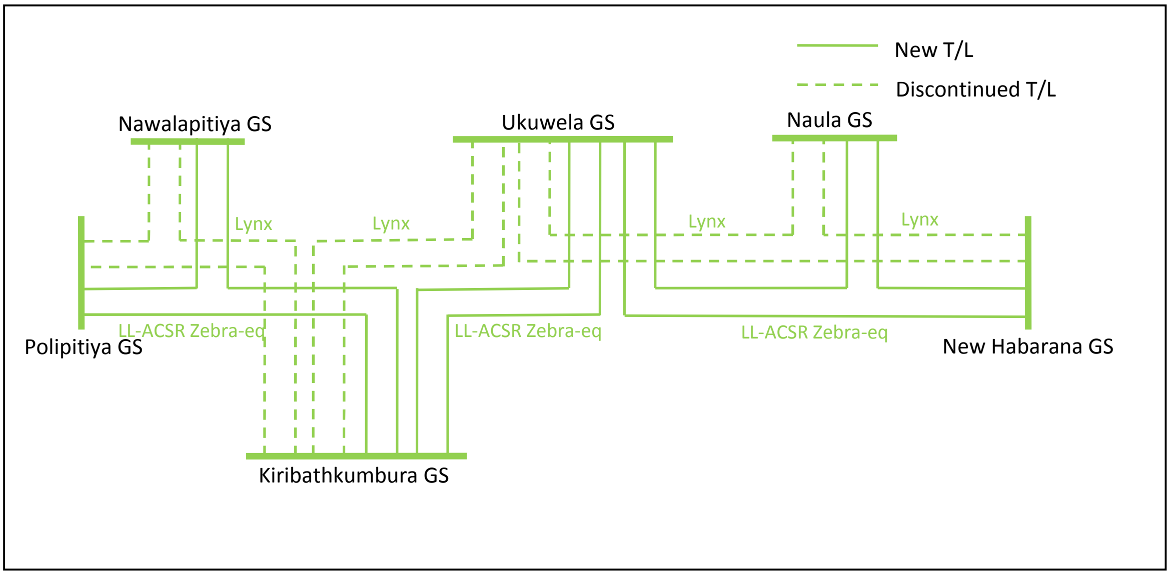
Detailed Scope of Project 6:

- Construction of 220kV Kothmale – New Polpitiya TL, 23km, 2cct, 2xLL-ACSR Zebra-eq
- Construction of 2x220kV one-and-half breaker busbar line bays at Kothmale power station
- Removal of the existing 132kV bays
- Common items

Note:

- Conductor was changed from CEB planed Zebra to LL-ACSR Zebra-eq on TL re-construction project of 220kV Kothmale – New Polpitiya TL because of economic efficiency.
- Removal of existing 132kV bay at Kothmale is added to CEB original plan. Because there is no bay extension area for 220kV Kothmale – New Polpitiya TL bay.

Project 7: Capacity Enhancement of 132kV Polpitiya - New Habarana TL



Detailed Scope of Project 7:

- Re-Construction of 132kV Polpitiya - Kiribathkumbura TL,52km, 2cct, 1xLL-ACSR Zebra-eq and Removal of TL of this section
- Removal of the existing 132kV transmission line Polpitiya - Kiribathkumbura
- Re-Construction of 132kV Kiribathkumbura - Ukuwela TL, 30km, 2cct, 1xLL-ACSR Zebra-eq and Removal of TL of this section
- Removal of the existing 132kV transmission line Kiribathkumbura - Ukuwela
- Re-Construction of 132kV Ukuwela – New Habarana TL, 82km, 2cct, 1xLL-ACSR Zebra-eq and Removal of TL of this section
- Removal of the existing 132kV transmission line Ukuwela – New Habarana
- Augmentation of Polpitiya PS
  - ➢ Replacement of 132kV CTs for 2 x TL
- Augmentation of Ukuwela PS
  - ➢ Replacement of 132kV CTs for 4 x TL
- Augmentation of Naula GS
  - ➢ Replacement of 132kV CTs for 2 x TL
- Connection with Nawarapitiya GS and Naula GS is not included in this Project.

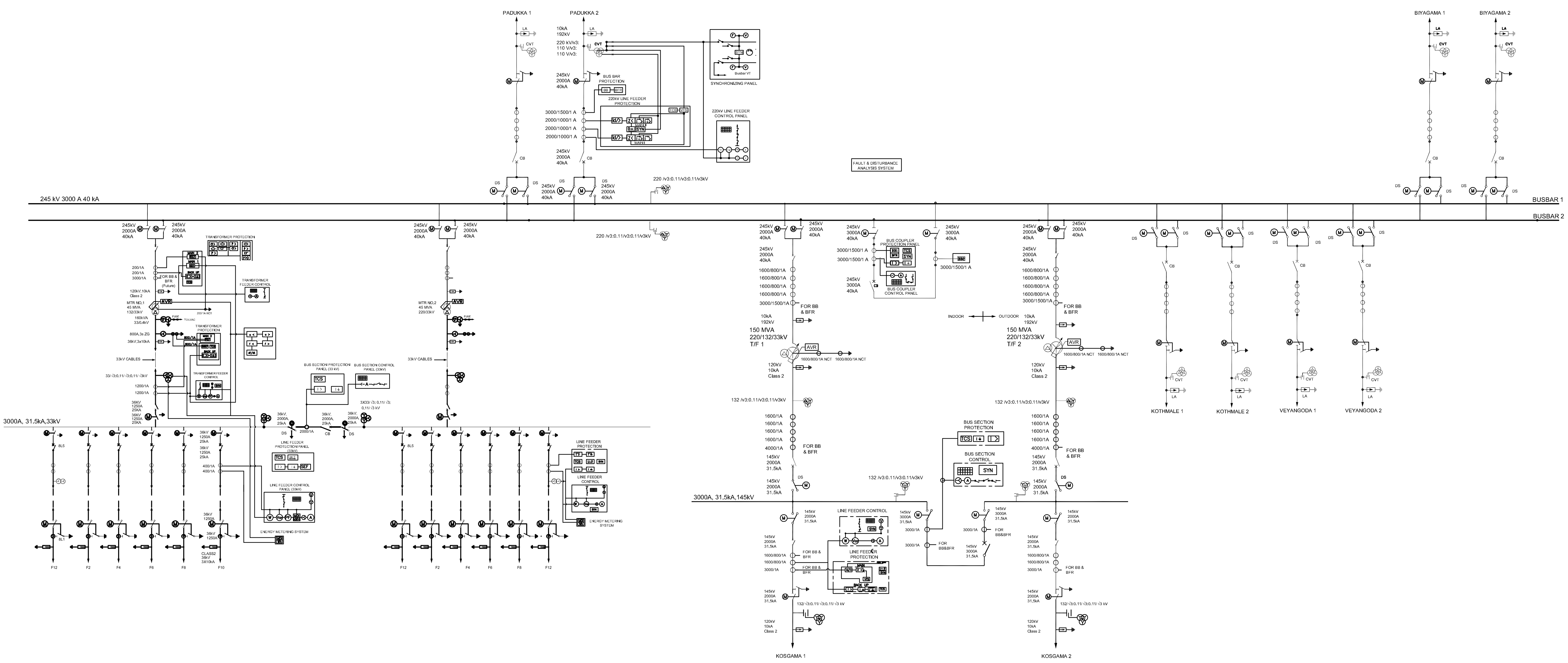
Note:

- Conductor was changed from CEB planed Zebra to LL-ACSR Zebra-eq on TL re-construction project of 132kV Polpitiya - Kiribathkumbura TL, Kiribathkumbura - Ukuwela TL and Ukuwela – New Habarana TL because of economic efficiency.
- Connection from Ukuwela – New Habarana TL to Naula GS is added to CEB original plan because CEB didn't consider it.

Single Line Diagram for Grid Substation

	Substation
Appendix 6-1-1	220/132/33kV Kirindiwera GS (New)
Appendix 6-1-2	220/132kV Veyangoda GS (220kV Bay Extension and 132kV Bay)
Appendix 6-1-3	220/132/kV Padukka GS (220kV Bay Extension)
Appendix 6-1-4	132/11kV Kosgama GS (Extension)
Appendix 6-1-5	132/33kV Seethawaka GS (Extension)
Appendix 6-1-6	132/33kV Thulhiriya GS
Appendix 6-1-7	132/33kV Battaramulla GS (New)
Appendix 6-1-8	132/33kV Panipitiya GS (Modificaion)
Appendix 6-1-9	132/33kV Ratmarana GS (Mondificaion)
Appendix 6-1-10	Kotmale PS (Bay Extension) : Existing SLD
Appendix 6-1-11	132/33kV Polpitiya GS (Modification)
Appendix 6-1-12	132/33kV Kiribathkumbura GS (For reference)
Appendix 6-1-13	132/33kV Ukuwela GS (Modification)
Appendix 6-1-14	132/33kV Naula GS (Modification)
Appendix 6-1-15	220/132kV New Habarana GS (For reference)

Appendix 6-1-1 220/132/33kV Kirindiwera GS



Property of CEB Tr. Design Branch

Revision Record					
Rev. No.	Date	Description	Drawn	Checked	Approved

CEYLON ELECTRICITY BOARD
TRANSMISSION DESIGN

Project Title

Funding Agency

Drawing Title
PROPOSED SINGLE LINE DIAGRAM FOR
KIRIDIWELA GSS

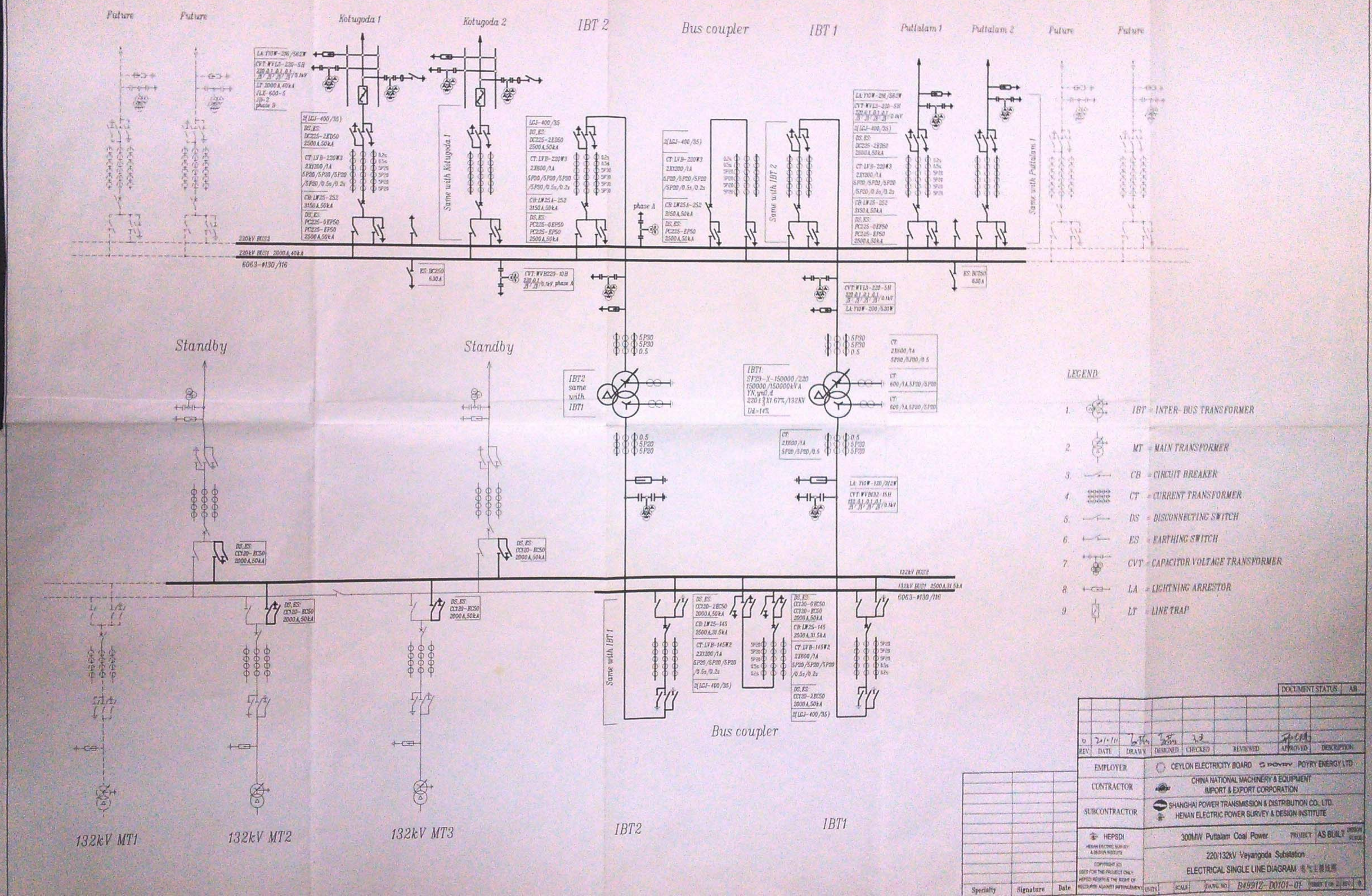
Scale - NA
Size - A3
Sheet of
Dwg. No.

Rev. Date 13.10.2014
Rev. 0

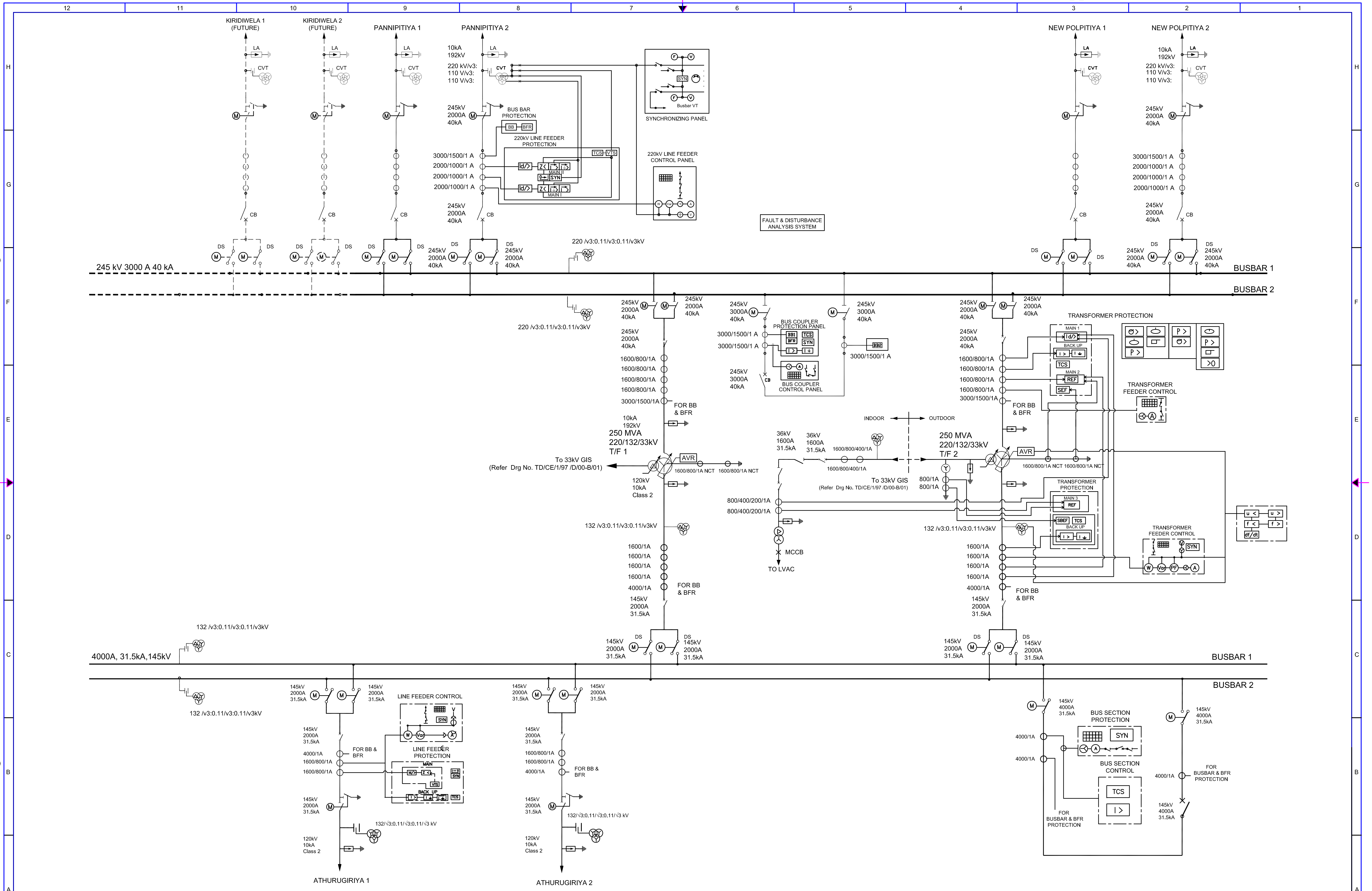
	Signature	Date
Drawn	Priyanthi	13.10.2014
Designed	Rasika	
Checked		
Approved		

Released for: Tendering ✓ / Construction

Appendix 6-1-2 220/132kV Veyangoda GS



Appendix 6-1-3 220/132/kV Padukka GS



Revision Record					
Rev. No.	Date	Description	Drawn	Checked	Approved

CEYLON ELECTRICITY BOARD
TRANSMISSION DESIGN

Project Title

Funding Agency: JICA

Drawing Title: SINGLE LINE DIAGRAM FOR PADUKKA GSS

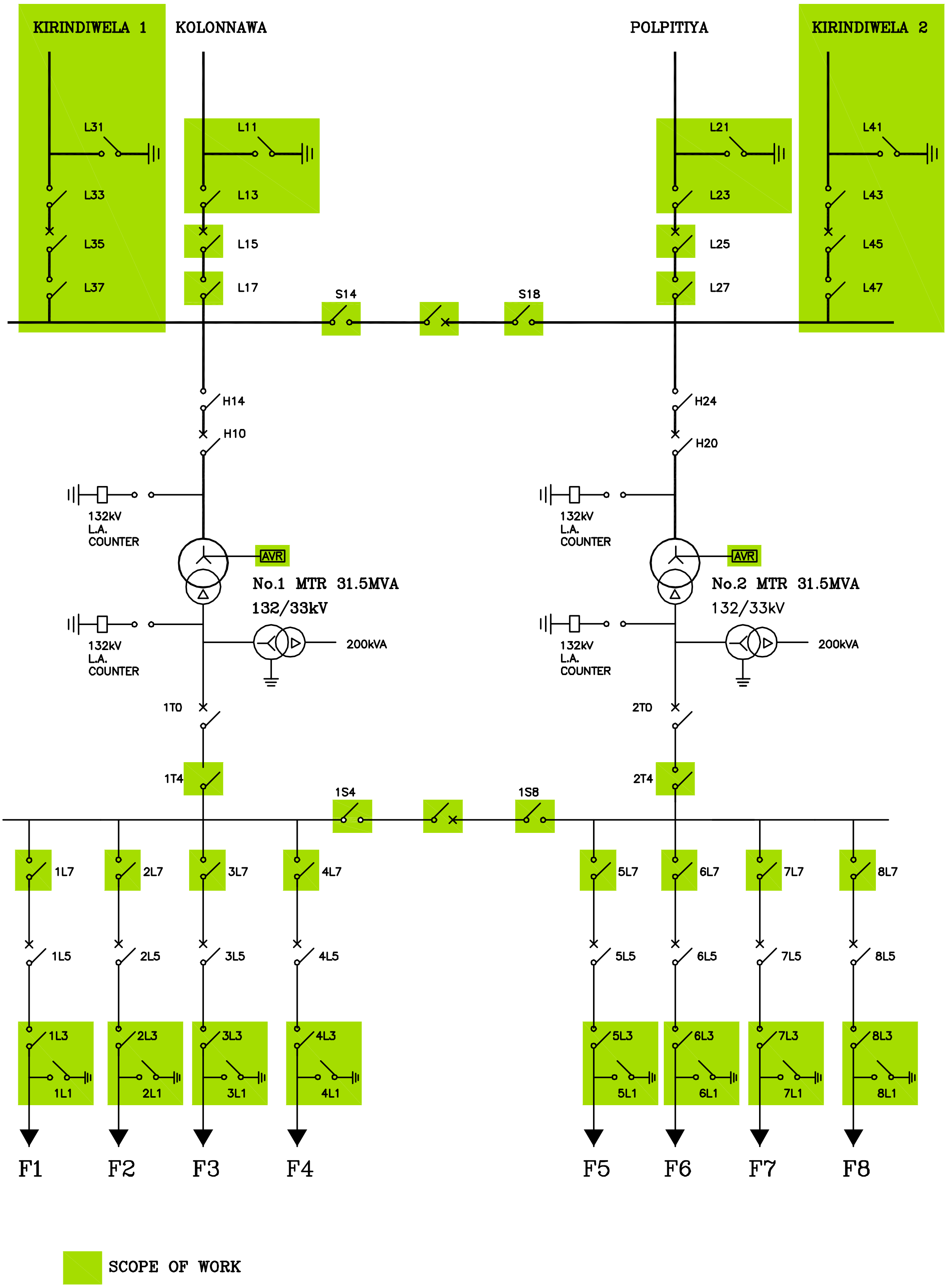
Scale -	NA	Rev. Date	
Size -	A3	12.06.2013	
Sheet	of	Rev.	0
Dwg. No.	TD/CE/1/97/D/00/01		

	Signature	Date
Drawn	Priyanthi	12.06.2013
Designed	Rasika	
Checked		
Approved		

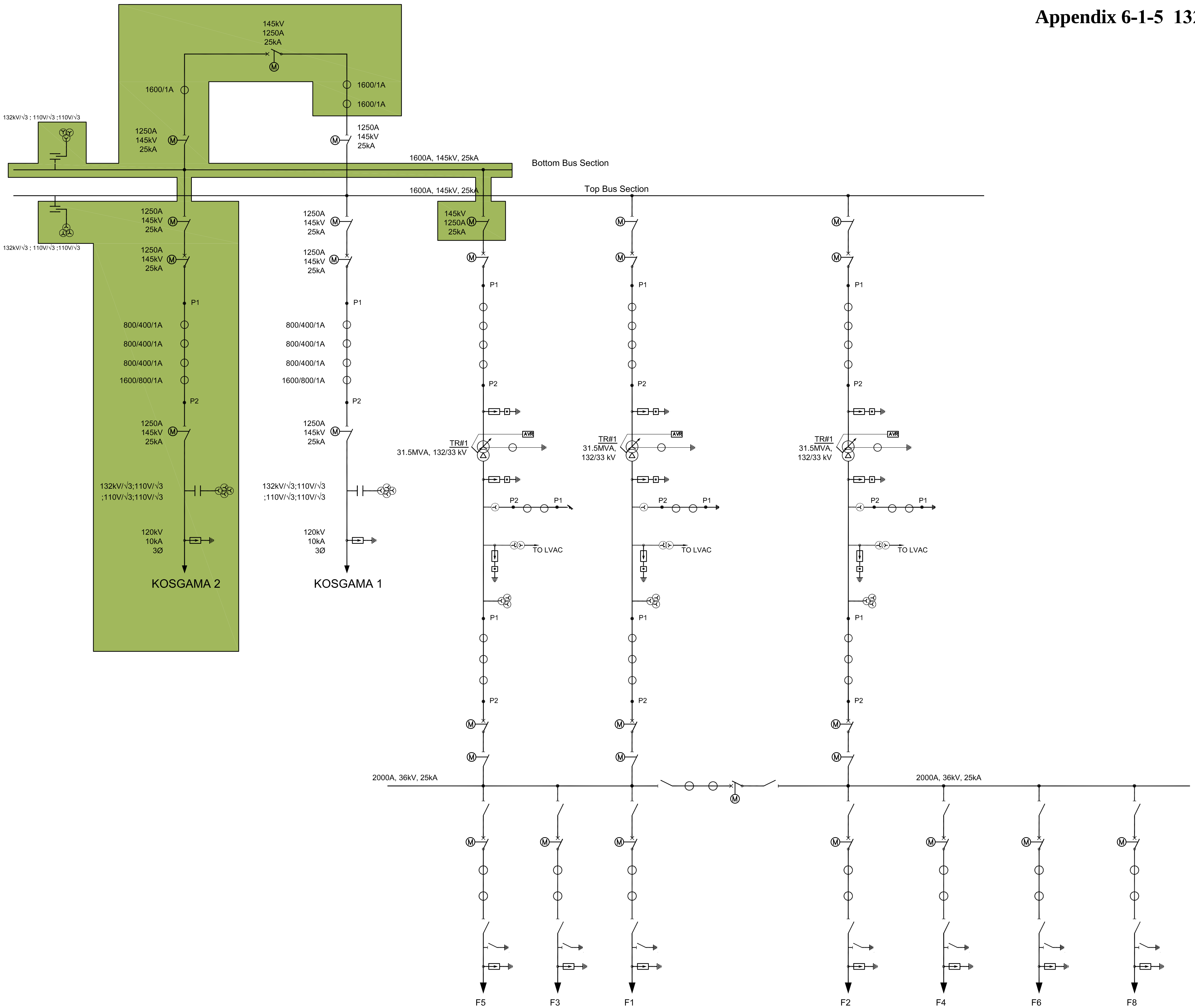
Released for: Tendering ✓ / Construction

Appendix 6-1-4 132/11kV Kosgama GS

KOSGAMA GRID SUBSTATION



Appendix 6-1-5 132/33kV Seethawaka GS



Revision Record					
			28.08.2012		
Rev. No.	Date	Description	Drawn	Checked	Approved

CEYLON ELECTRICITY BOARD
TRANSMISSION DESIGN

Project Title

Funding Agency

Drawing Title

SINGLE LINE DIAGRAM OF
SEETHAWAKA GSS

Scale -	NTS	Rev. Date		Signature	Date
Size -	A3	30.10.2014	Drawn	Buddhika	30.10.2014
Sheet	of	Rev. 0	Designed	Rasika	
			Checked		
			Approved		
Dwg. No. TD/CE/1/ /D/00/01			Released for	Tendering	✓
				Construction	

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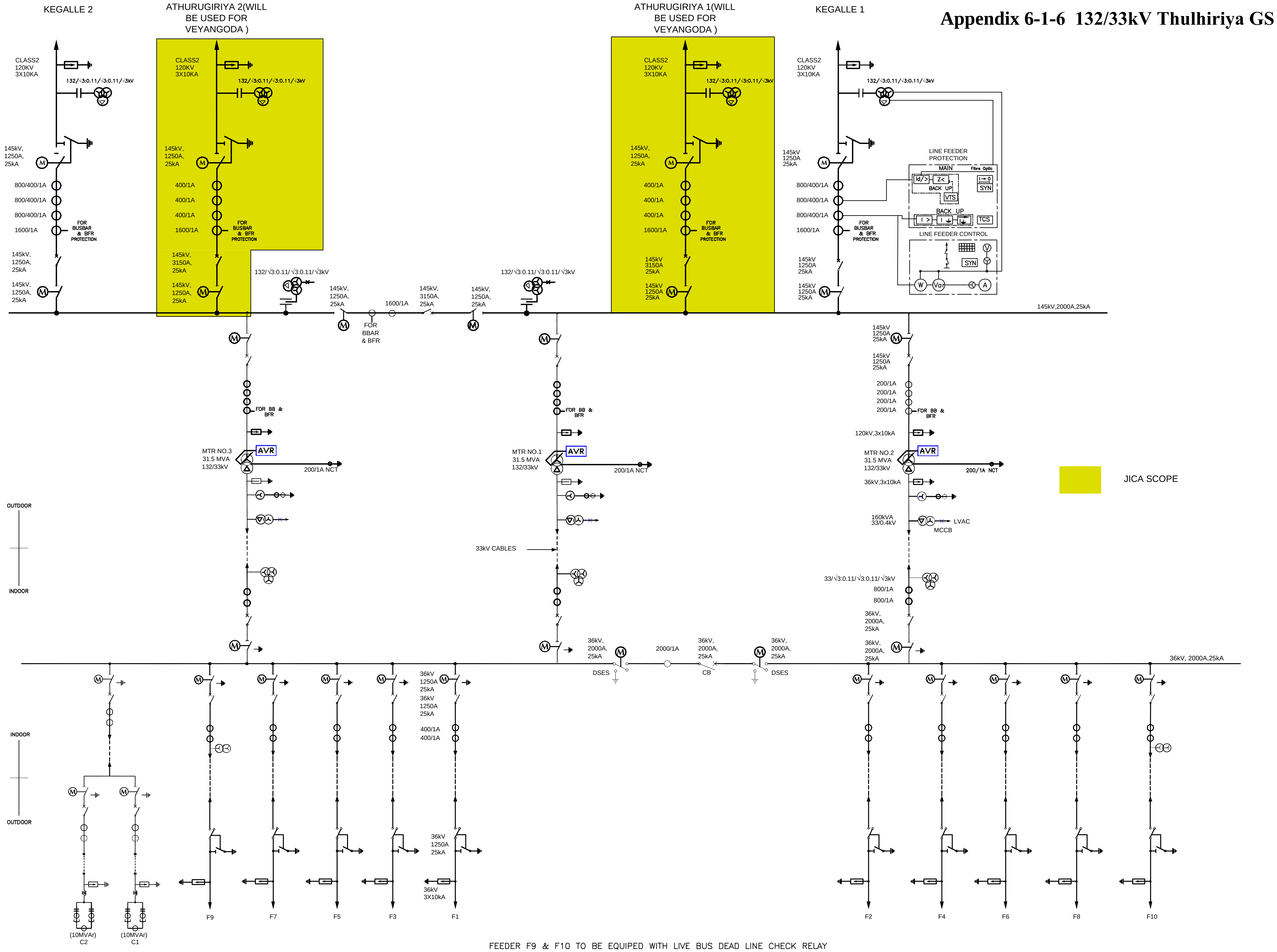
Appendix 6-1-6 132/33kV Thulhiriya GS



FEEDER F9 & F10 TO BE EQUIPED WITH LIVE BUS DEAD LINE CHECK RELAY

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Revision Record					
Rev. No.	Date	Description	Drawn	Checked	Approved

CEYLON ELECTRICITY BOARD
TRANSMISSION DESIGN

Project Title: *CLEAN ENERGY & NETWORK EFFICIENCY IMPROVEMENT PROJECT - PACKAGE 2 LOT A*

Funding Agency: JICA

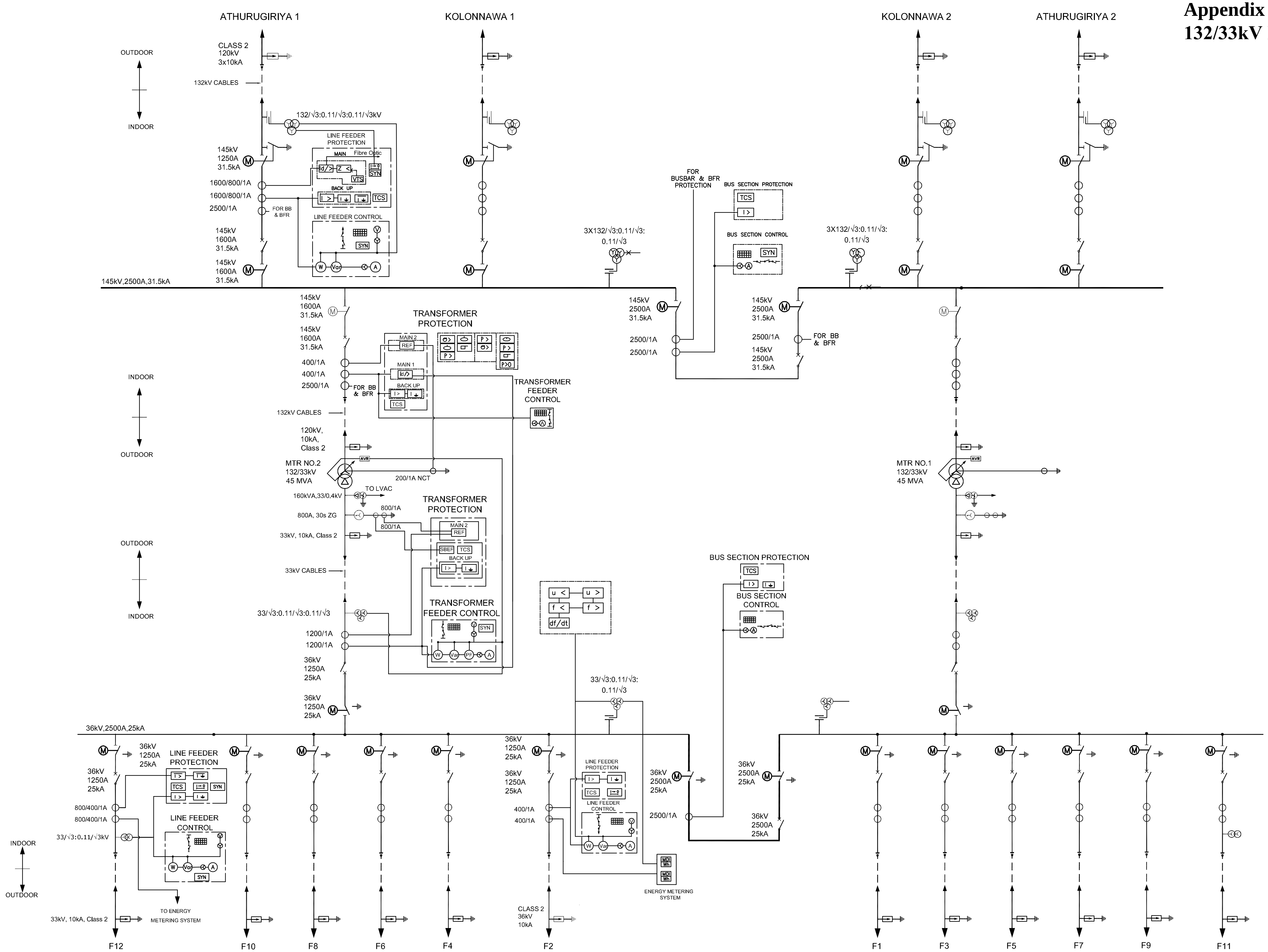
Drawing Title: SINGLE LINE DIAGRAM OF THULHIRIYA GSS

Scale -	NTS	Rev. Date	
Size -	A3	24.01.2013	
Sheet	of	Rev.	0
Dwg. No.	TD/CE/1/102/D/00/02		

	Signature	Date
Drawn	Wasantha	24.01.2013
Designed	Rasika	
Checked		
Approved		

Released for: Tendering ✓ / Construction

Appendix 6-1-7
132/33kV Battaramulla GS



Revision Record					
			18.09.2013		
Rev. No.	Date	Description	Drawn	Checked	Approved

CEYLON ELECTRICITY BOARD
TRANSMISSION DESIGN

Project Title

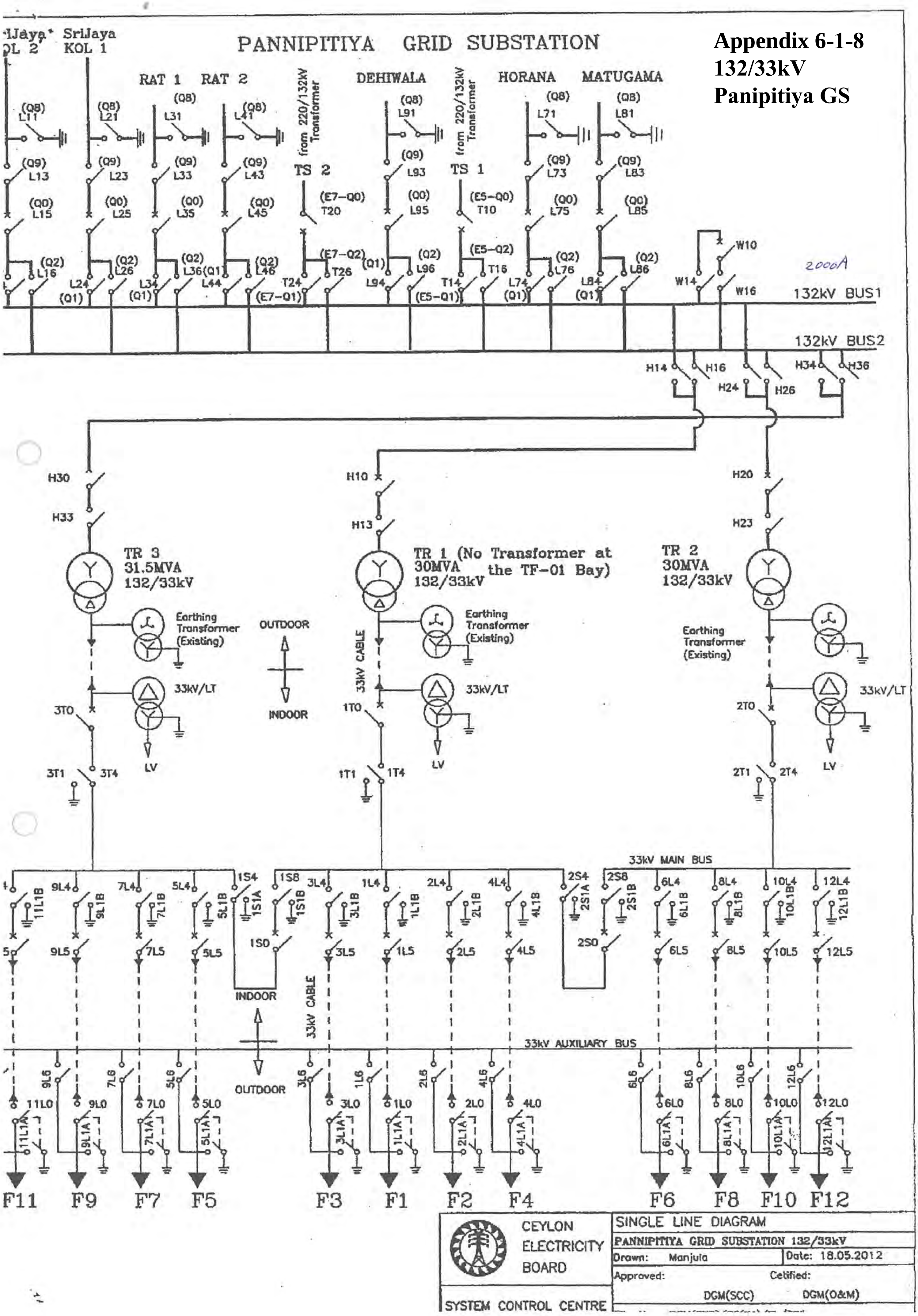
Funding Agency: JICA

Drawing Title: SINGLE LINE DIAGRAM FOR BATTARAMULLA GSS

Scale -	NTS	Rev. Date		Signature	Date
			Drawn	Priyanthi	13.10.2014
Size -	A3	13.10.2014	Designed	Rasika	
			Checked		
Sheet	of	Rev.	Approved		
Dwg. No.			Released for	Tendering	✓
				Construction	

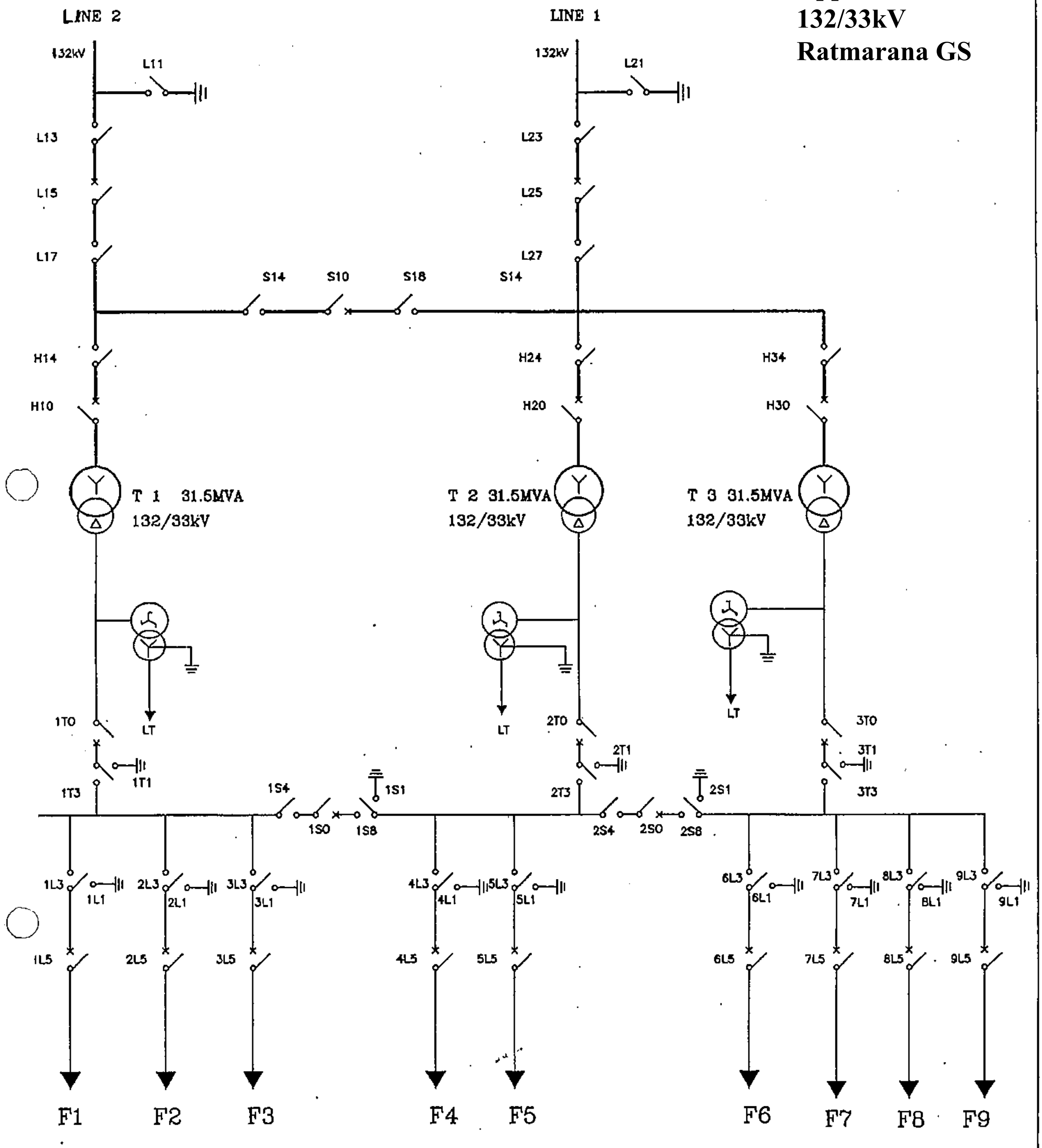
Property of CEB Tr. Design Branch

Appendix 6-1-8
132/33kV
Panipitiya GS



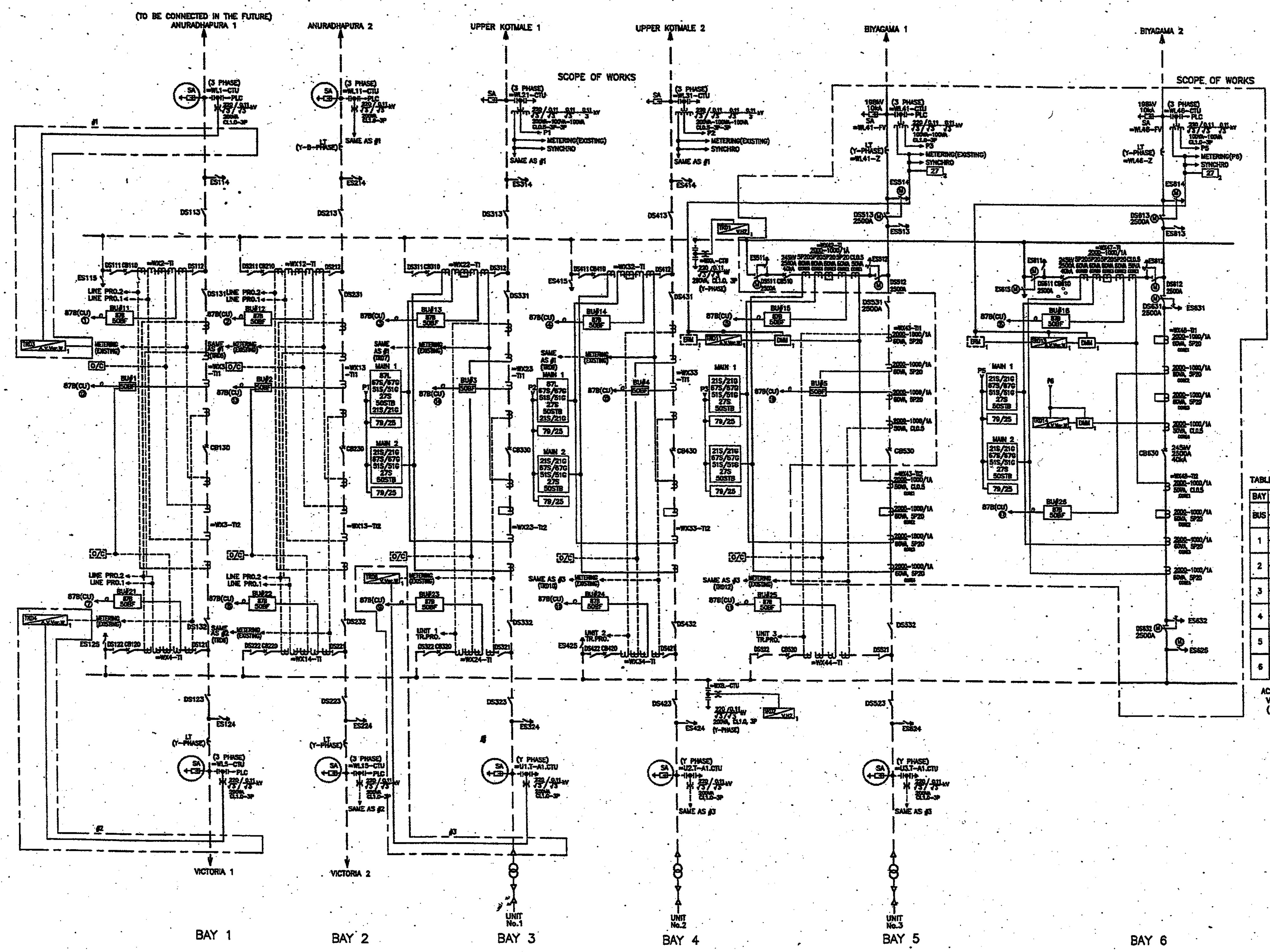
Appendix 6-1-9
132/33kV
Ratmarana GS

RATMALANA GRID SUBSTATION



CEYLON ELECTRICITY BOARD	SINGLE LINE DIAGRAM	
	RATMALANA GRID SUBSTATION	
	Drawn: Chandrika	Date: 02.05.2012
	Approved:	Certified:
	DGM(SCC)	DGM(O&M)
SYSTEM CONTROL CENTRE	File No. DGM(SYC)/CE(OA)/SL/706	

Appendix 6-1-10 Kotmale PS



LEGEND

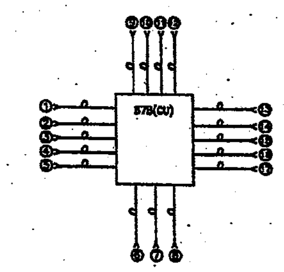
- CIRCUIT BREAKER
- DISCONNECTING SWITCH
- CENTER BREAK DISCONNECTING SWITCH WITH EARTHING SWITCH (MANUAL OPERATION)
- EARTHING SWITCH (MOTOR OPERATION)
- EARTHING SWITCH (MANUAL OPERATION)
- CURRENT TRANSFORMER
- SURGE ARRESTER
- BUSHING TERMINAL
- CAPACITOR VOLTAGE TRANSFORMER
- LT: LINE TRAP
- OPTICAL FIBER CABLE
- DIGITAL MULTIPLE TRANSDUCER (ELEMENT OF TRANSDUCER REFER TO TABLE 1 BELOW)
- DMM: DIGITAL MULTIMETER (A,V,W,VAR)
- ERM: ENERGY METER (EXISTING)
- 21S/21G: PHASE/GROUND FAULT DISTANCE RELAY
- 67S: DIRECTIONAL OVER-CURRENT RELAY FOR SHORT CIRCUIT FAULT
- 67G: DIRECTIONAL OVER-CURRENT RELAY FOR EARTH FAULT (CONSIDERED WITH ZERO-SEQUENCE OVER-CURRENT RELAY & HIGH IMPEADANCE GROUND FAULT RELAY)
- 27S: UNDER VOLTAGE RELAY
- 51S/51G: PHASE/GROUND FAULT DEFINIT TIME OVER-CURRENT RELAY
- 50STB: STUB PROTECTION RELAY
- 79/25: AUTO-RECLOSE/SYNCHROCHECKING RELAY
- 87L: LINE CURRENT DIFFERENTIAL RELAY
- 87B(CU): BUSBAR PROTECTION (CENTRAL UNIT) (CENTRALIZED)
- 87B: BUSBAR PROTECTION (BAY UNIT) (CENTRALIZED)
- 50BF: CB FAILURE PROTECTION RELAY
- O/C: OVER CURRENT PROTECTION RELAY (EXISTING)
- 27: UNDER VOLTAGE RELAY FOR INTERLOCK CONDITION

- SCOPE OF WORK
- OUT OF SCOPE

TABLE 1 ELEMENT OF DIGITAL MULTIPLE TRANSDUCER

BAY	Q'TY	No.	ELEMENT OF TRANSDUCER	SPECIFICATION CODE
BUS	1	TRD1	FOR BUS 1: (Vx1, Hzx1)	010-03000100-B-1
	1	TRD2	FOR BUS 2: (Vx1, Hzx1)	010-03000100-B-1
1	1	TRD3	FOR ANURADHAPURA 1: (Vx3, Ax3, Wx1, VARx1)	210-33110000-B-1
	1	TRD4	FOR VICTORIA 1: (Vx3, Ax3, Wx1, VARx1)	210-33110000-B-1
2	1	TRD5	FOR ANURADHAPURA 2: (Vx3, Ax3, Wx1, VARx1)	210-33110000-B-1
	1	TRD6	FOR VICTORIA 2: (Vx3, Ax3, Wx1, VARx1)	210-33110000-B-1
3	1	TRD7	FOR UPPER KOTMALE 1: (Vx3, Ax3, Wx1, VARx1)	210-33110000-B-1
	1	TRD8	FOR UNIT No.1: (Vx1, Wx1, VARx1)	210-02110000-B-1
4	1	TRD9	FOR UPPER KOTMALE 2: (Vx3, Ax3, Wx1, VARx1)	210-33110000-B-1
	1	TRD10	FOR UNIT No.2: (Vx1, Wx1, VARx1)	210-02110000-B-1
5	1	TRD11	FOR BIYAGAMA 1: (Vx3, Ax3, Wx1, VARx1)	210-33110000-B-1
	1	TRD12	FOR UNIT No.3: (Vx1, Wx1, VARx1)	210-02110000-B-1
6	1	TRD13	FOR BIYAGAMA 2: (Vx3, Ax3, Wx1, VARx1)	210-33110000-B-1
	1	TRD14	FOR SPARE: (Vx1, Ax3, Wx1, VARx1)	210-33110000-B-1

ACCURACY OF MULTIPLE TRANSDUCER
VOLTAGE,CURRENT,POWER,REACTIVE POWER,FREQUENCY : ±0.5%
(THE PERCENTAGE ERROR TO AN OUTPUT SPAN)



UPPER KOTMALE HYDROPOWER PROJECT
CEYLON ELECTRICITY BOARD
J-POWER/Electric Power Development Co.,Ltd
Mitsubishi Corporation

H	01-MAR-'11 H.T.		
G	10-MAY-'10 H.T. Y.T.		
F	14-OCT.-'09 Y.T.		
E	07-AUG.-'09 Y.T.		
D	07-JUL.-'09 Y.T.		
C	23-APR.-'09 Y.T.	DATE	5.NOV.2008
B	14-JAN.-'09 Y.T.	DRAWN	Y.O. Y.T.
A	17-DEC.-'08 Y.T.	APPROVED	K.U. Y.T.

MITSUBISHI ELECTRIC

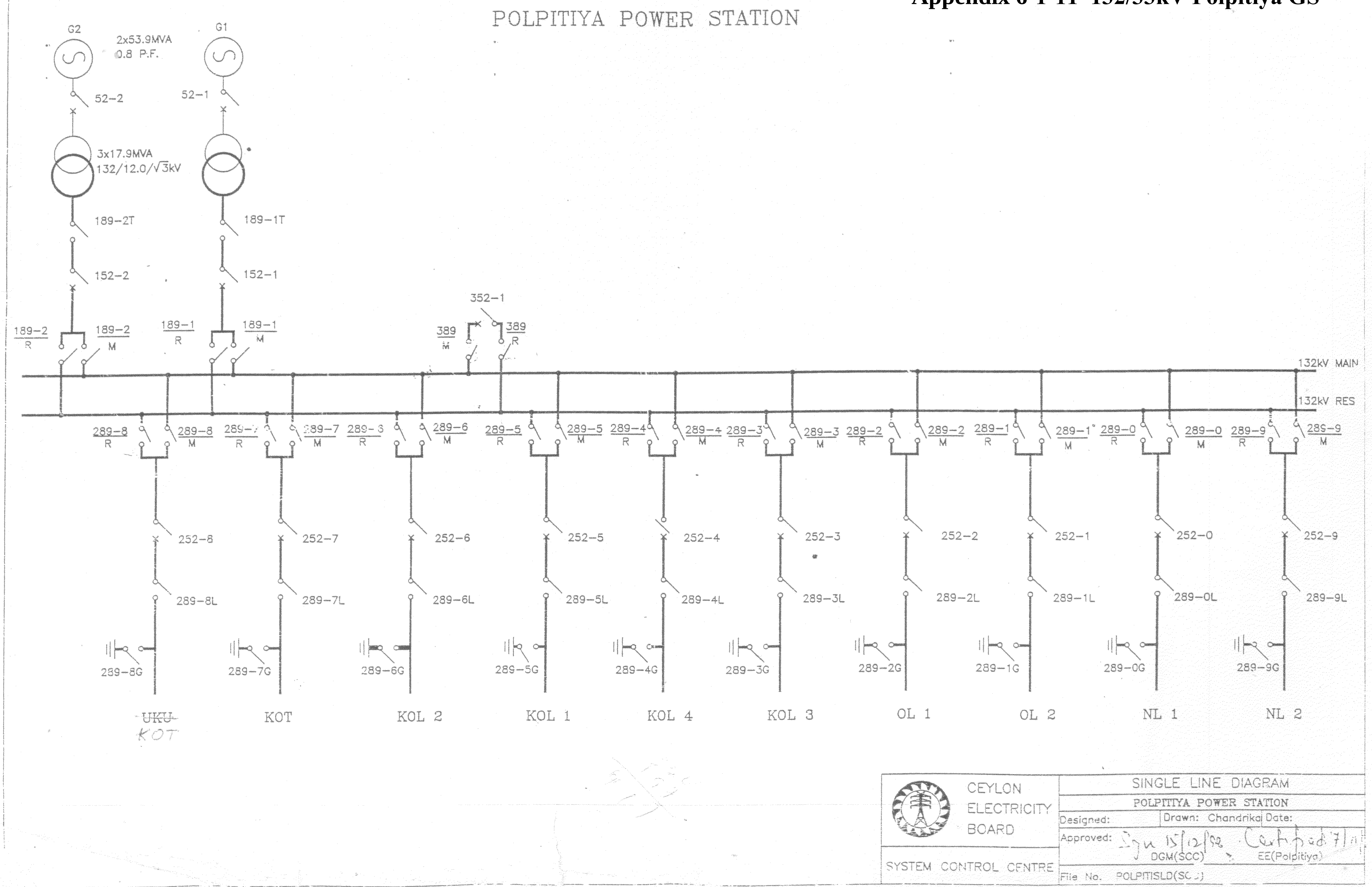
TITLE: EXPANSION OF KOTMALE 220kV SWITCHYARD SINGLE LINE DIAGRAM

SHEET NO.

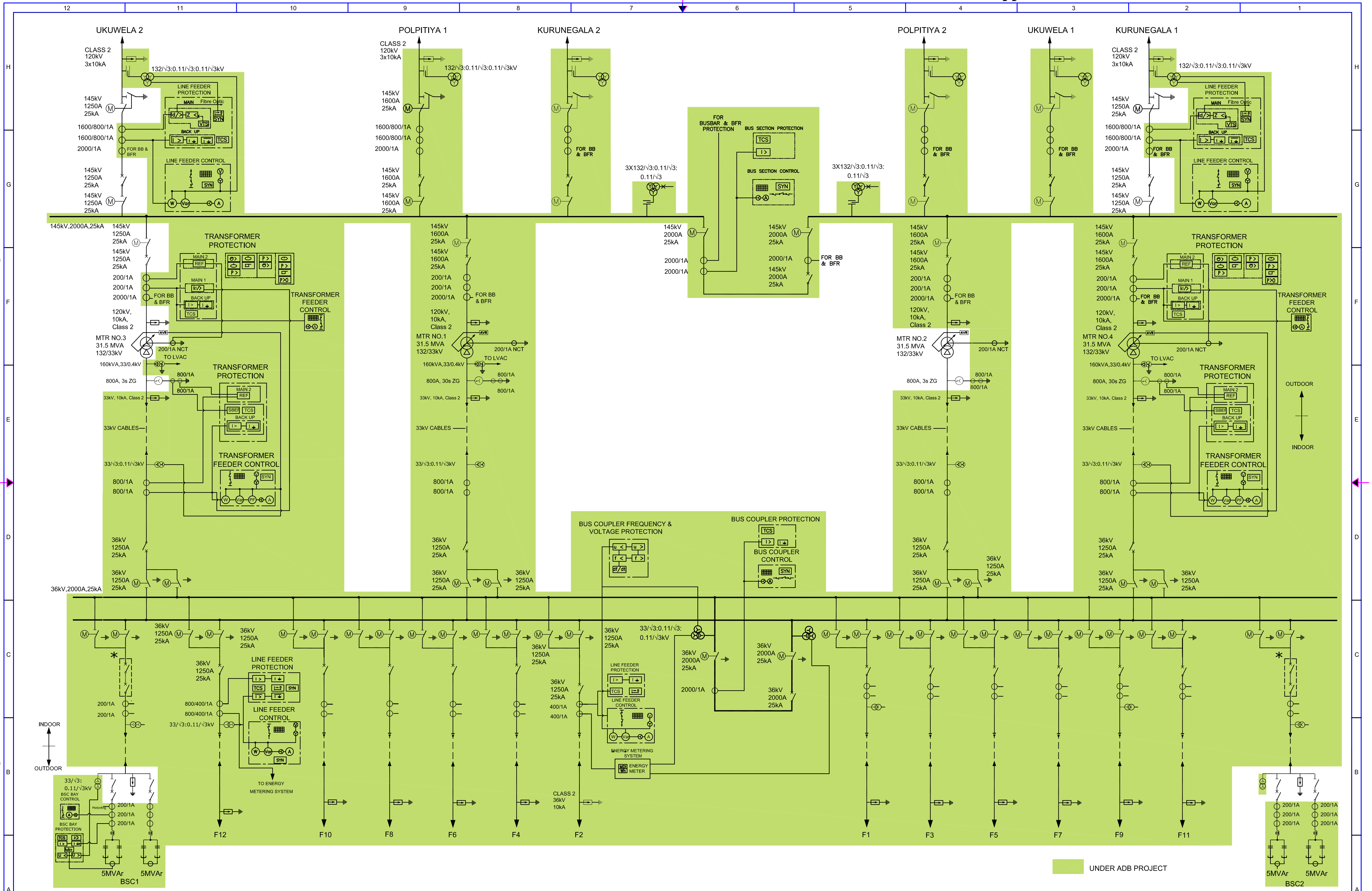
DWG NO. H1N7383

PAGE NO.

Appendix 6-1-11 132/33kV Polpitiya GS



Appendix 6-1-12 132/33kV Kiribathkumbura GS



Revision Record					
			18.09.2013		
Rev. No.	Date	Description	Drawn	Checked	Approved

CEYLON ELECTRICITY BOARD
TRANSMISSION DESIGN

Project Title

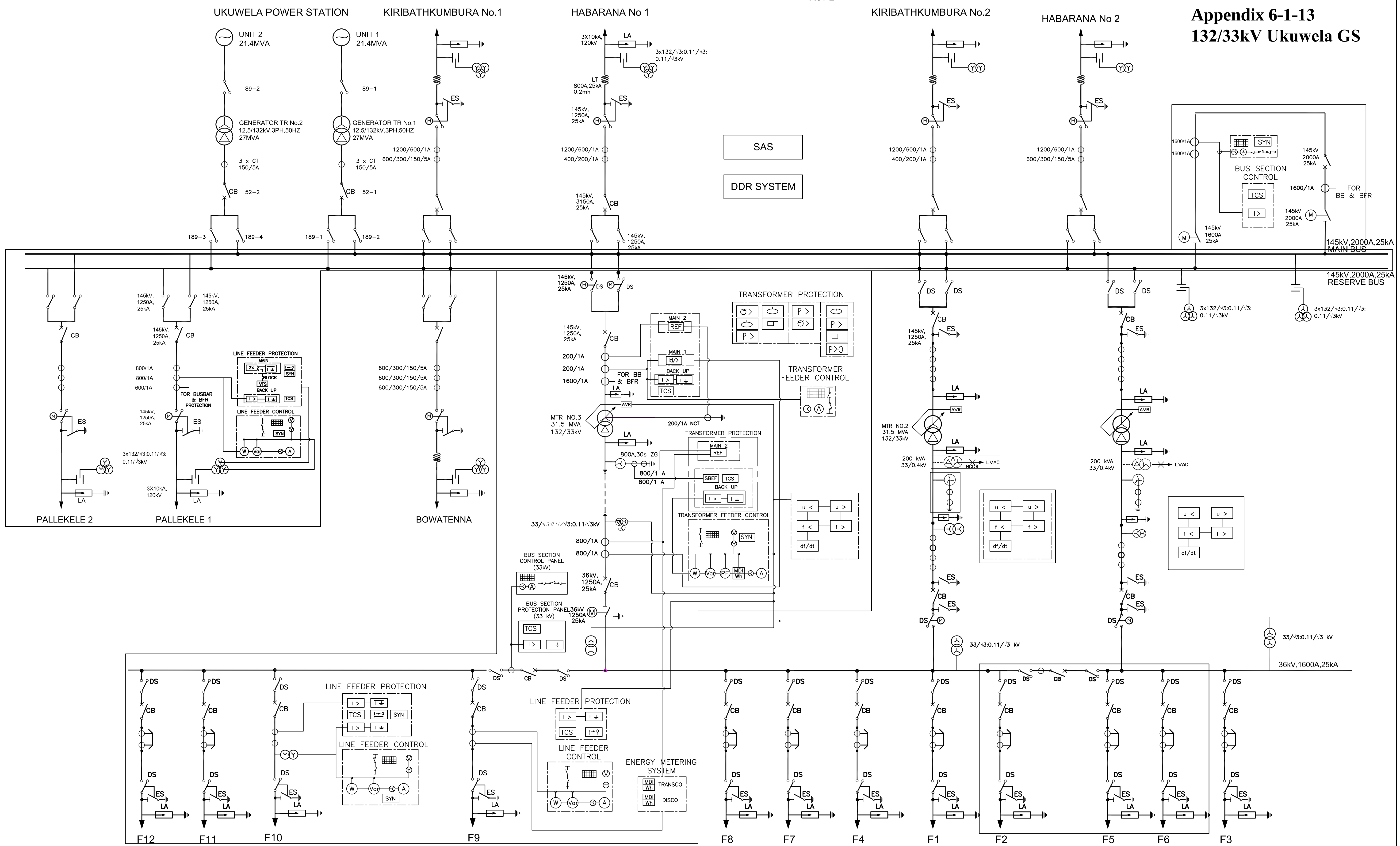
Funding Agency: JICA

Drawing Title: SINGLE LINE DIAGRAM FOR KIRIBATHKUMBURA GSS

Scale - NTS	Rev. Date		Signature	Date
Size - A3	27.06.2014	Drawn	Priyanthi	27.06. 2014
Sheet ... of	Rev. 0	Designed	Rasika	
		Checked		
		Approved		
Dwg. No. TD/CE/1/93/D/00/01		Released for	Tendering	✓
			Construction	

RevNo	Revision note	Date	Signature	Checked
Rev 2				

Appendix 6-1-13
132/33kV Ukuwela GS



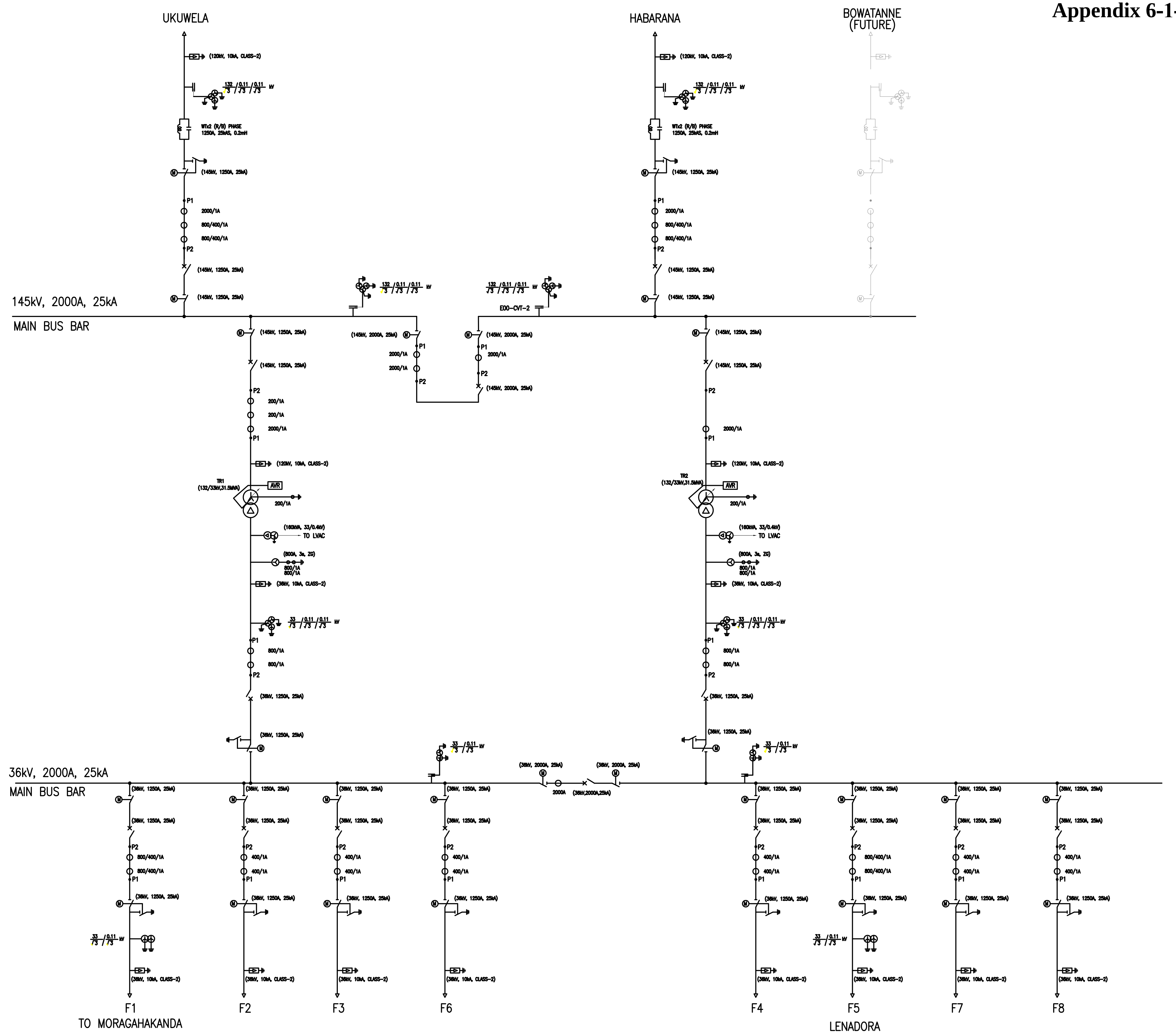
Checked by	Approved by - date		Scale NA
Designed by Upeka	Drawn by Priyanthi	Filename	Date 2009 Aug

CEYLON ELECTRICITY BOARD
TRANSMISSION DESIGN

SINGLE LINE DIAGRAM FOR UKUWELA GSS

TD/CE/1/64/D/00/06

Appendix 6-1-14 132/33kV Naula GS



Revision Record					
Rev. No.	Date	Description	Drawn	Checked	Approved

CEYLON ELECTRICITY BOARD
TRANSMISSION DESIGN

Project Title

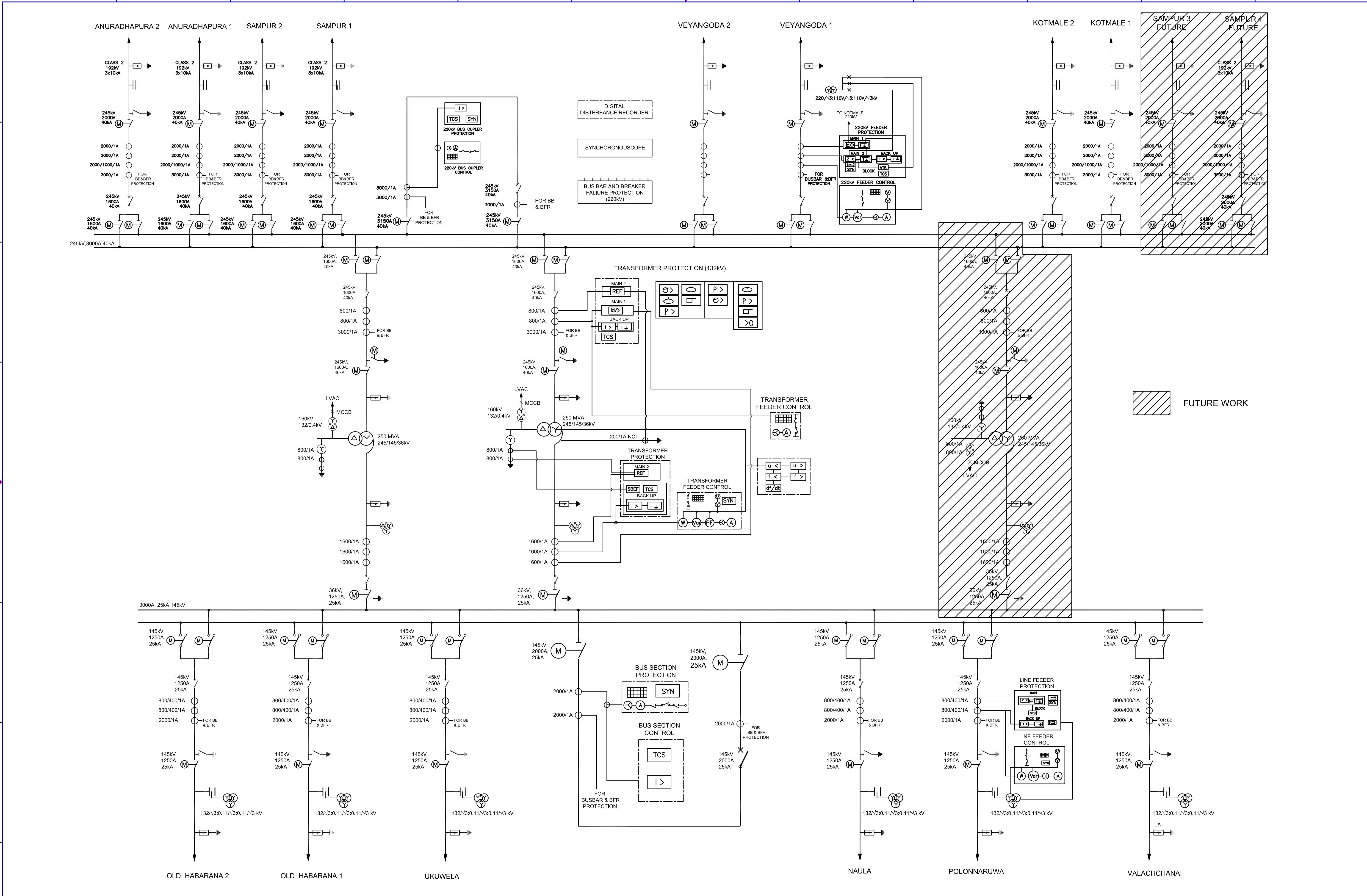
Funding Agency

Drawing Title
SINGLE LINE DIAGRAM OF
NAULA GSS

Scale -	NTS	Rev. Date	
Size -	A3	26.12.2013	
Sheet	of	Rev.	0
Dwg. No.	TD/CE/1/67/D/00/02		

	Signature	Date
Drawn		26.12.2013
Designed	Rasika	
Checked		
Approved		

Released for: Tendering ✓ / Construction



Revision Record					
Rev. No.	Date	Description	Drawn	Checked	Approved

CEYLON ELECTRICITY BOARD
TRANSMISSION DESIGN

Project Title: *NEW HABARANA SWITCHING STATION*

Funding Agency: CEB

Drawing Title: PROPOSED SINGLE LINE DIAGRAM FOR NEW HABARANA GSS

Scale -	NA	Rev. Date	
Size -	A3	18.11.2011	
Sheet	1 of 2	Rev.	0
Dwg. No.	TD/CE/1/95/D/00/01		

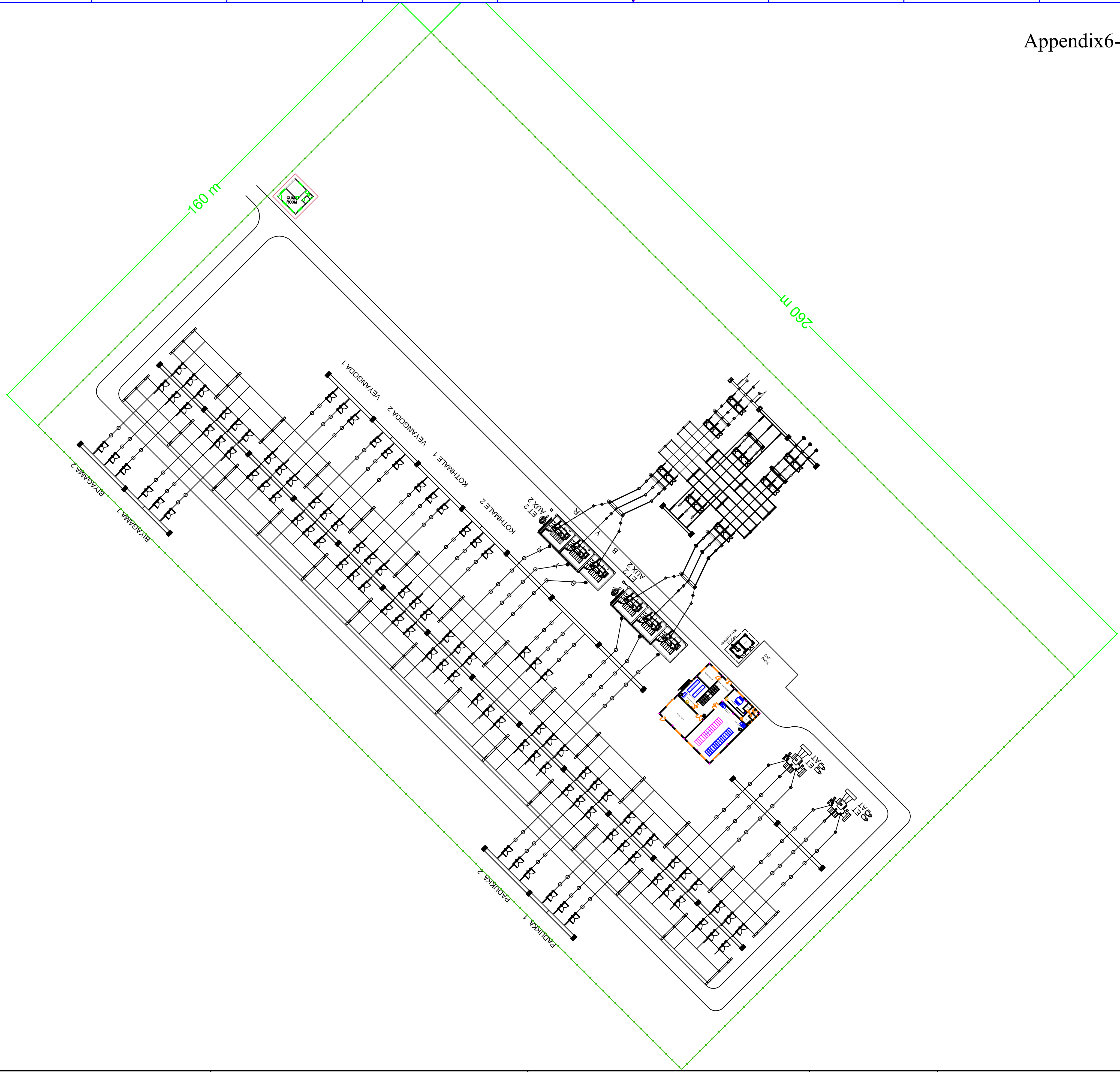
	Signature	Date
Drawn	Wasantha	18.11.2011
Designed	Upeka	
Checked		
Approved		

Released for: Tendering ✓ / Construction

Layout for Grid Substation

	Substation
Appendix 6-2-1	220/132/33kV Kirindiwera GS (New)
Appendix 6-2-2	220/132kV Veyangoda GS (220kV Bay Extension and 132kV Bay)
Appendix 6-2-3	220/132/kV Padukka GS (220kV Bay Extension)
Appendix 6-2-4	132/33kV Kosgama GS (Extension)
Appendix 6-2-5	132/22kV Seethawaka GS (Extension)
Appendix 6-2-6	132/33kV Thulhiriya GS
Appendix 6-2-7	132/33kV Battaramulla GS (New)
Appendix 6-2-8	132/33kV Kolonnawa GS (Modification)
Appendix 6-2-9	132/33kV Panipitiya GS (Modification)
Appendix 6-2-10	132/33kV Ratmarana GS (Modification)
Appendix 6-2-11	Kotmale PS (Bay Extension) : Existing SLD
Appendix 6-2-12	132/33kV Kiribathkumbura GS (For reference)
Appendix 6-2-13	132/33kV Ukuwela GS (Modification)
Appendix 6-2-14	132/33kV Naula GS (Modification)
Appendix 6-2-15	220/132kV New Habarana GS (For reference)

Appendix6-2-1 220/132/33kV Kirindiwera GS



Revision Record					
Rev. No.	Date	Description	Drawn	Checked	Approved

CEYLON ELECTRICITY BOARD
TRANSMISSION DESIGN

Project Title

Funding Agency: JICA

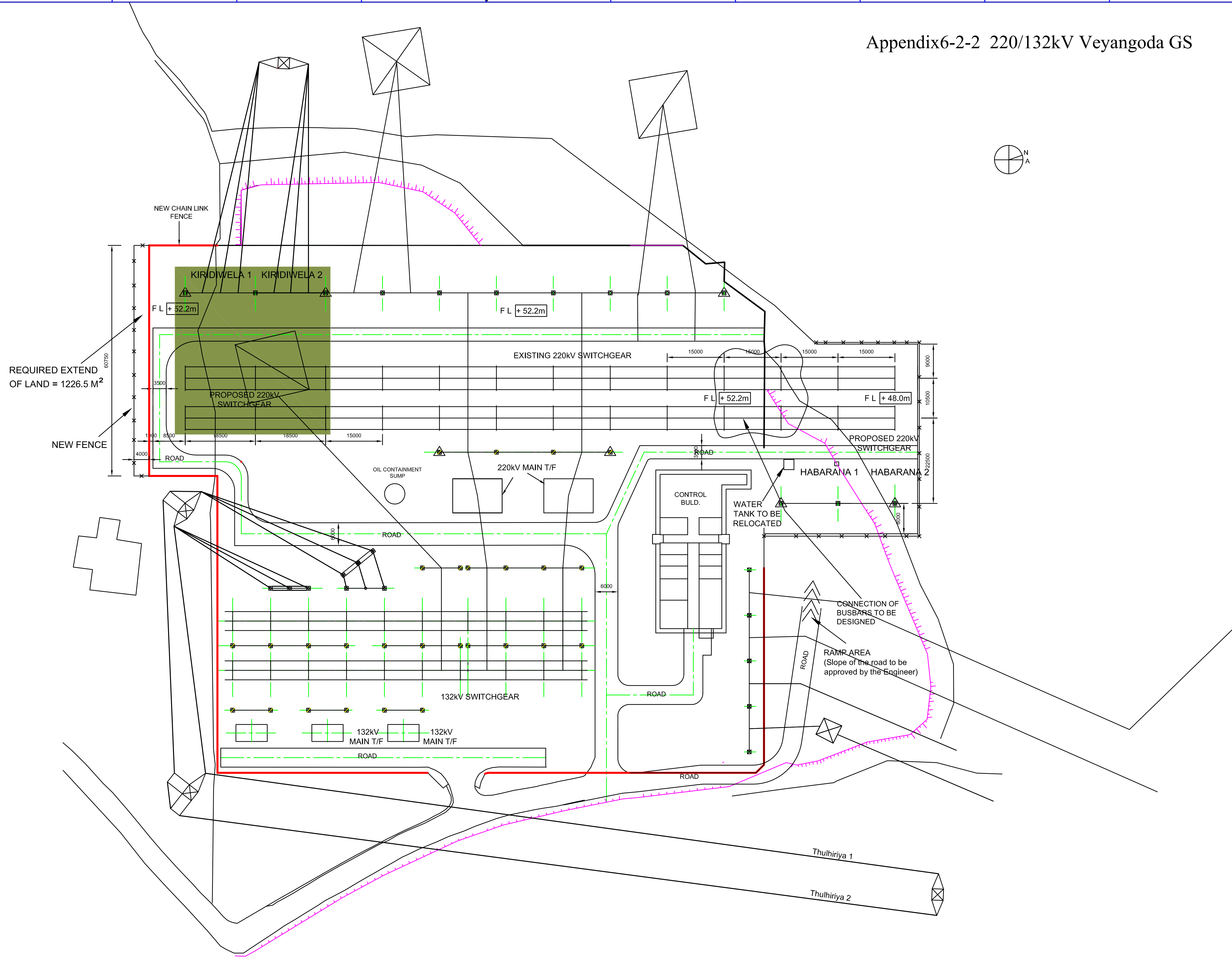
Drawing Title: PROPOSED LAYOUT FOR KIRIDIWELA GSS

Scale - NTS		Rev. Date	13.10.2014
Size - A3		Rev.	0
Sheet	of		
Dwg. No.			

	Signature	Date
Drawn	Buddhika	13.10.2014
Designed	Rasika	
Checked		
Approved		

Released for: Tendering / Construction

Appendix6-2-2 220/132kV Veyangoda GS



Property of CEB

Revision Record					
Rev. No.	Date	Description	Drawn	Checked	Approved

CEYLON ELECTRICITY BOARD
TRINCOMALEE COAL POWER PROJECT

Project Title

Funding Agency: JICA

Drawing Title: PROPOSED GENERAL LAYOUT FOR VEYANGODA GSS

Scale -	1:1000	Rev. Date	
Size -	A3	09.10.2014	
Sheet	of	Rev.	0
Dwg. No.			

	Signature	Date
Drawn	Wasantha	09.10.2014
Designed	Rasika	
Checked		
Approved		
Released for	Tendering	
	Construction	

Appendix6-2-3 220/132kV Padduka GS

Revision Record					
Rev. No.	Date	Description	Drawn	Checked	Approved

CEYLON ELECTRICITY BOARD
TRANSMISSION DESIGN

Project Title

Funding Agency: JICA

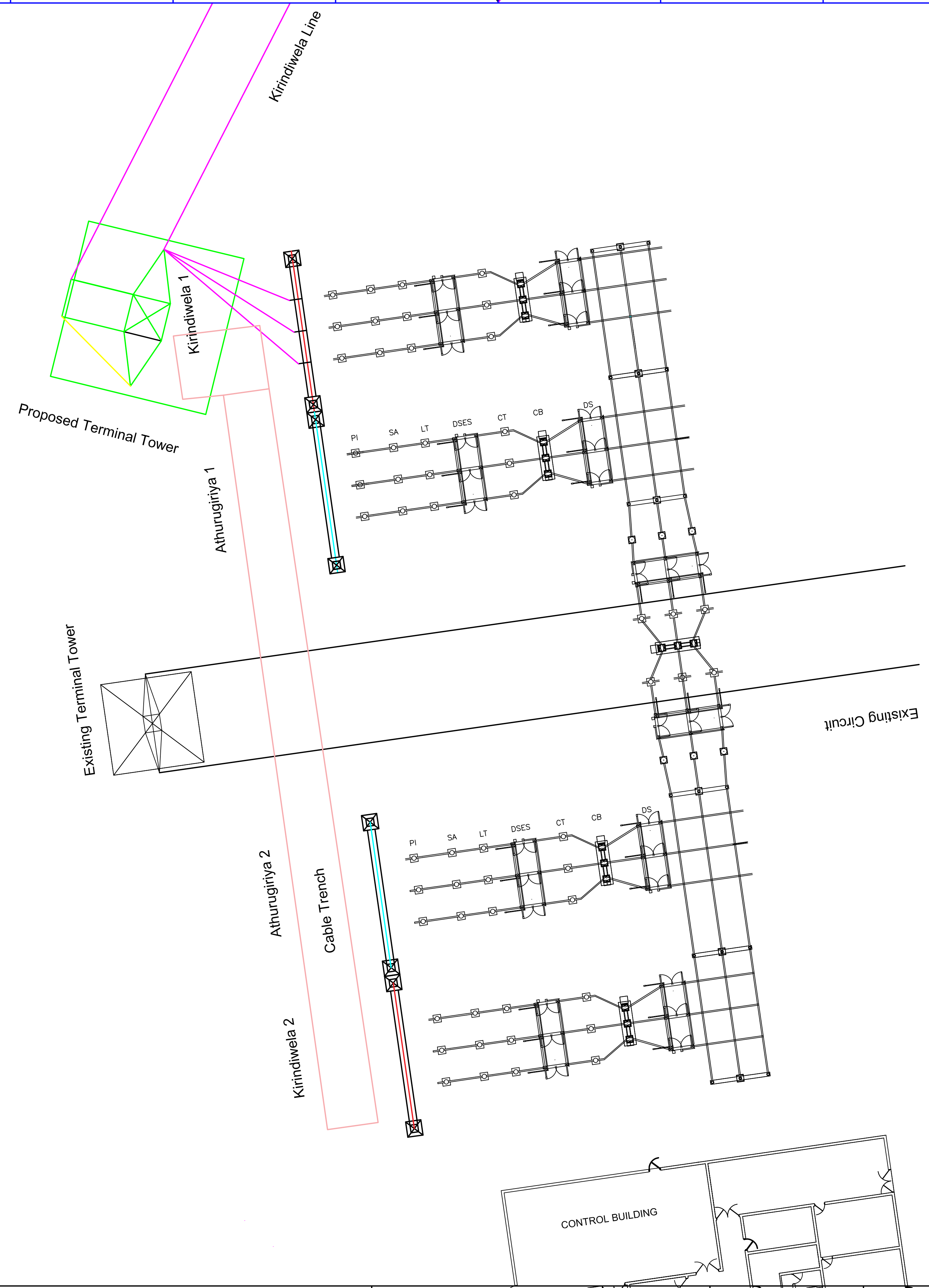
Drawing Title: LAYOUT OF PADUKKA GSS

Scale -	NTS	Rev. Date	
Size -	A3	23.10.2013	
Sheet	of	Rev.	0
Dwg. No.	TD/CE/1/97/D/01/01		

		Signature	Date
Drawn	Wasantha		23.10.2013
Designed	Rasika		
Checked			
Approved			
Released for	Tendering		✓
	Construction		

Property of CEB Tr. Design Branch

Appendix6-2-4 132/33kV Kosgama GS



Revision Record					
Rev. No.	Date	Description	Drawn	Checked	Approved

CEYLON ELECTRICITY BOARD
TRANSMISSION DESIGN

Project Title

Funding Agency: JICA

Drawing Title: PROPOSED TERMINAL TOWER ARRANGEMENT KOSGAMA GSS

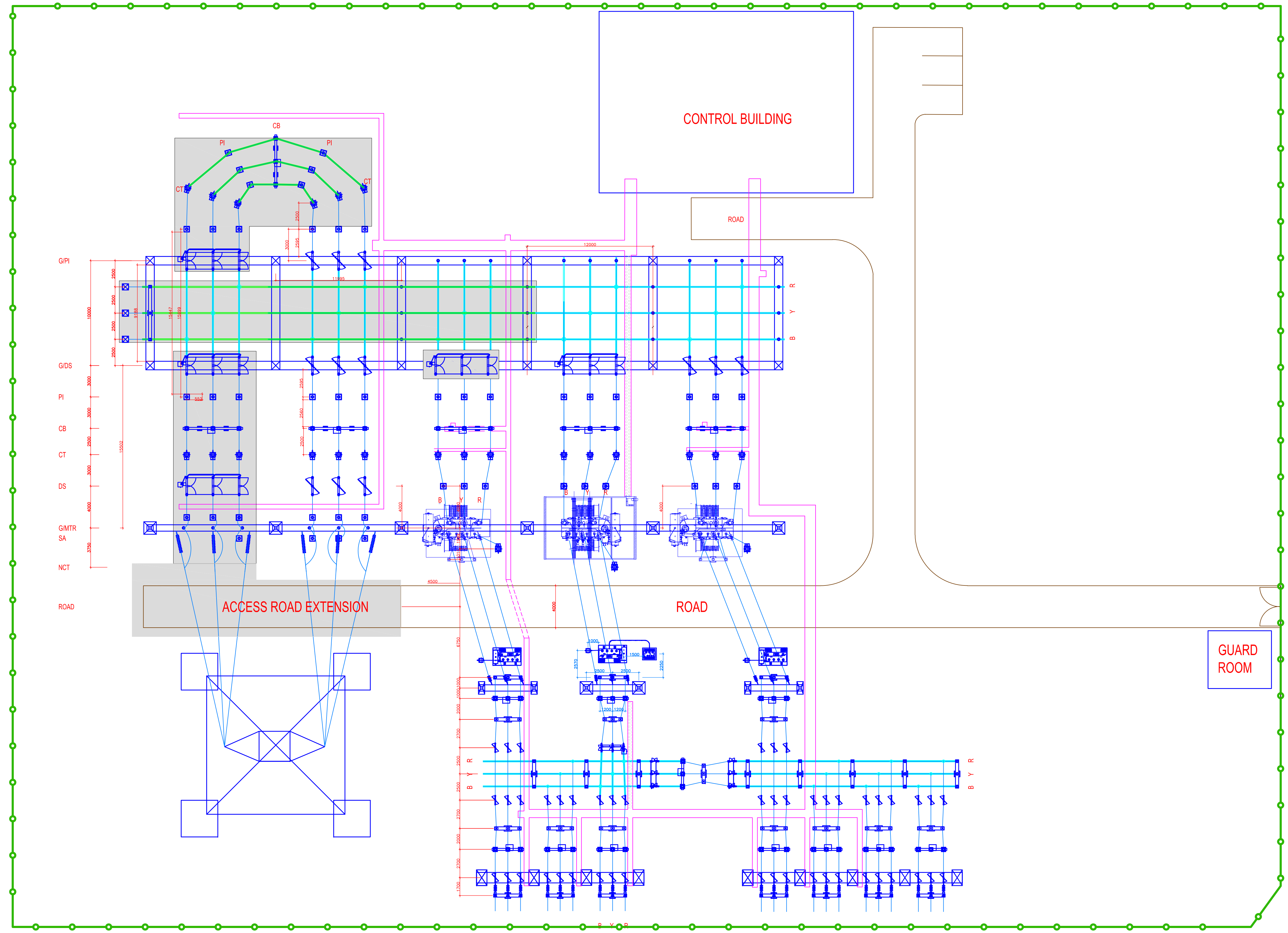
Scale -		Rev. Date
Size -	A3	14.10.2014
Sheet	of	Rev. 0
Dwg. No.		

	Signature		Date
Drawn	Dayan		14.10.2014
Designed	Dayan		
Checked			
Approved			
Released for	Tendering		
	Construction		

Property of CEB Tr. Design Branch

Appendix6-2-5
132/22kV Seethawaka GS

SCOPE OF WORK



Property of CEB Tr. Design Branch

Revision Record					
			28.08.2012		
Rev. No.	Date	Description	Drawn	Checked	Approved

CEYLON ELECTRICITY BOARD
TRANSMISSION DESIGN

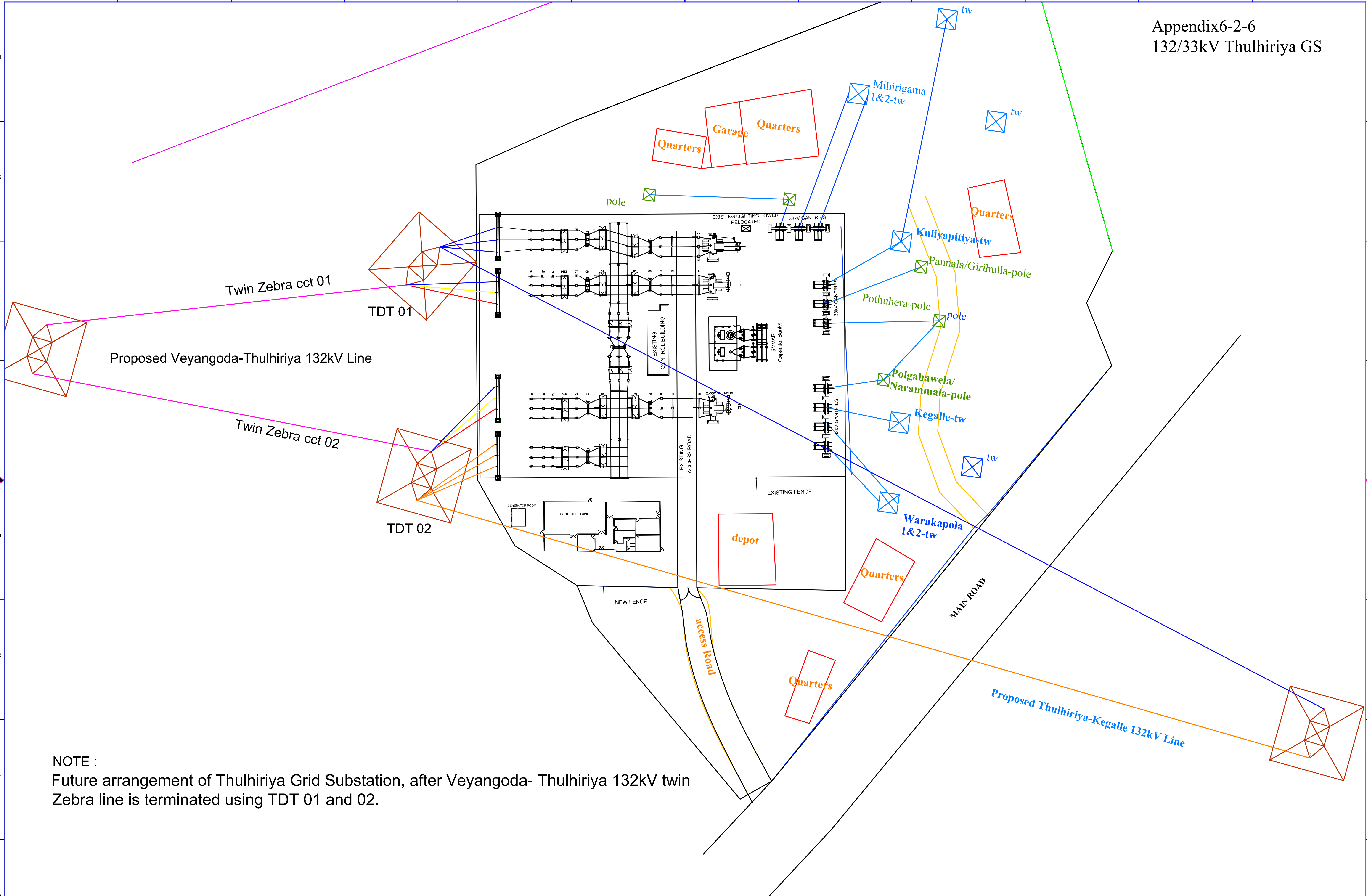
Project Title

Funding Agency

Drawing Title
PROPOSED LAYOUT FOR
SEETHAWAKA GSS

Scale - 1:400	Rev. Date		Signature / Date
Size - A3	30.10.2014	Drawn	Buddhika / 30.10.2014
Sheet of	Rev. 0	Designed	Rasika
		Checked	
		Approved	
Dwg. No. TD/CE/1/ /D/01/01		Released for	Tendering ✓
			Construction

Appendix6-2-6
132/33kV Thulhiriya GS



NOTE :

Future arrangement of Thulhiriya Grid Substation, after Veyangoda- Thulhiriya 132kV twin Zebra line is terminated using TDT 01 and 02.

Revision Record

Rev. No.	Date	Description	Drawn	Checked	Approved

CEYLON ELECTRICITY BOARD
TRANSMISSION DESIGN

Project Title: CLEAN ENERGY & NETWORK EFFICIENCY IMPROVEMENT PROJECT - PACKAGE 2 LOT C - 1

Funding Agency: ADB

Drawing Title: TERMINAL TOWER ARRANGEMENT FOR THULHIRIYA GSS - FUTURE ARRANGEMENT

				Signature	Date
Scale - 1:900	Rev. Date	Drawn	Wasantha		25.06.2013
Size - A3	25.06.2013	Designed	Dayan		
Sheet of	Rev. 0	Checked			
Dwg. No. TD/CE/1/99/D/01- B		Approved			
		Released for	Tendering	✓	
			Construction		

Property of CEB Tr. Design Branch

Appendix6-2-7
Battaramulla GS

Property of CEB Tr. Design Branch

Property of CEB Tr. Design Branch

Revision Record					
			24.02.2012		
Rev. No.	Date	Description	Drawn	Checked	Approved

CEYLON ELECTRICITY BOARD
TRANSMISSION DESIGN

Project Title

Funding Agency
JICA

Drawing Title
SUBSTATION BATTARAMULLA
SWITCHGEAR & CONTROL BUILDING
LAYOUT

Scale -	1:225	Rev. Date
Size -	A3	13.10.2014
Sheet	03 of 03	Rev. 0
Dwg. No.		

	Signature	Date
Drawn	Priyanthi	13.10.2014
Designed	Rasika	
Checked		
Approved		

Released for: Tendering ✓ / Construction

Appendix6-2-8 132/33kV Kolonnawa GS

Property of CEB Tr. Design Branch

Revision Record					
Rev. No.	Date	Description	Drawn	Checked	Approved

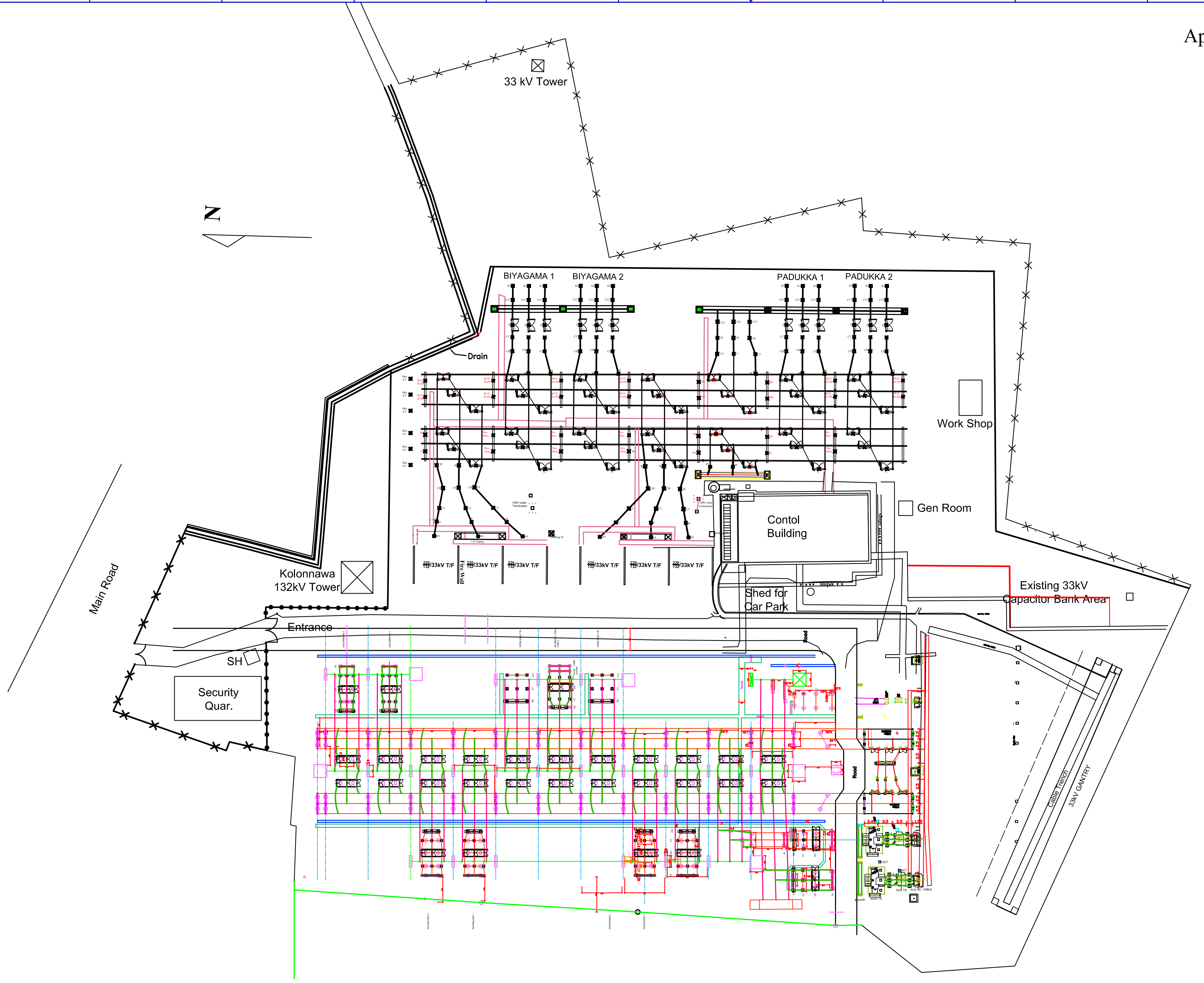
CEYLON ELECTRICITY BOARD
TRANSMISSION DESIGN

Project Title

Funding Agency: JICA

Drawing Title: LAYOUT FOR KOLONNAWA OLD GSS

					Signature	Date
Scale -	1:600	Rev. Date	Drawn	Wasantha		17.02.2014
Size -	A3	17.02.2014	Designed	Rasika		
Sheet	of	Rev. 0	Checked			
Dwg. No.	TD/CE/1/103/D/01/05		Approved			
			Released for	Tendering	✓	
				Construction		



SCOPE OF WORK

Revision Record

Rev. No.	Date	Description	Drawn	Checked	Approved
			19.02.2013		

CEYLON ELECTRICITY BOARD
TRANSMISSION DESIGN

Project Title
INSTALLATION OF 100MVAr BREAKER SWITCHED CAPACITORS AT PANNIPITIYA GRID SUBSTATION 132kV BUSBAR

Funding Agency

Drawing Title
LAYOUT OF
PANNIPITIYA GSS

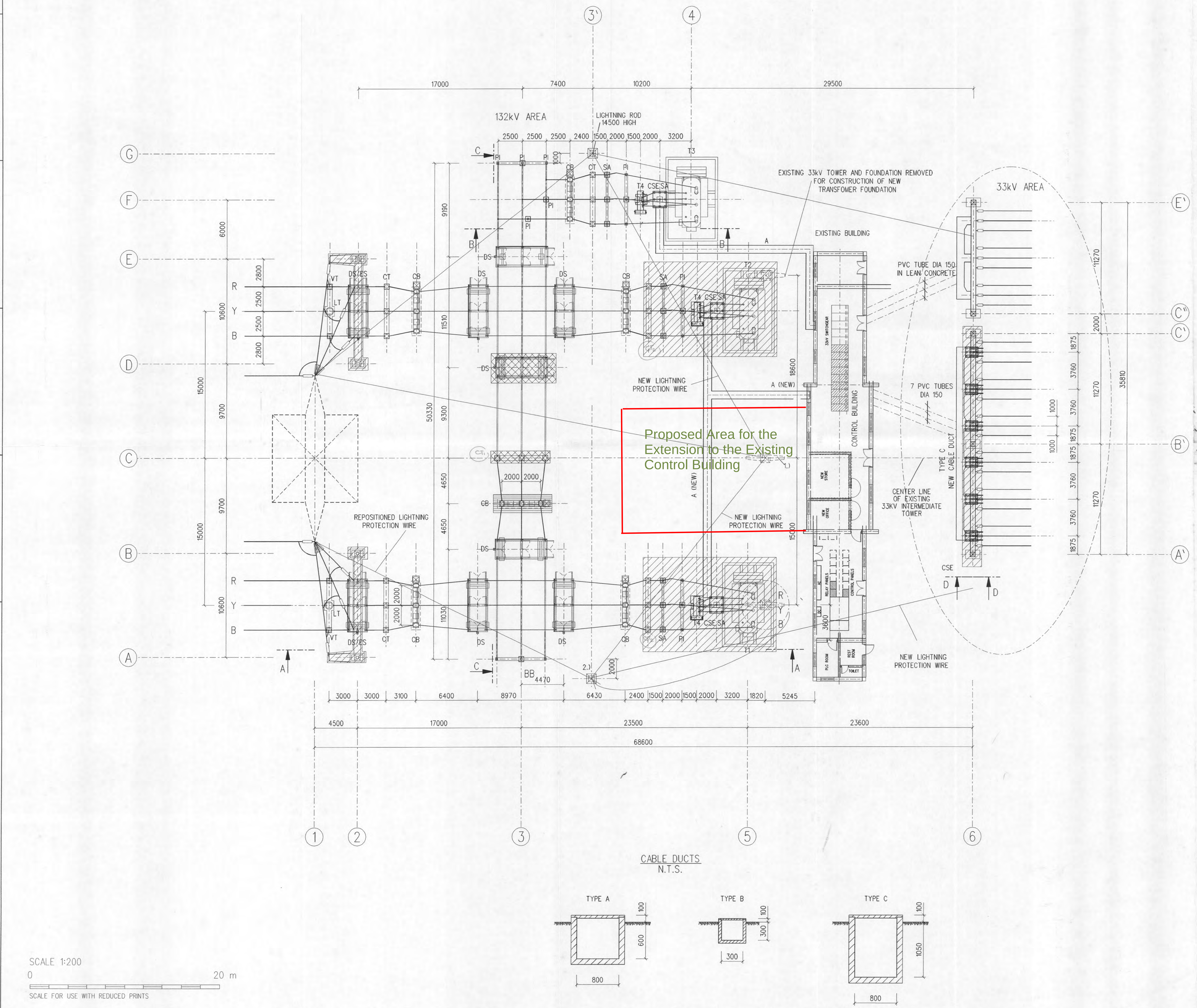
Scale -	1:1000	Rev. Date	
Size -	A3	19.11.2013	
Sheet	of	Rev.	
Dwg. No.	TD/CE/1/109/D/01/01 - A		

	Signature	Date
Drawn	Wasantha	19.11.2013
Designed	Rasika	
Checked		
Approved		
Released for: Tendering		✓
Released for: Construction		

Property of CEB Tr. Design Branch

Property of CEB Tr. Design Branch

Appendix6-2-10 132/33kV Ratmarana GS



KEY TO EQUIPMENT - 132kV - SUBSTATION

REF. NO	DESCRIPTION	QTY	TYPE	DRAWING NO
CB	CIRCUIT BREAKER THREE-PHASE	1	LTB 145	1HSB425455M621
CT1	CURRENT TRANSFORMER	3	IBM 145	YN1H200419-302
CT2	CURRENT TRANSFORMER	6	IBM 145	YN1H200419-301
DS	ISOLATOR SWITCH THREE-PHASE	1	SDC 145	IC 3423
DS/ES	ISOLATOR SWITCH WITH EARTHING SWITCH THREE-PHASE	-	SGF EXISTING	
VT	VOLTAGE TRANSFORMER	-	EXISTING	
LT	LINE TRAP	-	EXISTING	
SA	SURGE ARRESTER	6	PEXLIM Q 120-XH145	XL300024-536
SAu	SURGE ARRESTER UNDERHUNG	6	PEXLIM Q 120-XH145H	XL300024-537
PI	POST INSULATOR	6	C6-650	303948.00.01
T1/T2	31.5 MVA TRANSFORMER 132/33kV	2	31500/132PT	70/5238

KEY TO EQUIPMENT - 33kV - SUBSTATION

REF. NO	DESCRIPTION	QTY	TYPE	DRAWING NO
DS/ES	ISOLATOR SWITCH WITH EARTHING SWITCH THREE-PHASE	6	ON III 30 W	
SA	SURGE ARRESTER	6	PEXLIM Q 036-XV036	XL300024-535
SAu	SURGE ARRESTER UNDERHUNG	18	PEXLIM Q 036-XV036H	XL300024-538
T4	200 kVA TRANSFORMER 33/0.400kV	2		
CSE	CABLE SEALING END	30		

	MINIMUM AIR CLEARANCES IN mm	132 kV	33 kV
a	PHASE TO EARTH	1300	380
b	PHASE TO PHASE	1473	430
c	SAFETY CLEARANCE BETWEEN GROUND AND THE NEAREST POINT OF INSULATOR	2440	2440
d	SECTION CLEARANCE	3900	2700

NOTE:

- FOUNDATION, SUPPORT EXISTING EQUIPMENT NEW
- FOUNDATION, SUPPORT AND EQUIPMENT NEW
- CB AND FOUNDATION NEW

1.) - EXISTING CONDUCTORS, STRINGS, AND BRACKETS REMOVED. TOWER USED FOR LIGHTNING PROTECT.

2.) - EXISTING 33kV TOWER SHIFTED FROM EXISTING TO NEW POSITION USED FOR LIGHTNING PROTECTION.

PL INCLUDE SAu, CT1, CT2 IN THE PLAN 18/09/2000

RECOMMENDED FOR APPROVAL
Transmission Design Branch
Ceylon Electricity Board
Date 18/9/01 Sign.

REFERENCE DRAWINGS:

1HDD1 2 0317 CONTROL BUILDING
1HDD1 2 0316 SECTIONS

REV No.	DATE	DESCRIPTION	DRAWN	CHECKED	APPROVED
D	00-09-04	33kV Gantary revised	Freund	Roehrig	TB
C	00-07-13	Lightning Protection revised	Freund	Roehrig	TB
B	00-07-12	Lightning Shielding at Transf.rev. Note completed	Freund	Roehrig	TB
A	00-03-28	Rev.in accord.with CEB-letter PM/KR/112/R dated 2.March 00	Freund	Roehrig	TB

CEYLON ELECTRICITY BOARD
SRI LANKA

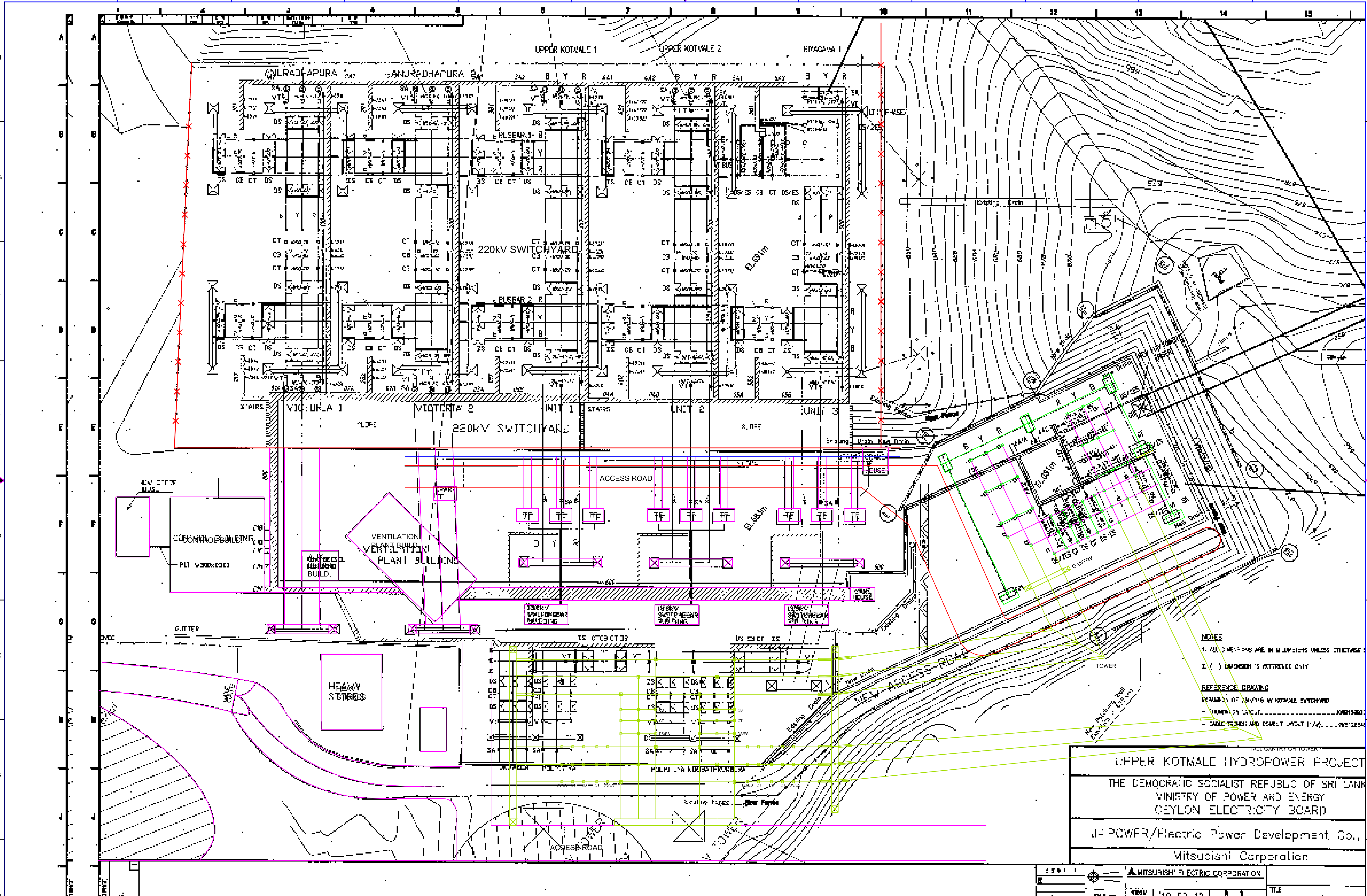
PROJECT: KELANIYA AND RATMALANA GRID SUBSTATION PROJECT

CONTRACT NO.: AGM/T/99/KfW/001

CONTRACTOR: ABB Calor Emag Schaltanlagen AG

Order No. | Contract No. DECES/TV2-162A0011 | Customer | Format A1
Prepared 25.01.00 FREUND | Responsible department DECES/EP2 | Title 132/33kV SWITCHGEAR RATMALANA EXTENSION PLAN VIEW
Approved 25.01.00 BRAUN | Take over department | Lang. EN
Revision | Derived from / Replaces 1HDD1 1 0555 | Scale 1:200 | No. sh. 1
ABB Calor Emag Schaltanlagen AG | Doc.No. 1HDD1 1 0695 | Rev. D | Sheet 1

04.09.00 15:05:07 Y:\AUFTRAG\162A0011\Ratmalana\Prim\1HDD11 0695.dgn



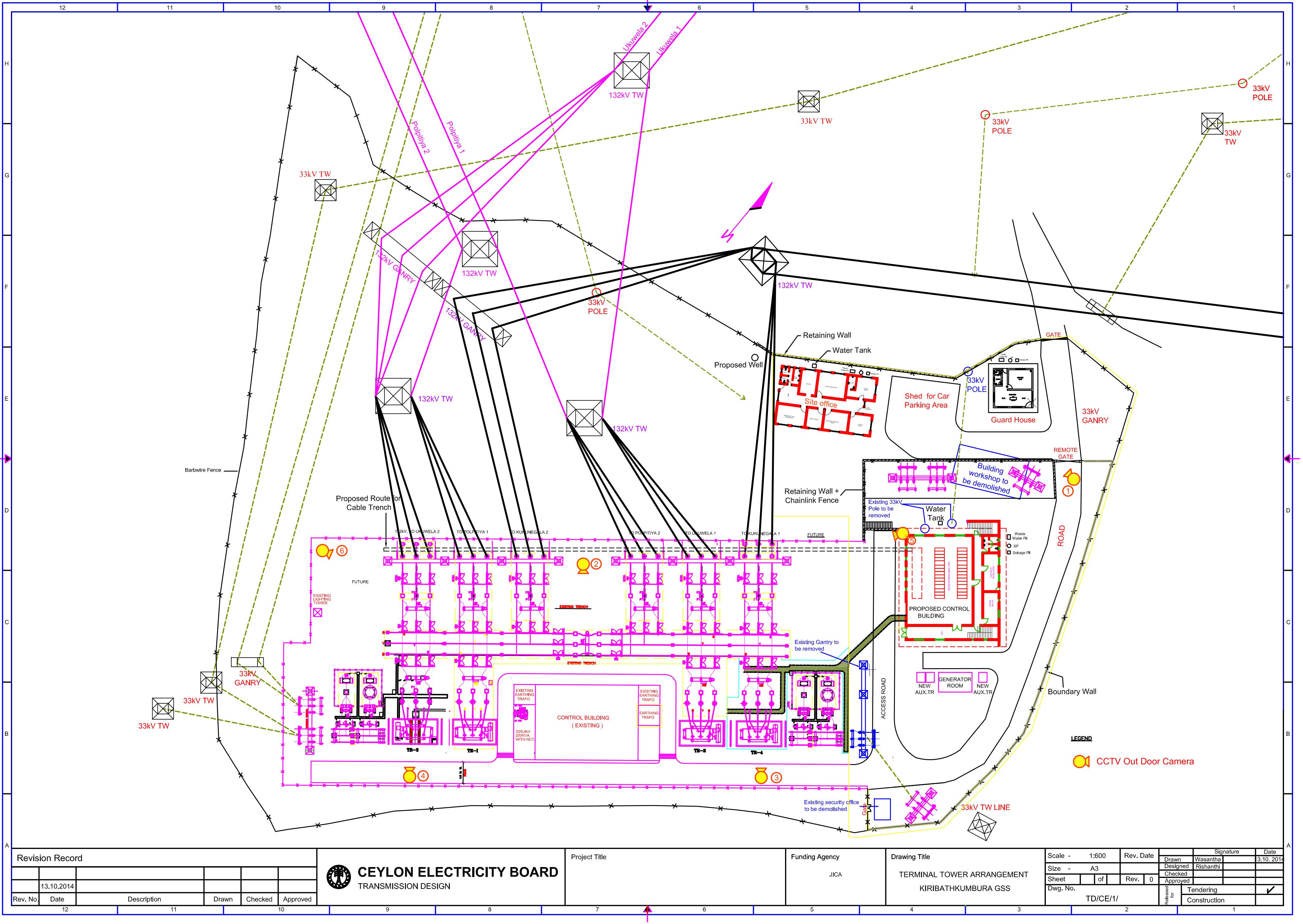
Revision Record					
	31.10.2014		31.10.2014		
Rev. No	Date	Description	Drawn	Checked	Approved

CEYLON ELECTRICITY BOARD
TRANSMISSION DESIGN

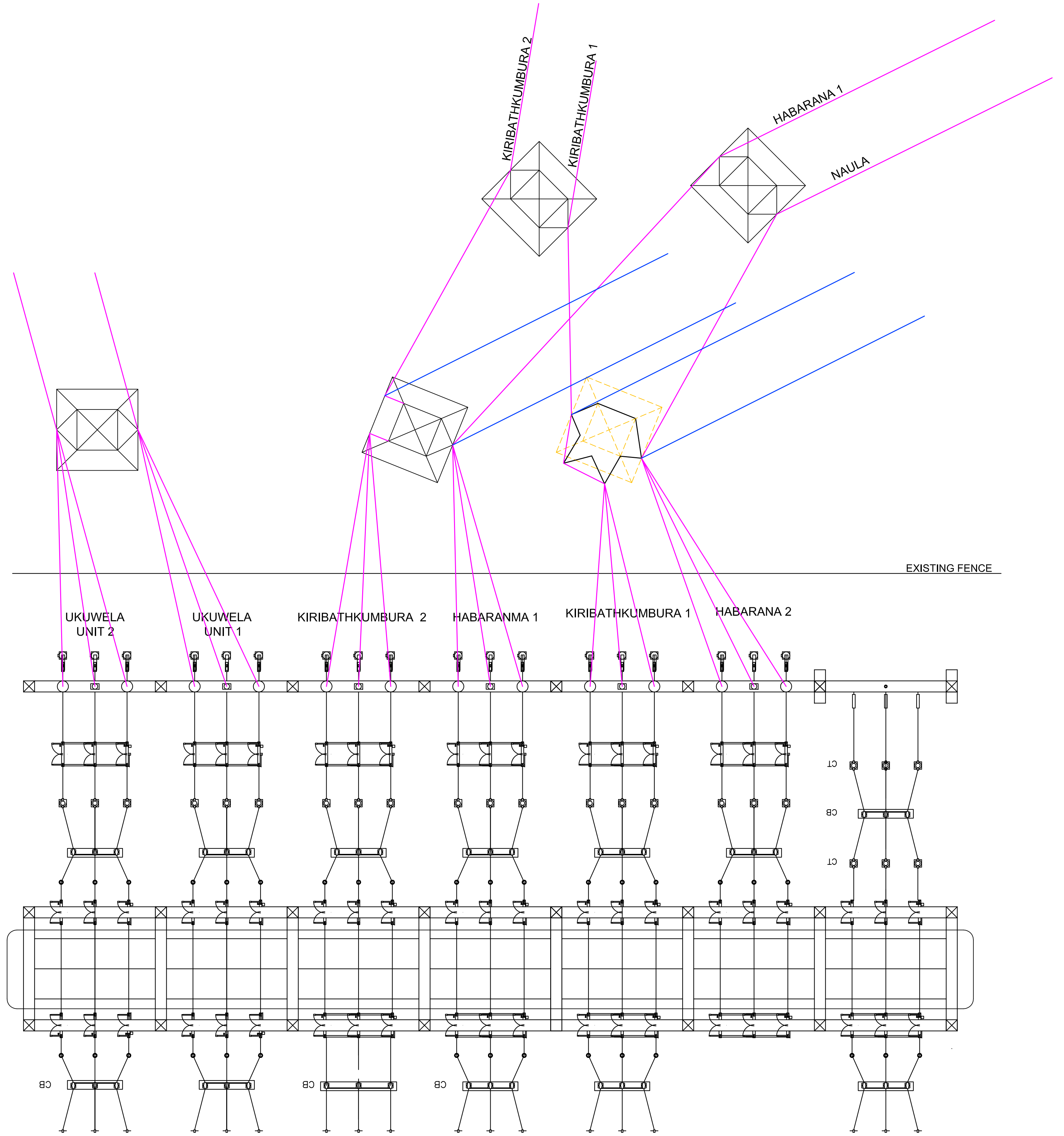
Project Title	Funding Agency	Drawing Title
		LAYOUT FOR KOTMALE GSS

Scale - 1:400	Rev. Date	Drawn	Wasantha 31.10.2014
Size - A3		Designed	Daham
Sheet of	Rev. 0	Checked	
Dwg. No. TD/CE/1/		Approved	
		Released for	Tendering ✓
			Construction

Appendix6-2-12 132/33kV Kiribathkumbura GS



Appendix6-2-13 132/33kV Ukuwela GS



Property of CEB Tr. Design Branch

Revision Record

Rev. No.	Date	Description	Drawn	Checked	Approved
	13.10.2014				

CEYLON ELECTRICITY BOARD
TRANSMISSION DESIGN

Project Title

Funding Agency: JICA

Drawing Title: TERMINAL TOWER ARRANGEMENT UKUWELA GSS

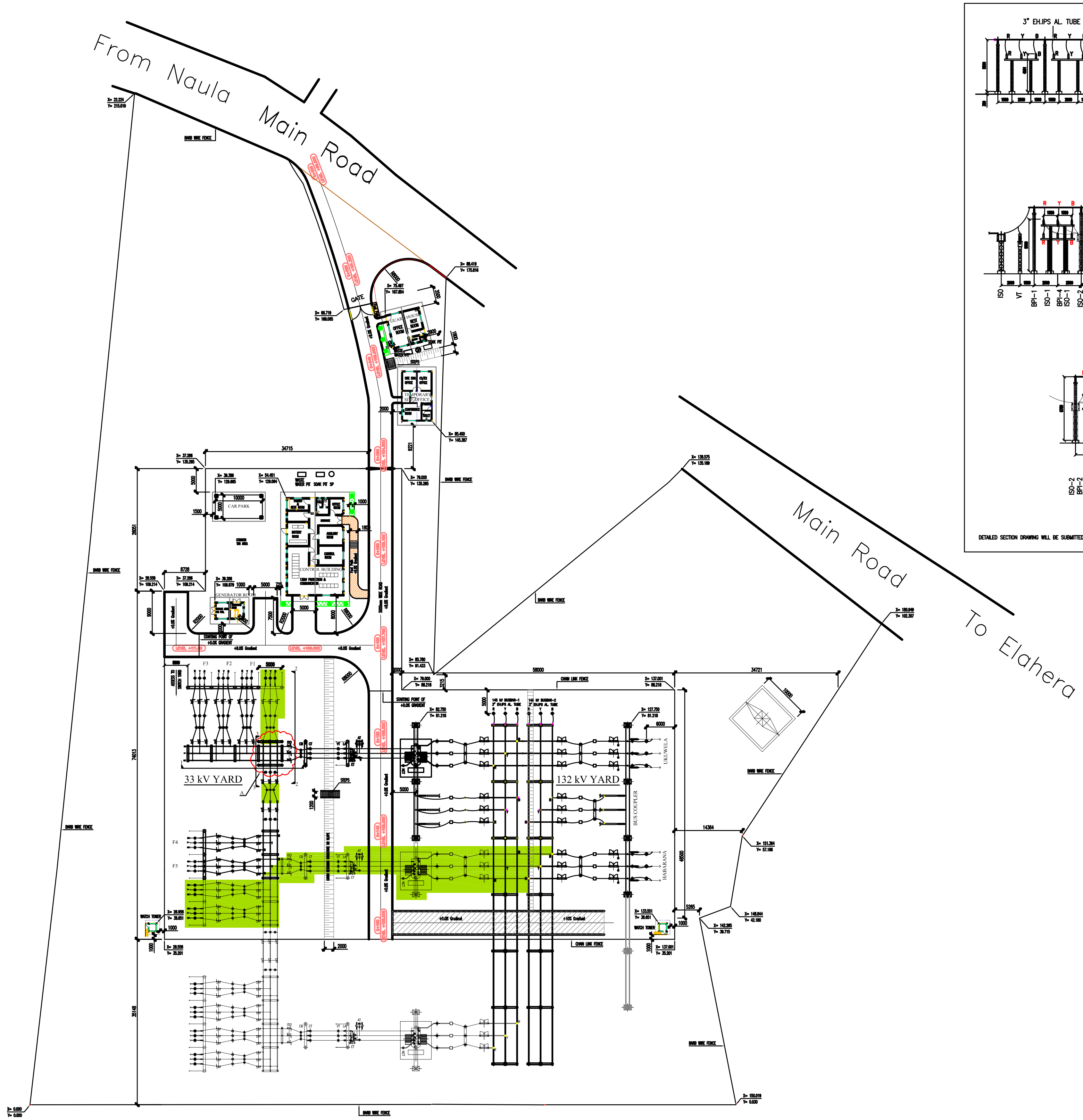
Scale - 1:400
Size - A3
Sheet of
Rev. Date
Rev. 0
Dwg. No. TD/CE/1/

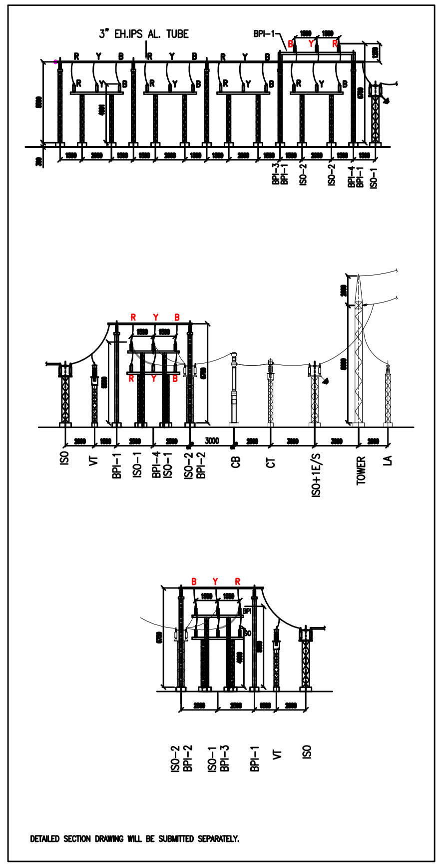
	Signature	Date
Drawn	Wasantha	3.10. 2014
Designed	Rishanthi	
Checked		
Approved		

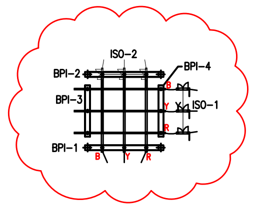
Released for: Tendering ✓ / Construction

1:500 SCALE A0 DRG.

Appendix6-2-14 132/33kV Naula GS







(1) ALL DIMENSIONS ARE IN mm. UNLESS OTHERWISE SPECIFIED.
(2) THE CHAINAGES & ROAD LEVELS ARE GIVEN IN METERS
(3) FINISHED GROUND LEVEL WILL BE ACCORDING TO THE DRAWING NUMBER P40251-02-7003
(4) ALL COORDINATES ARE GIVEN IN METERS
(5) DETAILS OF CONTROL BUILDING, GUARD ROOM, GENERATOR ROOM & WATCH TOWER WILL BE GIVEN IN ARCHITECTURAL DRAWINGS.
(6) DETAILS OF EARTH RETAINING STRUCTURES & SLOPE WILL BE GIVEN SEPARATELY
(7) REVISED SURVEY PLAN IS INCORPORATED & WILL SUBMIT SEPARATELY.

CENTRE LINE
BARB WIRE FENCE
CHAIN LINK FENCE

Under ADB Project

Revision Record

Rev. No.	Date	Description	Drawn	Checked	Approved

CEYLON ELECTRICITY BOARD
TRANSMISSION DESIGN

Project Title

Funding Agency

Drawing Title
LAYOUT FOR NUALA GSS

Scale -	1:1000	Rev. Date	
Size -	A3	26.12.2013	
Sheet	of	Rev.	0
Dwg. No.	TD/CE/1/67/D/01/02		

	Signature	Date
Drawn		26.12.2013
Designed	Rasika	
Checked		
Approved		

Released for: Tendering ✓ / Construction

Revision Record

Rev. No.	Date	Description	Drawn	Checked	Approved

CEYLON ELECTRICITY BOARD
TRANSMISSION DESIGN

Project Title: *NEW HABARANA SWITCHING STATION*

Funding Agency: CEB

Drawing Title: PROPOSED LAYOUT FOR NEW HABARANA GSS

Scale -	1:1000	Rev. Date	
Size -	A3	02.10.2012	
Sheet	02 of 02	Rev.	0
Dwg. No.	TD/CE/1/95/D/01/01		

	Signature	Date
Drawn	Wasantha	02.10.2012
Designed	Upeka	
Checked		
Approved		

Released for		
Tendering	✓	
Construction		

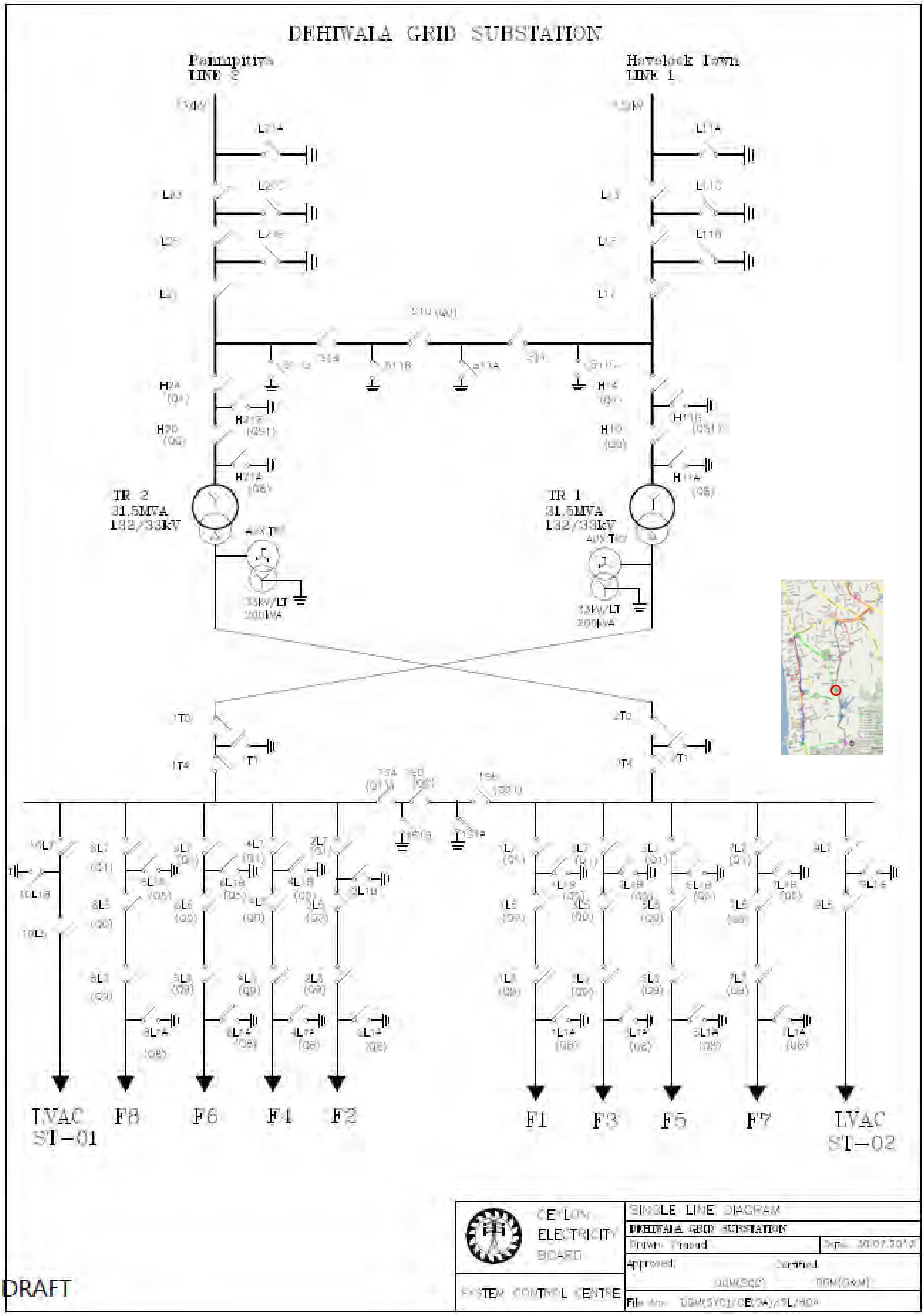
Appendix 7

Single Line Diagram, Layout and Others for Distribution

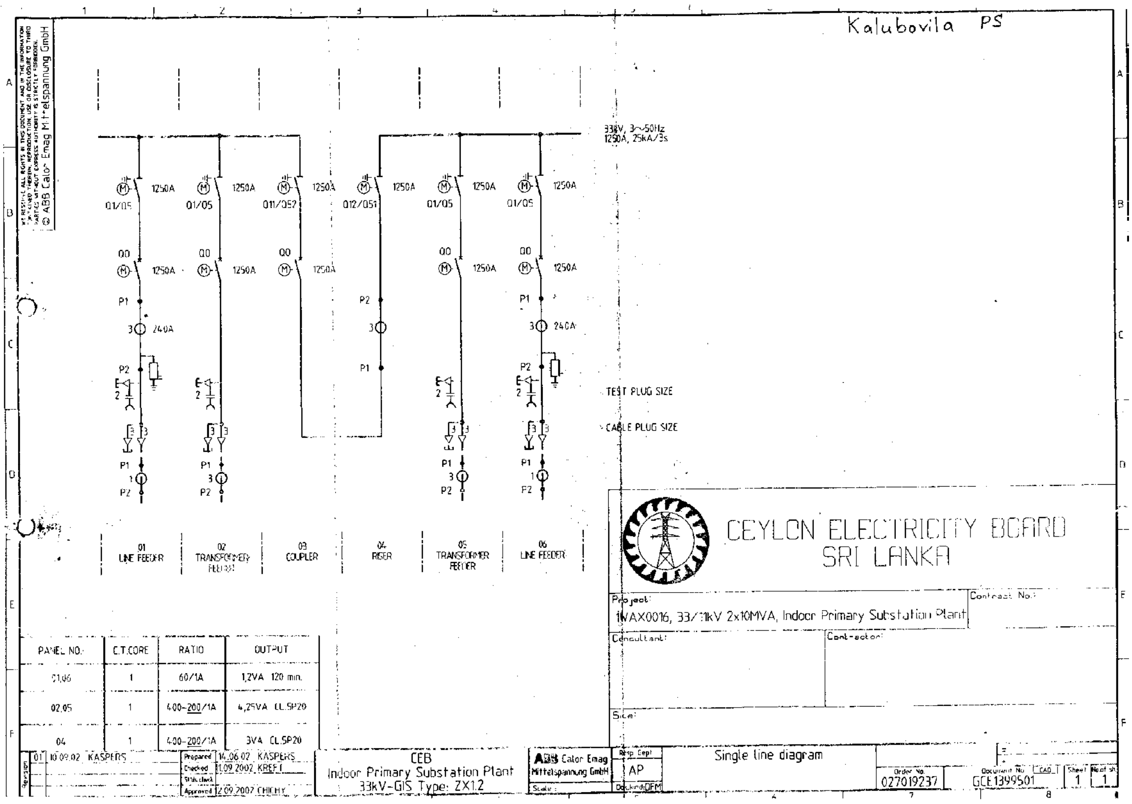
Appendix 7-1 Single Line Diagram of PSS & RSS and Cable for Distribution

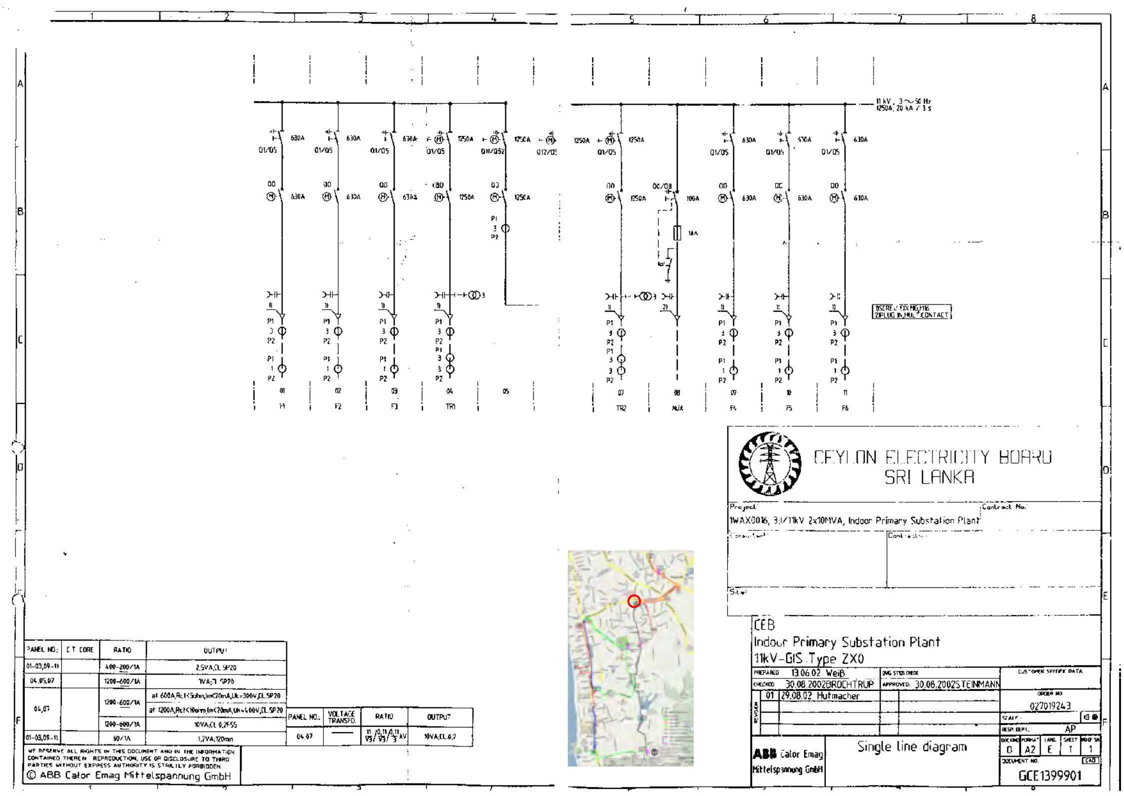
Appendix 7-1-1 PSS & RSS Single Line Diagram for Distribution line

Project 8 (CEB DD9)

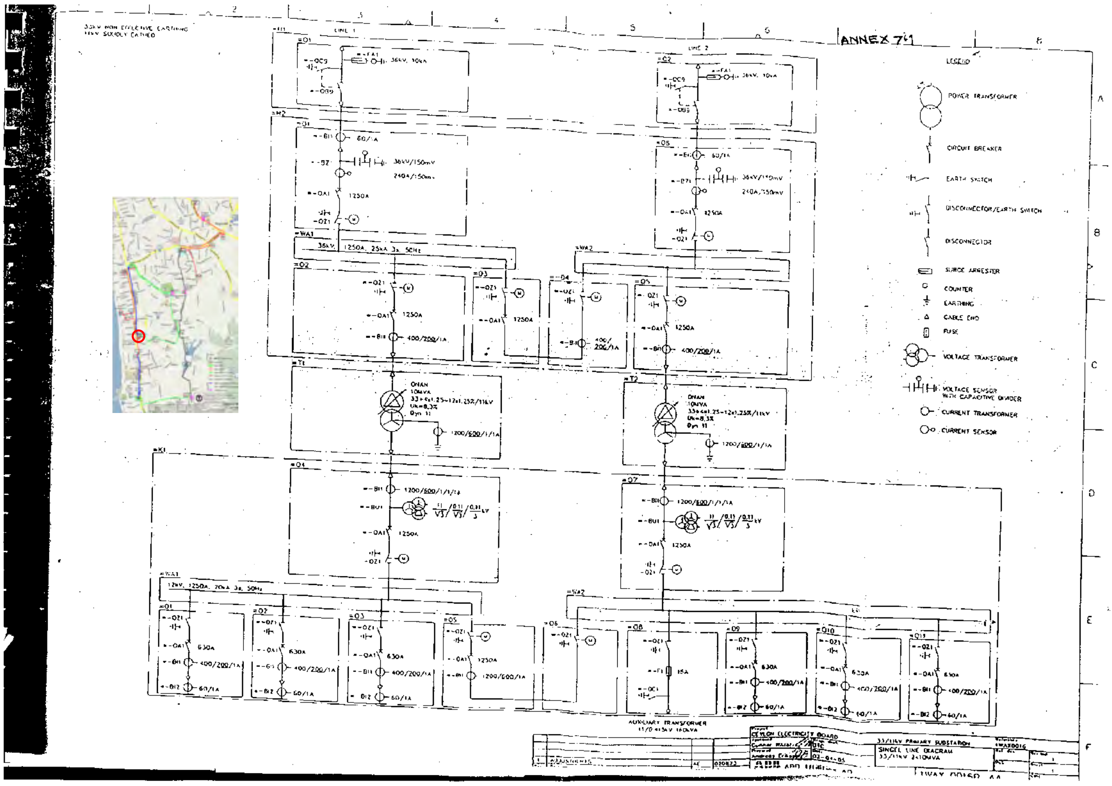


Dehiwara GSS



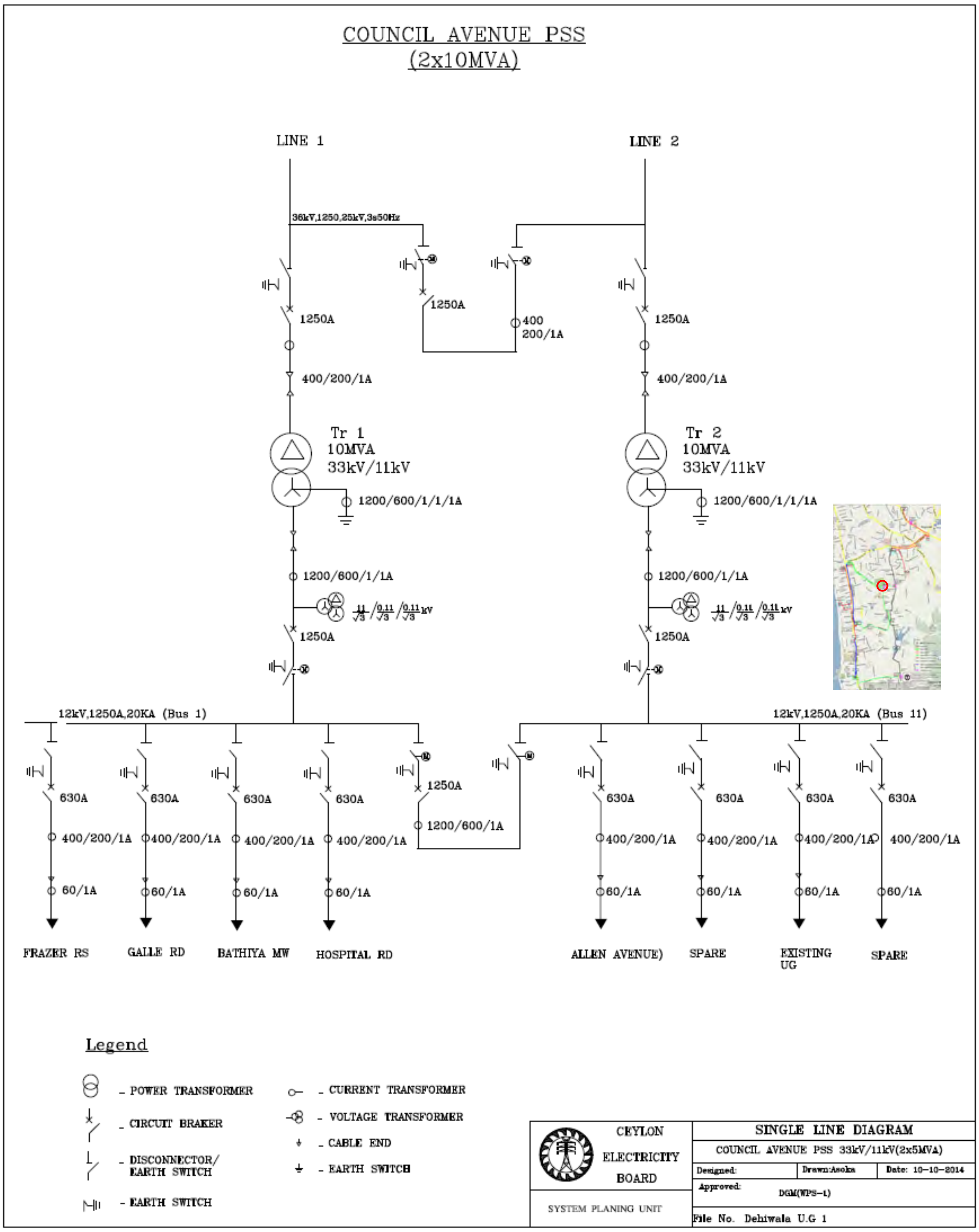


Kslubowila PSS(Upper side: 33 kV, Lower side: 11 KV)

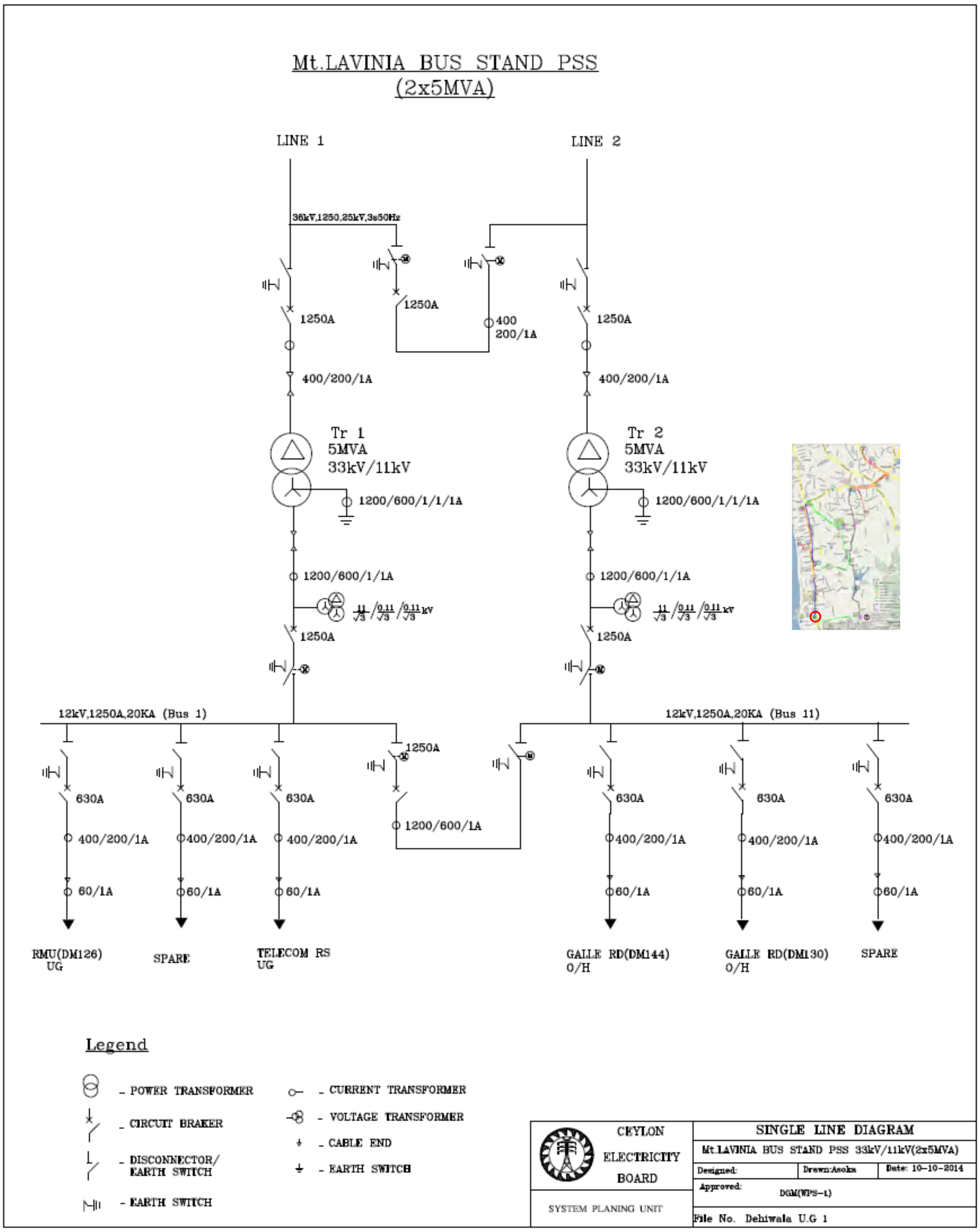


Dehiwala PSS

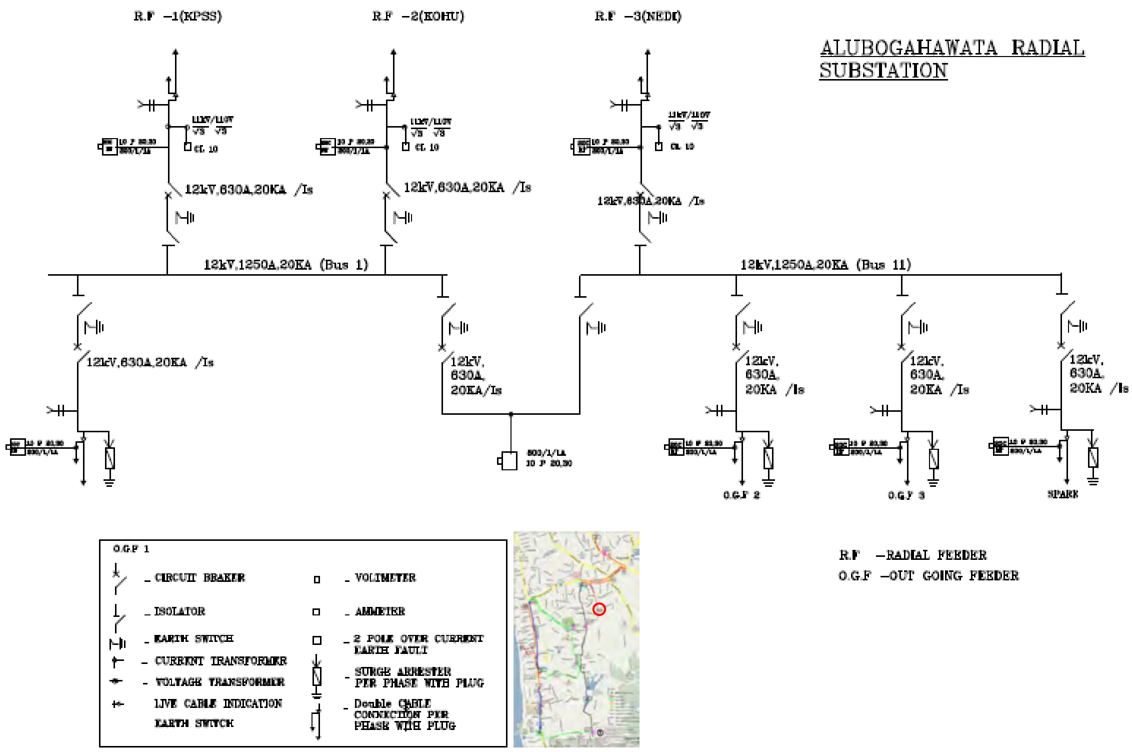
Kirulapana PSS (CEB Colombo City Office) Not available



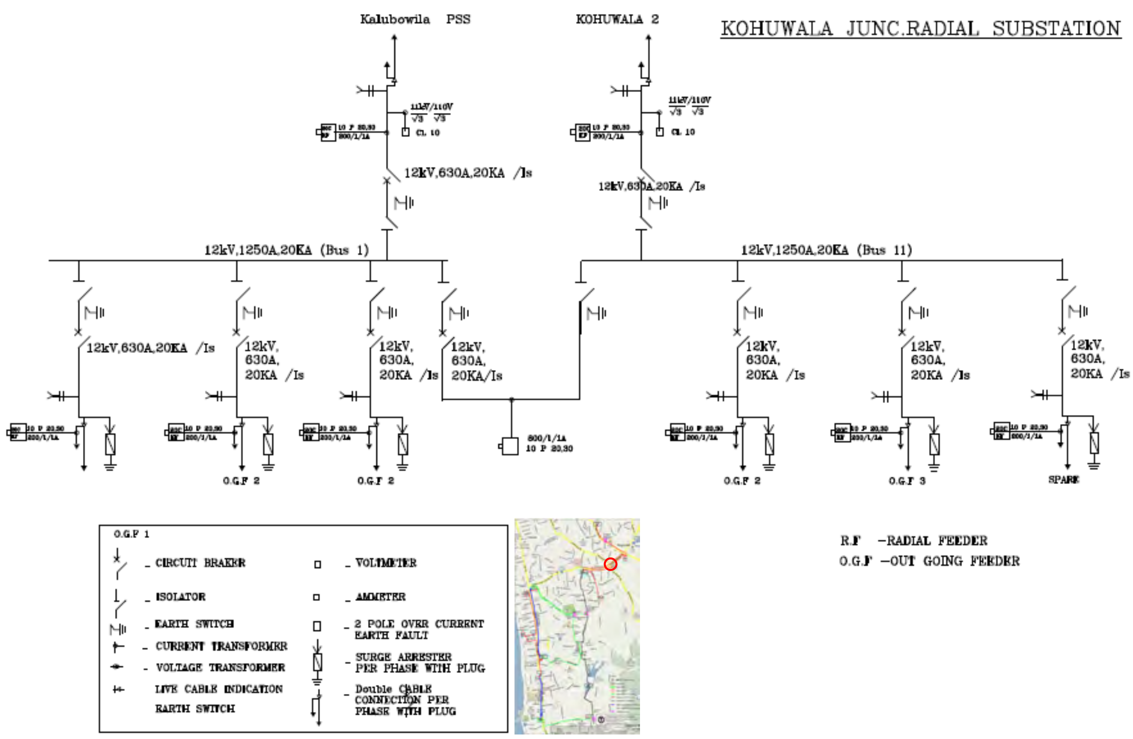
Council lane PSS (Proposed)



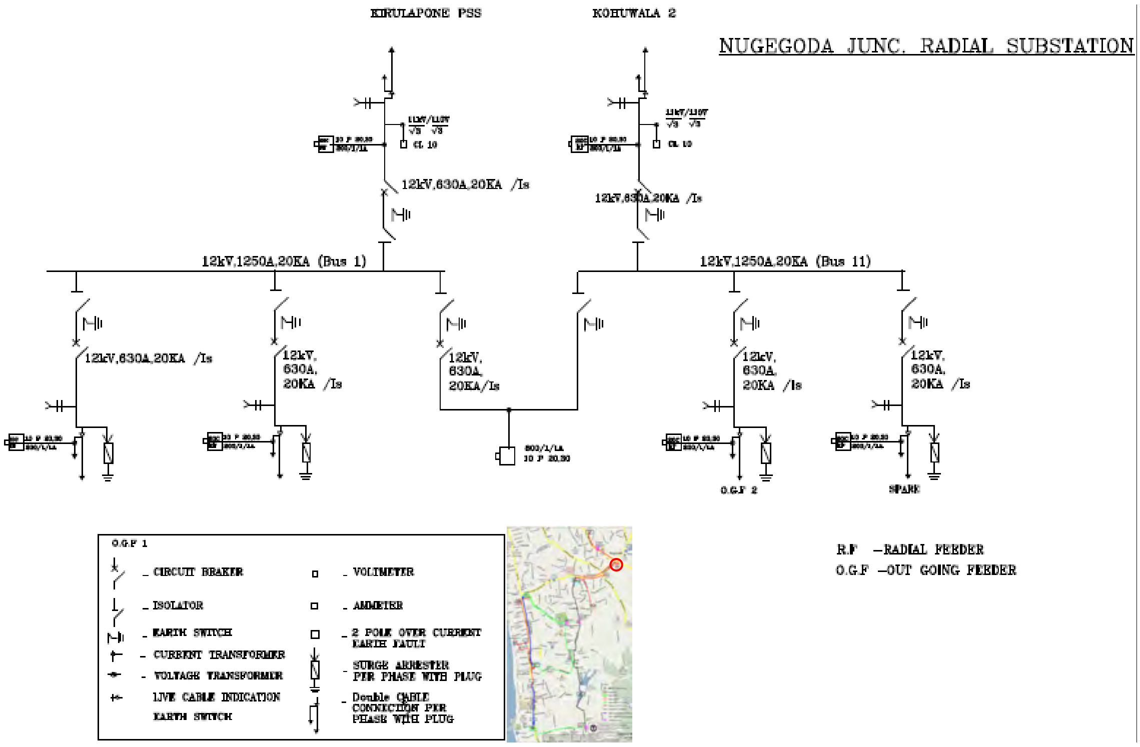
Mt. Lavinia Bus Station PSS (Proposed)



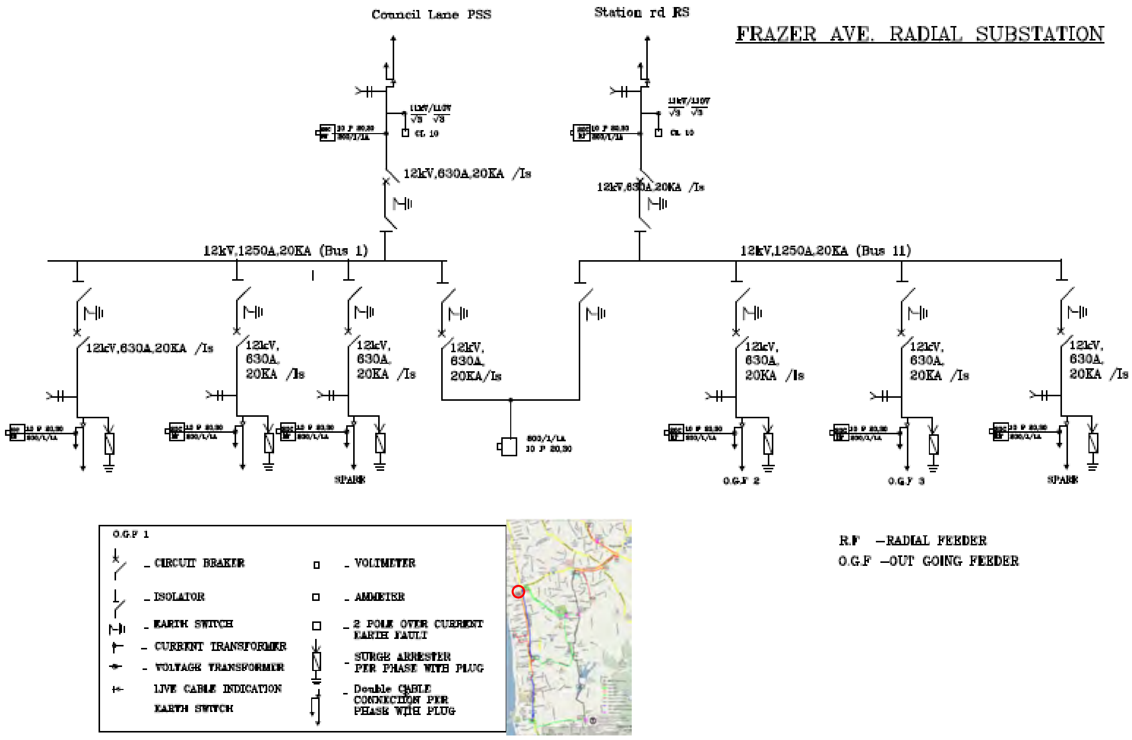
Alubogahawata RSS



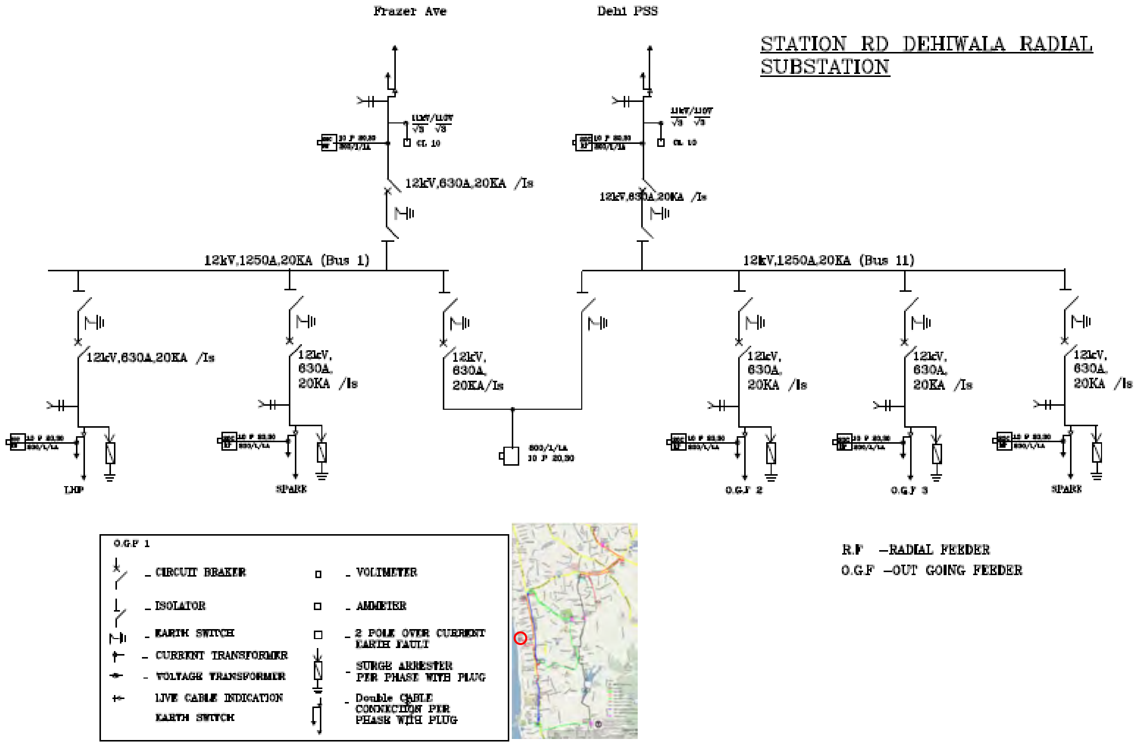
Kohuwala 1 RSS



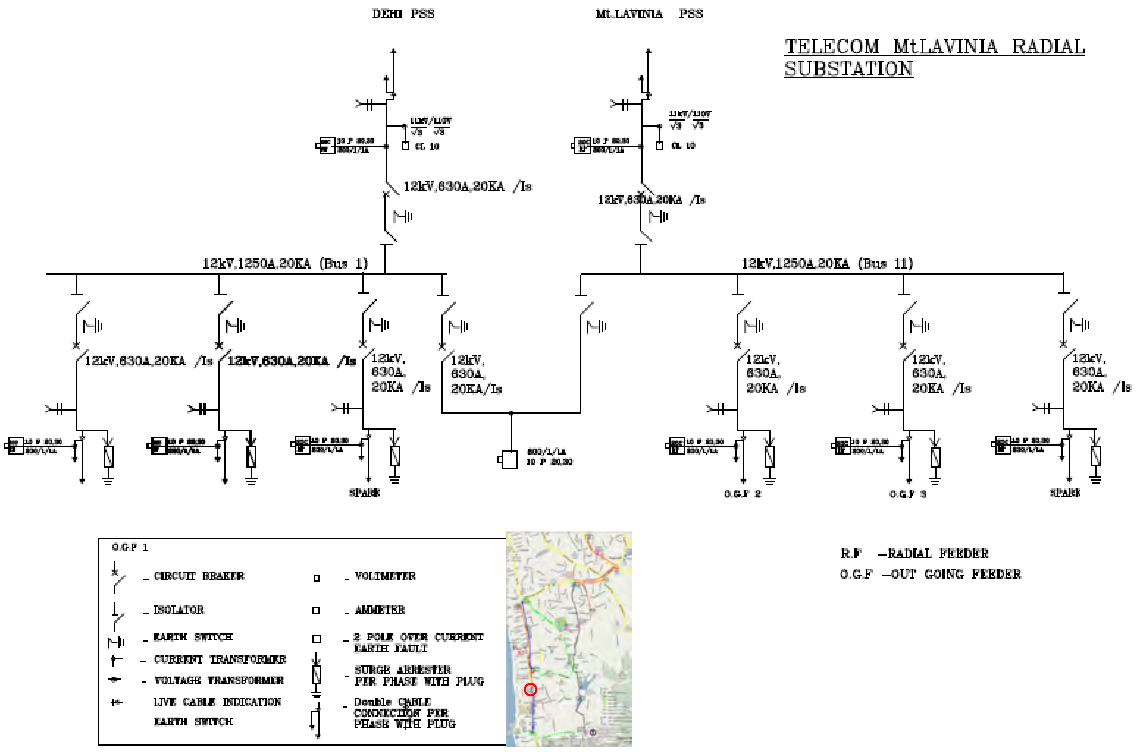
Kohuwala 2 (NUGEGODA JUNC.) RSS



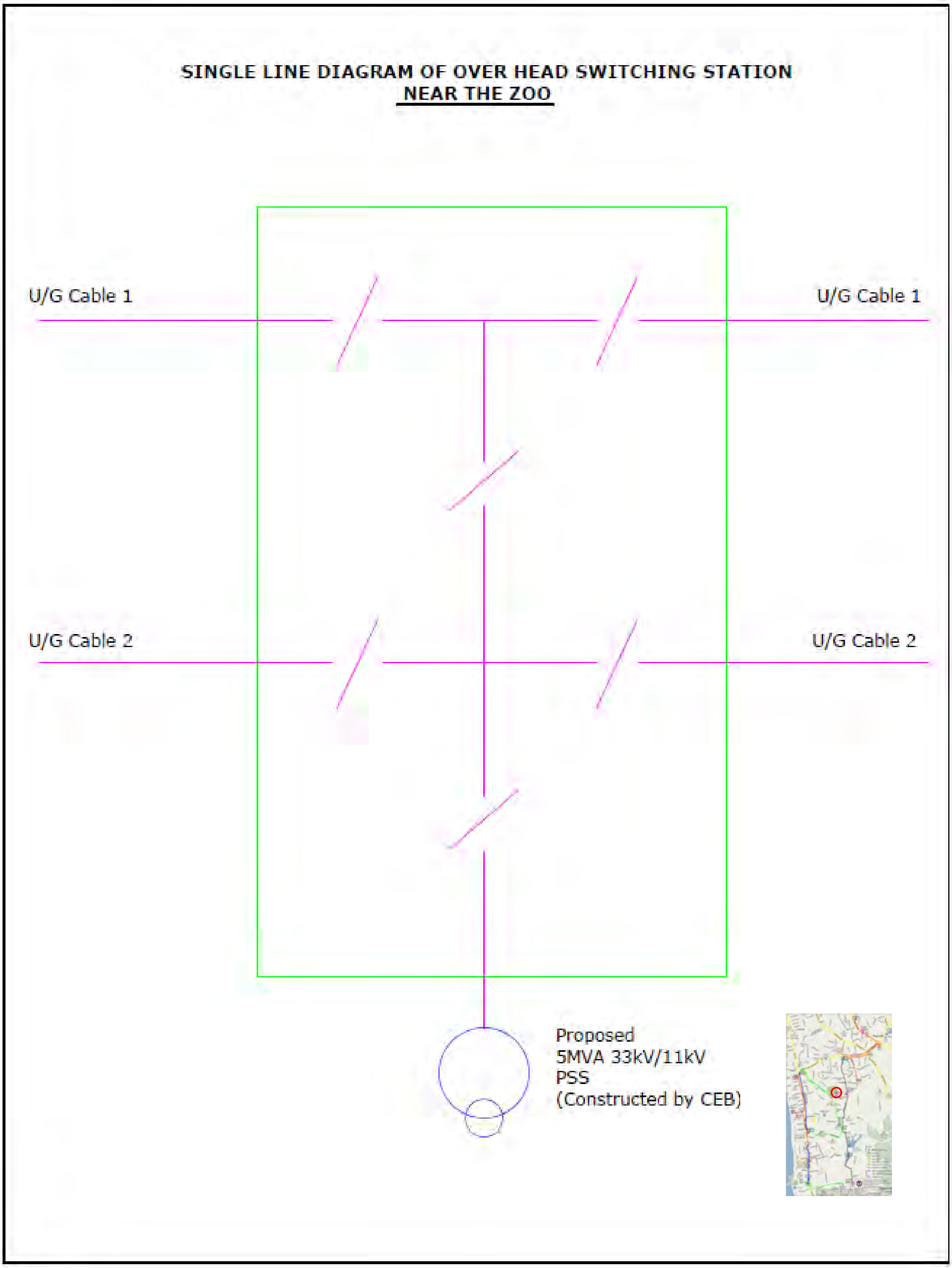
Frazer Avenue RSS



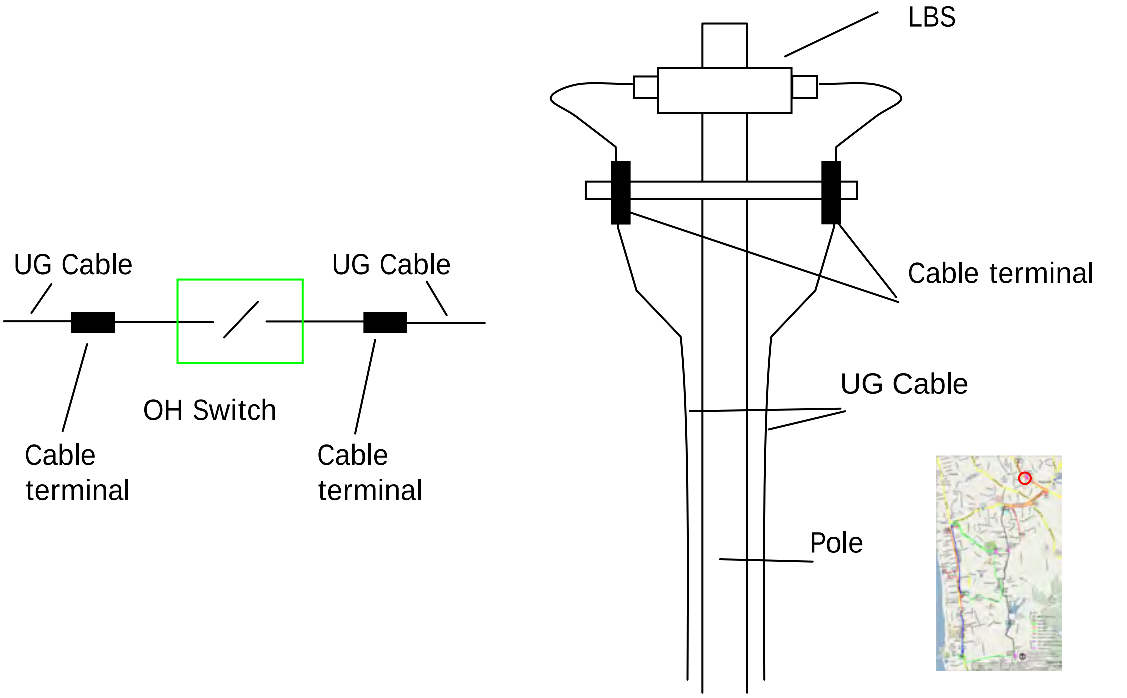
Station Road RSS



Telecom RSS

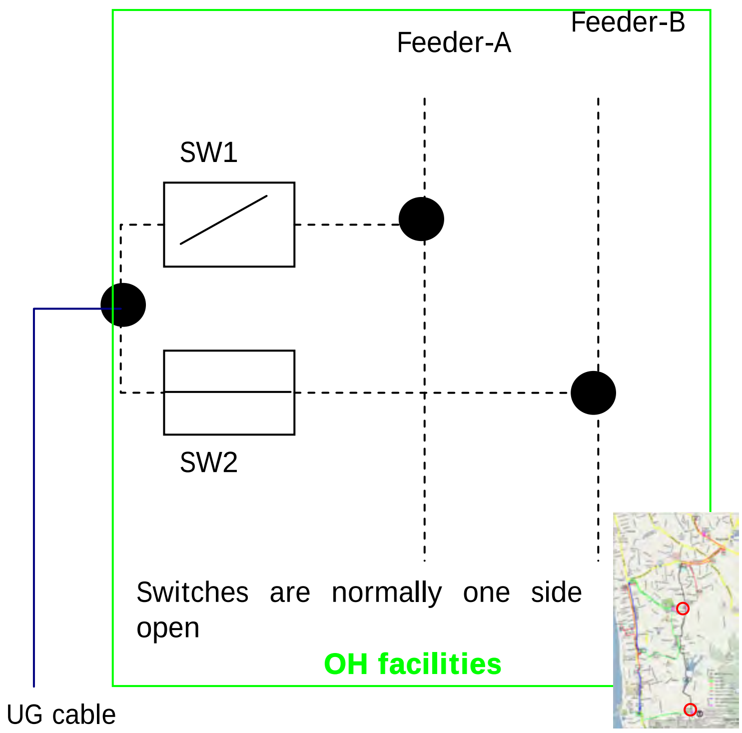


Switching Station near the Zoo (will install top of the pole)



(Designed by JICA Study Team based on the interviews to CEB)

Switching station design between kirulapana PSS to kohuwala 2 RSS (Tentative).

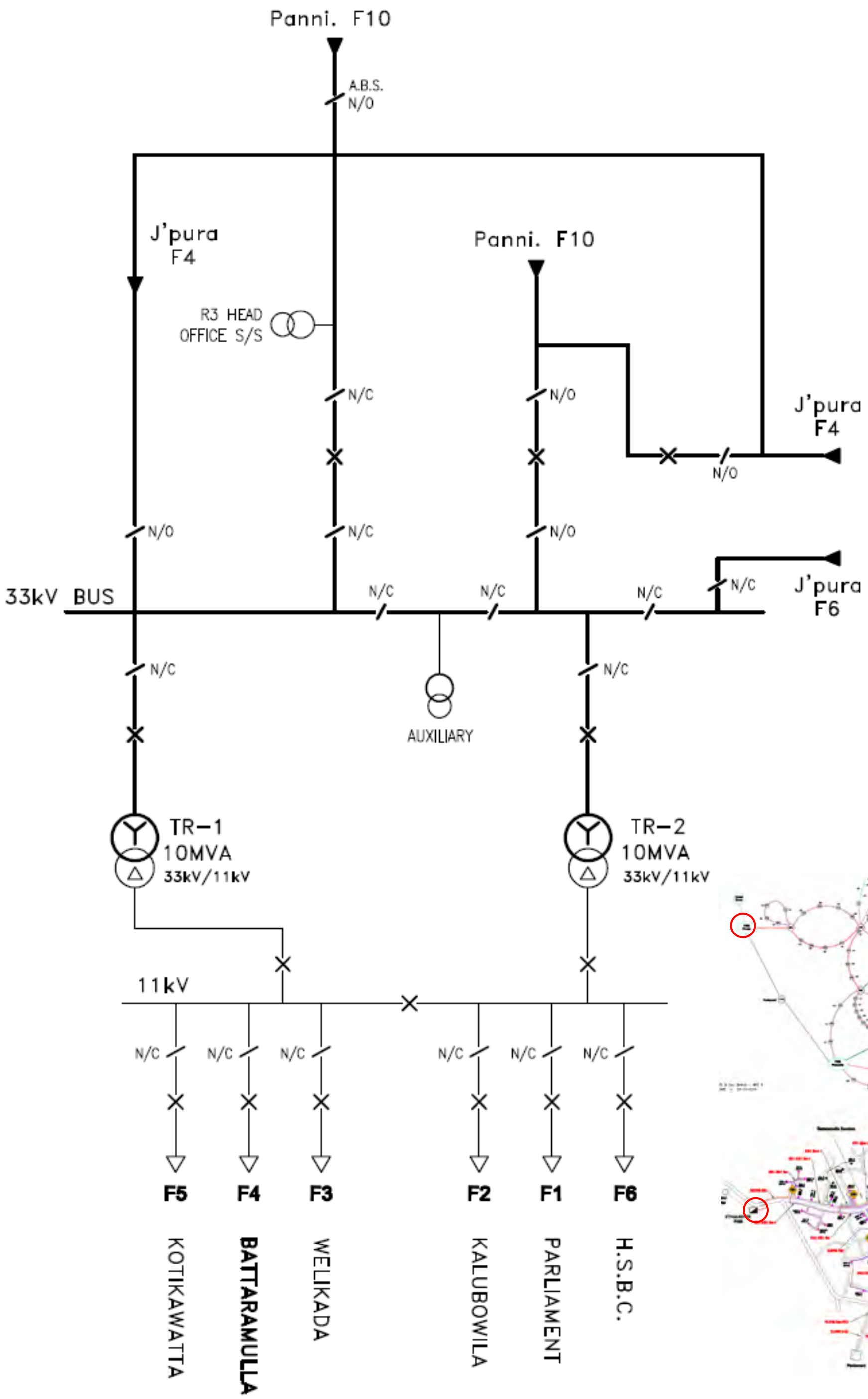


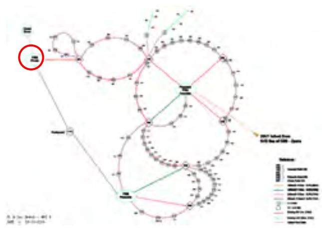
(Designed by JICA Study Team based on the interviews to CEB)

Design of UG cable connection (tapping) point to the OH line (Tentative).

Project 9 (CEB DD8)

CONNECTION DIAGRAM OF ETHULKOTTE PRIMARY SUBSTATION



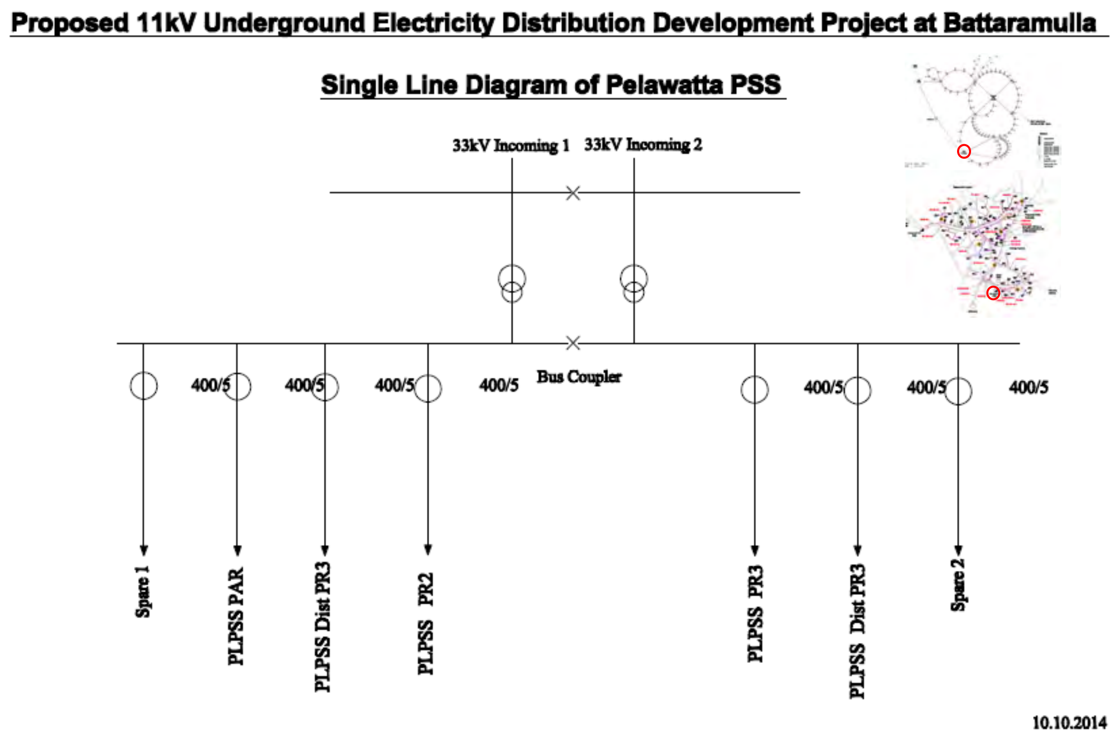


Note :-

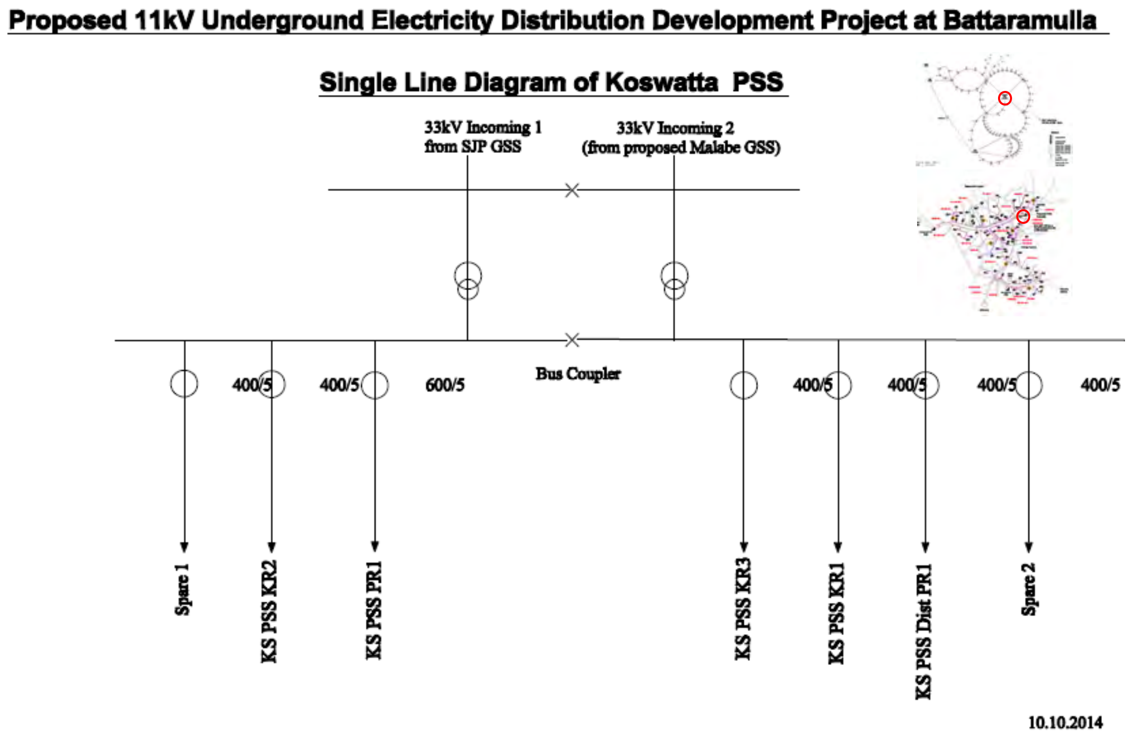
Only the feeder No.04 (towards Battaramulla) which will be connected to ER1 is considered under the project

Pl. & Dev. BRANCH
WPS II
27-01-2014

Ethulkotte PSS



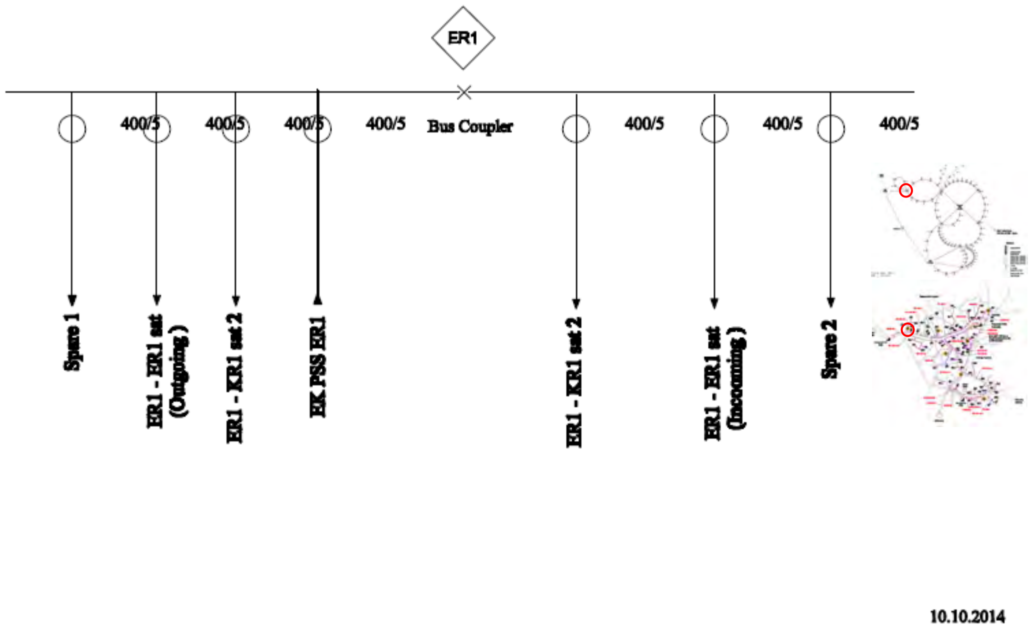
Palawatta PSS



Koswatta PSS (Proposed)

Proposed 11kV Underground Electricity Distribution Development Project at Battaramulla

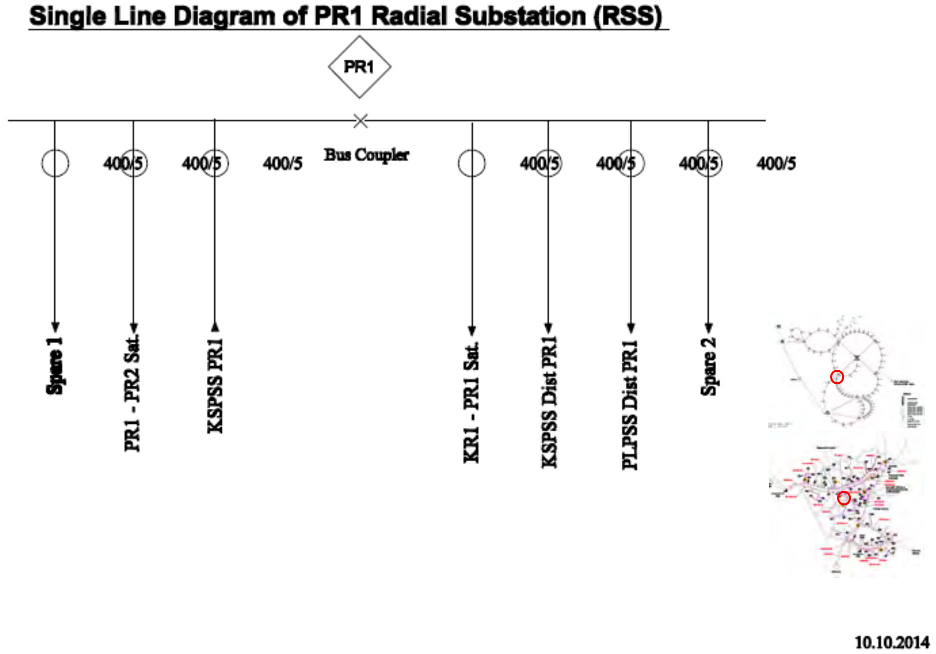
Single Line Diagram of ER1 Radial Substation (RSS)



ER1 RSS

Proposed 11kV Underground Electricity Distribution Development Project at Battaramulla

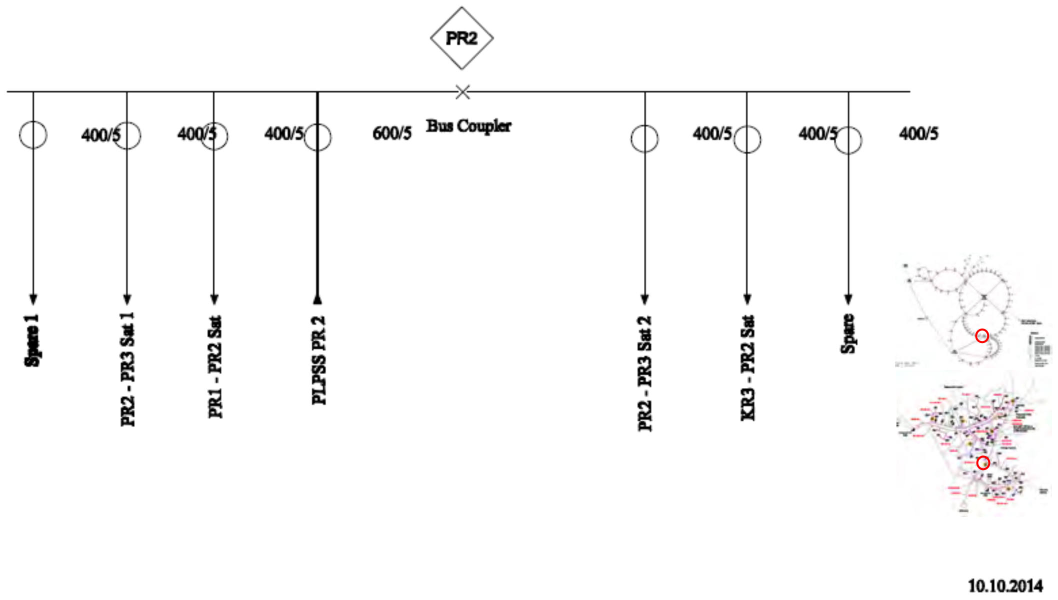
Single Line Diagram of PR1 Radial Substation (RSS)



PR1 RSS

Proposed 11kV Underground Electricity Distribution Development Project at Battaramulla

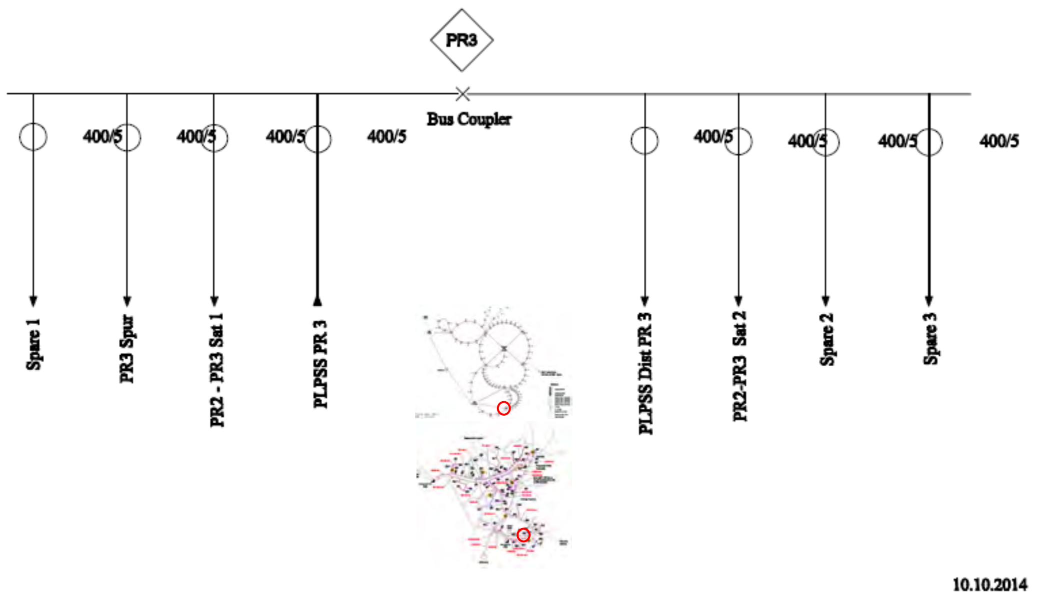
Single Line Diagram of PR2 Radial Substation (RSS)



PR2 RSS

Proposed 11kV Underground Electricity Distribution Development Project at Battaramulla

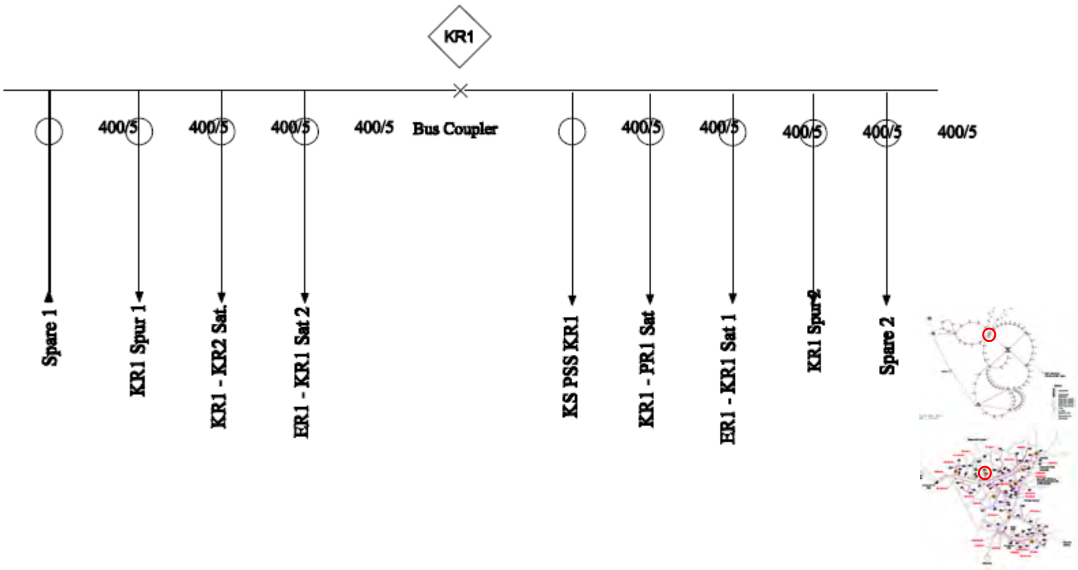
Single Line Diagram of PR3 Radial Substation (RSS)



PR3 RSS

Proposed 11kV Underground Electricity Distribution Development Project at Battaramulla

Single Line Diagram of KR1 Radial Substation (RSS)

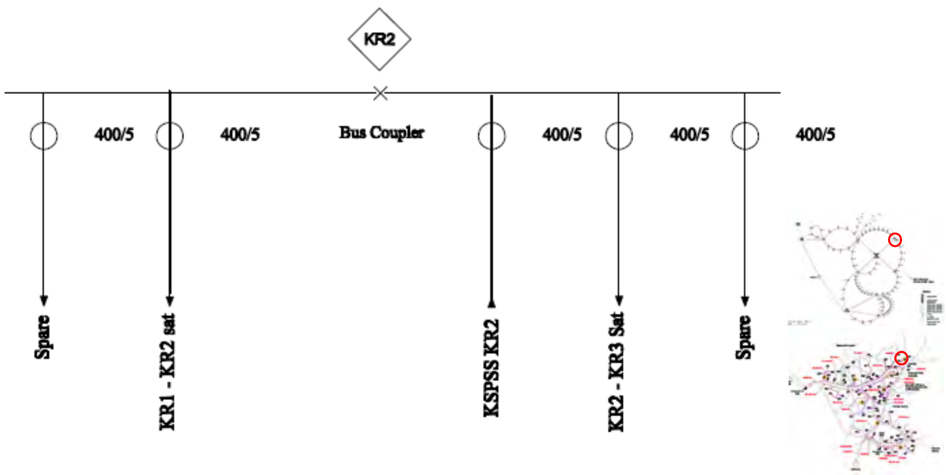


10.10.2014

KR1 RSS

Proposed 11kV Underground Electricity Distribution Development Project at Battaramulla

Single Line Diagram of KR2 Radial Substation (RSS)

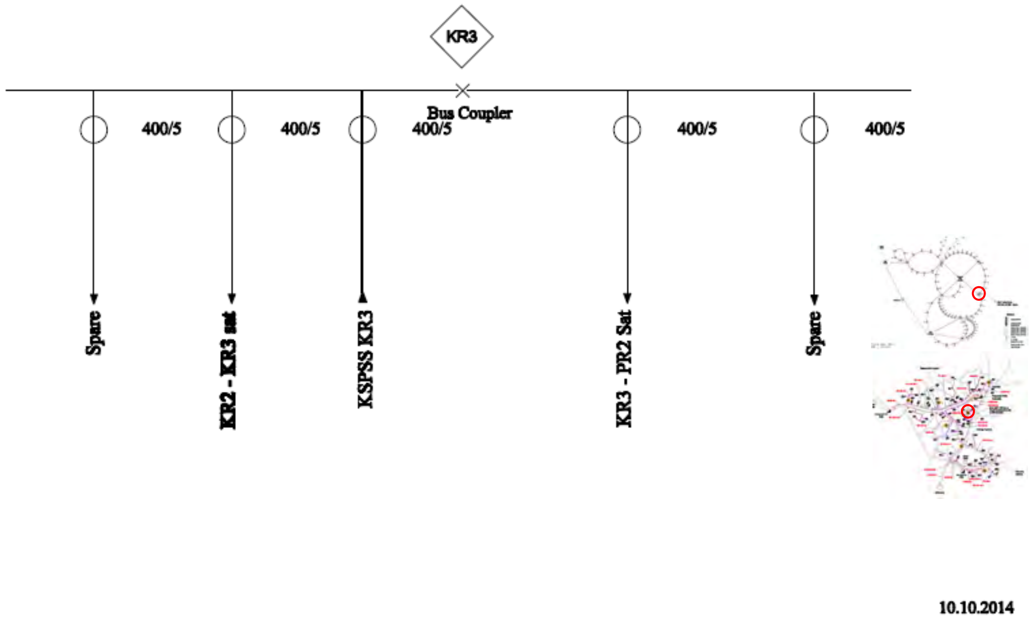


10.10.2014

KR2 RSS

Proposed 11kV Underground Electricity Distribution Development Project at Battaramulla

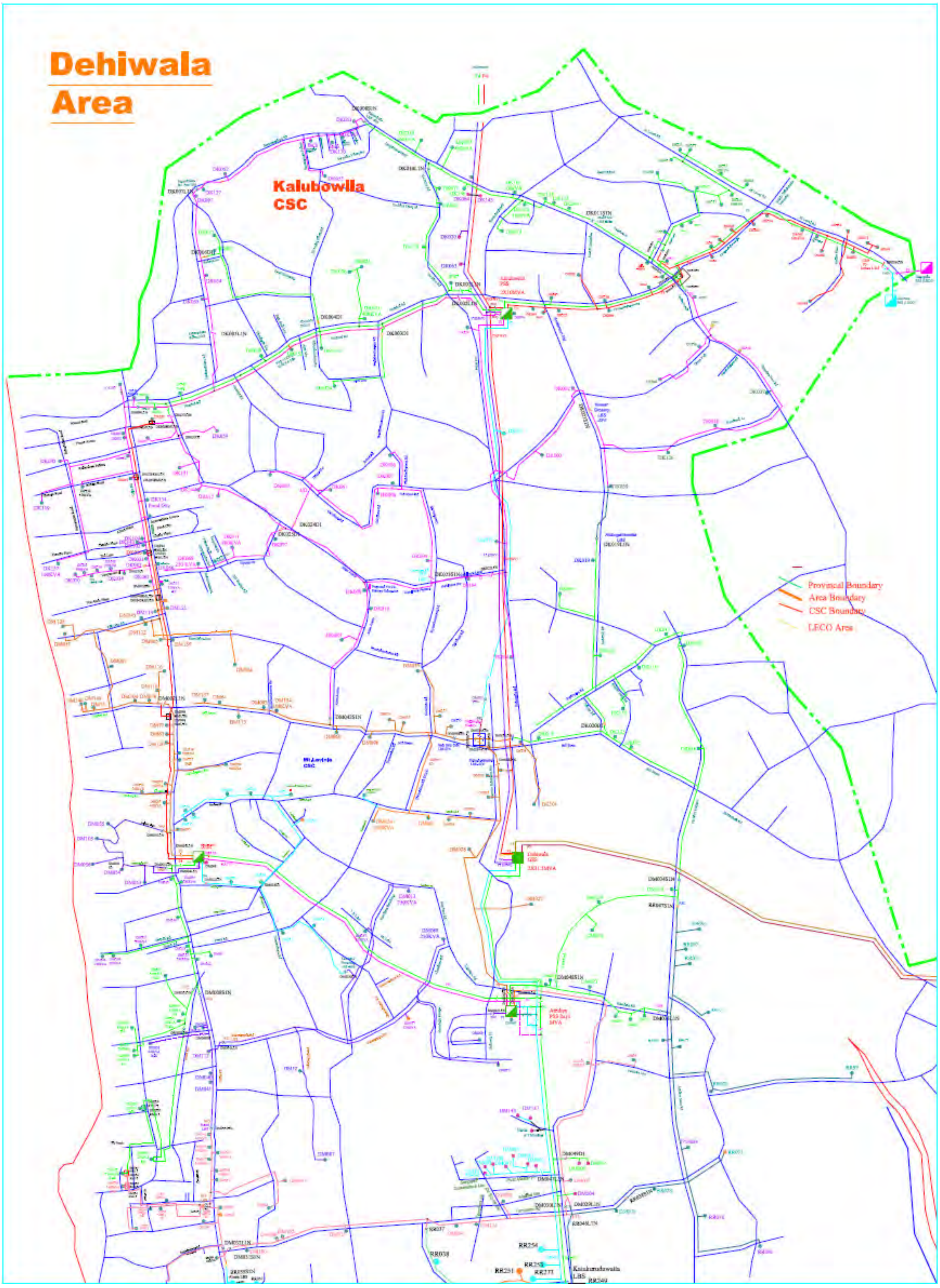
Single Line Diagram of KR3 Radial Substation (RSS)



KR3 RSS

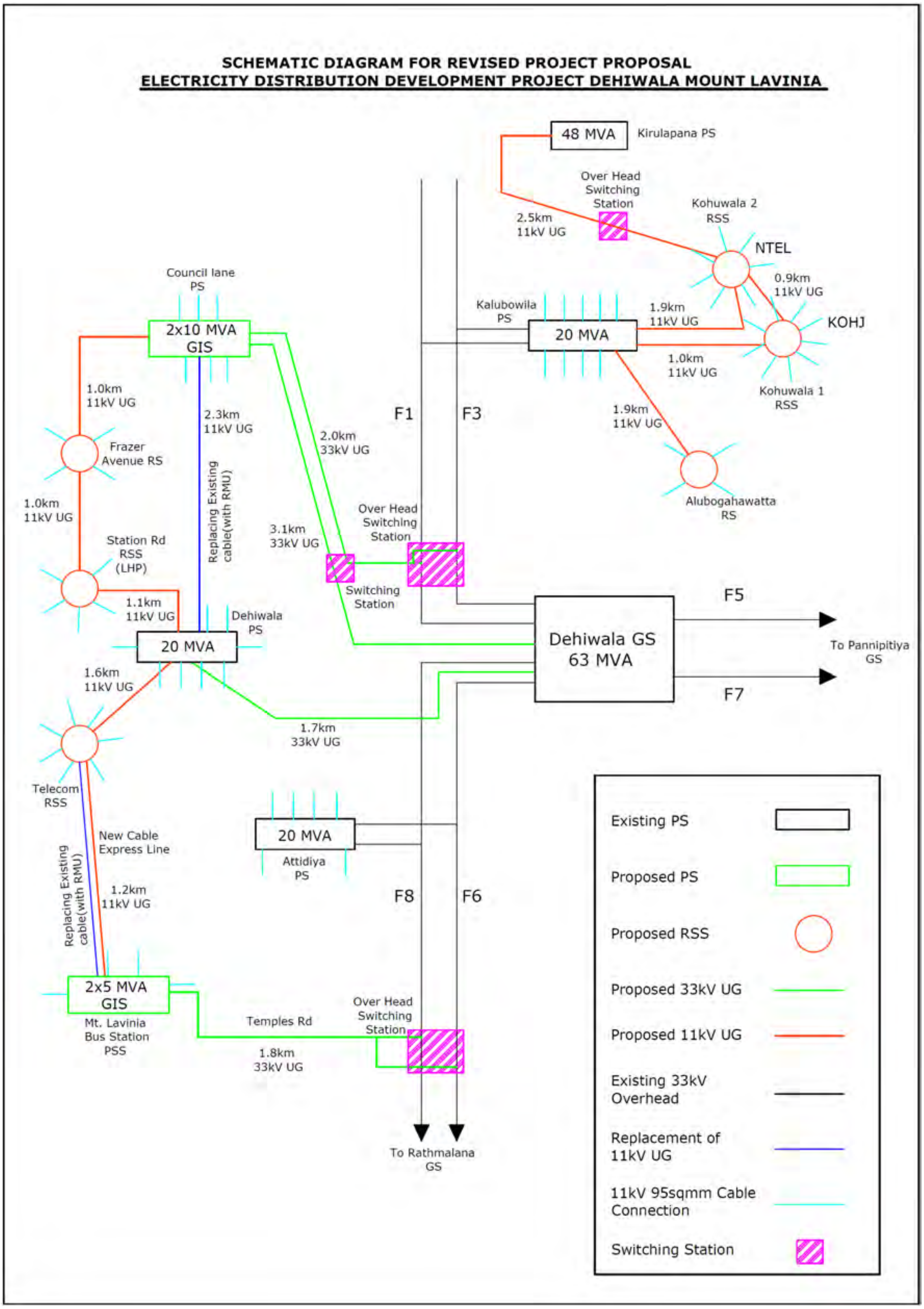
Appendix 7-1-2 Single line diagram of MV distribution line and optical fiber cable

1. Project 8 (CEB DD4) area

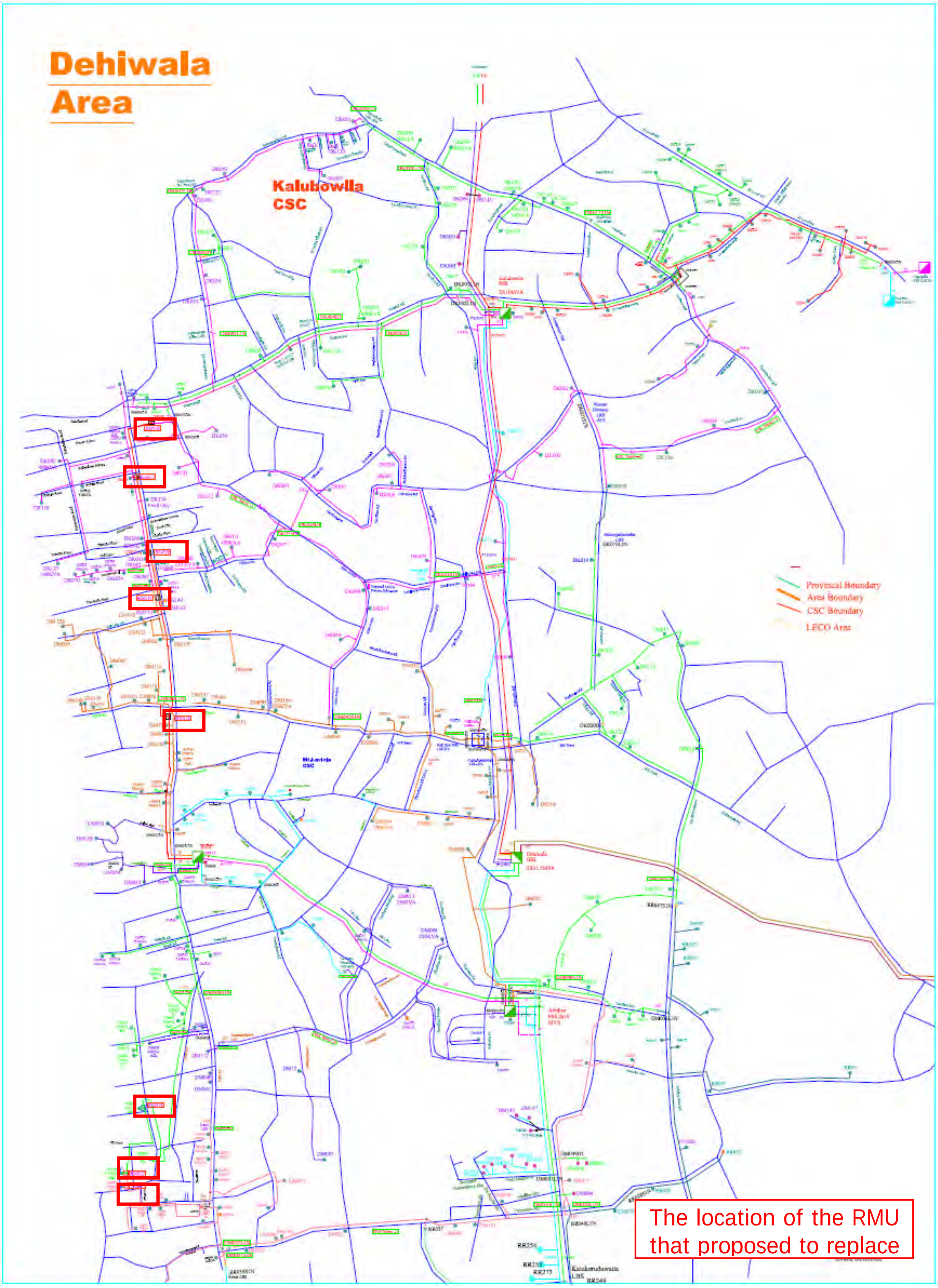


Existing MV distribution line.

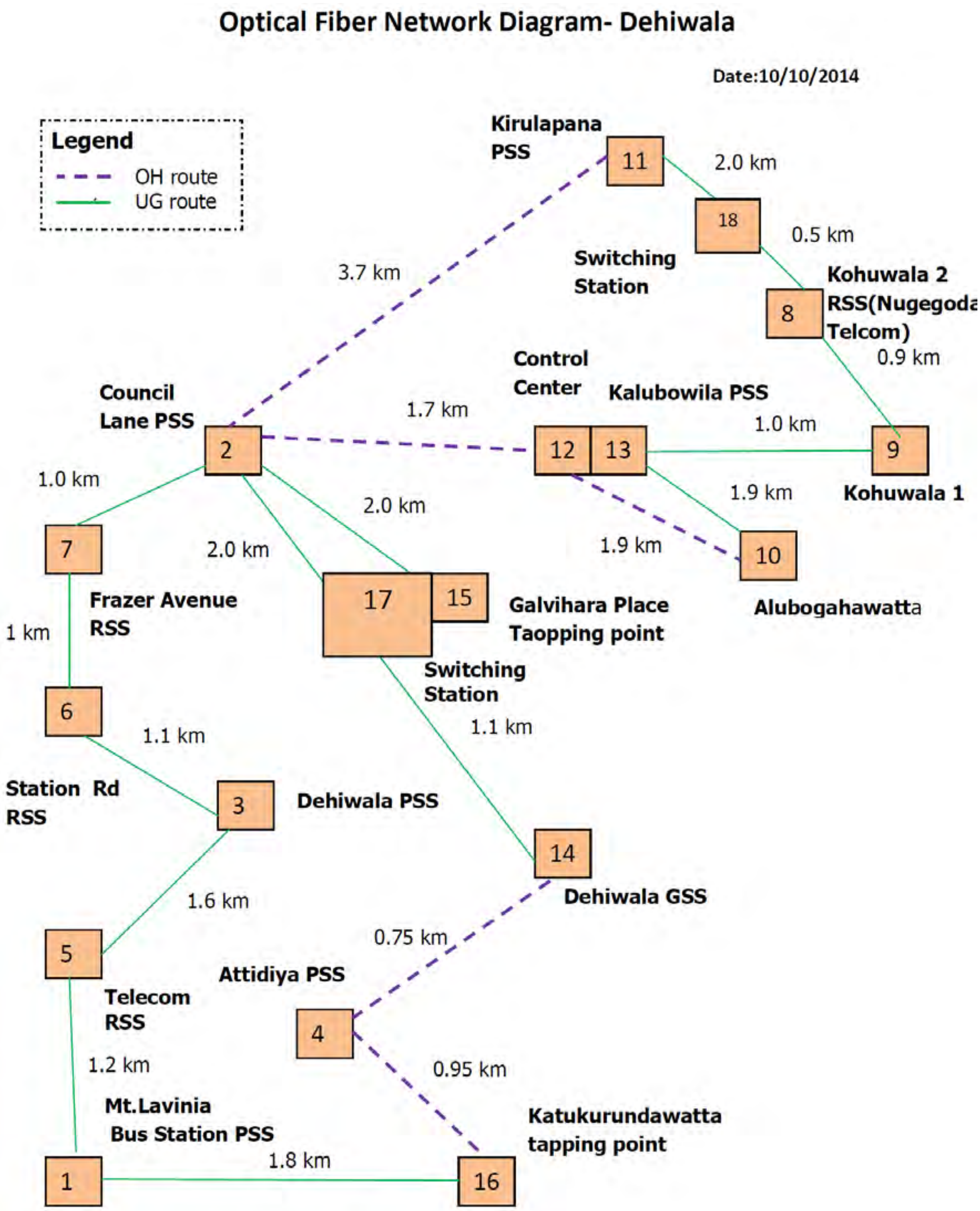
Design of the single line diagram on GIS map of Project 8.



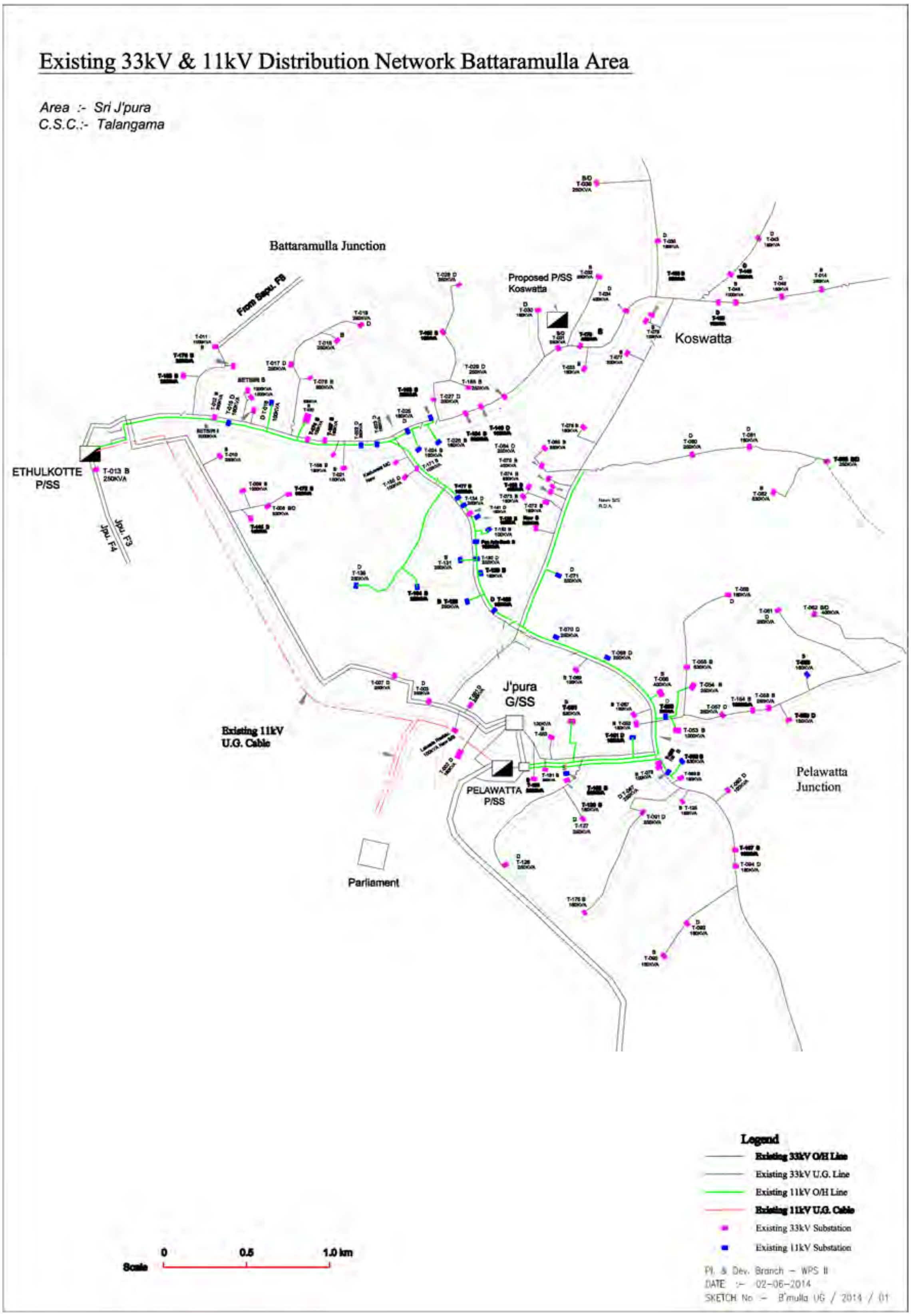
Schematic single line diagram design of the project of project 8



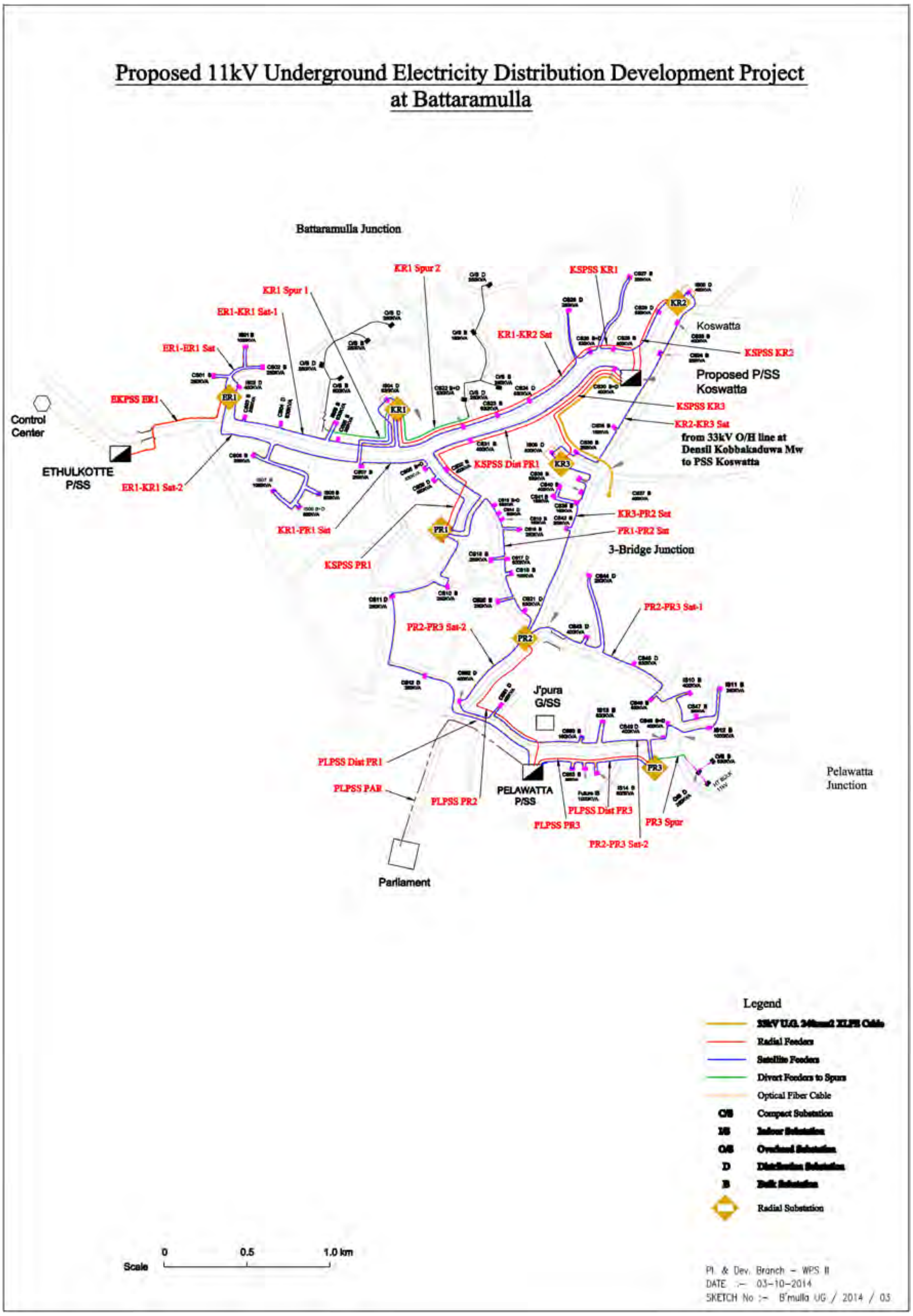
Locations of the proposed replaced old RMU.



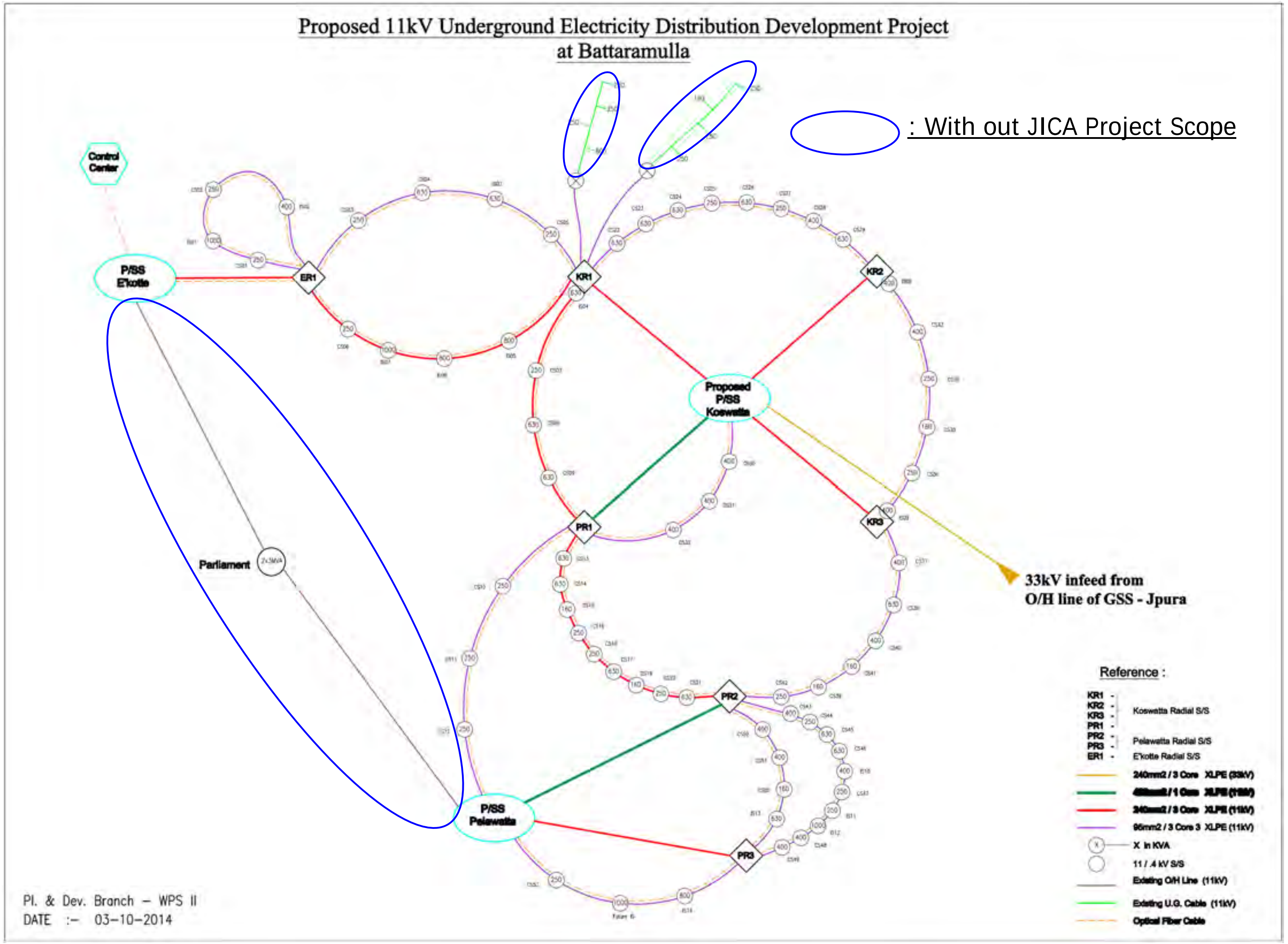
Proposed optical fiber network diagram



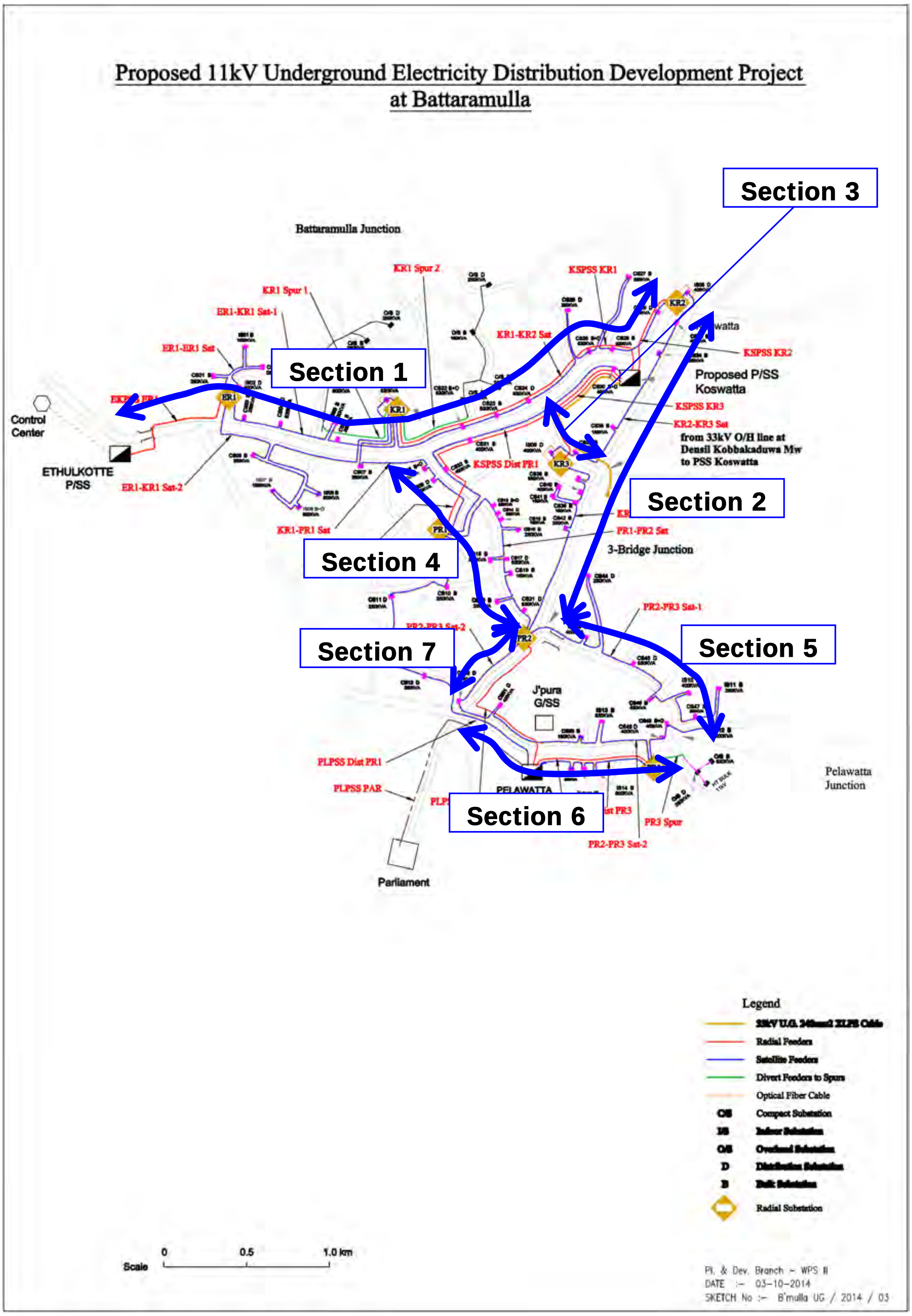
Design of the existing OH MV line diagram on GIS map of Project 9 area.



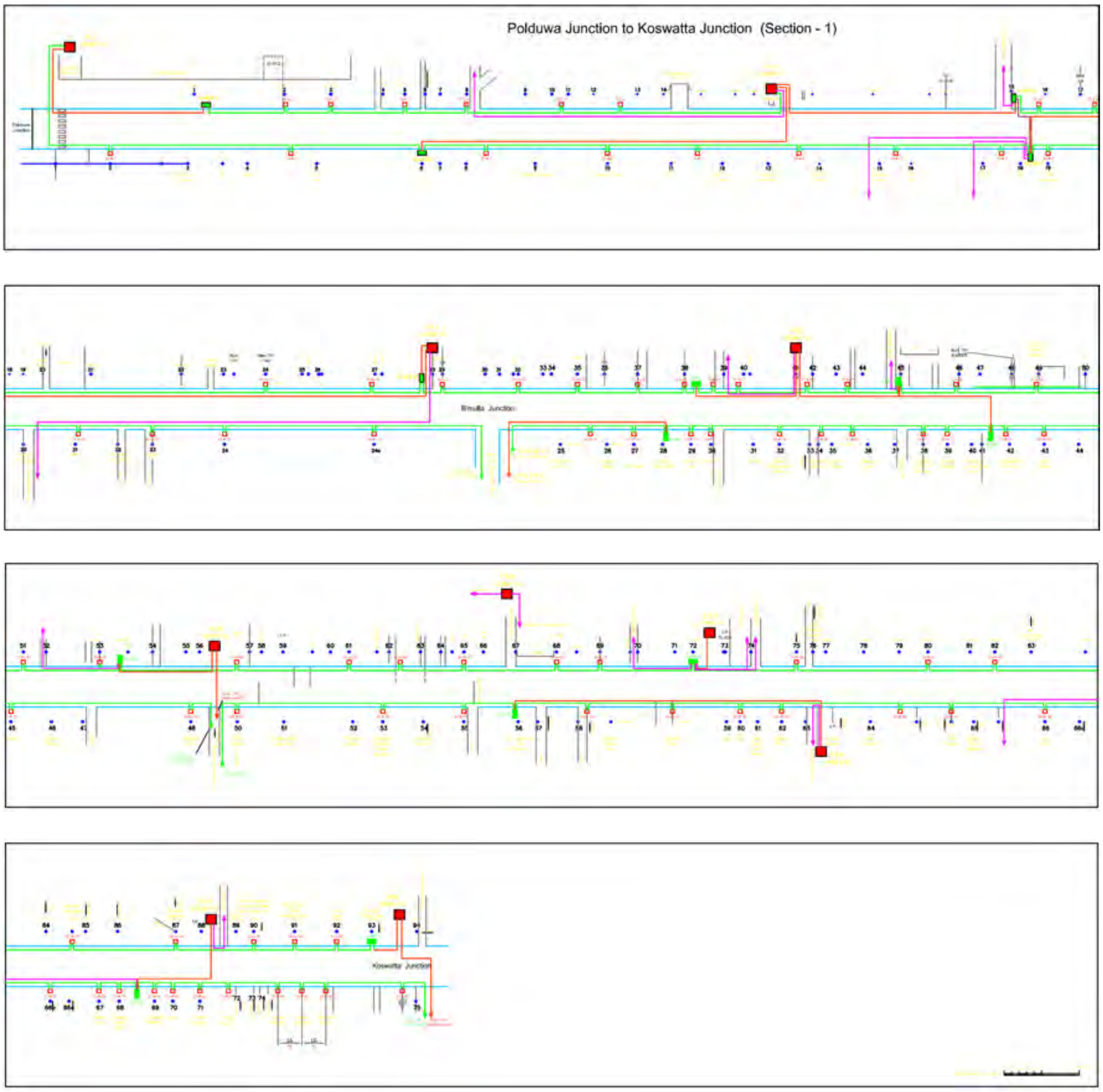
Design of the proposed UG MV line diagram single line diagram on GIS map of Project 9



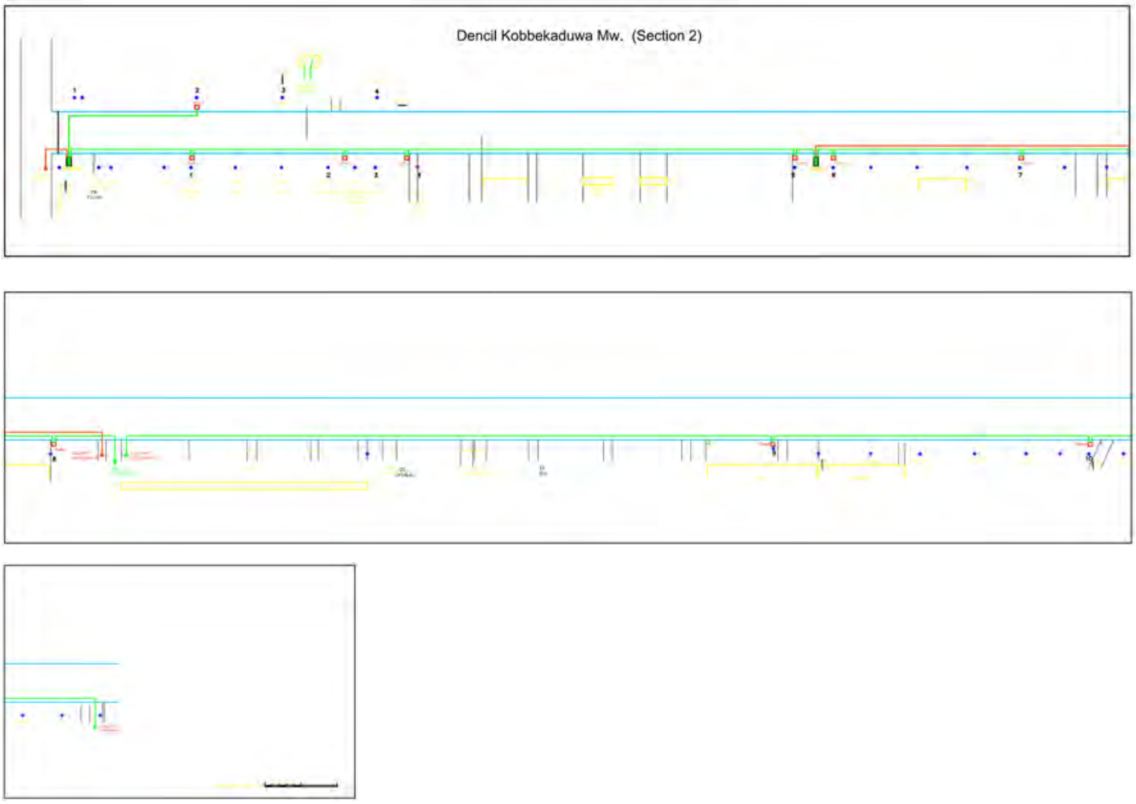
Schematic single line diagram design of the of project 9



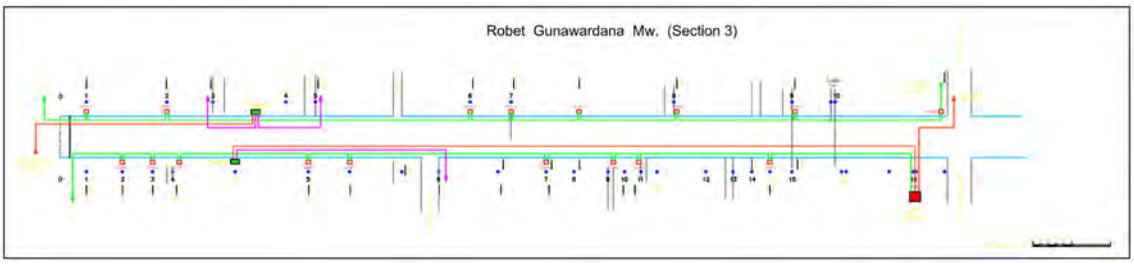
Project implementation Sections.


Polduwa Junction to Koswatta Junction (Section - 1)
Koswatta Junction

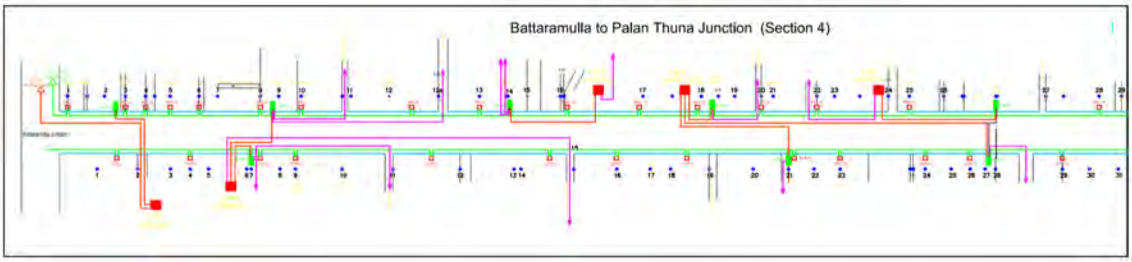
(a) Section 1

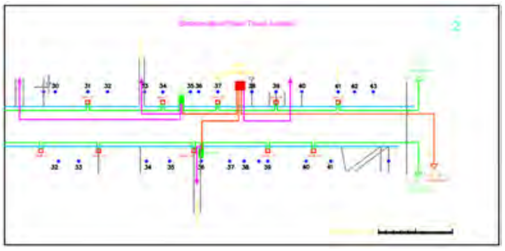


(b) Section 2

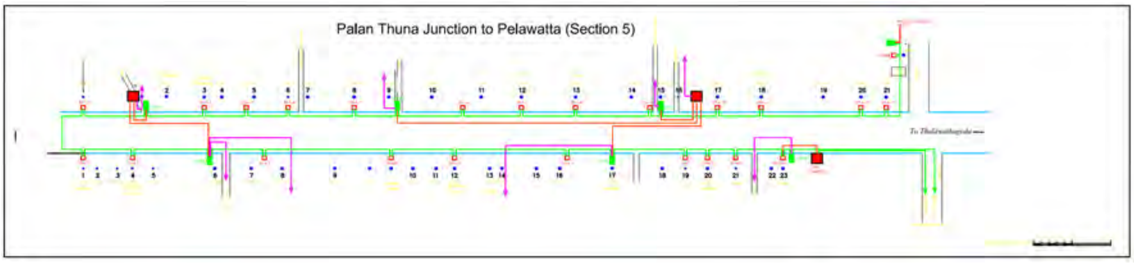


(c) Section 3

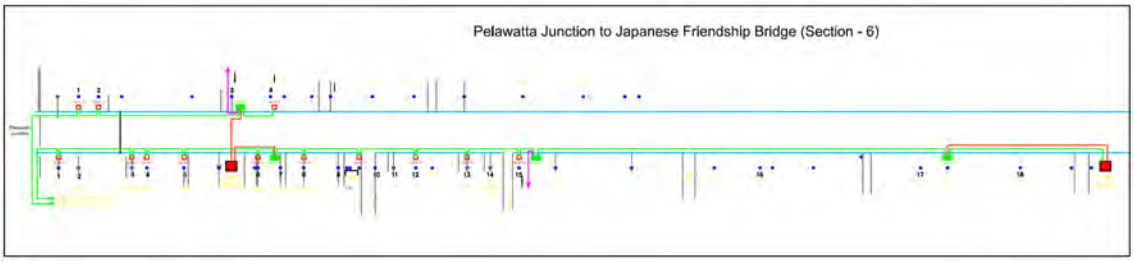


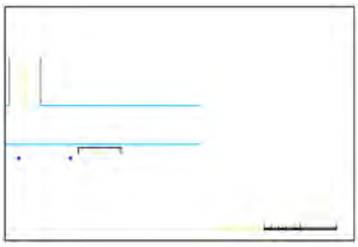


(d) Section 4

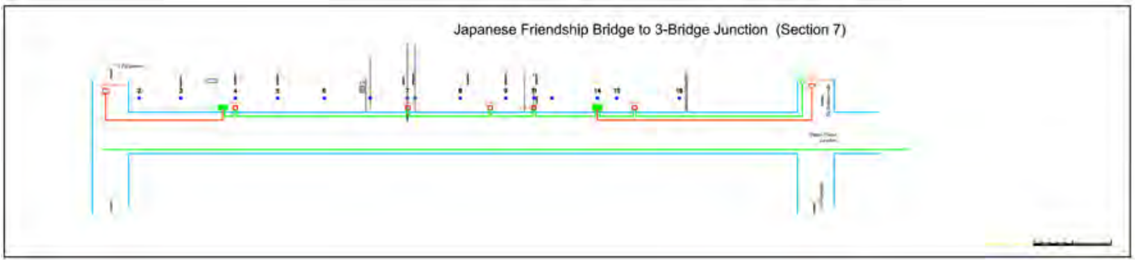


(e) Section 5





(f) Section 6



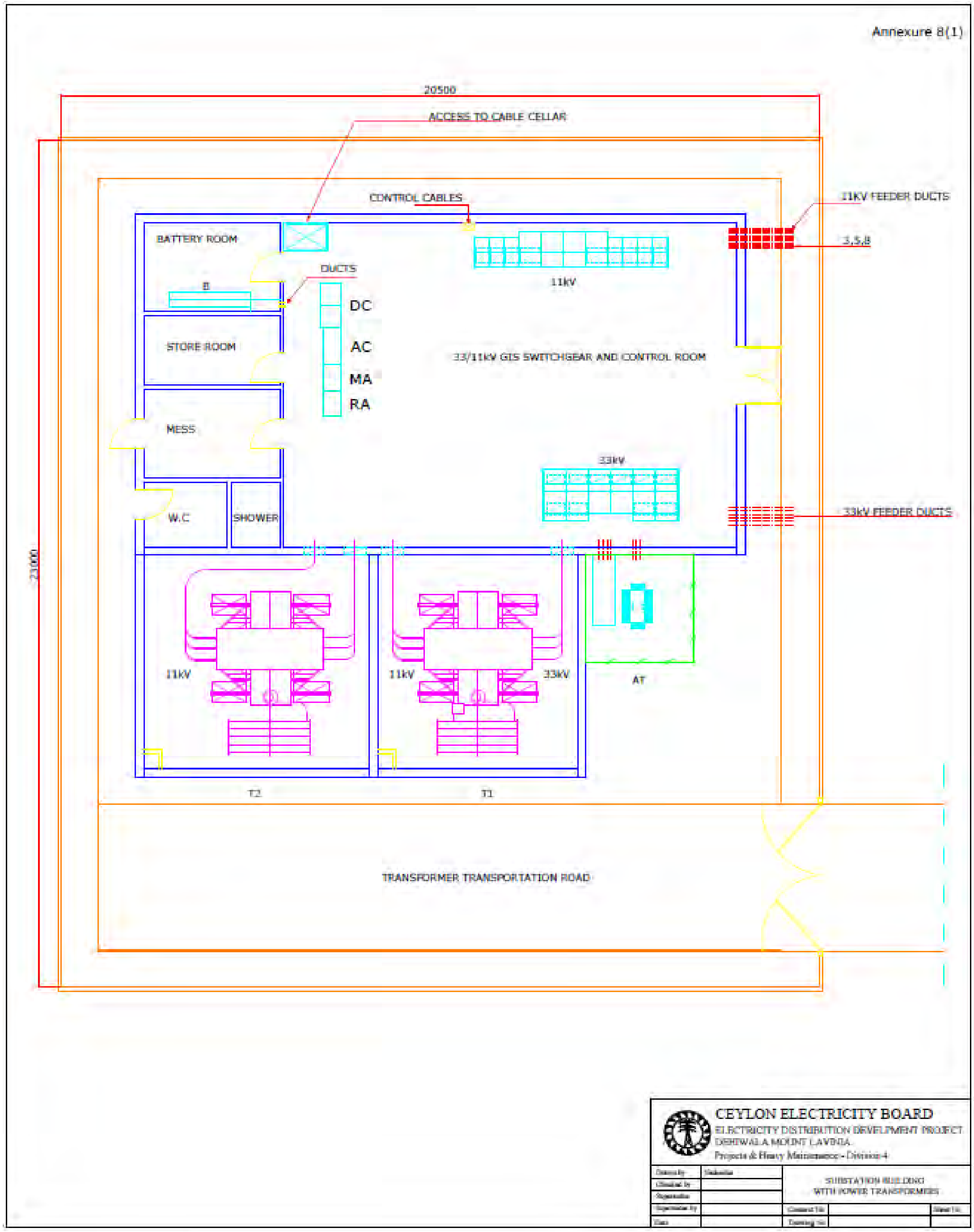
(g) Section 7

LV UG Cable Designs

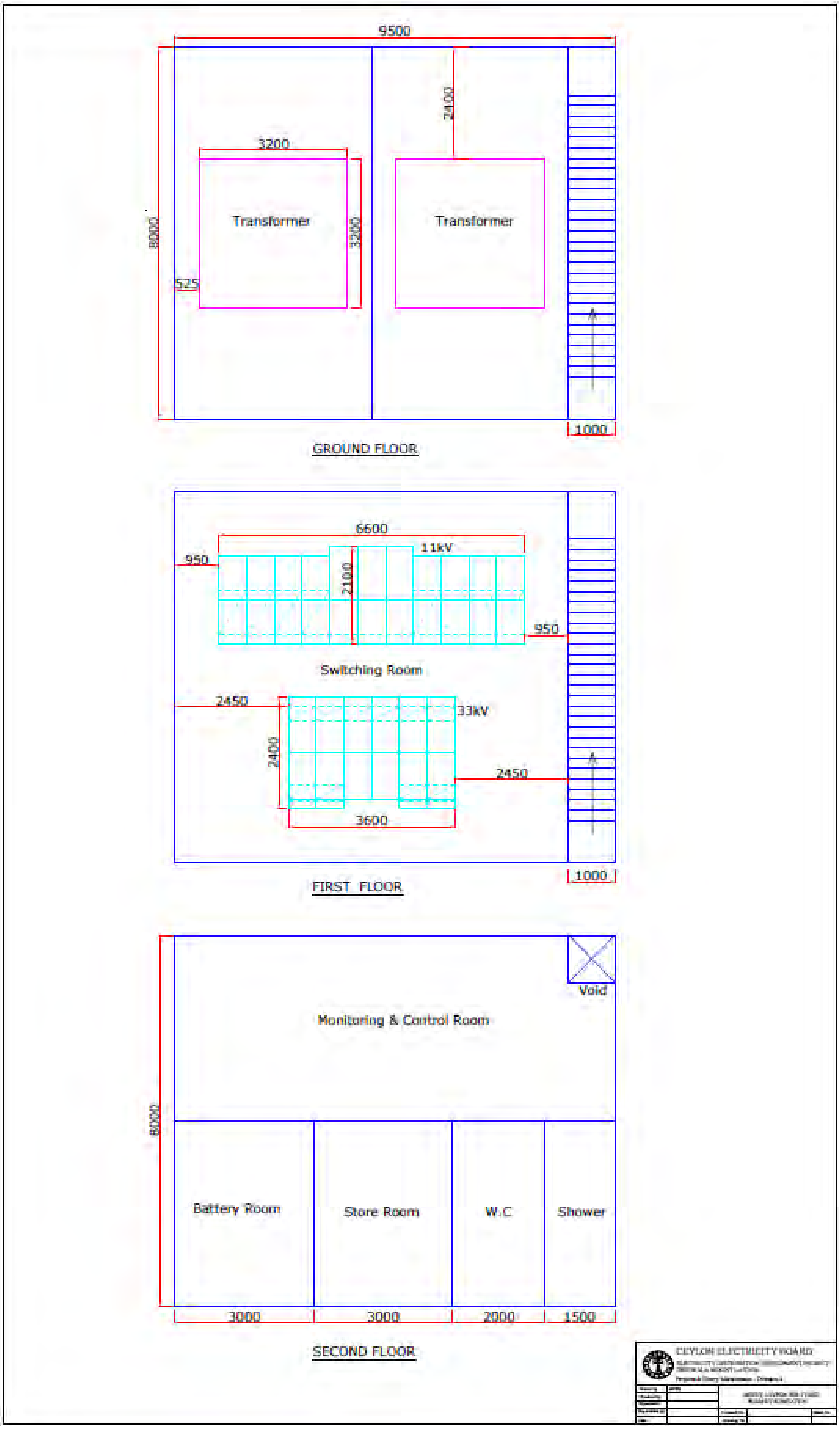
Appendix 7-2 Example of the building layout and the UG cable layout for Distribution

Appendix 7-2-1 Example of the building Layout design

Project 8 (CEB DD4)

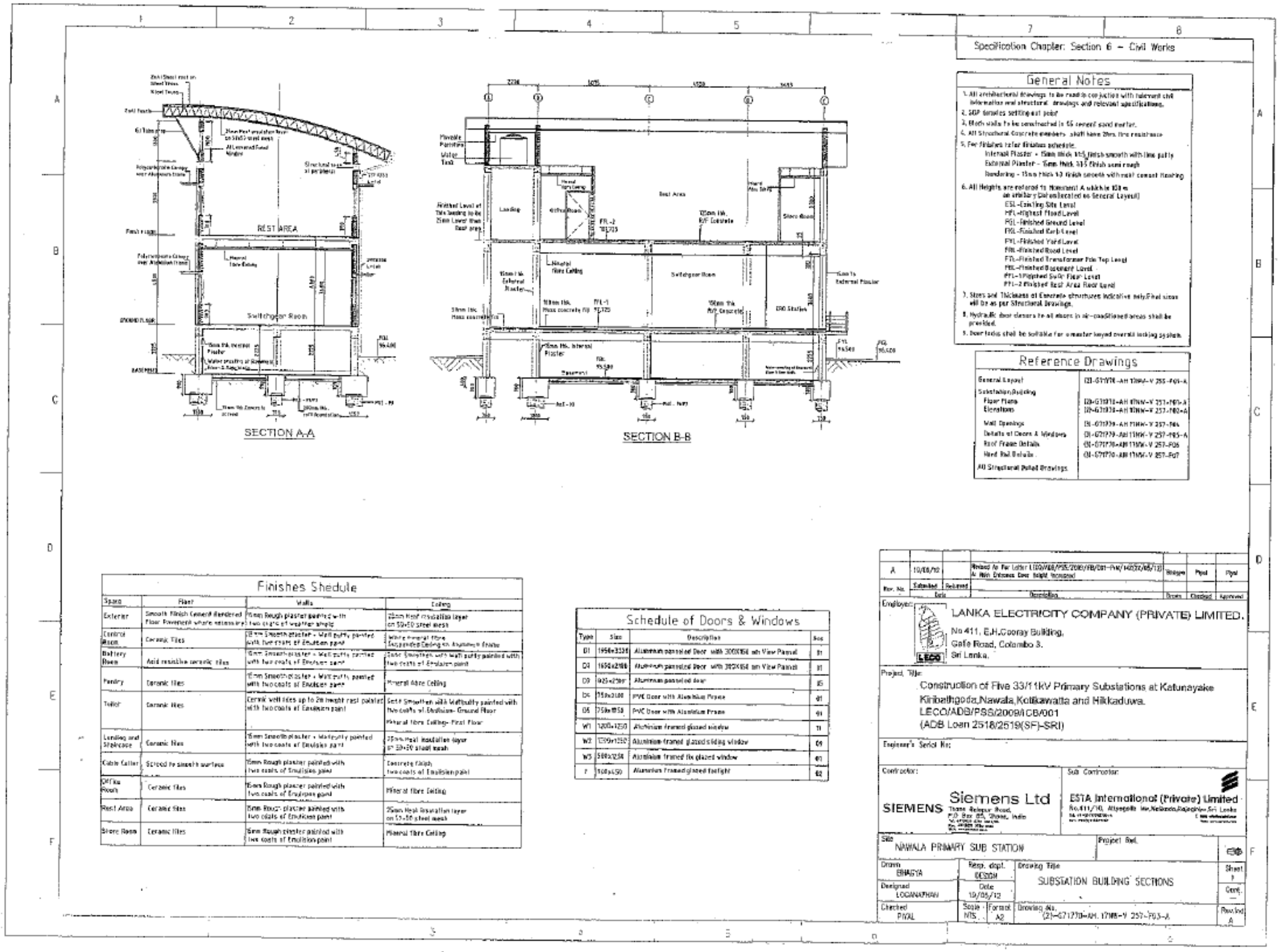


Design of Council Lane PSS

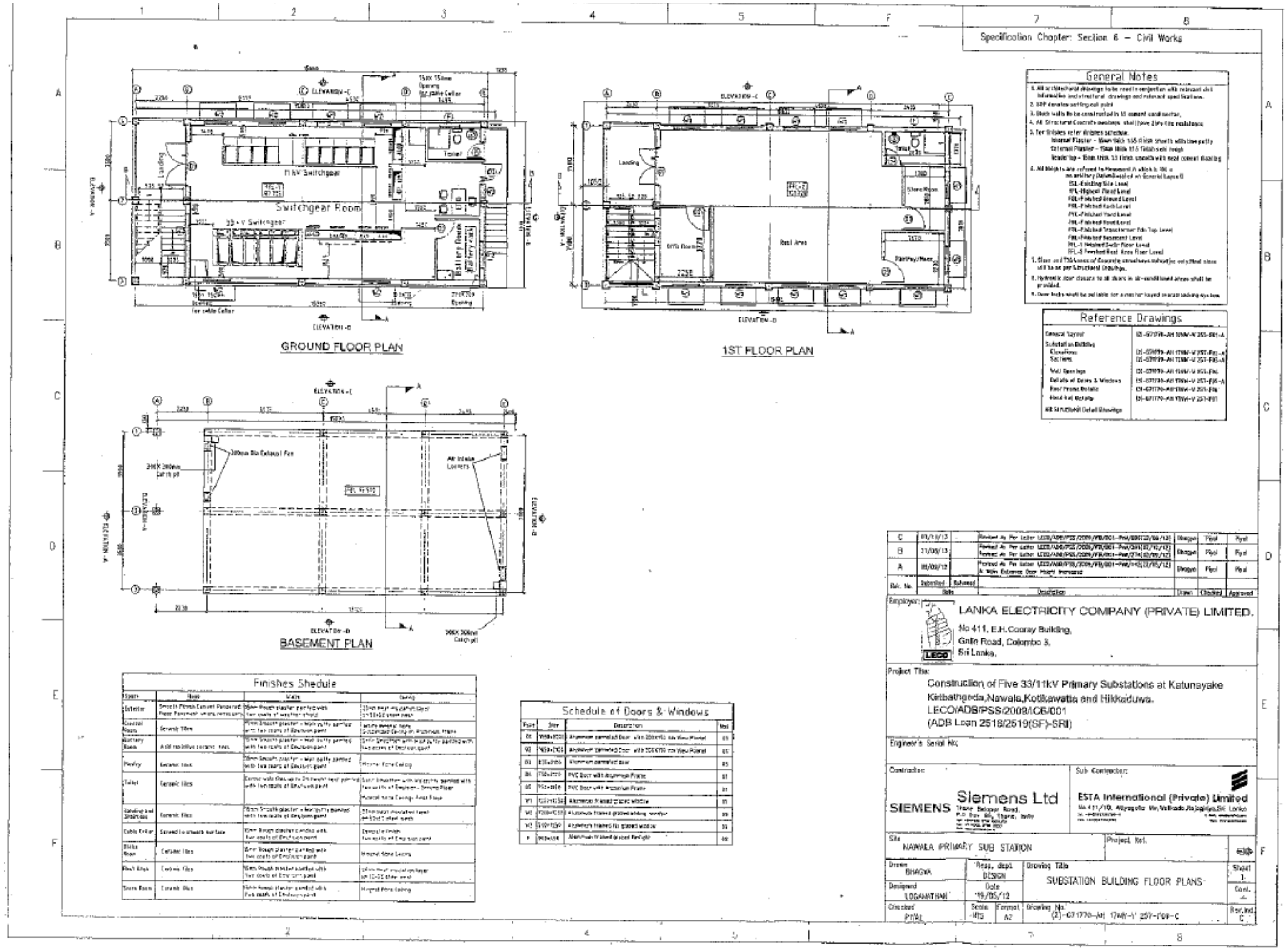


Mt. Lavinia Bus Station PSS

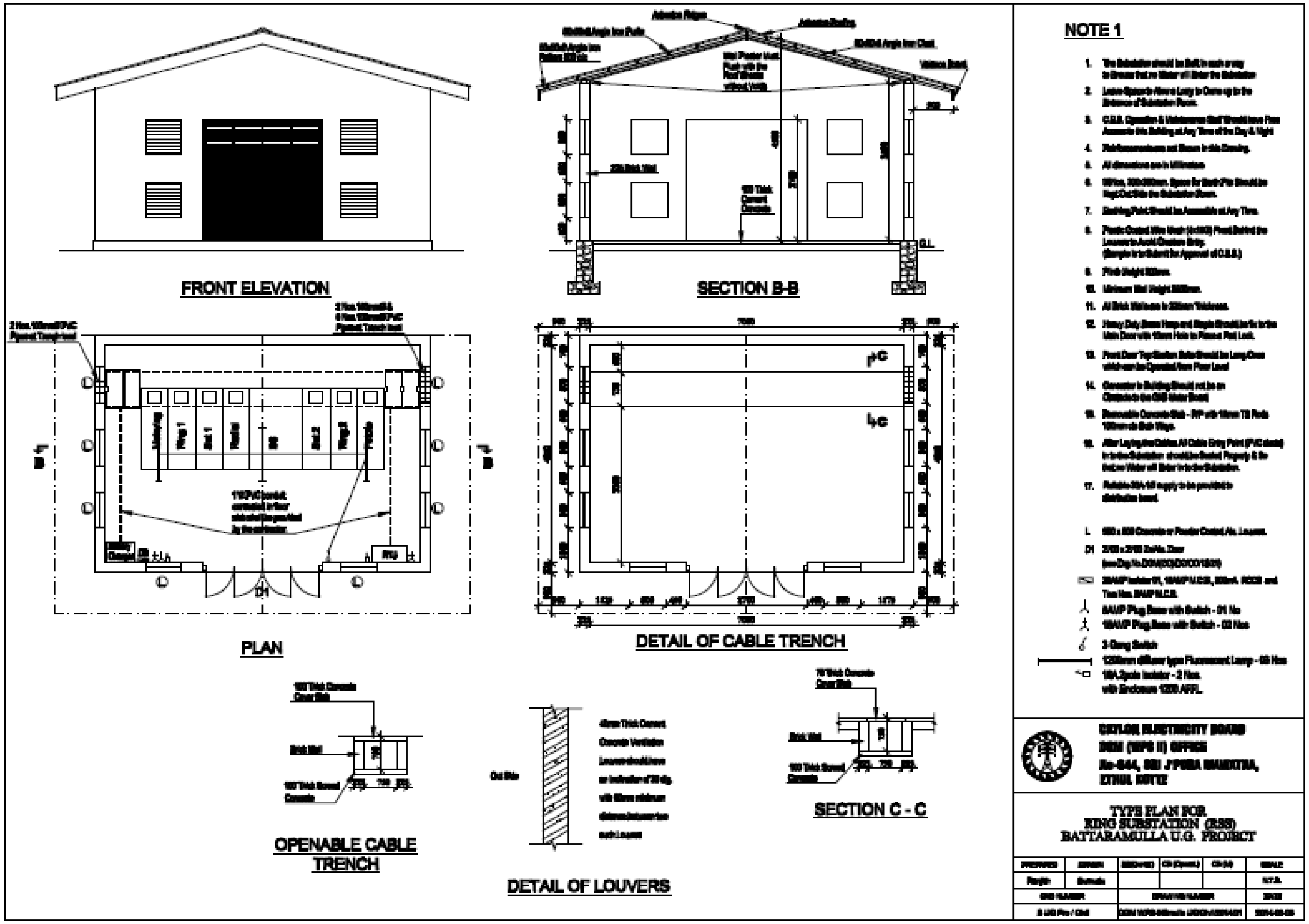
Project9 (CEB DD3)



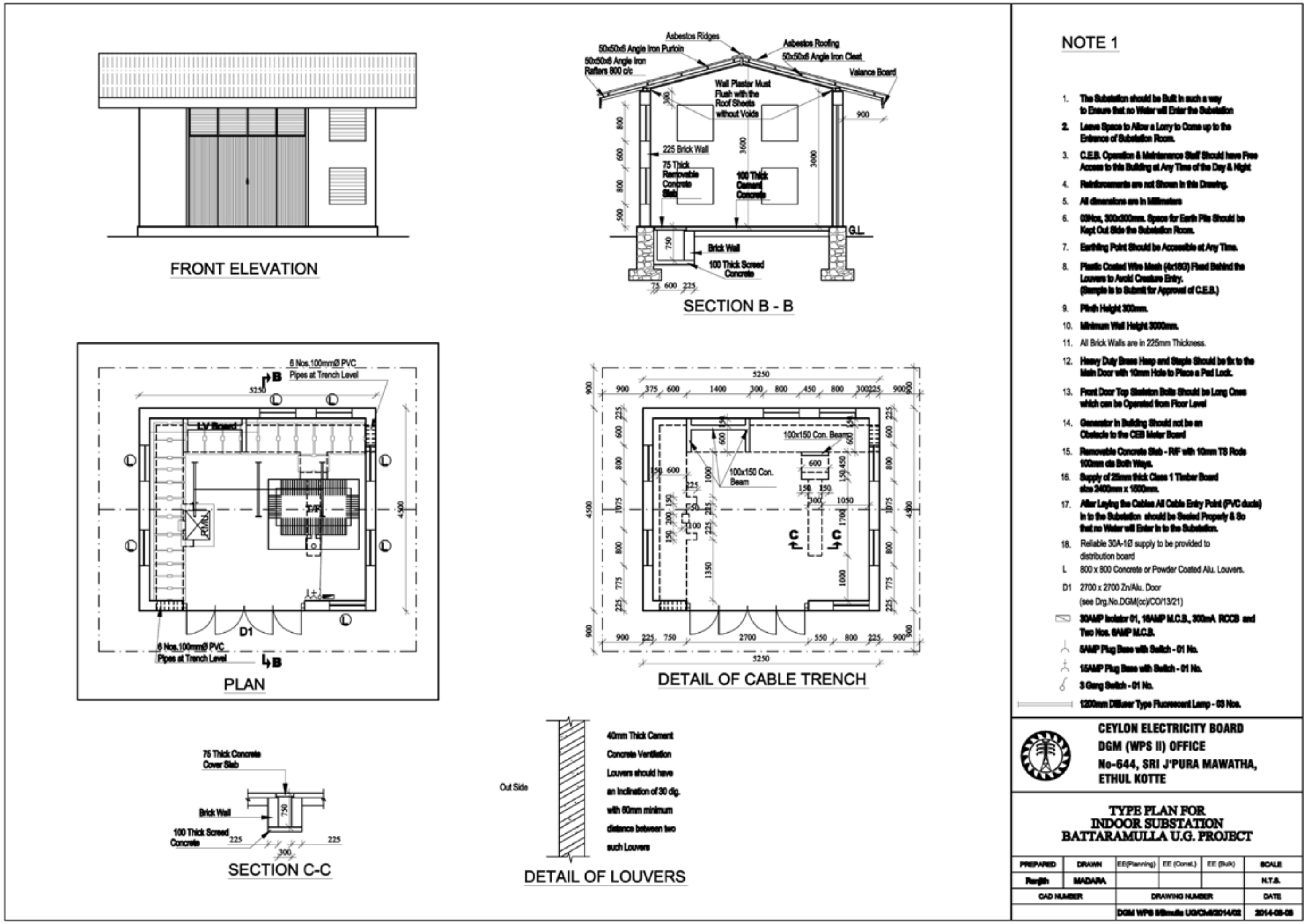
Proposed Design of PSS (Horizontal layout**: example of LECO Nawala PSS)**



Proposed Design of PSS (Top view Lay out: example of LECO Nawala PSS)



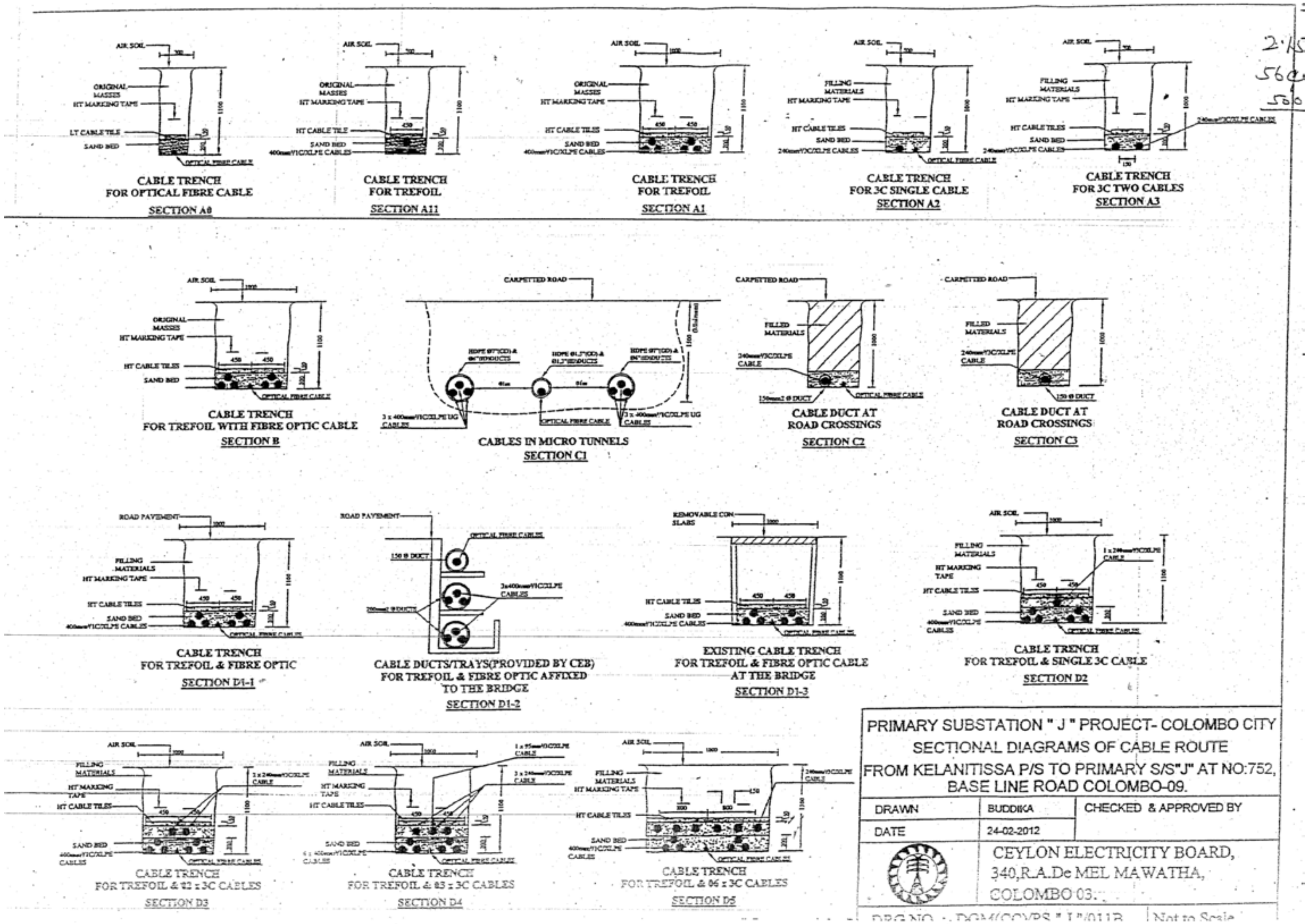
Example of RSS house



Example of Indoor Substation

Appendix 7-2-2 Example of the UG cable layout

According to the results of interviews with DD3 office, the manuals of UG cable burying method doesn't exist in CBE. There is existing the example of buried method which CEB Colombo city has been determined based on IEC 60502. Here shows example of the UG cable burring layout and the UG cable work instruction.



Example of the UG cable burying layout.

Example the UG cable work instruction is below.

2.14 **Temporary Closing of Excavated Trenches**

In certain busy areas, it would not be possible to leave open cable trenches for long periods. In such cases, it may become necessary to close these trenches temporarily with loose earth and open them again when required for cable laying. In areas. Work has to be carried out in the public and traffic.

These works have to be carried out by the contractor on the directions of the Engineer, wherever necessary.

2.15 **Steel Sheets to cover Cable Trenches across Streets**

It would be necessary to provide steel sheets covering for the excavated cable trenches, in road crossing, for un-interrupted movement of traffic or in entrances to private properties. All such arrangements shall be made by the contractor at no cost to CEB.

2.16 **Safety Measures**

Contactor shall made the following safety arrangements to ensure prevention of accidents according to CMC, RDA & Traffic Police requirements while executing construction works. The following safety equipment will be provided by CEB.

(i) Proper barricading
(ii) Warning lights at night
(iii) Display danger boards, red lanterns, red flags etc.
(iv) Display sign boards that, this work is carried out for CEB
(v) Display a Board of size 4' x 2' indicating the name and address of the Firm/Company including Telephone Numbers.
(vi) Other relevant sign boards and arrangements.

2.17 **Cable Laying**

The cable trenches shall be inspected by the Engineer or the supervising officer and shall require his approval before the cable laying could be carried out. Cables shall be laid underneath other services and structures intersecting the cable route. Cable may be laid either manually or with the aid of a winch. Cables laying shall be carried out only in the presence of the CEB supervising officer.

While the cables are being laid out of the cable drum and pulled, care shall be taken to ensure that it is never bent too sharply or allowed to form a kink. The cables being laid out of the drums shall be closely watched for any visible signs of damages or defects in manufacture. Such damages or defects shall be immediately reported to the Engineer.

Cables crossing, railway tracks shall be laid in separate steel conduits and truck roads shall be laid in separate PVC conduits. The steel and PYC conduits shall be supplied by the CEB.

Minimum bending radius for cables given below shall not be exceeded at any moment:

Cable type & Size	Minimum Bending Radius
11kV PILC Cables 70mm.sq./3c	1.5m
11kV PILC Cables 95mm.sq/3c	1.5m
11kV PILC Cables 185mm.sq/3c	2.0m
11kV PILC Cables 240mm.sq/3c	1.5m
11kV PILC Cables 95mm.sq/3c	1.0m
Pilot Cables 0.4mm.sq./6c	0.8m
LT PILC Cable 70mm.sq./4c	1.5m
LT PILC Cable 95mm.sq./4c	1.5m
LT PILC Cable 150mm.sq./4c	1.5m
LT PILC Cable 240mm.sq./4c	1.5m
LT PVC Cable 300mm.sq./4c	1.5m

2.18 **Cable Laying Clearances & Depths**

Parallel runs of cables shall have clearance of not less than 30cm with each other for 11 kV & LT cables & pilot cables may be laid along with its main power cables.

Where cables are laid in parallel to water or gas pipes a horizontal clearance of not less than 50cm shall be kept between them.

Runs of cables that cross over underground cables and pipes must be separated from each other by a layer of earth at least 20cm thick. All L T cables and II kV cables direct in ground shall be laid at a depth not less than 1.0 metre from the surface.

2.19 **Back Filling**

After the cables have laid it shall be ensured that a 15cm layer of soft earth of sand is placed over the cables. Thereafter, a layer of protective or warning cable tiles made of reinforced concrete shall be placed where at least 5cm beyond each side of underling cable or cables. There shall be no gaps between adjacent sides nor shall they overlap.

The cables trenches may be backfilled over the cable tiles with the same earth that was excavated provided that it does not contain stones, cinders and construction site debris or otherwise suitable loose earth shall be obtained from elsewhere by the contractor. Back filling shall be carried out by ramming the earth, layer of earth not **thicker than 15cm.**

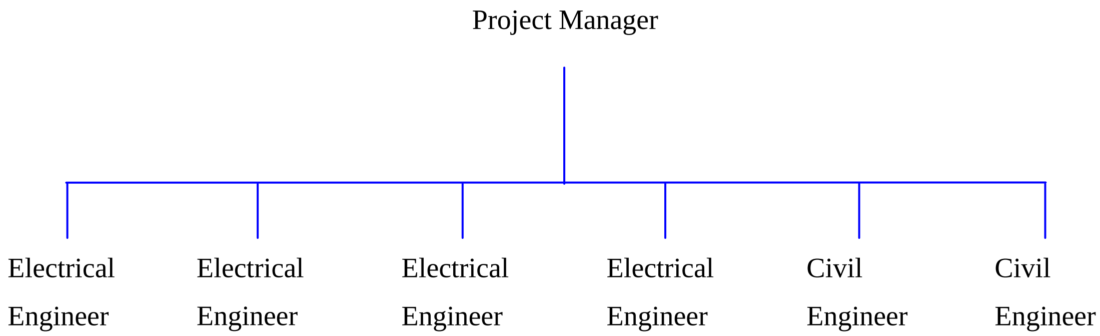
Any remaining earth or debris shall be cleared away by the contractor on completion of the back filling.

Cable tiles shall be supplied by the CEB

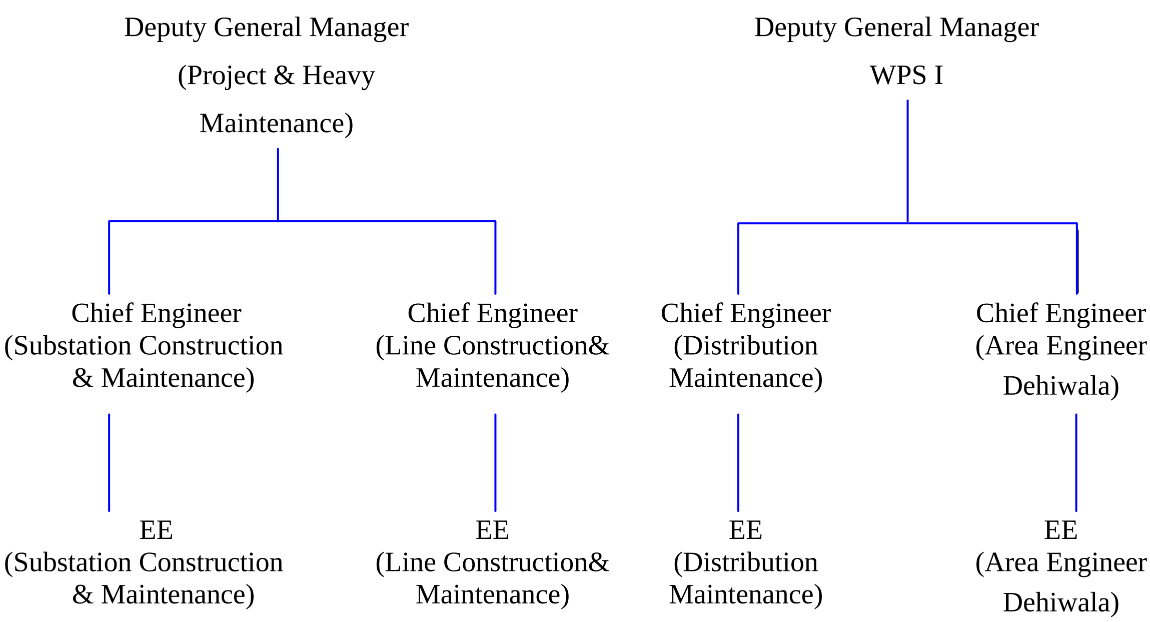
Appendix 7-3 Organization Structure of Distribution System Operation & Maintenance

1. Project 8 area (CEB DD4)

(a) Organization Structure of Distribution System Construction

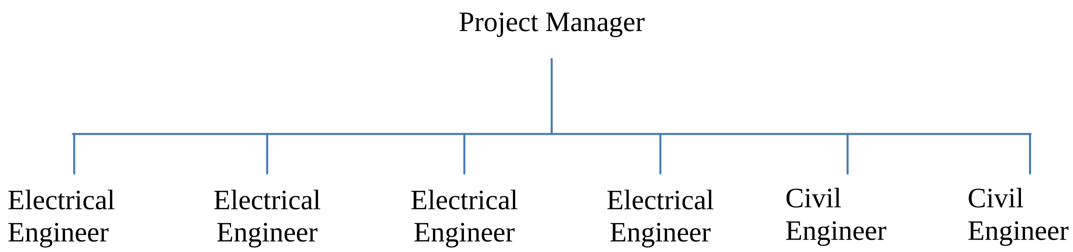


(b) Organization Structure of Distribution System Operation & Maintenance

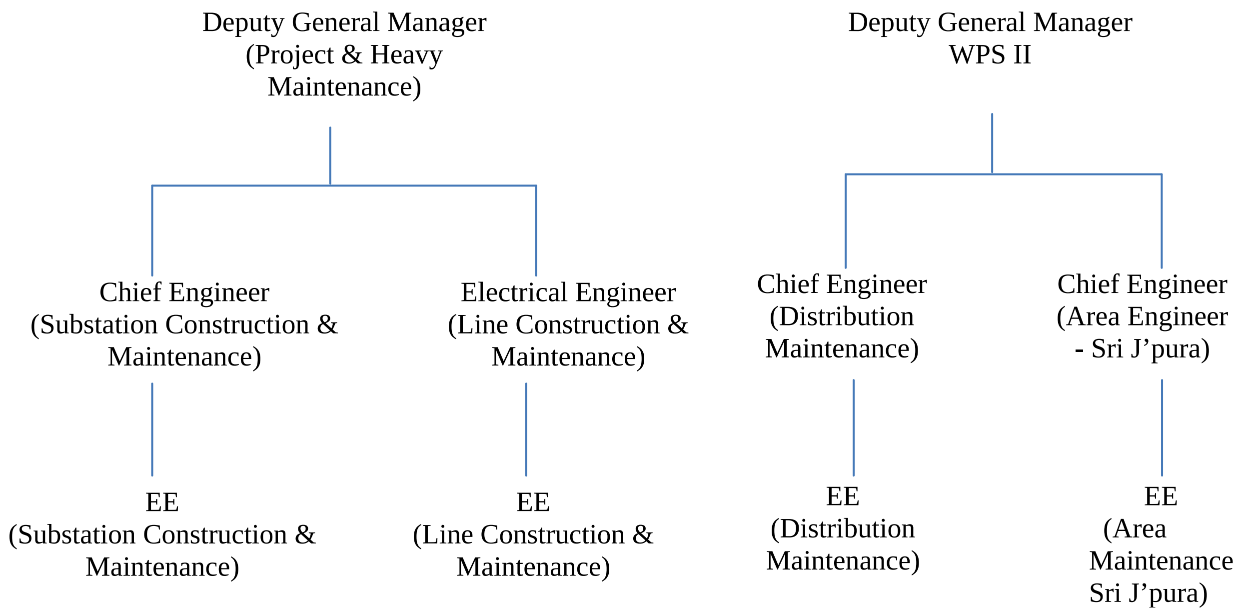


2. Project 9 area (CEB DD3)

(a) Organization Structure of Distribution System Construction



(b) Organization Structure of Distribution System Operation & Maintenance



Appendix 7-4 The electric wire/ cable parameters for SynerGEE

SynerGEE® in GNV GL's software, is one of the famous software used in the system analysis of the distribution line. SynerGEE® can perform to analysis of various parameters of distribution system.

Both of CEB DD3 and CEB DD4 are using the SynerGEE® for analyzing/ simulating the MV distribution line. They are using this software for system load analysis, loss analysis, power quality analysis and contingency analysis Etc. According to CEB DD3 and CEB DD4 engineer discussions, CEB does not specify the electric wire/ cable parameters of the company unified in present, operations are conducted by each CEB distribution division. Therefore, DD3 and DD4 are using the parameters of wire and cable company, there is a slight difference in each other. They manage the transformer capacity and the electric wire parameters, and perform various analyses by entering the current value of the distribution line feeder. The contingency analysis is carried out by generating a power outage by opening the switch in synergy©.

The electric wire/ cable parameters for SynerGEE® of CEB DD3/ CEB DD4 are below.

Electric wire/ Electric Cable parameters for SynerGEE® in CEB DD3.

ConductorName	PosSequenceResistance_PerLUL	PosSequenceReactance_PerLUL	PosSequenceAdmittance_PerLUL	ZeroSequenceResistance_PerLUL	ZeroSequenceReactance_PerLUL	ZeroSequenceAdmittance_PerLUL	Diameter_SUL	ContinuousCurrentRating	InterruptCurrentRating
11 kV 400 CU CABLE	0.104	0.0485	61.72	0.104	0.0485	61.72	400	430	450
11KV 240 CU CABLE	0.084	0.090	150	0.084	0.09	150	240	365	420
11KV 70 CU CABLE	0.3	0.108	93.6	0.3	0.108	93.6	70	220	220
11KV 95 CU CABLE	0.216	0.102	105	0.216	0.102	105	95	185	260
11KV RACOON SC H	0.431	0.375	3.366	0.58	1.651	1.334	75	200	220
33KV 240 CU CABLE	0.0978	0.111	9.009	0.0978	0.111	9.009	240	392	400
33KV LYNX SC H	0.177	0.313	3.693	0.177	0.313	3.693	175	400	500

Electric wire/ Electric Cable parameters for SynerGEE® in CEB DD4.

ConductorName	PosSequenceResistance_PerLUL	PosSequenceReactance_PerLUL	PosSequenceAdmittance_PerLUL	ZeroSequenceResistance_PerLUL	ZeroSequenceReactance_PerLUL	ZeroSequenceAdmittance_PerLUL	Diameter_SUL	ContinuousCurrentRating	InterruptCurrentRating
11kV UG Cable XLPE 90	0.247	0.1	0	0.5	0.55	0	7.7419	200	220
11kV 185sqmm XLPE UG	0.128	0.0091	0	0.23	0.15	0	3.048	300	400
11kV 240 XLPE UG Cable	0.098	0.088	150	0.3	0.4	150	3.048	370	400
11kV bus	0.0001	0.0386	0	0	0.0386	0	7.7419	1200	1200
11KV LYNX SC H	0.177	0.319	3.619	0.326	1.572	0.709	444.5	400	400
11KV LYNX SC T	0.177	0.319	3.619	0.326	1.572	0.709	444.5	400	440
11KV RACOON SC H	0.431	0.345	3.299	0.58	1.651	1.334	190.5	200	250
11KV RACOON SC T	0.431	0.375	3.299	0.58	1.634	0.709	190.5	200	220
11KV WEASEL SC H	1.1	0.403	3.031	1.249	1.662	1.289	76.2	95	110
33KV LYNX SC H	0.177	0.339	3.619	0.326	1.588	1.356	444.5	400	440
33KV LYNX SC T	0.177	0.364	3.156	0.405	1.44	1.702	444.5	400	400
33KV LYNX SC V	0.177	0.339	1.356	0.326	1.572	0	7.7419	400	440
33KV RACOON SC H	0.431	0.375	3.299	0.58	1.634	1.356	3.1166	200	220
33KV RACOON SC T	0.431	0.426	2.914	0.659	1.503	1.629	3.1166	200	220
33KV UG 185 sqmm Cu	0.128	0.111	0	0.4	0.5	0	3.048	300	400
33KV UG 90 sqmm Cu	0.247	0.123	0	0.6	0.5	0	3.048	200	220
33kV UG XLPE 240 cable	0.098	0.106	0	0.3	0.5	0	3.048	370	400
33KV WEASEL SC H	1.1	0.414	1.289	1.249	1.662	1.289	1.9736	95	130
UG 11kV 240 cu**	0.084	0.009	0	0.084	0.084	0	3.048	365	420
UG 33 kV 240 cu**	0.084	0.09	0	0.084	0.09	0	3.048	300	370

* CEB DD4 omitted the 11 kV 95 mm^2 UG XLPE cable of the feeding point for the MV OH distribution line.

**CEB DD4 are using these parameters for new install cable, and these parameters are found from a manufacture data sheet

Appendix 7-5 Current situation of Subproject 8 & 9 implementation area

Appendix 7-5-1 Equipment amount of DD3 & DD4

Existing distribution facilities of The CEB DD3 Western Province Area* and the CEB DD4 Western Province South1 Area are* below. Both are requested the project area.

Table. Existing facilities amount

Electric wire & Cable	Type	CEB DD3 Western Province (km)		CEB DD4 Western Province South1 (km)	
H. T. LINES	33kV - OH	1,187.165		909.623	
	33kV - UG	2.440		7.130	
	11kV - OH	13.080		55.025	
	11kV - UG	3.900		17.050	
H. T. LINES TOTAL		1,206.585		988.828	
L. T. LINES (OH)	3 phase	3,536.400		3,511.968	
	2 Phase	49.581		16.929	
	1 phase	2,154.314		691.926	
SUB TOTAL		5,740.295		4,220.823	
LV Line (UG)	LT UG	5.900		2.530	
SUB TOTAL		5.900		2.530	
LV Line TOTAL		5,746.195		4,223.353	
Transformers Type	Voltage	Number	Capacity (MVA)	Number	Capacity (MVA)
01. Primary Sub	(a) 33kV/11kV	7.0	130.0	16.0	200.0
02. Bulk*	(a) 33kV/LV	757.0	298.7	299.0	111.9
	(b) 11kV/LV	16.0	12.2	158.0	43.8
SUB TOTAL		773.0	311.0	457.0	155.6
03. Distribution	(a) 33kV/LV	1,006.0	189.4	734.0	130.1
	(b) 11kV/LV	15.0	3.2	235.0	67.7
SUB TOTAL		1,021.0	192.6	969.0	197.8
04. Distribution & Bulk	(a) 33kV/LV	122.0	26.0	0.0	0.0
	(b) 11kV/LV	0.0	0.0	0.0	0.0
SUB TOTAL		122.0	26.0	0.0	0.0
TOTAL OF 02,03,04		1,916.0	529.5	1,426.0	353.4

DD4: July. 2014

DD3: Aug. 2014

*BULK Transformer: For More than 42 kVA (60A) Customer

Appendix 7-5-2 Failure causes of DD3 & DD4

Here shows CEB DD3 and CEB DD4 failure cause. CEB DD3 data is WPS II Call Centre Area data (including proposed project 8 area), CEB DD4 is Dehiwara area data (proposed project 9). Both the CEB DD3 and CEV DD4 area, accident to vehicle, contact to vegetation and creature, Etc., specific failure to OH facilities has occupied the top reasons in these report.

By the installing of underground facilities and the strengthening of networking by the project implementation, the prevention of outage and the reduction of power failure time are expected.

Failure cause of CEB DD3 WPS II Call Centre Area.

(a) Yearly failure cause of 2014 (Jan. – Sep.)

Failure Type	Failure Cause	Failure Description	total
LV	Feeder fuse blown / MCCB tripping	Accident due to vehicle	82
		Broken earth conductor	19
		Broken/Burnt tail lines and cable	5
		Cable/conductor broken	104
		Could not find the reason	2603
		Due to birds and animals	34
		Due to broken poles	2
		Due to line overload	46
		Due to not using proper fuses	8
		Due to tree branches coming from distance	467
		Due to vegetation	291
		Lightning	6
		Loose span & entanglement	220
		Other	83
		Reason was not given	328
		Terminal loose connection	8
		Sub Total	4306
	Neutral leak	Broken earth conductor	7
		Due to consumers	12
		Due to Lightning	0
		Due to street light	4
		Other	47
		Vegetation	1
		Sub Total	71
	O/H- Line	Accident due to vehicles	146
		Broken conductors	623
		Broken Tail Wire	13
		Burnt / Damage bundle conductor	29
		Burnt LT Fuse Box	21
		Burnt Tail Wire	21
		Jumper point failure	1766
		Loose span and entanglement	202

		Low Voltage Problem	8
		LT Tail wire terminal burnt	22
		Midspan joint failure	4
		Other	404
		T/F Neutral earth conductor damaged	8
		T/F Neutral earth conductor loose connection	3
		Vegetation	888
		Sub Total	4158
	Problems of poles	Pole broken due to accident	12
		Pole Broken due to other	28
		Pole slanted	19
		Sub Total	59
	Sub Total		5146
MV	DDLO Fuse Blown	Substation DDLO Fuse Blown	182
		Accident due to vehicles	10
		Bad Whether	92
		Branches coming from distances	55
		Could not find the reason	719
		Cracked insulators	5
		DDLO carrier damage	26
		Due to birds and animals	53
		Due to lines overloading	21
		Other	86
		Terminal loose connection	0
		Vegetation	45
		Sub Total	1268
	OH Line	Accident due to vehicles	207
		Bad weather	15
		Broken/damage HT conductor	14
		Burnt HT Conductor	6
		Insulator damaged	19
		Jumper failure	43
		Loose connection at jumper point	15
		Other	69
		Spark at the conductor due to entanglement	11

		Tree branches coming from distance	26
		Vegetation	55
		Sub Total	257
	T/F failure	Creature fault	28
		Flashed due to loose connection	0
		Lightning	0
		Lightning Arrester damage	3
		LT tail wire terminal burnt	18
		LT/HT Bushing damage/cracked	5
		Other	16
		T/F & Arrester earth wire damage	3
		T/F & Arrester earth wire loose connection	1
		T/F Neutral Earth conductor damage	1
		T/F Neutral Earth conductor loose connection	2
		T/F oil leaking	6
		Tap changer damage	0
		Transformer Fault	11
		Sub Total	58
	Sub Total		810
Other	Feeder Tripping	HT feeder tripping	37
		LT feeder tripping	642
		Sub Total	509
	Other	Related to other job	9924
		Related to Phase out	3727
		Restoration Feed Back was received from consumer	7554
		Sub Total	20378
	Sub Total		14819
SM	Connection point at pole	Loose connection at crimp	2453
		Loose connection at line tap	477
		Loose connection at pg clamp	88
		Loose connection at wire joint	885
		Loose connection of piercing connector	1245
		Other	270
		Oxide at the tapping point	1608
		Service wire disconnected at tapping point	414
		Unspecified problem of connection at pole	33

	Sub Total	5125
Consumer Fault	Consumer informed - Supply OK	3681
	Consumer internal fault	3374
	Other	1770
	Supply OK when bd vehicle attend the place	733
	Sub Total	8262
kwh Meter	Internal fault in the meter	746
	Loose connection at meter terminal	235
	Loose connection at meter terminal wires	454
	Meter burnt	359
	Meter damaged	80
	Meter terminal burnt	82
	Meter wire burnt	190
	Other	120
	Oxide in the meter terminal	69
	Perished meter box/board	162
	Sub Total	1603
Service Cutout/MCB	Cutout Burnt/Damaged	2115
	Cutout fuse blown due to overload	1672
	Cutout/MCB terminal burnt	322
	Cutout/MCB wire damage	246
	Cutout/MCB wire loose connection	1091
	MCB Burnt/Damage	526
	MCB tripped	560
	Misplace of Service Cutout	163
	Other	97
	Oxide in the termination	65
	Sub Total	5672
Service pole	Other	685
	Service pole perished/damage	21
	Sub Total	82
Service Wire	L Iron Broken	283
	Loose connection at D-Bracket	138
	Loose connection at wire joint	713
	Other	262

		Over sag of service wire	1099
		Service wire broken	3375
		Service wire burnt	362
		Service wire damaged	173
		Wire broken at middle pole	2500
		Sub Total	8782
	Sub Total		31684
Total			63987

(b) Yearly failure cause of 2013

Voltage	Failure Description	Total
MV	Vegetation	58
	Branches coming from distance	361
	Brunt jumpers & conductor due to loose connections	72
	Loose span and entanglement	5
	Cracked insulator , L/A and transformer bushings	19
	Due to animal and birds	69
	Non availability of LT protection	2
	CB tripping ,fuses blown	475
	U.G Cable faults	0
	Consumer faults	3
	Sabotage	0
	Accident due to vehicles	5
	Due to broken poles	0
	Transformer failures	10
	Brunt tail Wires and Cables	15
	Aging of fuses	183
	Bad weather	131
	Transformer DDLO Blown	110
	Service Pole Broken due to accident	63
	No line tap	0
	Neutral Loose Connection	0
	Piercing Connector Problems	0
	Meter Burn	0
	Meter Terminal Burnt	0
	Fuse Cutout Burnt	26
	Fuse Cutout Damage	0
	Fuse Cutout Terminal Burnt	0
	Service Wire Broken	0
	Loose Connection	0
	Other	28
	Sub total	1635
LV	Vegetation	727
	Branches coming from distance	1856

	Brunt jumpers & conductor due to loose connections	2067
	Loose span and entanglement	464
	Cracked insulator , L/A and transformer bushings	39
	Due to animal and birds	165
	Non availability of LT protection	129
	CB tripping ,fuses blown	2474
	U.G Cable faults	2
	Consumer faults	266
	Sabotage	15
	Accident due to vehicles	49
	Due to broken poles	137
	Transformer failures	3
	Brunt tail Wires and Cables	99
	Aging of fuses	1366
	Bad weather	559
	Transformer DDLO Blown	150
	Service Pole Broken due to accident	193
	No line tap	35
	Neutral Loose Connection	19
	Piercing Connector Problems	7
	Meter Burn	10
	Meter Terminal Burnt	33
	Fuse Cutout Burnt	278
	Fuse Cutout Damage	67
	Fuse Cutout Terminal Burnt	52
	Service Wire Broken	49
	Loose Connection	169
	Other	151
	Sub total	11630
SM*	Vegetation	496
	Branches coming from distance	1459
	Brunt jumpers & conductor due to loose connections	63
	Loose span and entanglement	130
	Cracked insulator , L/A and transformer bushings	0
	Due to animal and birds	357
	Non availability of LT protection	0
	CB tripping ,fuses blown	71
	U.G Cable faults	0
	Consumer faults	3315
	Sabotage	4
	Accident due to vehicles	17
	Due to broken poles	20
	Transformer failures	2
	Brunt tail Wires and Cables	160
	Aging of fuses	766
	Bad weather	867

	Transformer DDLO Blown	103
	Service Pole Broken due to accident	81
	No line tap	1363
	Neutral Loose Connection	800
	Piercing Connector Problems	909
	Meter Burn	637
	Meter Terminal Burnt	619
	Fuse Cutout Burnt	2991
	Fuse Cutout Damage	677
	Fuse Cutout Terminal Burnt	1313
	Service Wire Broken	4983
	Loose Connection	3324
	Other	620
	Sub total	26147
	Total	39412

*SM: The Service Maintenance. That is breakdowns in consumer service wires.

- The Data forms are different from 2013 and 2014.

- Green character determines a fault specific to OH

Failure cause of CEB DD4 Dehiwara Mt. Lavinia Area.

MV Failure Cause	Failure Description	Total	
		2013	to Aug. 2014
Feeder fuse	Fuse burnt due to loose connection	1	1
	Fuse burnt due to over loading	5	1
	Feeder tripping (Auto)	288	212
Feeder tripping	Feeder tripping (Manual)	296	226
No supply	Electricity dim	4	5
OH line	Burnt conductor	14	57
	DDLO blown	45	4
	Insulator damaged	15	15
	Jumper failure	4	1
	Loose connection at jumper point	4	0
	No fault found	1	0
	Pole damaged	5	0
	Pole slanted	3	0
	Spark at the conductor	1	82
	Vegetation	72	7
Transformer failure	Bushing damaged/cracked	6	8
	Creature fault	0	66
	DDLO Blown	63	2
	Flashed due to loose connection	0	0
	Lightning	1	0
	N-E loose connection	0	5
	Oil leak	4	2
	Tap changer damaged	0	0

- Green character determines a fault specific to OH

Consultant Services MM Schedule

Appendix 8

		Position	BillingRate		2015												2016												2017												2018												2019												2020												2021												
			F/C Yen	LC/ LKR	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	Total
														1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																									51
		Engineering and Consulting Services			**3**												**12**												**12**												**12**												**12**												**0**												**0**												**51**
		(45th)																																																																																			
		Detail design incl Feasibility Study review and power system analysis												1	1	1	1																																																																		4
		Tender Assistance												1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																																																									15
		Preparation of PQ & technical spec.												1	1	1	1																																																																	4
		PQ evaluation														1	1																																																																	2
		Preparation of Tender Documents (incl. JICA concurrence)																1	1	1																																																																3
		Tender Period																			1	1	1				1	1																																																								5
		Tender Evaluation																						1	1	1																																																											3
		JICA's Concurrence of Tender Evaluation																							1	1																																																											2
		Negotiation of Contract																									1																																																											1
		JICA's Concurrence of Contract																										1																																																									1
		Signing on Contract																										1																																																										1
		(46th)																																																																																				
		Detail design incl Feasibility Study review and power system analysis												1	1	1	1																																																																		4
		Tender Assistance												1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																																																									15
		Preparation of PQ & technical spec.												1	1	1	1																																																																4
		PQ evaluation														1	1																																																																		2
		Preparation of Tender Documents (incl. JICA concurrence)																1	1	1																																																																3
		Tender Period																			1	1	1				1	1																																																								5.0
		Tender Evaluation																						1	1	1																																																										3.0
		JICA's Concurrence of Tender Evaluation																							1	1																																																											2.0
		Negotiation of Contract																									1																																																											1.0
		JICA's Concurrence of Contract																										1																																																									1.0
		Signing on Contract																										1																																																									1.0
		International Consultants																																																																																				0.0
		(45th)																																																																																				
A	1	Team Leader (for 45th and 46th)	3,400,000	0										1	1	1	1	1	1	1				1	1	1	1	0.5	1	1	1	1	1	0.5	1	1	1	1	1	0.5	1	1	1	1	1	0.5	1	1	1	1	1	1						1						1																									36.0
A	2	Power System Engineer1	3,400,000	0										1																																																																										1.0
A	3	Transmission Line Engineer 1	3,400,000	0										1	1	1	1	1	1	1				1	1	1	1		1	1	1	1	1	1			1	1	1	1					1	1	1	1			1	1						1						1																									29.0
A	4	Transmission Line Engineer 2	3,400,000	0										1	1	1	1	1	1	1				1					1	1	1	1							1	1	1	1					1	1	1	1	1	1																																					22.0
A	5	Transmission Line Engineer 3	3,400,000	0										1	1	1	1	1	1	1				1					1	1			1	1	1	1					1	1	1	1					1	1	1	1																																					22.0
A	6	Transmission Line Engineer 4	3,400,000	0										1	1	1	1	1	1	1				1					1	1					1	1	1	1					1	1	1	1					1	1																																					20.0
A	7	Civil Engineer 1	3,400,000	0										1	1	1	1	1	1	1				1					1	1	1			1	1	1		1	1	1																																																	17.0
A	8	Substation Engineer 1 (Electrical, including GIS)	3,400,000	0										1	1	1	1	1	1	1				1	1	1	1		1	1	1	1			1	1	1	1			1	1	1	1			1	1	1	1	1	1						1						1																									31.0
A	9	Substation Engineer 2 (Electrical, including GIS)	3,400,000	0										1	1	1	1	1	1	1				1					1	1			1	1	1	1			1	1	1	1			1	1	1	1		1	1	1																																					25.0
A	10	Substation Engineer 3 (Electrical, including GIS)	3,400,000	0										1	1	1	1	1	1	1				1							1	1	1	1			1	1	1	1			1	1	1	1			1	1	1	1																																					24.0
A	11	Control and Protection Engineer 1	3,400,000	0										1	1	1	1	1	1	1				1						1	1				1						1					1					1	1																																					15.0
A	12	Communication Engineer 1	3,400,000	0										1	1	1	1	1	1	1				1						1	1				1						1					1					1	1																																					15.0
A	13	Cost Estimator1	3,400,000	0													1																																																																								1.0
A	14	Distribution Engineer(Team Leader Pac4)	3,400,000	0										1	1	1	1	1	1	1				1	1	1	1		1	1	1	1	1	0.5	1	1	1	1	1	0.5	1	1	1	1	1	0.5	1	1	1	1	1	1						1						1																									35.5
A	15	Distribution Engineer(Substation and Distribution)	3,400,000	0										1	1	1	1	1	1	1				1	1	1	1		1	1	1	1									1	1	1							1	1	1																																					21.0
A	16	Distribution Engineer(DAS Specialist)	3,400,000	0										1	1	1	1	1	1	1									1	1	1	1			1	1	1										1	1		1	1	1																																					19.0
A	17	Contract Expert (for 45th and 46th)	3,400,000	0										1				1						1					1								1															1																																					6.0
		(46th)																																																																																				
A	17	Power System Engineer2	3,400,000	0										1																																																																										1.0
A	18	Transmission Line Engineer 5	3,400,000	0										1	1	1	1	1	1	1				1	1	1	1																																																												11.0
A	19	Civil Engineer 2	3,400,000	0										1	1	1	1	1	1	1				1																																																																	8.0
A	20	Substation Engineer 4 (Electrical, including GIS)	3,400,000	0										1	1	1	1	1	1	1				1	1	1	1																																																												11.0
A	21	Control and Protection Engineer 2	3,400,000	0										1	1	1	1	1	1	1				1																																																																	8.0
A	22	Communication Engineer 2	3,400,000	0										1	1	1	1	1	1	1				1																																																																	8.0
		Local Consultants																																																																																				
		(45th)																																																																																			
B	1	Transmission Line Engineer 1	0	1,378,000										1	1	1	1	1	1	1				1	1	1	1		1	1		1	1	1	1			1	1	1	1			1	1	1	1			1	1	1						1						1																									29.5
B	2	Transmission Line Engineer 2	0	1,378,000										1	1	1	1	1											1	1		1	1			1	1	1	1			1	1	1	1			1	1	1	1	1						1						1																									23.5
B	3	Transmission Line Engineer 3	0	1,378,000										1	1	1	1	1											1	1		1	1			1	1	1	1			1	1	1	1			1	1	1	1	1						1						1																									23.5
B	4	Transmission Line Engineer 4	0	1,378,000										1	1	1	1	1											1	1				1	1	1	1			1	1	1	1			1	1	1	1		1	1						1						1																									22.5
B	5	Civil Engineer 1	0	1,378,000										1	1	1	1	1						1					1	1	1	1			1	1			1	1																		1																															15.0
B	6	Civil Engineer 2	0	1,378,000										1	1	1	1	1											1	1			1	1			1	1	1	1																		1																															14.0
B	7	Substation Engineer 1 (Electrical, including GIS)	0	1,378,000										1	1	1	1	1	1	1				1	1	1	1		1	1	1	1			1	1			1	1			1	1			1	1			1	1						1						1																									26.5
B	8	Substation Engineer 2 (Electrical, including GIS)	0	1,378,000										1	1	1	1	1											1	1			1	1			1	1			1	1			1	1			1	1	1	1						1						1																									20.5
B	9	Civil & Building Engineer	0	1,378,000										1	1	1	1	1						1					1	1			1	1			1	1			1	1			1	1			1	1	1	1						1						1																									21.5
B	10	EIA Expert 1	0	1,378,000										1	1	1													1	1			1				1					1				1				1								1						1																									11.5
B	11	Distribution Engineer(Team Leader Pac4)	0	1,378,000										1	1	1	1	1	1	1				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1						1						1																									36.5
B	12	Distribution Engineer(Substation and Distribution)	0	1,378,000										1	1	1	1	1						1	1	1	1		1	1	1	1			1	1	1				1	1	1				1	1		1	1	1																																					23.0
B	13	Distribution Engineer(DAS Specialist)	0	1,378,000										1	1	1	1	1						1	1	1	1		1	1	1	1			1	1	1				1	1	1				1	1		1	1	1																																					23.0
		(46th)																																																																																				
B	14	Transmission Line Engineer 5	0	1,378,000																					1	1	1	1	1	1	1				1	1	1	1																																																	11.0
B	15	Civil Engineer 3	0	1,378,000																					1	1	1	1	1	1	1				1																																																						8.0
B	16	Substation Engineer 3 (Electrical, including GIS)	0	1,378,000																					1	1	1	1	1	1	1				1	1	1	1																																																	11.0
B	17	EIA Expert 2	0	1,378,000																					1	1	1																																																																	3.0

		Position	BillingRate		Total
			F/C Yen	LC/ LKR	
		Engineering and Consulting Services			51
					51
		[Total of Pro-A]			**386.5**
		[Total of Pro-B]			**323.5**
		[Total of Pro-A+Pro-B]			710.0
		Total Cost of FC for Each Month(Pro-A)			1,314,100,000
		Total Cost of FC for Each Month(Pro-B)			0
		Total Cost of LC for Each Month(Pro-A)			0
		Total Cost of LC for Each Month(Pro-B)			445,783,000
			0	0	0
C	1	Secretary 1	0	138000	48
C	2	Secretary 2	0	138000	48
C	3	Clerk 1	0	138000	48
C	4	Clerk 2	0	138000	48
C	5	Cost Monitoring Staff 1	0	138000	29
C	6	Cost Monitoring Staff 2	0	138000	29
			0	0	0
			0	0	0
			0	0	0
		[Total of Supporting Staff]			**250**
		Total Cost of LC for Each Month(SS)			34,500,000
		Grand Total			**960.0**

Position	2015											
	1	2	3	4	5	6	7	8	9	10	11	12
Engineering and Consulting Services										1	1	1
	3											
[Total of Pro-A]	**60**											
[Total of Pro-B]	**39**											
[Total of Pro-A+Pro-B]	99											
Total Cost of FC for Each Month(Pro-A)	204,000,000											
Total Cost of FC for Each Month(Pro-B)	0											
Total Cost of LC for Each Month(Pro-A)	0											
Total Cost of LC for Each Month(Pro-B)	53,742,000											
Secretary 1										1	1	1
Secretary 2										1	1	1
Clerk 1										1	1	1
Clerk 2										1	1	1
Cost Monitoring Staff 1												
Cost Monitoring Staff 2												
[Total of Supporting Staff]	**12**											
Total Cost of LC for Each Month(SS)	1,656,000											
Grand Total	**111**											

Position	2016											
	1	2	3	4	5	6	7	8	9	10	11	12
Engineering and Consulting Services	1	1	1	1	1	1	1	1	1	1	1	1
	12											
[Total of Pro-A]	**119**											
[Total of Pro-B]	**65**											
[Total of Pro-A+Pro-B]	184											
Total Cost of FC for Each Month(Pro-A)	402,900,000											
Total Cost of FC for Each Month(Pro-B)	0											
Total Cost of LC for Each Month(Pro-A)	0											
Total Cost of LC for Each Month(Pro-B)	89,570,000											
Secretary 1	1	1	1	1				1	1	1	1	1
Secretary 2	1	1	1	1				1	1	1	1	1
Clerk 1	1	1	1	1				1	1	1	1	1
Clerk 2	1	1	1	1				1	1	1	1	1
Cost Monitoring Staff 1								1	1	1	1	1
Cost Monitoring Staff 2								1	1	1	1	1
[Total of Supporting Staff]	**46**											
Total Cost of LC for Each Month(SS)	6,348,000											
Grand Total	**230**											

Position	2017											
	1	2	3	4	5	6	7	8	9	10	11	12
Engineering and Consulting Services	1	1	1	1	1	1	1	1	1	1	1	1
	12											
[Total of Pro-A]	**102**											
[Total of Pro-B]	**116**											
[Total of Pro-A+Pro-B]	218											
Total Cost of FC for Each Month(Pro-A)	346,800,000											
Total Cost of FC for Each Month(Pro-B)	0											
Total Cost of LC for Each Month(Pro-A)	0											
Total Cost of LC for Each Month(Pro-B)	159,848,000											
Secretary 1	1	1	1	1	1	1	1	1	1	1	1	1
Secretary 2	1	1	1	1	1	1	1	1	1	1	1	1
Clerk 1	1	1	1	1	1	1	1	1	1	1	1	1
Clerk 2	1	1	1	1	1	1	1	1	1	1	1	1
Cost Monitoring Staff 1	1	1	1	1	1	1	1	1	1	1	1	1
Cost Monitoring Staff 2	1	1	1	1	1	1	1	1	1	1	1	1
[Total of Supporting Staff]	**72**											
Total Cost of LC for Each Month(SS)	9,936,000											
Grand Total	**290**											

Position	2018											
	1	2	3	4	5	6	7	8	9	10	11	12
Engineering and Consulting Services	1	1	1	1	1	1	1	1	1	1	1	1
	12											
[Total of Pro-A]	**98**											
[Total of Pro-B]	**88**											
[Total of Pro-A+Pro-B]	186											
Total Cost of FC for Each Month(Pro-A)	333,200,000											
Total Cost of FC for Each Month(Pro-B)	0											
Total Cost of LC for Each Month(Pro-A)	0											
Total Cost of LC for Each Month(Pro-B)	121,264,000											
Secretary 1	1	1	1	1	1	1	1	1	1	1	1	1
Secretary 2	1	1	1	1	1	1	1	1	1	1	1	1
Clerk 1	1	1	1	1	1	1	1	1	1	1	1	1
Clerk 2	1	1	1	1	1	1	1	1	1	1	1	1
Cost Monitoring Staff 1	1	1	1	1	1	1	1	1	1	1	1	1
Cost Monitoring Staff 2	1	1	1	1	1	1	1	1	1	1	1	1
[Total of Supporting Staff]	**72**											
Total Cost of LC for Each Month(SS)	9,936,000											
Grand Total	**258**											

Position	2019											
	1	2	3	4	5	6	7	8	9	10	11	12
Engineering and Consulting Services	1	1	1	1	1	1	1	1	1	1	1	1
	12											
[Total of Pro-A]	**8**											
[Total of Pro-B]	**16**											
[Total of Pro-A+Pro-B]	24											
Total Cost of FC for Each Month(Pro-A)	27,200,000											
Total Cost of FC for Each Month(Pro-B)	0											
Total Cost of LC for Each Month(Pro-A)	0											
Total Cost of LC for Each Month(Pro-B)	21,359,000											
Secretary 1	1	1	1	1	1	1	1	1	1	1	1	1
Secretary 2	1	1	1	1	1	1	1	1	1	1	1	1
Clerk 1	1	1	1	1	1	1	1	1	1	1	1	1
Clerk 2	1	1	1	1	1	1	1	1	1	1	1	1
Cost Monitoring Staff 1												
Cost Monitoring Staff 2												
[Total of Supporting Staff]	**48**											
Total Cost of LC for Each Month(SS)	6,624,000											
Grand Total	**72**											

Position	2020											
	1	2	3	4	5	6	7	8	9	10	11	12
Engineering and Consulting Services												
	0											
[Total of Pro-A]	**0**											
[Total of Pro-B]	**0**											
[Total of Pro-A+Pro-B]	0											
Total Cost of FC for Each Month(Pro-A)	0											
Total Cost of FC for Each Month(Pro-B)	0											
Total Cost of LC for Each Month(Pro-A)	0											
Total Cost of LC for Each Month(Pro-B)	0											
Secretary 1												
Secretary 2												
Clerk 1												
Clerk 2												
Cost Monitoring Staff 1												
Cost Monitoring Staff 2												
[Total of Supporting Staff]	**0**											
Total Cost of LC for Each Month(SS)	0											
Grand Total	**0**											

Position	2021											
	1	2	3	4	5	6	7	8	9	10	11	12
Engineering and Consulting Services												
	0											
[Total of Pro-A]	**0**											
[Total of Pro-B]	**0**											
[Total of Pro-A+Pro-B]	0											
Total Cost of FC for Each Month(Pro-A)	0											
Total Cost of FC for Each Month(Pro-B)	0											
Total Cost of LC for Each Month(Pro-A)	0											
Total Cost of LC for Each Month(Pro-B)	0											
Secretary 1												
Secretary 2												
Clerk 1												
Clerk 2												
Cost Monitoring Staff 1												
Cost Monitoring Staff 2												
[Total of Supporting Staff]	**0**											
Total Cost of LC for Each Month(SS)	0											
Grand Total	**0**											

Cost Breakdown for the Consulting Services

US $	= JPY	107.1
LKR	= JPY	0.823

	Unit	Qty.	Foreign Portion (JPY) Rate	Foreign Portion (JPY) Amount ('000)	Local Portion LKR Rate	Local Portion LKR Amount ('000)	Combined Total ('000) Yen
A Remuneration							
1 Professional (A)	M/M	386. 5	3, 400, 000	1, 314, 100	0	0	1, 314, 100
2 Professional (B)	M/M	323. 5	0	0	1, 378, 000	445, 783	366, 879
3 Supporting Staffs	M/M	250	0	0	138, 000	34, 500	28, 394
Subtotal of A				1, 314, 100		480, 283	1, 709, 373
B Direct Cost							
1 International Airfare		125	510, 000	63, 750		0	63, 750
2 Domestic Airfare			0	0		0	0
3 Domestic Travel				0		0	0
4 Accommodation Allowance (A)	M/M	386. 5	600, 000	231, 900		0	231, 900
Accommodation Allowance (B)	M/M	32. 35	0	0	100, 000	3, 235	2, 662
		250		0		0	0
5 Vehicle Rental	Car/M	355	0	0	280, 000	99, 400	81, 806
6 Office Rental	Month	41	0	0	1, 000, 000	41, 000	33, 743
7 International Communications	Month	41	170, 000	6, 970	0	0	6, 970
8 Domestic Communications	Month	41	0	0	240, 000	9, 840	8, 098
9 Office Supply	set	1		0	30, 000, 000	30, 000	24, 690
10 Office Furniture and Equipment	Month	41		0	300, 000	12, 300	10, 123
11 Report Preparation	Month	41	0	0	150, 000	6, 150	5, 061
12 Training of Academic Staff	set	1			25, 000, 000	25, 000	20, 575
13 Software Simulation Models for training Power Station and Grid Substation	set	1			70, 000, 000	70, 000	57, 610
14 Advanced Training Models Generation, Transmission and	set	1			30, 000, 000	30, 000	24, 690
15 Training in Consultant's Home Country for 400kV TL & SS	Lot	1			20, 000, 000	20, 000	16, 460
16 Factory Acceptance Test including Remuneration	Lot	1			20, 720, 000	20, 720	17, 053
Subtotal of B				302, 620		367, 645	605, 192
Total				1, 616, 720		847, 928	2, 314, 565

Implementation Schedule

Appendix 10-1

	2014	2015	2016	2017	2018	2019	2020	2021	Month
									0
Appraisal	11								1
Pledge	12								1
Signing of Loan Agreement		3							1
Selection of Engineering Consulting Services	12	1–9							10
Invitation of Expression of Interest	12	1							2
Prepreration of TOR, Short-List, L/I		1–3							3
JICA concurrence to TOR, Short-List, L/I		4							1
Issurance of L/I to Short-listed consultants		5							1
Proposal submission by Consultants		5–6							2
Evaluation of Consultant Proposal		7							1
JICA Approval of Evaluation of Consultant		8							1
Signing Consultant Contract		9							1
JICA Signing Consultant Contract		9							1
									0
Engineering and Bidding Period		10–12	1–12						15
Detail design incl Feasibility Study review and power sys		10–12	1						4
Tender Assistance		10–12	1–12						15
Preparation of PQ & technical spec.		10–12	1						4
PQ evaluation		12	1						2
Preparation of Tender Documents (incl. JICA concurrenc			2–4						3
Tender Period			5–7						3
Tender Evaluation			8–10						3
JICA's Concurrence of Technical Evaluation			9						1
JICA's Concurrence of Cost Evaluation			10						1
Negotiation of Contract			11						1
JICA's Concurrence of Contract			12						1
Signing on Construction Contract			12						1
									0
									0
Land Acquisition	0	1 (12)	12 (1–12)	2 (1–2)	0	0	0	0	15
Package 01: Construction of Tranmission Line(Project 1-5	0	0	0	12 (1–12)	12 (1–12)	0	0	0	24
Package 02:Construction of Grid Substation(Project 1-7)	0	0	0	12 (1–12)	12 (1–12)	0	0	0	24
Package 03: Construction of Transmission Line(Project 6	0	0	0	12 (1–12)	12 (1–12)	0	0	0	24
Package 04: Construction of Distribution Cables	0	0	0	12 (1–12)	12 (1–12)	0	0	0	24
Package 05: Training Center	0	0	0	1 (1)	0	0	0	0	1
Warranty / Defect Liability Period	0	0	0	0	0	12 (1–12)	0	0	12

Implementation

Appendix 10-2

	2014	2015	2016	2017	2018	2019	2020	2021	Month
Appraisal									1
Pledge									1
Signing of Loan Agreement									1
Selection of Engineering Consulting Services									10
Engineering and Bidding Period									15
Land Acquisition	0	1	12	2	0	0	0	0	15
Construction period	0	0	0	12	12	0	0	0	24
	0	0	0	0	0	0	0	0	0
Package 01: Construction of Tranmission Line(Project 1-5)	0	0	0	12	12	0	0	0	24
1. Project 1: Construction of 220/132kV Kirindiwela SwS and 220/33kV Kirindiwela GS with related 132kV and 220kV TLs	0	0	0	12	12	0	0	0	24
1.1 Double In & Out Connection from 220kV Biyagama - Kotmale TL	0	0	0	0	12	0	0	0	12
1.2 Construction of 220kV Veyangoda - Kirindiwela TL	0	0	0	12	12	0	0	0	24
1.3 Construction of 400kV Kirindiwela - Padduka TL	0	0	0	12	12	0	0	0	24
1.4 Construction of 132kV Kirindiwela - Kosgama TL	0	0	0	12	12	0	0	0	24
1.5 Equipment for Transmission Line	0	0	0	12	12	0	0	0	24
2. Project 2: Construction of 132kV Thulhiriya - Veyangoda TL	0	0	0	12	12	0	0	0	24
2.1 Tulhiriya-Veyangoda 132kV transmission line	0	0	0	12	12	0	0	0	24
2.2 Augmentation of Tulhiriya Grid Substation	0	0	0	12	12	0	0	0	24
#REF!	0	0	0	12	12	0	0	0	24
#REF!	0	0	0	0	12	0	0	0	12
4. Project 4: Capacity Enhancement of 132kV Kolonnawa - Pannipitiya TL	0	0	0	12	12	0	0	0	24
5. Project 5: Capacity Enhancement of 132kV Pannipitiya - Ratmalana TL	0	0	0	12	12	0	0	0	24
5.1 Re-construction of 132kV Pannipitiya - Rathmalana TL	0	0	0	12	12	0	0	0	24
	0	0	0	0	0	0	0	0	0
Package 02:Construction of Grid Substation(Project 1-7)	0	0	0	12	12	0	0	0	24
1. Project 1: Construction of 220/132kV Kirindiwela SwS and 220/33kV Kirindiwela GS with related 132kV and 220kV TLs	0	0	0	12	12	0	0	0	24
1.1 Construction of 220/132kV Kirindiwela SwS	0	0	0	12	12	0	0	0	24
1.2 Construction of 220/33kV Kirindiwela GS	0	0	0	12	12	0	0	0	24
1.3 Modification of Existing 220kV Protection and Control Facilities at Biyagama and Kotmale GSs	0	0	0	12	12	0	0	0	24
1.4 Construction of 220kV Veyangoda - Kirindiwela TL	0	0	0	12	12	0	0	0	24
1.5 Construction of 400kV Kirindiwela - Padduka TL	0	0	0	12	12	0	0	0	24
1.6 Augmentation of 132kV/33kV Kosgama GS	0	0	0	12	12	0	0	0	24
1.7 Augmentation of 132kV/33kV Seethawaka GS	0	0	0	12	12	0	0	0	24
1.8 Vehicle and Equipment for Substation	0	0	0	12	12	0	0	0	24
2. Project 2: Construction of 132kV Thulhiriya - Veyangoda TL	0	0	0	12	12	0	0	0	24
2.1 Augmentation of Tulhiriya Grid Substation	0	0	0	12	12	0	0	0	24
2.2 Augmentation of Veyangoda Grid Substation	0	0	0	12	12	0	0	0	24
3. Project 3: Construction of 132/33kV Battaramulla GS	0	0	0	12	12	0	0	0	24
3.1 Construction of 132kV/33kV Battaramulla GS	0	0	0	12	12	0	0	0	24
3.3 Modification of Existing 132kV Protection and Control Facilities at Kolonnawa and Athurugiriya GSs	0	0	0	12	12	0	0	0	24
4. Project 5: Capacity Enhancement of 132kV Pannipitiya - Ratmalana TL	0	0	0	12	12	0	0	0	24
4.1 Augmentation of 132kV/33kV Ratmalana GS	0	0	0	12	12	0	0	0	24
4.2 Augmentation of 132kV/33kV Pannipitiya GS	0	0	0	12	12	0	0	0	24
5. Project 6: Construction of 220kV Kothmale – New Polpitiya TL	0	0	0	12	12	0	0	0	24
5.1 Kotmale GSS	0	0	0	12	12	0	0	0	24
6. Project 7: Capacity Enhancement of 132kV Polpitiya - New Habarana TL	0	0	0	12	12	0	0	0	24
6.1 Augmentation of Polpitiya PS	0	0	0	12	12	0	0	0	24
6.2 Augmentation of Ukuwela PS	0	0	0	12	12	0	0	0	24
6.3 Augmentation of Naula PS	0	0	0	12	12	0	0	0	24
	0	0	0	0	0	0	0	0	0
Package 03: Construction of Transmission Line(Project 6 and 7)	0	0	0	12	12	0	0	0	24
1. Project 6: Construction of 220kV Kothmale – New Polpitiya TL	0	0	0	12	12	0	0	0	24
1.1 Kotmale - New Polpitiya 220kV TL	0	0	0	12	12	0	0	0	24

2. Project 7: Capacity Enhancement of 132kV Polpitiya - New Habarana TL	0	0	0	12	12	0	0	0	24
2.1 Re-Construction of 132kV Polpitiya - Kiribathkumbura TL	0	0	0	12	12	0	0	0	24
2.2 Re-Construction of 132kV Kiribathkumbura - Ukuwela TL	0	0	0	12	12	0	0	0	24
2.3 Re-Construction of 132kV Ukuwela - New Habarana TL	0	0	0	12	12	0	0	0	24
2.4 Connect Naula GS to Ukuwela - New Habarana 132kV TL	0	0	0	12	12	0	0	0	24
	0	0	0	0	0	0	0	0	0
Package 04: Construction of Distribution Cables	0	0	0	12	12	0	0	0	24
1. Project 8: Underground Electricity Distribution Development Project in Dehiwala Mount Lavinia Area	0	0	0	12	12	0	0	0	24
2. Project 9: 11kV Underground Electricity Distribution Development Project at Battaramulla	0	0	0	12	12	0	0	0	24
	0	0	0	0	0	0	0	0	0
Warranty / Defect Liability Period	0	0	0	0	0	12	0	0	12
	0	0	0	0	0	0	0	0	0

Annual Fund Requirement

Base Year for Cost Estimation:	Aug, 2014					FC & Total:	million JPY
Exchange Rates	LKR = JPY	0.823		US$ 1 = = JPY	107.1	LC :	million LKR
Price Escalation:	FC: 2.0%	LC: 3.8%					
Physical Contingency	5%						
Physical Contingency for Consultant	5%						

Item	Total			2015			2016			2017			2018			2019			2020		
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
A. ELIGIBLE PORTION	Mill. JPY	Mill. LKR	Mill. JPY	Mill. JPY	Mill. LKR	Mill. JPY	Mill. JPY	Mill. LKR	Mill. JPY	Mill. JPY	Mill. LKR	Mill. JPY	Mill. JPY	Mill. LKR	Mill. JPY	Mill. JPY	Mill. LKR	Mill. JPY	Mill. JPY	Mill. LKR	Mill. JPY
Ⅰ) Procurement / Construction	18,030	6,792	23,620	0	0	0	0	0	0	8,926	3,333	11,669	9,104	3,459	11,952	0	0	0	0	0	0
Package 01: Construction of Tranmission Line(Project 1-5)	4,144	1,611	5,470	0	0	0	0	0	0	2,072	806	2,735	2,072	806	2,735	0	0	0	0	0	0
Package 02:Construction of Grid Substation(Project 1-7)	5,222	914	5,974	0	0	0	0	0	0	2,611	457	2,987	2,611	457	2,987	0	0	0	0	0	0
Package 03: Construction of Transmission Line(Project 6 and 7)	4,093	2,306	5,991	0	0	0	0	0	0	2,046	1,153	2,996	2,046	1,153	2,996	0	0	0	0	0	0
Package 04: Construction of Distribution Cables	2,563	845	3,258	0	0	0	0	0	0	1,281	422	1,629	1,281	422	1,629	0	0	0	0	0	0
Base cost for JICA financing	16,021	5,676	20,693	0	0	0	0	0	0	8,011	2,838	10,346	8,011	2,838	10,346	0	0	0	0	0	0
Price escalation	1,151	793	1,803	0	0	0	0	0	0	490	336	767	660	457	1,036	0	0	0	0	0	0
Physical contingency	859	323	1,125	0	0	0	0	0	0	425	159	556	434	165	569	0	0	0	0	0	0
Ⅱ) Consulting services	1,791	992	2,608	264	116	359	526	216	703	490	332	763	469	277	697	43	51	85	0	0	0
Base cost	1,617	848	2,315	246	107	334	481	191	638	440	283	672	412	228	600	37	40	70	0	0	0
Price escalation	89	97	169	5	4	8	19	15	32	27	33	54	34	37	64	4	8	11	0	0	0
Physical contingency	85	47	124	13	6	17	25	10	33	23	16	36	22	13	33	2	2	4	0	0	0
Total (Ⅰ + Ⅱ)	19,822	7,784	26,228	264	116	359	526	216	703	9,416	3,665	12,432	9,573	3,737	12,649	43	51	85	0	0	0
B. NON ELIGIBLE PORTION																					
a Procurement / Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Package 01: Construction of Tranmission Line(Project 1-5)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Package 02:Construction of Grid Substation(Project 1-7)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Package 03: Construction of Transmission Line(Project 6 and 7)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Package 04: Construction of Distribution Cables	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Base cost for Borrower financing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Price escalation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physical contingency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
b Land Acquisition	0	870	716	0	0	0	0	56	46	0	694	571	0	120	99	0	0	0	0	0	0
Base cost	0	739	608	0	0	0	0	49	41	0	591	486	0	98	81	0	0	0	0	0	0
Price escalation	0	90	74	0	0	0	0	4	3	0	70	58	0	16	13	0	0	0	0	0	0
Physical contingency	0	41	34	0	0	0	0	3	2	0	33	27	0	6	5	0	0	0	0	0	0
c Administration cost	0	327	269	0	4	4	0	9	7	0	158	130	0	155	127	0	1	1	0	0	0
d VAT	0	1,039	855	0	14	11	0	33	27	0	523	430	0	463	381	0	6	5	0	0	0
e Import Tax	0	2,890	2,379	0	38	32	0	77	63	0	1,373	1,130	0	1,396	1,149	0	6	5	0	0	0
Total (a+b+c+d+e)	0	5,126	4,219	0	57	47	0	174	143	0	2,748	2,262	0	2,134	1,756	0	13	11	0	0	0
TOTAL (A+B)	19,822	12,910	30,447	264	173	406	526	390	847	9,416	6,413	14,694	9,573	5,870	14,405	43	64	96	0	0	0
C. Interest during Construction	250	0	250	0	0	0	0	0	0	35	0	35	71	0	71	71	0	71	72	0	72
Interest during Construction(Const.)	249	0	249	0	0	0	0	0	0	35	0	35	71	0	71	71	0	71	71	0	71
Interest during Construction (Consul.)	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D. Front End Fee	53	0	53	53	0	53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GRAND TOTAL (A+B+C+D)	20,125	12,910	30,750	317	173	459	526	390	847	9,451	6,413	14,729	9,645	5,870	14,476	115	64	167	72	0	72
		M USD	287.11																		
E. JICA finance portion incl. IDC (A + C)	20,072	7,784	26,478	264	116	359	526	216	703	9,451	3,665	12,467	9,645	3,737	12,720	115	51	156	72	0	72
		M USD	**247.23**	**86.1%**		Consul	9.85%														

Administration Cost = 1%

VAT= 12% of the expenditure in local currency of the eligible portion

Import Tax= 12%

Cost Breakdown for Subproject

Package 1	US $	=JPY	107.1
Package 2	LKR	=JPY	0.823
Package 3	Ratio of YEN Loan		100

item	unit	Quantity	Unit Price		Cost		Total	(Reference) Total	
			Foreign	Local	Foreign	Local			
			JPY	LKR	JPY	LKR	JPY	LKR	USD
1. Project 1: Construction of 220/132kV Kirindiwela SwS and 220/33kV Kirindiwela GS with related 132kV and 220kV TLs					**5,954,711,165**	**1,494,640,000**	**7,184,799,885**	**8,730,012,011**	**67,084,966**
1.1 Construction of 220/132kV Kirindiwela SwS									
1) 220/132kV 150MVA Transformer & E.Tr. & Aux. Tr.	sets	2	245,155,240	32,970,000	490,310,480	65,940,000	544,579,100	661,700,000	5,084,772
2) 220kV Double Busbar Type for Transformer Bay	sets	2	45,470,750	5,210,000	90,941,500	10,420,000	99,517,160	120,920,000	929,199
3) 220 kV Double Busbar Type for Line Bay	sets	8	58,194,330	5,110,000	465,554,640	40,880,000	499,198,880	606,560,000	4,661,054
4) 220 kV Double Busbar Arrangement including Bus Coupler Bay	set	1	60,235,370	5,120,000	60,235,370	5,120,000	64,449,130	78,310,000	601,766
5) 132 kV Single Busbar Type for Transformer Bay	sets	2	27,636,340	5,350,000	55,272,680	10,700,000	64,078,780	77,860,000	598,308
6) 132 kV Single Busbar Type for Line Bay	sets	2	25,628,220	5,550,000	51,256,440	11,100,000	60,391,740	73,380,000	563,882
7) 132 kV Single Busbar Arrangement including Bus Coupler Bay	set	1	41,495,660	4,320,000	41,495,660	4,320,000	45,051,020	54,740,000	420,644
8) Common Items 220/132kV for Protection, AC/DC Sys., Grounding, Civil Works, Building, Materials, etc.	lot	1	230,226,020	141,410,000	230,226,020	141,410,000	346,606,450	421,150,000	3,236,288
9) Substation Automation System	lot	1	50,342,910	610,000	50,342,910	610,000	50,844,940	61,780,000	474,743
10) Spare Parts (7%)	lot				107,492,030	20,340,000	124,231,850	150,950,000	1,159,961
1.2 Construction of 220/33kV Kirindiwela GS									
1) 220/33kV 45MVA Transformer & E.Tr. & Aux. Tr.	sets	2	157,711,490	21,210,000	315,422,980	42,420,000	350,334,640	425,680,000	3,271,098
2) 220kV Double Busbar Type for Transformer Bay	sets	2	45,470,750	5,210,000	90,941,500	10,420,000	99,517,160	120,920,000	929,199
3) 33kV Single Busbar Type for Transformer Bay	sets	2	17,019,640	170,000	34,039,280	340,000	34,319,100	41,700,000	320,440
4) 33kV Single Busbar Type for Feeder Bay	sets	12	13,826,400	130,000	165,916,800	1,560,000	167,200,680	203,160,000	1,561,164
5) 33kV Single Busbar Arrangement including Bus Section Bay	set	1	15,579,390	160,000	15,579,390	160,000	15,711,070	19,090,000	146,695
6) Common Items 220/33 kV for Protection, AC/DC Sys., Grounding, Civil Works, Building, Materials, etc.	lot	1	187,150,200	118,350,000	187,150,200	118,350,000	284,552,250	345,750,000	2,656,884
7) Substation Automation System	lot	1	50,342,910	610,000	50,342,910	610,000	50,844,940	61,780,000	474,743
8) Spare Parts	lot				60,161,300	12,170,000	70,177,210	85,270,000	655,249
1.3 Double In & Out Connection from 220kV Biyagama - Kotmale TL									
1) 220kV 2cct TL (2xZebra)	km	1	35,397,230	17,300,000	35,397,230	17,300,000	49,635,130	60,310,000	463,447
1.4 Modification of Existing 220kV Protection and Control Facilities at Biyagama and Kotmale GSs									
1) Protection & Control Panels for 220kV Line Bays	sets	4	10,945,900	30,000	43,783,600	120,000	43,882,360	53,320,000	409,733
1.5 Construction of 220kV Veyangoda - Kirindiwela TL									
1) 220kV 2cct TL (2xLL-ACSR Zebra-eq)	km	17.5	38,397,230	17,300,000	671,951,525	302,750,000	921,114,775	1,119,216,009	8,600,511
2) 220kV Double Busbar Line Bay at Veyangoda GS	sets	2	58,194,330	5,110,000	116,388,660	10,220,000	124,799,720	151,640,000	1,165,263
3) Existing tower removal	sets	2		30,000	0	60,000	49,380	60,000	461
1.6 Construction of 220kV Kirindiwela - Padukka TL									
1) 400kV 2cct TL (4xZebra)	km	20	95,640,830	26,170,000	1,912,816,600	523,400,000	2,343,574,800	2,847,600,000	21,882,118
2) 220kV Double Busbar Line Bay at Padukka	set	2	58,194,330	5,110,000	116,388,660	10,220,000	124,799,720	151,640,000	1,165,263
1.7 Construction of 132kV Kirindiwela - Kosgama TL									
1) 132kV 2cct TL (1xLL-ACSR Zebra-eq)	km	10	19,301,490	11,070,000	193,014,900	110,700,000	284,121,000	345,226,002	2,652,857
1.8 Augmentation of 132kV/33kV Kosgama GS									
1) 132kV Single Busbar Type for Line Bay	sets	2	25,628,220	5,550,000	51,256,440	11,100,000	60,391,740	73,380,000	563,882
2) 132kV Bus Section Bay	set	1	25,307,250	4,240,000	25,307,250	4,240,000	28,796,770	34,990,000	268,877
3) 132kV Circuit Breakers	sets	4	4,172,610	30,000	16,690,440	120,000	16,789,200	20,400,000	156,762
4) 132kV isolaters with earth switch	sets	2	1,349,720	20,000	2,699,440	40,000	2,732,360	3,320,000	25,512
5) 132kV isolaters	sets	4	855,920	10,000	3,423,680	40,000	3,456,600	4,200,000	32,275
6) 33kV isolaters with earth switch	sets	8	839,460	40,000	6,715,680	320,000	6,979,040	8,480,000	65,164
7) 33kV isolaters	sets	12	839,460	40,000	10,073,520	480,000	10,468,560	12,720,000	97,746
8) 33kV Single Busbar Arrangement including Bus Setion Bay	set	1	15,579,390	160,000	15,579,390	160,000	15,711,070	19,090,000	146,695
9) 110V Battery System	set	1	10,048,830	190,000	10,048,830	190,000	10,205,200	12,400,000	95,287
10) Battery Charger for 110V Battery System	sets	2	4,304,290	80,000	8,608,580	160,000	8,740,260	10,620,000	81,608
11) Automatic Voltage Regulator for Transformer	sets	2	3,538,900	210,000	7,077,800	420,000	7,423,460	9,020,000	69,313
12) Protection & control panels for 132kV line bays	sets	2	9,250,520	70,000	18,501,040	140,000	18,616,260	22,620,000	173,821
13) Protection & control panels for 132kV transformer bays	sets	2	7,983,100	260,000	15,966,200	520,000	16,394,160	19,920,000	153,073
14) Substation Automation System	sets	1	50,342,910	610,000	50,342,910	610,000	50,844,940	61,780,000	474,743
1.9 Augmentation of 132kV/33kV Seethawaka GS									
1) 132kV Double Busbar (Including Bus Coupler)	sets	1	41,495,660	4,320,000	41,495,660	4,320,000	45,051,020	54,740,000	420,644
2) Protection & control panels for 132kV line bays	sets	2	9,250,520	70,000	18,501,040	140,000	18,616,260	22,620,000	173,821
1.10 Vehicle and Equipment for Substation									
1) 10 ton lorry	unit	1	16,460,000	0	16,460,000	0	16,460,000	20,000,000	153,688
2) Online oil filtering plants	sets	3	6,584,000	0	19,752,000	0	19,752,000	24,000,000	184,426
3) Secondary injection sets	sets	3	6,584,000	0	19,752,000	0	19,752,000	24,000,000	184,426
4) Primary injection sets	sets	3	8,230,000	0	24,690,000	0	24,690,000	30,000,000	230,532
5) Disolve gas analyse	sets	3	8,230,000	0	24,690,000	0	24,690,000	30,000,000	230,532
1.11 Equipment for Transmission Line									
1) Live line tools (bare hand, including sticks)	sets	10	24,690,000	0	246,900,000	0	246,900,000	300,000,000	2,305,322

Cost Breakdown for Subproject

2. Project 2: Construction of Tulhiriya-Veyangoda 132kV TL with 2xZebra					734,840,240	405,810,000	1,068,821,870	1,298,690,000	9,979,663
2.1 Tulhiriya-Veyangoda 132kV transmission line									
1) 132kV 2cct TL (2xZebra)	km	28	23,480,190	13,840,000	657,445,320	387,520,000	976,374,280	1,186,360,000	9,116,473
2.2 Augmentation of Tulhiriya Grid Substation									
1) 132kV isolaters with earth switch	sets	2	1,349,720	20,000	2,699,440	40,000	2,732,360	3,320,000	25,512
2) 132kV isolaters	sets	4	855,920	10,000	3,423,680	40,000	3,456,600	4,200,000	32,275
3) 132kV Current Transformer [1 phase]	sets	6	1,045,210	20,000	6,271,260	120,000	6,370,020	7,740,000	59,477
4) Protection & control panels for 132kV line bays	sets	2	9,250,520	70,000	18,501,040	140,000	18,616,260	22,620,000	173,821
5) 132kV gantry for line termination	sets	2	10,863,600	8,800,000	21,727,200	17,600,000	36,212,000	44,000,000	338,114
6) 132kV Existing gantry removal	sets	2	0	30,000	0	60,000	49,380	60,000	461
7) 132kV Existing tower removal	sets	1	0	30,000	0	30,000	24,690	30,000	231
2.3 Augmentation of Veyangoda Grid Substation									
1) 132kV Current Transformer [1 phase]	sets	6	1,045,210	20,000	6,271,260	120,000	6,370,020	7,740,000	59,477
2) Protection & control panels for 132kV line bays	sets	2	9,250,520	70,000	18,501,040	140,000	18,616,260	22,620,000	173,821

Cost Breakdown for Subproject

Ratio of YEN Loan 100

item	unit	Quantity	Unit Price		Cost		Total	(Reference) Total	
			Foreign	Local	Foreign	Local			
			JPY	LKR	JPY	LKR	JPY	LKR	USD
3. Project 3: Construction of 132/33kV Battaramulla GS					1,225,670,856	263,086,000	1,442,190,634	1,752,358,000	13,465,832
3.1 Construction of 132kV/33kV Battaramulla GS									
1) 132/33kV 45MVA Transformers & E.Tr. & Aux. Tr.	sets	2	131,400,180	32,110,000	262,800,360	64,220,000	315,653,420	383,540,000	2,947,277
2) 132kV GIS Single Busbar Type for Transformer Bay (Indoor)	sets	2	57,099,740	1,570,000	114,199,480	3,140,000	116,783,700	141,900,000	1,090,417
3) 132kV GIS Single Busbar Type for Incoming LineBay (Indoor)	sets	4	57,437,170	1,740,000	229,748,680	6,960,000	235,476,760	286,120,000	2,198,663
4) 132kV GIS Single Busbar (including Bus Section)	set	1	59,371,220	2,060,000	59,371,220	2,060,000	61,066,600	74,200,000	570,183
5) 33kV GIS Single Busbar Type for Transformer Bay (Indoor)	sets	2	17,019,640	170,000	34,039,280	340,000	34,319,100	41,700,000	320,440
6) 33kV GIS Single Busbar Type for Bus Setion Bay (Indoor)	set	1	15,579,390	160,000	15,579,390	160,000	15,711,070	19,090,000	146,695
7) 33kV GIS Single Busbar Type for Feeder Bay (Indoor)	set	12	13,826,400	130,000	165,916,800	1,560,000	167,200,680	203,160,000	1,561,164
8) Common Items 132/33kV for Protection, AC/DC Sys., Grounding, Civil Works, Building, Materials, etc.	lot	1	170,130,560	161,390,000	170,130,560	161,390,000	302,954,530	368,110,000	2,828,707
9) Substation Automation System	lot	1	50,342,910	610,000	50,342,910	610,000	50,844,940	61,780,000	474,743
10) Spare Parts	lot				77,148,020	16,830,000	90,999,110	110,570,000	849,665
3.2 Double In & Out Connection from 132kV Kolonnawa - Athurugiriya TL									
1) 132kV 2cct TL (2xZebra)	km	0.4	23,480,190	13,840,000	9,392,076	5,536,000	13,948,204	16,948,000	130,235
3.3 Modification of Existing 132kV Protection and Control Facilities at Kolonnawa and Athurugiriya GSs									
1) 132kV protection & control facilities	sets	4	9,250,520	70,000	37,002,080	280,000	37,232,520	45,240,000	347,643
4. Project 4: Capacity Enhancement of 132kV Kolonnawa - Pannipitiya TL					248,989,221	177,762,000	395,287,347	480,300,543	3,690,825
1) 132kV 2cct TL (1xLL-ACSR Zebra-eq)	km	12.9	19,301,490	13,280,000	248,989,221	171,312,000	389,978,997	473,850,543	3,641,260
2) Existing Transmission Line Removal	km	12.9	0	500,000	0	6,450,000	5,308,350	6,450,000	49,564
5. Project 5: Capacity Enhancement of 132kV Pannipitiya - Ratmalana TL					644,633,022	159,410,000	775,827,452	942,682,202	7,243,954
5.1 Re-construction of 132kV Pannipitiya - Rathmalana TL									
1) 132kV 2cct TL (1xLL-ACSR Zebra-eq)	km	7	19,301,490	11,070,000	135,110,430	77,490,000	198,884,700	241,658,202	1,857,000
2) Existing Transmission Line Removal	km	7	0	500,000	0	3,500,000	2,880,500	3,500,000	26,895
3) 132kV 1cct TL (1xZebra) temporally line	km	1.2	14,089,760	8,300,000	16,907,712	9,960,000	25,104,792	30,504,000	234,405
4) 132kV temporally line Removal	km	1.2	0	500,000	0	600,000	493,800	600,000	4,611
5.2 Augmentation of 132kV/33kV Ratmalana GS									
1) 132kV Circuit Breakers	sets	3	4,172,610	30,000	12,517,830	90,000	12,591,900	15,300,000	117,571
2) 132kV isolaters	sets	9	855,920	10,000	7,703,280	90,000	7,777,350	9,450,000	72,618
3) 132kV Protection & Control Panels for Line Bays	sets	2	9,250,520	70,000	18,501,040	140,000	18,616,260	22,620,000	173,821
4)132kV Protection & Control Panels for Transformer Bays	sets	3	7,983,100	260,000	23,949,300	780,000	24,591,240	29,880,000	229,610
5) 132kV Protection & Control Panels for Bus Coupler Bay	set	1	7,900,800	60,000	7,900,800	60,000	7,950,180	9,660,000	74,231
6) 33kV isolaters with Earth Switch	sets	4	839,460	40,000	3,357,840	160,000	3,489,520	4,240,000	32,582
7) 132kV Current Transformer [1 phase]	sets	6	1,045,210	20,000	6,271,260	120,000	6,370,020	7,740,000	59,477
8) Common Items 132/33 kV for Protection, AC/DC Sys., Grounding, Civil Works, Building, Materials, etc.	lot	1	96,834,180	58,610,000	96,834,180	58,610,000	145,070,210	176,270,000	1,354,530
9) Substation Automation System	lot	1	50,342,910	610,000	50,342,910	610,000	50,844,940	61,780,000	474,743
10) Spare Parts					15,916,820	4,250,000	19,414,570	23,590,000	181,275
5.3 Augmentation of 132kV/33kV Pannipitiya GS									
1) 132kV Circuit Breakers	sets	9	4,172,610	30,000	37,553,490	270,000	37,775,700	45,900,000	352,714
2) 132kV Protection & Control Panels for Line Bays	sets	9	9,250,520	70,000	83,254,680	630,000	83,773,170	101,790,000	782,196
3) 132kV Protection & Control Panels for Transformer Bays	sets	3	7,983,100	260,000	23,949,300	780,000	24,591,240	29,880,000	229,610
4) 132kV Protection & Control Panels for Bus Coupler Bay	set	1	7,900,800	60,000	7,900,800	60,000	7,950,180	9,660,000	74,231
5) 132kV Voltage Transformers (1 Phase)	sets	36	938,220	10,000	33,775,920	360,000	34,072,200	41,400,000	318,134
6) 132kV Current Transformer [1 Phase]	sets	12	1,045,210	20,000	12,542,520	240,000	12,740,040	15,480,000	118,955
7) Substation Automation System	lot	1	50,342,910	610,000	50,342,910	610,000	50,844,940	61,780,000	474,743

Cost Breakdown for Subproject

Ratio of YEN Loan 100

item	unit	Quantity	Unit Price Foreign	Unit Price Local	Cost Foreign	Cost Local	Total	(Reference) Total	
			JPY	LKR	JPY	LKR	JPY	LKR	USD
6. Project 6: Construction of 220kV Kothmale – New Polpitiya TL					**1,012,577,730**	**421,580,000**	**1,359,538,070**	**1,651,929,611**	**12,694,100**
6.1 Kotmale - New Polpitiya 220kV TL									
1) 220kV 2cct TL (2xLL-ACSR Zebra-eq)	km	23	38,397,230	17,300,000	883,136,290	397,900,000	1,210,607,990	1,470,969,611	11,303,529
6.2 Kotmale GSS									
1) 220kV one-and-half breaker line bays	sets	2	64,720,720	5,790,000	129,441,440	11,580,000	138,971,780	168,860,000	1,297,589
2) Existing 132kV bay Removal	set	1	0	1,100,000	0	1,100,000	905,300	1,100,000	8,453
3) Common Items	set	1	0	11,000,000	0	11,000,000	9,053,000	11,000,000	84,528
7. Project 7: Capacity Enhancement of 132kV Polpitiya - New Habarana TL					**3,209,830,890**	**1,909,030,000**	**4,780,962,580**	**5,809,189,040**	**44,640,173**
7.1 Re-Construction of 132kV Polpitiya - Kiribathkumbura TL									
1) 132kV 2cct TL (1xLL-ACSR Zebra-eq)	km	52	19,301,490	11,070,000	1,003,677,480	575,640,000	1,477,429,200	1,795,175,213	13,794,857
2) Existing Transmission Line Removal	km	52	0	500,000	0	26,000,000	21,398,000	26,000,000	199,795
7.2 Re-Construction of 132kV Kiribathkumbura - Ukuwela TL									
1) 132kV 2cct TL (1xLL-ACSR Zebra-eq)	km	30	19,301,490	11,070,000	579,044,700	332,100,000	852,363,000	1,035,678,007	7,958,571
2) Existing Transmission Line Removal	km	30	0	500,000	0	15,000,000	12,345,000	15,000,000	115,266
7.3 Re-Construction of 132kV Ukuwela - New Habarana TL									
1) 132kV 2cct TL (1xLL-ACSR Zebra-eq)	km	82	19,301,490	11,070,000	1,582,722,180	907,740,000	2,329,792,200	2,830,853,220	21,753,429
2) Existing Transmission Line Removal	km	82	0	500,000	0	41,000,000	33,743,000	41,000,000	315,061
7.4 Connect Naula GS to Ukuwela - New Habarana 132kV TL									
1) 132kV 2cct TL (1xLL-ACSR Zebra-eq) (Naula - Uku Hab line)	km	1	19,301,490	11,070,000	19,301,490	11,070,000	28,412,100	34,522,600	265,286
7.5 Augmentation of Polpitiya PS									
1) 132kV Current Transformer [1 phase]	sets	6	1,045,210	20,000	6,271,260	120,000	6,370,020	7,740,000	59,477
7.6 Augmentation of Ukuwela PS									
1) 132kV Current Transformer [1 phase]	sets	12	1,045,210	20,000	12,542,520	240,000	12,740,040	15,480,000	118,955
7.7 Augmentation of Naula PS									
1) 132kV Current Transformer [1 phase]	sets	6	1,045,210	20,000	6,271,260	120,000	6,370,020	7,740,000	59,477
7.8. Dispute Board Fee					**25,061,400**	**0**	**25,061,400**	**30,451,276**	**234,000**
1) Dispute Board Fee	set	1	25,061,400		25,061,400	0	25,061,400	30,451,276	234,000
							0	0	0
Total					**4,247,470,020**	**2,330,610,000**	**6,165,562,050**	**7,491,569,927**	**57,568,273**

Ratio of YEN Loan 100

item	unit	Quantity	Unit Price Foreign	Unit Price Local	Cost Foreign	Cost Local	Total		
			JPY	LKR	JPY	LKR	JPY	LKR	USD
8. Project 8: Underground Electricity Distribution Development Project in Dehiwala Mount Lavinia Area					**1,184,203,961**	**302,470,000**	**1,433,136,771**	**1,741,356,951**	**13,381,296**
1) No. 2x10MVA – Primary Substation 33kV/11kV - GIS	lot	1	253,484,000	52,000,000	253,484,000	52,000,000	296,280,000	360,000,000	2,766,387
2) No. 2x5MVA – Primary Substation 33kV/11kV - GIS	lot	1	207,396,000	48,000,000	207,396,000	48,000,000	246,900,000	300,000,000	2,305,322
3) Installation of 33kV/XLPE/Cu/3C/240mm2 UG Cable	lot	1	269,133,345	47,300,000	269,133,345	47,300,000	308,061,245	374,315,000	2,876,389
4) Construction of 11kV RSS	lot	1	44,442,000	18,000,000	44,442,000	18,000,000	59,256,000	72,000,000	553,277
5) Installation of 11kV/XLPE/Cu/3C/240mm2 UG Cable	lot	1	142,613,967	80,370,000	142,613,967	80,370,000	208,758,477	253,655,500	1,949,192
6) Replacing old UG Cable by 11kV/XLPE/Cu/3C/240mm2 UG Cable	lot	1	35,386,943	21,000,000	35,386,943	21,000,000	52,669,943	63,997,500	491,783
7) 11kV/XLPE/Cu/3C/95mm2 Cable to connect existing 11kV line	lot	1	27,405,900	28,500,000	27,405,900	28,500,000	50,861,400	61,800,000	474,896
8) Utility vehicle for distribution of work	lot	1	27,159,000	0	27,159,000	0	27,159,000	33,000,000	253,585
9) Tools and Equipment to maintain UG Network	lot	1	14,780,258	0	14,780,258	0	14,780,258	17,959,001	138,004
10) Switching Arrangements	lot	1	23,611,829	4,300,000	23,611,829	4,300,000	27,150,729	32,989,950	253,508
11) SCADA System fiber optic cabling,GPRS Modems and switches	lot	1	137,144,720	0	137,144,720	0	137,144,720	166,640,000	1,280,530
12) Training of CEB staff on Maintenance of UG System including fault location, jointing etc	lot	1	1,646,000	3,000,000	1,646,000	3,000,000	4,115,000	5,000,000	38,422
9. Project 9: 11kV Underground Electricity Distribution Development Project at Battaramulla					**1,378,353,436**	**542,310,416**	**1,824,674,908**	**2,217,101,954**	**17,037,114**
1) 33/11 kV Primary Substation at Koswatta	lot	1	240,192,550	91,000,000	240,192,550	91,000,000	315,085,550	382,850,000	2,941,975
2) 11 kV Radial Substation	lot	1	87,408,773	11,201,400	87,408,773	11,201,400	96,627,525	117,408,900	902,218
3) 240 mm2/3C 33 kV XLPE Cable from Densil Kobbekaduwa Mw to PSS at Koswatta	lot	1	43,611,707	10,751,279	43,611,707	10,751,279	52,460,009	63,742,417	489,823
4) 400 mm2/3C 11 kV XLPE Connecting Primary Substations and Radial Substations	lot	1	108,965,858	10,040,270	108,965,858	10,040,270	117,229,000	142,441,070	1,094,575
5) 240 mm2/3C 11 kV XLPE Connecting Primary Substations and Radial Substations	lot	1	84,944,217	34,462,547	84,944,217	34,462,547	113,306,893	137,675,447	1,057,954
6) 95 mm2/3C 11 kV XLPE to interconnection between Radial Substation and 11 kV distributors	lot	1	85,027,175	88,117,903	85,027,175	88,117,903	157,548,210	191,431,603	1,471,038
7) Laying of Optical Fiber Cables	lot	1	16,295,400	4,500,000	16,295,400	4,500,000	19,998,900	24,300,000	186,731
8) Replacement of 33 kV Substations with 11 kV compact substations	lot	1	342,505,853	25,598,160	342,505,853	25,598,160	363,573,138	441,765,660	3,394,707
9) 11 kV indoor substations	lot	1	30,245,250	9,660,840	30,245,250	9,660,840	38,196,121	46,410,840	356,640
10) Anticipated UG LV Network	lot	1	53,732,847	164,978,016	53,732,847	164,978,016	189,509,754	230,267,016	1,769,465

Cost Breakdown for Subproject

11) Specialized vehicle for distribution of work	lot	1	27,159,000	0	27,159,000	0	27,159,000	33,000,000	253,585
12) Equipment and tools for distribution of work	lot	1	14,780,257	0	14,780,257	0	14,780,257	17,959,000	138,004
13) 33/11kV Primary Substation at Pelavatta	lot	1	240,192,550	91,000,000	240,192,550	91,000,000	315,085,550	382,850,000	2,941,975
14) Training	lot	1	3,292,000	1,000,000	3,292,000	1,000,000	4,115,000	5,000,000	38,422

Training Center Ratio of YEN Loan 100

item	unit	Quantity	Unit Price		Cost		Total		
			Foreign	Local	Foreign	Local			
			yen	LKR	yen	LKR	yen	LKR	USD
1)Procurement of Software Simulation Models – Power Station and Grid Substation	set	1	0	0	0	0	0	0	0
2)Procurement of Advanced Training Models – Generation, Transmission and Distribution	set	1	0	0	0	0	0	0	0
3)Construction and establishment of an Administrative Complex and a Gymnasium	set	1	0	0	0	0	0	0	0
Total					**0**	**0**	**0**	**0**	**0**

Cost Breakdown for Package

US $	=JPY	107.1
LKR	=JPY	0.823

item	Local	Total	(Reference) Total	
	LKR	JPY	LKR	USD
Land Acquisition Cost	738,708,609	607,957,185	738,708,609	5,676,538

Package 01: Construction of Tranmission Line(Project 1-5) Ratio of YEN Loan 100

item	unit	Quantity	Unit Price		Cost		Total	(Reference) Total	
			Foreign	Local	Foreign	Local			
			JPY	LKR	JPY	LKR	JPY	LKR	USD
1. Project 1: Construction of 220/132kV Kirindiwela SwS and 220/33kV Kirindiwela GS with related 132kV and 220kV TLs					**3,060,080,255**	**954,210,000**	**3,845,395,085**	**4,672,412,011**	**35,904,716**
1.1 Double In & Out Connection from 220kV Biyagama - Kotmale TL									
1) 220kV 2cct TL (2xZebra)	km	1	35,397,230	17,300,000	35,397,230	17,300,000	49,635,130	60,310,000	463,447
1.2 Construction of 220kV Veyangoda - Kirindiwela TL									
1) 220kV 2cct TL (2xLL-ACSR Zebra-eq)	km	18	38,397,230	17,300,000	671,951,525	302,750,000	921,114,775	1,119,216,009	8,600,511
2) Existing tower removal	sets	2	0	30,000	0	60,000	49,380	60,000	461
1.3 Construction of 400kV Kirindiwela - Padduka TL									
1) 400kV 2cct TL (4xZebra)	km	20	95,640,830	26,170,000	1,912,816,600	523,400,000	2,343,574,800	2,847,600,000	21,882,118
1.4 Construction of 132kV Kirindiwela - Kosgama TL									
1) 132kV 2cct TL (1xLL-ACSR Zebra-eq)	km	10	19,301,490	11,070,000	193,014,900	110,700,000	284,121,000	345,226,002	2,652,857
1.5 Equipment for Transmission Line									
1) Live line tools (bare hand, including sticks)	sets	10	24,690,000	0	246,900,000	0	246,900,000	300,000,000	2,305,322
2. Project 2: Construction of 132kV Thulhiriya - Veyangoda TL					**657,445,320**	**387,550,000**	**976,398,970**	**1,186,390,000**	**9,116,704**
2.1 Tulhiriya-Veyangoda 132kV transmission line									
1) 132kV 2cct TL (2xZebra)	km	28	23,480,190	13,840,000	657,445,320	387,520,000	976,374,280	1,186,360,000	9,116,473
2.2 Augmentation of Tulhiriya Grid Substation									
7) 132kV Existing tower removal	sets	1	0	30,000	0	30,000	24,690	30,000	231
4. Project 4: Capacity Enhancement of 132kV Kolonnawa - Pannipitiya TL					**248,989,221**	**177,762,000**	**395,287,347**	**480,300,543**	**3,690,825**
1) 132kV 2cct TL (1xLL-ACSR Zebra-eq)	km	13	19,301,490	13,280,000	248,989,221	171,312,000	389,978,997	473,850,543	3,641,260
2) Existing Transmission Line Removal	km	13	0	500,000	0	6,450,000	5,308,350	6,450,000	49,564
5. Project 5: Capacity Enhancement of 132kV Pannipitiya - Ratmalana TL					**152,018,142**	**91,550,000**	**227,363,792**	**276,262,202**	**2,122,911**
5.1 Re-construction of 132kV Pannipitiya - Rathmalana TL									
1) 132kV 2cct TL (1xLL-ACSR Zebra-eq)	km	7	19,301,490	11,070,000	135,110,430	77,490,000	198,884,700	241,658,202	1,857,000
2) Existing Transmission Line Removal	km	7	0	500,000	0	3,500,000	2,880,500	3,500,000	26,895
3) 132kV 1cct TL (1xZebra) temporally line	km	1	14,089,760	8,300,000	16,907,712	9,960,000	25,104,792	30,504,000	234,405
4) 132kV temporally line Removal	km	1	0	500,000	0	600,000	493,800	600,000	4,611
6. Dispute Board Fee					**25,061,400**	**0**	**25,061,400**	**30,451,276**	**234,000**
1) Dispute Board Fee	set	1	25,061,400	0	25,061,400	0	25,061,400	30,451,276	234,000
Total					**4,143,594,338**	**1,611,072,000**	**5,469,506,594**	**6,645,816,032**	**51,069,156**

Cost Breakdown for Package

Package 02:Construction of Grid Substation(Project 1-7) Ratio of YEN Loan 100

item	unit	Quantity	Unit Price		Cost		Total	(Reference) Total	
			Foreign	Local	Foreign	Local			
			JPY	LKR	JPY	LKR	JPY	LKR	USD
1. Project 1: Construction of 220/132kV Kirindiwela SwS and 220/33kV Kirindiwela GS with related 132kV and 220kV TLs					**3,246,874,910**	**540,430,000**	**3,691,648,800**	**4,485,600,000**	**34,469,176**
1.1 Construction of 220/132kV Kirindiwela SwS									
1) 220/132kV 150MVA Transformer & E.Tr. & Aux. Tr.	sets	2	245,155,240	32,970,000	490,310,480	65,940,000	544,579,100	661,700,000	5,084,772
2) 220kV Double Busbar Type for Transformer Bay	sets	2	45,470,750	5,210,000	90,941,500	10,420,000	99,517,160	120,920,000	929,199
3) 220 kV Double Busbar Type for Line Bay	sets	8	58,194,330	5,110,000	465,554,640	40,880,000	499,198,880	606,560,000	4,661,054
4) 220 kV Double Busbar Arrangement including Bus Coupler Bay	set	1	60,235,370	5,120,000	60,235,370	5,120,000	64,449,130	78,310,000	601,766
5) 132 kV Single Busbar Type for Transformer Bay	sets	2	27,636,340	5,350,000	55,272,680	10,700,000	64,078,780	77,860,000	598,308
6) 132 kV Single Busbar Type for Line Bay	sets	2	25,628,220	5,550,000	51,256,440	11,100,000	60,391,740	73,380,000	563,882
7) 132 kV Single Busbar Arrangement including Bus Coupler Bay	set	1	41,495,660	4,320,000	41,495,660	4,320,000	45,051,020	54,740,000	420,644
8) Common Items 220/132kV for Protection, AC/DC Sys., Grounding, Civil Works, Building, Materials, etc.	lot	1	230,226,020	141,410,000	230,226,020	141,410,000	346,606,450	421,150,000	3,236,288
9) Substation Automation System	lot	1	50,342,910	610,000	50,342,910	610,000	50,844,940	61,780,000	474,743
10) Spare Parts (7%)	lot	0	0	0	107,492,030	20,340,000	124,231,850	150,950,000	1,159,961
1.2 Construction of 220/33kV Kirindiwela GS									
1) 220/33kV 45MVA Transformer & E.Tr. & Aux. Tr.	sets	2	157,711,490	21,210,000	315,422,980	42,420,000	350,334,640	425,680,000	3,271,098
2) 220kV Double Busbar Type for Transformer Bay	sets	2	45,470,750	5,210,000	90,941,500	10,420,000	99,517,160	120,920,000	929,199
3) 33kV Single Busbar Type for Transformer Bay	sets	2	17,019,640	170,000	34,039,280	340,000	34,319,100	41,700,000	320,440
4) 33kV Single Busbar Type for Feeder Bay	sets	12	13,826,400	130,000	165,916,800	1,560,000	167,200,680	203,160,000	1,561,164
5) 33kV Single Busbar Arrangement including Bus Section Bay	set	1	15,579,390	160,000	15,579,390	160,000	15,711,070	19,090,000	146,695
6) Common Items 220/33 kV for Protection, AC/DC Sys., Grounding, Civil Works, Building, Materials, etc.	lot	1	187,150,200	118,350,000	187,150,200	118,350,000	284,552,250	345,750,000	2,656,884
7) Substation Automation System	lot	1	50,342,910	610,000	50,342,910	610,000	50,844,940	61,780,000	474,743
8) Spare Parts	lot	0	0	0	60,161,300	12,170,000	70,177,210	85,270,000	655,249
1.3 Modification of Existing 220kV Protection and Control Facilities at Biyagama and Kotmale GSs									
1) Protection & Control Panels for 220kV Line Bays	sets	4	10,945,900	30,000	43,783,600	120,000	43,882,360	53,320,000	409,733
1.4 Construction of 220kV Veyangoda - Kirindiwela TL									
1) 220kV Double Busbar Line Bay at Veyangoda GS	sets	2	58,194,330	5,110,000	116,388,660	10,220,000	124,799,720	151,640,000	1,165,263
1.5 Construction of 400kV Kirindiwela - Padduka TL									
1) 220kV Double Busbar Line Bay at Padukka	set	2	58,194,330	5,110,000	116,388,660	10,220,000	124,799,720	151,640,000	1,165,263
1.6 Augmentation of 132kV/33kV Kosgama GS									
1) 132kV Single Busbar Type for Line Bay	sets	2	25,628,220	5,550,000	51,256,440	11,100,000	60,391,740	73,380,000	563,882
2) 132kV Bus Section Bay	set	1	25,307,250	4,240,000	25,307,250	4,240,000	28,796,770	34,990,000	268,877
3) 132kV Circuit Breakers	sets	4	4,172,610	30,000	16,690,440	120,000	16,789,200	20,400,000	156,762
4) 132kV isolaters with earth switch	sets	2	1,349,720	20,000	2,699,440	40,000	2,732,360	3,320,000	25,512
5) 132kV isolaters	sets	4	855,920	10,000	3,423,680	40,000	3,456,600	4,200,000	32,275
6) 33kV isolaters with earth switch	sets	8	839,460	40,000	6,715,680	320,000	6,979,040	8,480,000	65,164
7) 33kV isolaters	sets	12	839,460	40,000	10,073,520	480,000	10,468,560	12,720,000	97,746
8) 33kV Single Busbar Arrangement including Bus Setion Bay	set	1	15,579,390	160,000	15,579,390	160,000	15,711,070	19,090,000	146,695
9) 110V Battery System	set	1	10,048,830	190,000	10,048,830	190,000	10,205,200	12,400,000	95,287
10) Battery Charger for 110V Battery System	sets	2	4,304,290	80,000	8,608,580	160,000	8,740,260	10,620,000	81,608
11) Automatic Voltage Regulator for Transformer	sets	2	3,538,900	210,000	7,077,800	420,000	7,423,460	9,020,000	69,313
12) Protection & control panels for 132kV line bays	sets	2	9,250,520	70,000	18,501,040	140,000	18,616,260	22,620,000	173,821
13) Protection & control panels for 132kV transformer bays	sets	2	7,983,100	260,000	15,966,200	520,000	16,394,160	19,920,000	153,073
14) Substation Automation System	sets	1	50,342,910	610,000	50,342,910	610,000	50,844,940	61,780,000	474,743
1.7 Augmentation of 132kV/33kV Seethawaka GS									
1) 132kV Double Busbar (Including Bus Coupler)	sets	1	41,495,660	4,320,000	41,495,660	4,320,000	45,051,020	54,740,000	420,644
2) Protection & control panels for 132kV line bays	sets	2	9,250,520	70,000	18,501,040	140,000	18,616,260	22,620,000	173,821
1.8 Vehicle and Equipment for Substation									
1) 10 ton lorry	unit	1	16,460,000	0	16,460,000	0	16,460,000	20,000,000	153,688
2) Online oil filtering plants	sets	3	6,584,000	0	19,752,000	0	19,752,000	24,000,000	184,426
3) Secondary injection sets	sets	3	6,584,000	0	19,752,000	0	19,752,000	24,000,000	184,426
4) Primary injection sets	sets	3	8,230,000	0	24,690,000	0	24,690,000	30,000,000	230,532
5) Disolve gas analyse	sets	3	8,230,000	0	24,690,000	0	24,690,000	30,000,000	230,532
2. Project 2: Construction of 132kV Thulhiriya - Veyangoda TL					**77,394,920**	**18,260,000**	**92,422,900**	**112,300,000**	**862,959**
2.1 Augmentation of Tulhiriya Grid Substation									
1) 132kV isolaters with earth switch	sets	2	1,349,720	20,000	2,699,440	40,000	2,732,360	3,320,000	25,512
2) 132kV isolaters	sets	4	855,920	10,000	3,423,680	40,000	3,456,600	4,200,000	32,275
3) 132kV Current Transformer [1 phase]	sets	6	1,045,210	20,000	6,271,260	120,000	6,370,020	7,740,000	59,477
4) Protection & control panels for 132kV line bays	sets	2	9,250,520	70,000	18,501,040	140,000	18,616,260	22,620,000	173,821
5) 132kV gantry for line termination	sets	2	10,863,600	8,800,000	21,727,200	17,600,000	36,212,000	44,000,000	338,114
6) 132kV Existing gantry removal	sets	2	0	30,000	0	60,000	49,380	60,000	461
2.2 Augmentation of Veyangoda Grid Substation									
1) 132kV Current Transformer [1 phase]	sets	6	1,045,210	20,000	6,271,260	120,000	6,370,020	7,740,000	59,477
2) Protection & control panels for 132kV line bays	sets	2	9,250,520	70,000	18,501,040	140,000	18,616,260	22,620,000	173,821

Cost Breakdown for Package

3. Project 3: Construction of 132/33kV Battaramulla GS					**1,225,670,856**	**263,086,000**	**1,442,190,634**	**1,752,358,000**	**13,465,832**
3.1 Construction of 132kV/33kV Battaramulla GS									
1) 132/33kV 45MVA Transformers & E.Tr. & Aux. Tr.	sets	2	131,400,180	32,110,000	262,800,360	64,220,000	315,653,420	383,540,000	2,947,277
2) 132kV GIS Single Busbar Type for Transformer Bay (Indoor)	sets	2	57,099,740	1,570,000	114,199,480	3,140,000	116,783,700	141,900,000	1,090,417
3) 132kV GIS Single Busbar Type for Incoming LineBay (Indoor)	sets	4	57,437,170	1,740,000	229,748,680	6,960,000	235,476,760	286,120,000	2,198,663
4) 132kV GIS Single Busbar (including Bus Section)	set	1	59,371,220	2,060,000	59,371,220	2,060,000	61,066,600	74,200,000	570,183
5) 33kV GIS Single Busbar Type for Transformer Bay (Indoor)	sets	2	17,019,640	170,000	34,039,280	340,000	34,319,100	41,700,000	320,440
6) 33kV GIS Single Busbar Type for Bus Setion Bay (Indoor)	set	1	15,579,390	160,000	15,579,390	160,000	15,711,070	19,090,000	146,695
7) 33kV GIS Single Busbar Type for Feeder Bay (Indoor)	set	12	13,826,400	130,000	165,916,800	1,560,000	167,200,680	203,160,000	1,561,164
8) Common Items 132/33kV for Protection, AC/DC Sys., Grounding, Civil Works, Building, Materials, etc.	lot	1	170,130,560	161,390,000	170,130,560	161,390,000	302,954,530	368,110,000	2,828,707
9) Substation Automation System	lot	1	50,342,910	610,000	50,342,910	610,000	50,844,940	61,780,000	474,743
10) Spare Parts	lot	0	0	0	77,148,020	16,830,000	90,999,110	110,570,000	849,665
3.2 Double In & Out Connection from 132kV Kolonnawa - Athurugiriya TL									
1) 132kV 2cct TL (2xZebra)	km	0	23,480,190	13,840,000	9,392,076	5,536,000	13,948,204	16,948,000	130,235
3.3 Modification of Existing 132kV Protection and Control Facilities at Kolonnawa and Athurugiriya GSs									
1) 132kV protection & control facilities	sets	4	9,250,520	70,000	37,002,080	280,000	37,232,520	45,240,000	347,643
4. Project 5: Capacity Enhancement of 132kV Pannipitiya - Ratmalana TL					**492,614,880**	**67,860,000**	**548,463,660**	**666,420,000**	**5,121,043**
4.1 Augmentation of 132kV/33kV Ratmalana GS									
1) 132kV Circuit Breakers	sets	3	4,172,610	30,000	12,517,830	90,000	12,591,900	15,300,000	117,571
2) 132kV isolaters	sets	9	855,920	10,000	7,703,280	90,000	7,777,350	9,450,000	72,618
3) 132kV Protection & Control Panels for Line Bays	sets	2	9,250,520	70,000	18,501,040	140,000	18,616,260	22,620,000	173,821
4)132kV Protection & Control Panels for Transformer Bays	sets	3	7,983,100	260,000	23,949,300	780,000	24,591,240	29,880,000	229,610
5) 132kV Protection & Control Panels for Bus Coupler Bay	set	1	7,900,800	60,000	7,900,800	60,000	7,950,180	9,660,000	74,231
6) 33kV isolaters with Earth Switch	sets	4	839,460	40,000	3,357,840	160,000	3,489,520	4,240,000	32,582
7) 132kV Current Transformer [1 phase]	sets	6	1,045,210	20,000	6,271,260	120,000	6,370,020	7,740,000	59,477
8) Common Items 132/33 kV for Protection, AC/DC Sys., Grounding, Civil Works, Building, Materials, etc.	lot	1	96,834,180	58,610,000	96,834,180	58,610,000	145,070,210	176,270,000	1,354,530
9) Substation Automation System	lot	1	50,342,910	610,000	50,342,910	610,000	50,844,940	61,780,000	474,743
10) Spare Parts	0	0	0	0	15,916,820	4,250,000	19,414,570	23,590,000	181,275
4.2 Augmentation of 132kV/33kV Pannipitiya GS									
1) 132kV Circuit Breakers	sets	9	4,172,610	30,000	37,553,490	270,000	37,775,700	45,900,000	352,714
2) 132kV Protection & Control Panels for Line Bays	sets	9	9,250,520	70,000	83,254,680	630,000	83,773,170	101,790,000	782,196
3) 132kV Protection & Control Panels for Transformer Bays	sets	3	7,983,100	260,000	23,949,300	780,000	24,591,240	29,880,000	229,610
4) 132kV Protection & Control Panels for Bus Coupler Bay	set	1	7,900,800	60,000	7,900,800	60,000	7,950,180	9,660,000	74,231
5) 132kV Voltage Transformers (1 Phase)	sets	36	938,220	10,000	33,775,920	360,000	34,072,200	41,400,000	318,134
6) 132kV Current Transformer [1 Phase]	sets	12	1,045,210	20,000	12,542,520	240,000	12,740,040	15,480,000	118,955
7) Substation Automation System	lot	1	50,342,910	610,000	50,342,910	610,000	50,844,940	61,780,000	474,743
5. Project 6: Construction of 220kV Kothmale – New Polpitiya TL					**129,441,440**	**23,680,000**	**148,930,080**	**180,960,000**	**1,390,570**
5.1 Kotmale GSS									
1) 220kV one-and-half breaker line bays	sets	2	64,720,720	5,790,000	129,441,440	11,580,000	138,971,780	168,860,000	1,297,589
2) Existing 132kV bay Removal	set	1	0	1,100,000	0	1,100,000	905,300	1,100,000	8,453
3) Common Items	set	1	0	11,000,000	0	11,000,000	9,053,000	11,000,000	84,528
6. Project 7: Capacity Enhancement of 132kV Polpitiya - New Habarana TL					**25,085,040**	**480,000**	**25,480,080**	**30,960,000**	**237,909**
6.1 Augmentation of Polpitiya PS									
1) 132kV Current Transformer [1 phase]	sets	6	1,045,210	20,000	6,271,260	120,000	6,370,020	7,740,000	59,477
6.2 Augmentation of Ukuwela PS									
1) 132kV Current Transformer [1 phase]	sets	12	1,045,210	20,000	12,542,520	240,000	12,740,040	15,480,000	118,955
6.3 Augmentation of Naula PS									
1) 132kV Current Transformer [1 phase]	sets	6	1,045,210	20,000	6,271,260	120,000	6,370,020	7,740,000	59,477
7. Dispute Board Fee					**25,061,400**	**0**	**25,061,400**	**30,451,276**	**234,000**
1) Dispute Board Fee	set	1	25,061,400		25,061,400	0	25,061,400	30,451,276	234,000
							0	0	0
Total					**5,222,143,446**	**913,796,000**	**5,974,197,554**	**7,259,049,276**	**55,781,490**

Cost Breakdown for Package

Package 03: Construction of Transmission Line(Project 6 and 7) Ratio of YEN Loan 100

item	unit	Quantity	Unit Price		Cost		Total	(Reference) Total	
			Foreign	Local	Foreign	Local			
			JPY	LKR	JPY	LKR	JPY	LKR	USD
1. Project 6: Construction of 220kV Kothmale – New Polpitiya TL					**883,136,290**	**397,900,000**	**1,210,607,990**	**1,470,969,611**	**11,303,529**
1.1 Kotmale - New Polpitiya 220kV TL									
1) 220kV 2cct TL (2xLL-ACSR Zebra-eq)	km	23	38,397,230	17,300,000	883,136,290	397,900,000	1,210,607,990	1,470,969,611	11,303,529
2. Project 7: Capacity Enhancement of 132kV Polpitiya - New Habarana TL					**3,184,745,850**	**1,908,550,000**	**4,755,482,500**	**5,778,229,040**	**44,402,264**
2.1 Re-Construction of 132kV Polpitiya - Kiribathkumbura TL									
1) 132kV 2cct TL (1xLL-ACSR Zebra-eq)	km	52	19,301,490	11,070,000	1,003,677,480	575,640,000	1,477,429,200	1,795,175,213	13,794,857
2) Existing Transmission Line Removal	km	52	0	500,000	0	26,000,000	21,398,000	26,000,000	199,795
2.2 Re-Construction of 132kV Kiribathkumbura - Ukuwela TL									
1) 132kV 2cct TL (1xLL-ACSR Zebra-eq)	km	30	19,301,490	11,070,000	579,044,700	332,100,000	852,363,000	1,035,678,007	7,958,571
2) Existing Transmission Line Removal	km	30	0	500,000	0	15,000,000	12,345,000	15,000,000	115,266
2.3 Re-Construction of 132kV Ukuwela - New Habarana TL									
1) 132kV 2cct TL (1xLL-ACSR Zebra-eq)	km	82	19,301,490	11,070,000	1,582,722,180	907,740,000	2,329,792,200	2,830,853,220	21,753,429
2) Existing Transmission Line Removal	km	82	0	500,000	0	41,000,000	33,743,000	41,000,000	315,061
2.4 Connect Naula GS to Ukuwela - New Habarana 132kV TL									
1) 132kV 2cct TL (1xLL-ACSR Zebra-eq) (Naula - Uku Hab line)	km	1	19,301,490	11,070,000	19,301,490	11,070,000	28,412,100	34,522,600	265,286
3. Dispute Board Fee					**25,061,400**	**0**	**25,061,400**	**30,451,276**	**234,000**
1) Dispute Board Fee	set	1	25,061,400		25,061,400	0	25,061,400	30,451,276	234,000
							0	0	0
Total					**4,092,943,540**	**2,306,450,000**	**5,991,151,890**	**7,279,649,927**	**55,939,794**

Package 04: Construction of Distribution Cables Ratio of YEN Loan 100

item	unit	Quantity	Unit Price		Cost		Total		
			Foreign	Local	Foreign	Local			
			JPY	LKR	JPY	LKR	JPY	LKR	USD
1. Project 8: Underground Electricity Distribution Development Project in Dehiwala Mount Lavinia Area					**1,184,203,961**	**302,470,000**	**1,433,136,771**	**1,741,356,951**	**13,381,296**
1) No. 2x10MVA – Primary Substation 33kV/11kV - GIS	lot	1	253,484,000	52,000,000	253,484,000	52,000,000	296,280,000	360,000,000	2,766,387
2) No. 2x5MVA – Primary Substation 33kV/11kV - GIS	lot	1	207,396,000	48,000,000	207,396,000	48,000,000	246,900,000	300,000,000	2,305,322
3) Installation of 33kV/XLPE/Cu/3C/240mm2 UG Cable	lot	1	269,133,345	47,300,000	269,133,345	47,300,000	308,061,245	374,315,000	2,876,389
4) Construction of 11kV RSS	lot	1	44,442,000	18,000,000	44,442,000	18,000,000	59,256,000	72,000,000	553,277
5) Installation of 11kV/XLPE/Cu/3C/240mm2 UG Cable	lot	1	142,613,967	80,370,000	142,613,967	80,370,000	208,758,477	253,655,500	1,949,192
6) Replacing old UG Cable by 11kV/XLPE/Cu/3C/240mm2 UG Cable	lot	1	35,386,943	21,000,000	35,386,943	21,000,000	52,669,943	63,997,500	491,783
7) 11kV/XLPE/Cu/3C/95mm2 Cable to connect existing 11kV line	lot	1	27,405,900	28,500,000	27,405,900	28,500,000	50,861,400	61,800,000	474,896
8) Utility vehicle for distribution of work	lot	1	27,159,000	0	27,159,000	0	27,159,000	33,000,000	253,585
9) Tools and Equipment to maintain UG Network	lot	1	14,780,258	0	14,780,258	0	14,780,258	17,959,001	138,004
10) Switching Arrangements	lot	1	23,611,829	4,300,000	23,611,829	4,300,000	27,150,729	32,989,950	253,508
11) SCADA System fiber optic cabling,GPRS Modems and switches	lot	1	137,144,720	0	137,144,720	0	137,144,720	166,640,000	1,280,530
12) Training of CEB staff on Maintenance of UG System including fault location, jointing etc.	lot	1	1,646,000	3,000,000	1,646,000	3,000,000	4,115,000	5,000,000	38,422
2. Project 9: 11kV Underground Electricity Distribution Development Project at Battaramulla					**1,378,353,436**	**542,310,416**	**1,824,674,908**	**2,217,101,954**	**17,037,114**
1) 33/11 kV Primary Substation at Koswatta	lot	1	240,192,550	91,000,000	240,192,550	91,000,000	315,085,550	382,850,000	2,941,975
2) 11 kV Radial Substation	lot	1	87,408,773	11,201,400	87,408,773	11,201,400	96,627,525	117,408,900	902,218
3) 240 mm2/3C 33 kV XLPE Cable from Densil Kobbekaduwa Mw to PSS at Koswatta	lot	1	43,611,707	10,751,279	43,611,707	10,751,279	52,460,009	63,742,417	489,823
4) 400 mm2/3C 11 kV XLPE Connecting Primary Substations and Radial Substations	lot	1	108,965,858	10,040,270	108,965,858	10,040,270	117,229,000	142,441,070	1,094,575
5) 240 mm2/3C 11 kV XLPE Connecting Primary Substations and Radial Substations	lot	1	84,944,217	34,462,547	84,944,217	34,462,547	113,306,893	137,675,447	1,057,954
6) 95 mm2/3C 11 kV XLPE to interconnection between Radial Substation and 11 kV distributors	lot	1	85,027,175	88,117,903	85,027,175	88,117,903	157,548,210	191,431,603	1,471,038
7) Laying of Optical Fiber Cables	lot	1	16,295,400	4,500,000	16,295,400	4,500,000	19,998,900	24,300,000	186,731
8) Replacement of 33 kV Substations with 11 kV compact substations	lot	1	342,505,853	25,598,160	342,505,853	25,598,160	363,573,138	441,765,660	3,394,707
9) 11 kV indoor substations	lot	1	30,245,250	9,660,840	30,245,250	9,660,840	38,196,121	46,410,840	356,640
10) Anticipated UG LV Network	lot	1	53,732,847	164,978,016	53,732,847	164,978,016	189,509,754	230,267,016	1,769,465
11) Specialized vehicle for distribution of work	lot	1	27,159,000	0	27,159,000	0	27,159,000	33,000,000	253,585
12) Equipment and tools for distribution of work	lot	1	14,780,257	0	14,780,257	0	14,780,257	17,959,000	138,004
13) 33/11kV Primary Substation at Pelawatta	lot	1	240,192,550	91,000,000	240,192,550	91,000,000	315,085,550	382,850,000	2,941,975
14) Training	lot	1	3,292,000	1,000,000	3,292,000	1,000,000	4,115,000	5,000,000	38,422
3. Dispute Board Fee					**0**	**0**	**0**	**0**	**0**
1) Dispute Board Fee	set	1			0	0	0	0	0
							0	0	0
Total					**2,562,557,396**	**844,780,416**	**3,257,811,679**	**3,958,458,905**	**30,418,410**

Package 05: Training Center Ratio of YEN Loan 100

Cost Breakdown for Package

item	unit	Quantity	Unit Price		Cost		Total		
			Foreign	Local	Foreign	Local			
			yen	LKR	yen	LKR	yen	LKR	USD
1)Procurement of Software Simulation Models – Power Station and Grid Substation	set	1	0	0	0	0	0	0	0
2)Procurement of Advanced Training Models – Generation, Transmission and Distribution	set	1	0	0	0	0	0	0	0
3)Construction and establishment of an Administrative Complex and a Gymnasium	set	1	0	0	0	0	0	0	0
4)Training of Academic Staff	set	0	0	0	0	0	0	0	0
Total					**0**	**0**	**0**	**0**	**0**

Appendix 14

Cost Estimate for Dispute Board

Construction Period	24	Months
Warranty Period	12	Months

Cost estimate for the regular Site visits is shown below:

Cost Category	For 1 DB member for calculation purpose			1-Person DB
Monthly Retainer Fee	Fee 3,000 USD	Const Period x 24 Months	=	USD **72,000**
Monthly Retainer during DNP	Fee 2,000 USD	Const Period x 12 Months	=	USD **24,000**
Daily fee for Site Visits (3 days for Site visit, 1 day x 2 for travel)	Fee 3,000 USD	Const Period x 5 Days (3+2)	x 6 Times (1Nos/4 months) =	USD **90,000**
Site Visit Expenses (Air tickets, accommodation, etc.)	Fee 1,000 USD	Const Period x 6 Times (1Nos/4 months)	=	USD **6,000**
Sub-Total (1)				**192,000**

Cost estimate for the referrals is shown below:

Cost Category	For 1 DB member for calculation purpose			1-Person DB
Additional Daily Fee at Regular Site Visits	Fee 3,000 USD	Const Period x 1 Days	x 2 Times =	USD 6,000
Additional Daily Fee at Regular Site Visits	Fee 3,000 USD	Const Period x 6 Days (3+3)	x 2 Times =	USD 36,000
Sub-Total (2)				**42,000**

Total		**234,000**

Project 1: Construction of 220/132kV Kirindiwela SwS and 220/33kV Kirindiwela GS with related 132kV and 220kV TLs

Economic Internal Rate of Return **(Unit: Mill LKR)**

S. NO.	FISICAL YEAR	CAPITAL OUTFLOW: CAPITAL EXPEN-DITURE	CAPITAL OUTFLOW: O&M COST	CAPITAL OUTFLOW: OUTFLOW TOTAL	CASH INFLOW: SAVINGS DUE TO LOSS REDUCTION	CASH INFLOW: INFLOW TOTAL	NET CASH FLOW
	1	2	3	4=2+3	5	6=5	7=6-4
	2015	134.49		134.49			-134.49
	2016	258.47		258.47			-258.47
	2017	4351.64		4351.64			-4351.64
	2018	4325.97		4325.97			-4325.97
1	2019	26.31	87.30	113.61	263.30	263.30	149.69
2	2020		87.30	87.30	284.23	284.23	196.93
3	2021		87.30	87.30	306.84	306.84	219.54
4	2022		87.30	87.30	331.24	331.24	243.94
5	2023		87.30	87.30	357.58	357.58	270.28
6	2024		87.30	87.30	386.01	386.01	298.71
7	2025		87.30	87.30	416.71	416.71	329.41
8	2026		87.30	87.30	449.85	449.85	362.55
9	2027		87.30	87.30	485.62	485.62	398.32
10	2028		87.30	87.30	524.23	524.23	436.93
11	2029		87.30	87.30	565.92	565.92	478.62
12	2030		87.30	87.30	610.92	610.92	523.62
13	2031		87.30	87.30	659.51	659.51	572.21
14	2032		87.30	87.30	659.51	659.51	572.21
15	2033		87.30	87.30	659.51	659.51	572.21
16	2034		87.30	87.30	659.51	659.51	572.21
17	2035		87.30	87.30	659.51	659.51	572.21
18	2036		87.30	87.30	659.51	659.51	572.21
19	2037		87.30	87.30	659.51	659.51	572.21
20	2038		87.30	87.30	659.51	659.51	572.21
21	2039		87.30	87.30	659.51	659.51	572.21
22	2040		87.30	87.30	659.51	659.51	572.21
23	2041		87.30	87.30	659.51	659.51	572.21
24	2042		87.30	87.30	659.51	659.51	572.21
25	2043		87.30	87.30	659.51	659.51	572.21
26	2044		87.30	87.30	659.51	659.51	572.21
27	2045		87.30	87.30	659.51	659.51	572.21
28	2046		87.30	87.30	659.51	659.51	572.21
29	2047		87.30	87.30	659.51	659.51	572.21
30	2048		87.30	87.30	659.51	659.51	572.21
	TOTAL	**9,096.87**	**2,619.00**	**11,715.88**	**16,853.56**	**16,853.56**	**5,137.68**

EIRR= 2.60%

Project 2: Construction of 132kV Thulhiriya - Veyangoda TL

Economic Internal Rate of Return (Unit: Mill LKR)

S. NO.	FISICAL YEAR	CAPITAL OUTFLOW			CASH INFLOW		NET CASH FLOW
		CAPITAL EXPEN-DITURE	O&M COST	OUTFLOW TOTAL	SAVINGS DUE TO LOSS REDUCTION	INFLOW TOTAL	
	1	2	3	4=2+3	5	6=5	7=6-4
	2015	20.53		20.53			-20.53
	2016	38.93		38.93			-38.93
	2017	641.57		641.57			-641.57
	2018	636.37		636.37			-636.37
1	2019	4.73	12.99	17.71	40.98	40.98	23.27
2	2020		12.99	12.99	44.24	44.24	31.26
3	2021		12.99	12.99	47.76	47.76	34.78
4	2022		12.99	12.99	51.56	51.56	38.57
5	2023		12.99	12.99	55.66	55.66	42.67
6	2024		12.99	12.99	60.09	60.09	47.10
7	2025		12.99	12.99	64.86	64.86	51.88
8	2026		12.99	12.99	70.02	70.02	57.04
9	2027		12.99	12.99	75.59	75.59	62.60
10	2028		12.99	12.99	81.60	81.60	68.62
11	2029		12.99	12.99	88.09	88.09	75.10
12	2030		12.99	12.99	95.10	95.10	82.11
13	2031		12.99	12.99	102.66	102.66	89.67
14	2032		12.99	12.99	110.82	110.82	97.84
15	2033		12.99	12.99	119.64	119.64	106.65
16	2034		12.99	12.99	129.15	129.15	116.16
17	2035		12.99	12.99	139.42	139.42	126.43
18	2036		12.99	12.99	150.51	150.51	137.52
19	2037		12.99	12.99	162.47	162.47	149.49
20	2038		12.99	12.99	175.39	175.39	162.41
21	2039		12.99	12.99	189.34	189.34	176.35
22	2040		12.99	12.99	204.40	204.40	191.41
23	2041		12.99	12.99	220.65	220.65	207.67
24	2042		12.99	12.99	238.20	238.20	225.21
25	2043		12.99	12.99	257.14	257.14	244.15
26	2044		12.99	12.99	277.59	277.59	264.60
27	2045		12.99	12.99	299.66	299.66	286.68
28	2046		12.99	12.99	323.49	323.49	310.50
29	2047		12.99	12.99	349.22	349.22	336.23
30	2048		12.99	12.99	376.99	376.99	364.00
	TOTAL	**1,342.12**	**389.61**	**1,731.73**	**4,602.30**	**4,602.30**	**2,870.58**

EIRR= 5.84%

Project 3: Construction of 132/33kV Battaramulla GS

Economic Internal Rate of Return (Unit: Mill LKR)

S. NO.	FISICAL YEAR	CAPITAL OUTFLOW			CASH INFLOW		NET CASH FLOW
		CAPITAL EXPEN-DITURE	O&M COST	OUTFLOW TOTAL	SAVINGS DUE TO LOSS REDUCTION	INFLOW TOTAL	
	1	2	3	4=2+3	5	6=5	7=6-4
	2015	26.89		26.89			-26.89
	2016	51.78		51.78			-51.78
	2017	874.66		874.66			-874.66
	2018	869.79		869.79			-869.79
1	2019	5.12	17.52	22.64	19.87	19.87	-2.77
2	2020		17.52	17.52	21.45	21.45	3.93
3	2021		17.52	17.52	23.16	23.16	5.63
4	2022		17.52	17.52	25.00	25.00	7.48
5	2023		17.52	17.52	26.99	26.99	9.46
6	2024		17.52	17.52	29.13	29.13	11.61
7	2025		17.52	17.52	31.45	31.45	13.93
8	2026		17.52	17.52	33.95	33.95	16.43
9	2027		17.52	17.52	36.65	36.65	19.13
10	2028		17.52	17.52	39.56	39.56	22.04
11	2029		17.52	17.52	42.71	42.71	25.19
12	2030		17.52	17.52	46.11	46.11	28.58
13	2031		17.52	17.52	49.77	49.77	32.25
14	2032		17.52	17.52	53.73	53.73	36.21
15	2033		17.52	17.52	58.00	58.00	40.48
16	2034		17.52	17.52	58.00	58.00	40.48
17	2035		17.52	17.52	58.00	58.00	40.48
18	2036		17.52	17.52	58.00	58.00	40.48
19	2037		17.52	17.52	58.00	58.00	40.48
20	2038		17.52	17.52	58.00	58.00	40.48
21	2039		17.52	17.52	58.00	58.00	40.48
22	2040		17.52	17.52	58.00	58.00	40.48
23	2041		17.52	17.52	58.00	58.00	40.48
24	2042		17.52	17.52	58.00	58.00	40.48
25	2043		17.52	17.52	58.00	58.00	40.48
26	2044		17.52	17.52	58.00	58.00	40.48
27	2045		17.52	17.52	58.00	58.00	40.48
28	2046		17.52	17.52	58.00	58.00	40.48
29	2047		17.52	17.52	58.00	58.00	40.48
30	2048		17.52	17.52	58.00	58.00	40.48
	TOTAL	**1,828.24**	**525.71**	**2,353.95**	**1,407.62**	**1,407.62**	**-946.33**

EIRR= -3.48%

Project 4: Capacity Enhancement of 132kV Kolonnawa - Pannipitiya TL

Economic Internal Rate of Return (Unit: Mill LKR)

S. NO.	FISICAL YEAR	CAPITAL OUTFLOW			CASH INFLOW		NET CASH FLOW
		CAPITAL EXPEN-DITURE	O&M COST	OUTFLOW TOTAL	SAVINGS DUE TO LOSS REDUCTION	INFLOW TOTAL	
	1	2	3	4=2+3	5	6=5	7=6-4
	2015	7.67		7.67			-7.67
	2016	14.47		14.47			-14.47
	2017	236.40		236.40			-236.40
	2018	234.27		234.27			-234.27
1	2019	1.87	4.80	6.67	32.91	32.91	26.24
2	2020		4.80	4.80	35.53	35.53	30.73
3	2021		4.80	4.80	38.35	38.35	33.55
4	2022		4.80	4.80	38.35	38.35	33.55
5	2023		4.80	4.80	38.35	38.35	33.55
6	2024		4.80	4.80	38.35	38.35	33.55
7	2025		4.80	4.80	38.35	38.35	33.55
8	2026		4.80	4.80	38.35	38.35	33.55
9	2027		4.80	4.80	38.35	38.35	33.55
10	2028		4.80	4.80	38.35	38.35	33.55
11	2029		4.80	4.80	38.35	38.35	33.55
12	2030		4.80	4.80	38.35	38.35	33.55
13	2031		4.80	4.80	38.35	38.35	33.55
14	2032		4.80	4.80	38.35	38.35	33.55
15	2033		4.80	4.80	38.35	38.35	33.55
16	2034		4.80	4.80	38.35	38.35	33.55
17	2035		4.80	4.80	38.35	38.35	33.55
18	2036		4.80	4.80	38.35	38.35	33.55
19	2037		4.80	4.80	38.35	38.35	33.55
20	2038		4.80	4.80	38.35	38.35	33.55
21	2039		4.80	4.80	38.35	38.35	33.55
22	2040		4.80	4.80	38.35	38.35	33.55
23	2041		4.80	4.80	38.35	38.35	33.55
24	2042		4.80	4.80	38.35	38.35	33.55
25	2043		4.80	4.80	38.35	38.35	33.55
26	2044		4.80	4.80	38.35	38.35	33.55
27	2045		4.80	4.80	38.35	38.35	33.55
28	2046		4.80	4.80	38.35	38.35	33.55
29	2047		4.80	4.80	38.35	38.35	33.55
30	2048		4.80	4.80	38.35	38.35	33.55
	TOTAL	**494.68**	**144.09**	**638.77**	**1,142.37**	**1,142.37**	**503.60**

EIRR= 4.98%

Project 5: Capacity Enhancement of 132kV Pannipitiya - Ratmalana TL

Economic Internal Rate of Return **(Unit: Mill LKR)**

S. NO.	FISICAL YEAR	CAPITAL OUTFLOW			CASH INFLOW		NET CASH FLOW
		CAPITAL EXPEN-DITURE	O&M COST	OUTFLOW TOTAL	SAVINGS DUE TO LOSS REDUCTION	INFLOW TOTAL	
	1	2	3	4=2+3	5	6=5	7=6-4
	2015	14.52		14.52			-14.52
	2016	27.90		27.90			-27.90
	2017	469.96		469.96			-469.96
	2018	467.20		467.20			-467.20
1	2019	2.83	9.43	12.26	4.97	4.97	-7.29
2	2020		9.43	9.43	5.36	5.36	-4.06
3	2021		9.43	9.43	5.79	5.79	-3.64
4	2022		9.43	9.43	6.25	6.25	-3.18
5	2023		9.43	9.43	6.75	6.75	-2.68
6	2024		9.43	9.43	7.28	7.28	-2.14
7	2025		9.43	9.43	7.86	7.86	-1.56
8	2026		9.43	9.43	8.49	8.49	-0.94
9	2027		9.43	9.43	9.16	9.16	-0.26
10	2028		9.43	9.43	9.89	9.89	0.46
11	2029		9.43	9.43	10.68	10.68	1.25
12	2030		9.43	9.43	11.53	11.53	2.10
13	2031		9.43	9.43	12.44	12.44	3.02
14	2032		9.43	9.43	13.43	13.43	4.01
15	2033		9.43	9.43	14.50	14.50	5.07
16	2034		9.43	9.43	15.65	15.65	6.23
17	2035		9.43	9.43	16.90	16.90	7.47
18	2036		9.43	9.43	18.24	18.24	8.82
19	2037		9.43	9.43	19.69	19.69	10.27
20	2038		9.43	9.43	21.26	21.26	11.83
21	2039		9.43	9.43	22.95	22.95	13.52
22	2040		9.43	9.43	24.78	24.78	15.35
23	2041		9.43	9.43	26.75	26.75	17.32
24	2042		9.43	9.43	28.87	28.87	19.45
25	2043		9.43	9.43	31.17	31.17	21.74
26	2044		9.43	9.43	33.65	33.65	24.22
27	2045		9.43	9.43	36.32	36.32	26.90
28	2046		9.43	9.43	39.21	39.21	29.78
29	2047		9.43	9.43	42.33	42.33	32.90
30	2048		9.43	9.43	42.33	42.33	32.90
	TOTAL	**982.42**	**282.80**	**1,265.22**	**554.49**	**554.49**	**-710.73**

EIRR= -4.72%

Project 6: Construction of 220kV Kothmale – New Polpitiya TL

Economic Internal Rate of Return (Unit: Mill LKR)

S. NO.	FISICAL YEAR	CAPITAL OUTFLOW			CASH INFLOW		NET CASH FLOW
		CAPITAL EXPEN-DITURE	O&M COST	OUTFLOW TOTAL	SAVINGS DUE TO LOSS REDUCTION	INFLOW TOTAL	
	1	2	3	4=2+3	5	6=5	7=6-4
	2015	25.84		25.84			-25.84
	2016	49.27		49.27			-49.27
	2017	819.06		819.06			-819.06
	2018	813.15		813.15			-813.15
1	2019	5.59	16.52	22.11	168.91	168.91	146.80
2	2020		16.52	16.52	182.34	182.34	165.82
3	2021		16.52	16.52	196.84	196.84	180.32
4	2022		16.52	16.52	212.49	212.49	195.97
5	2023		16.52	16.52	229.39	229.39	212.87
6	2024		16.52	16.52	247.63	247.63	231.11
7	2025		16.52	16.52	267.32	267.32	250.80
8	2026		16.52	16.52	288.58	288.58	272.06
9	2027		16.52	16.52	311.53	311.53	295.01
10	2028		16.52	16.52	336.30	336.30	319.78
11	2029		16.52	16.52	363.04	363.04	346.53
12	2030		16.52	16.52	391.91	391.91	375.39
13	2031		16.52	16.52	423.08	423.08	406.56
14	2032		16.52	16.52	456.72	456.72	440.20
15	2033		16.52	16.52	493.04	493.04	476.52
16	2034		16.52	16.52	532.25	532.25	515.73
17	2035		16.52	16.52	574.57	574.57	558.06
18	2036		16.52	16.52	620.27	620.27	603.75
19	2037		16.52	16.52	620.27	620.27	603.75
20	2038		16.52	16.52	620.27	620.27	603.75
21	2039		16.52	16.52	620.27	620.27	603.75
22	2040		16.52	16.52	620.27	620.27	603.75
23	2041		16.52	16.52	620.27	620.27	603.75
24	2042		16.52	16.52	620.27	620.27	603.75
25	2043		16.52	16.52	620.27	620.27	603.75
26	2044		16.52	16.52	620.27	620.27	603.75
27	2045		16.52	16.52	620.27	620.27	603.75
28	2046		16.52	16.52	620.27	620.27	603.75
29	2047		16.52	16.52	620.27	620.27	603.75
30	2048		16.52	16.52	620.27	620.27	603.75
	TOTAL	**1,712.92**	**495.58**	**2,208.50**	**13,739.40**	**13,739.40**	**11,530.91**

EIRR= 14.58%

Project 7: Capacity Enhancement of 132kV Polpitiya - New Habarana TL

Economic Internal Rate of Return **(Unit: Mill LKR)**

S. NO.	FISICAL YEAR	CAPITAL OUTFLOW			CASH INFLOW		NET CASH FLOW
		CAPITAL EXPEN-DITURE	O&M COST	OUTFLOW TOTAL	SAVINGS DUE TO LOSS REDUCTION	INFLOW TOTAL	
	1	2	3	4=2+3	5	6=5	7=6-4
	2015	92.09		92.09			-92.09
	2016	174.40		174.40			-174.40
	2017	2866.84		2866.84			-2866.84
	2018	2842.87		2842.87			-2842.87
1	2019	21.56	58.09	79.65	213.62	213.62	133.97
2	2020		58.09	58.09	230.61	230.61	172.51
3	2021		58.09	58.09	248.94	248.94	190.85
4	2022		58.09	58.09	268.74	268.74	210.65
5	2023		58.09	58.09	268.74	268.74	210.65
6	2024		58.09	58.09	268.74	268.74	210.65
7	2025		58.09	58.09	268.74	268.74	210.65
8	2026		58.09	58.09	268.74	268.74	210.65
9	2027		58.09	58.09	268.74	268.74	210.65
10	2028		58.09	58.09	268.74	268.74	210.65
11	2029		58.09	58.09	268.74	268.74	210.65
12	2030		58.09	58.09	268.74	268.74	210.65
13	2031		58.09	58.09	268.74	268.74	210.65
14	2032		58.09	58.09	268.74	268.74	210.65
15	2033		58.09	58.09	268.74	268.74	210.65
16	2034		58.09	58.09	268.74	268.74	210.65
17	2035		58.09	58.09	268.74	268.74	210.65
18	2036		58.09	58.09	268.74	268.74	210.65
19	2037		58.09	58.09	268.74	268.74	210.65
20	2038		58.09	58.09	268.74	268.74	210.65
21	2039		58.09	58.09	268.74	268.74	210.65
22	2040		58.09	58.09	268.74	268.74	210.65
23	2041		58.09	58.09	268.74	268.74	210.65
24	2042		58.09	58.09	268.74	268.74	210.65
25	2043		58.09	58.09	268.74	268.74	210.65
26	2044		58.09	58.09	268.74	268.74	210.65
27	2045		58.09	58.09	268.74	268.74	210.65
28	2046		58.09	58.09	268.74	268.74	210.65
29	2047		58.09	58.09	268.74	268.74	210.65
30	2048		58.09	58.09	268.74	268.74	210.65
	TOTAL	**5,997.75**	**1,742.76**	**7,740.51**	**7,949.14**	**7,949.14**	**208.63**

EIRR= 0.21%

Project 8: Underground Electricity Distribution Development Project in Dehiwala Mount Lavinia Area

Economic Internal Rate of Return **(Unit: Mill LKR)**

S. NO.	FISICAL YEAR	CAPITAL OUTFLOW			CASH INFLOW				NET CASH FLOW
		CAPITAL EXPEN-DITURE	O&M COST	OUTFLOW TOTAL	SAVINGS DUE TO LOSS REDUCTION	BENEFIT OF UNSERVED ENERGY	BENEFIT OF AVOIDED DEMAND SUPPRESSION	INFLOW TOTAL	
	1	2	3	4=2+3	5	6	7	8=5+6+7	9=8-4
	2015	26.84		26.84					-26.84
	2016	51.57		51.57					-51.57
	2017	867.88		867.88					-867.88
	2018	862.72		862.72					-862.72
1	2019	5.27	17.41	22.68	26.22	118.05	495.34	639.62	616.94
2	2020		17.41	17.41	29.72	125.16	1040.10	1194.98	1177.57
3	2021		17.41	17.41	33.37	132.70	1617.55	1783.62	1766.21
4	2022		17.41	17.41	37.51	140.69	2229.64	2407.84	2390.43
5	2023		17.41	17.41	42.27	149.17	2878.46	3069.90	3052.49
6	2024		17.41	17.41	47.52	158.16	3566.22	3771.89	3754.48
7	2025		17.41	17.41	52.35	167.64	4292.02	4512.01	4494.59
8	2026		17.41	17.41	57.67	177.70	4292.02	4527.39	4509.97
9	2027		17.41	17.41	63.52	188.37	4292.02	4543.91	4526.49
10	2028		17.41	17.41	69.98	199.67	4292.02	4561.66	4544.25
11	2029		17.41	17.41	77.09	211.65	4292.02	4580.75	4563.34
12	2030		17.41	17.41	84.92	224.35	4292.02	4601.28	4583.87
13	2031		17.41	17.41	93.55	237.81	4292.02	4623.37	4605.96
14	2032		17.41	17.41	103.05	252.08	4292.02	4647.15	4629.73
15	2033		17.41	17.41	113.52	267.20	4292.02	4672.74	4655.33
16	2034		17.41	17.41	125.06	283.23	4292.02	4700.31	4682.89
17	2035		17.41	17.41	125.06	283.23	4292.02	4700.31	4682.89
18	2036		17.41	17.41	125.06	283.23	4292.02	4700.31	4682.89
19	2037		17.41	17.41	125.06	283.23	4292.02	4700.31	4682.89
20	2038		17.41	17.41	125.06	283.23	4292.02	4700.31	4682.89
21	2039		17.41	17.41	125.06	283.23	4292.02	4700.31	4682.89
22	2040		17.41	17.41	125.06	283.23	4292.02	4700.31	4682.89
23	2041		17.41	17.41	125.06	283.23	4292.02	4700.31	4682.89
24	2042		17.41	17.41	125.06	283.23	4292.02	4700.31	4682.89
25	2043		17.41	17.41	125.06	283.23	4292.02	4700.31	4682.89
26	2044		17.41	17.41	125.06	283.23	4292.02	4700.31	4682.89
27	2045		17.41	17.41	125.06	283.23	4292.02	4700.31	4682.89
28	2046		17.41	17.41	125.06	283.23	4292.02	4700.31	4682.89
29	2047		17.41	17.41	125.06	283.23	4292.02	4700.31	4682.89
30	2048		17.41	17.41	125.06	283.23	4292.02	4700.31	4682.89
	TOTAL	**1,814.27**	**522.41**	**2,336.68**	**2,808.14**	**6,998.87**	**114,835.69**	**124,642.71**	**122,306.03**

EIRR= 61.45%

Project 9: 11kV Underground Electricity Distribution Development Project at Battaramulla

Economic Internal Rate of Return **(Unit: Mill LKR)**

S. NO.	FISICAL YEAR	CAPITAL OUTFLOW			CASH INFLOW				NET CASH FLOW
		CAPITAL EXPEN-DITURE	O&M COST	OUTFLOW TOTAL	SAVINGS DUE TO LOSS REDUCTION	BENEFIT OF UNSERVED ENERGY	BENEFIT OF AVOIDED DEMAND SUPPRESSION	INFLOW TOTAL	
	1	2	3	4=2+3	5	6	7	8=5+6+7	9=8-4
	2015	34.62		34.62					-34.62
	2016	66.07		66.07					-66.07
	2017	1100.02		1100.02					-1100.02
	2018	1092.28		1092.28					-1092.28
1	2019	7.40	22.17	29.57	18.05	24.95	855.12	898.11	868.54
2	2020		22.17	22.17	18.70	27.93	990.87	1037.50	1015.33
3	2021		22.17	22.17	19.54	31.02	1129.14	1179.70	1157.53
4	2022		22.17	22.17	20.28	33.42	1271.01	1324.71	1302.54
5	2023		22.17	22.17	21.09	36.73	1415.02	1472.84	1450.67
6	2024		22.17	22.17	21.96	39.59	1562.27	1623.82	1601.65
7	2025		22.17	22.17	25.18	45.64	2119.85	2190.67	2168.50
8	2026		22.17	22.17	26.75	49.50	2383.13	2459.37	2437.20
9	2027		22.17	22.17	28.31	54.48	2646.41	2729.20	2707.03
10	2028		22.17	22.17	29.88	58.67	2909.69	2998.24	2976.07
11	2029		22.17	22.17	31.44	63.02	3172.97	3267.43	3245.26
12	2030		22.17	22.17	33.01	67.51	3436.25	3536.77	3514.59
13	2031		22.17	22.17	33.01	67.51	3436.25	3536.77	3514.59
14	2032		22.17	22.17	33.01	67.51	3436.25	3536.77	3514.59
15	2033		22.17	22.17	33.01	67.51	3436.25	3536.77	3514.59
16	2034		22.17	22.17	33.01	67.51	3436.25	3536.77	3514.59
17	2035		22.17	22.17	33.01	67.51	3436.25	3536.77	3514.59
18	2036		22.17	22.17	33.01	67.51	3436.25	3536.77	3514.59
19	2037		22.17	22.17	33.01	67.51	3436.25	3536.77	3514.59
20	2038		22.17	22.17	33.01	67.51	3436.25	3536.77	3514.59
21	2039		22.17	22.17	33.01	67.51	3436.25	3536.77	3514.59
22	2040		22.17	22.17	33.01	67.51	3436.25	3536.77	3514.59
23	2041		22.17	22.17	33.01	67.51	3436.25	3536.77	3514.59
24	2042		22.17	22.17	33.01	67.51	3436.25	3536.77	3514.59
25	2043		22.17	22.17	33.01	67.51	3436.25	3536.77	3514.59
26	2044		22.17	22.17	33.01	67.51	3436.25	3536.77	3514.59
27	2045		22.17	22.17	33.01	67.51	3436.25	3536.77	3514.59
28	2046		22.17	22.17	33.01	67.51	3436.25	3536.77	3514.59
29	2047		22.17	22.17	33.01	67.51	3436.25	3536.77	3514.59
30	2048		22.17	22.17	33.01	67.51	3436.25	3536.77	3514.59
	TOTAL	**2,300.38**	**665.13**	**2,965.52**	**888.29**	**1,747.64**	**85,744.22**	**88,380.14**	**85,414.63**

EIRR= 43.66%

All Project

Economic Internal Rate of Return (Unit: Mill LKR)

S. NO.	FISICAL YEAR	CAPITAL OUTFLOW				
		CAPITAL EXPEN-DITURE	O&M COST	OUTFLOW TOTAL	INFLOW TOTAL	NET CASH FLOW
	1	2	3	4=2+3	5	6=5-4
	2015	383.49		383.49		-383.49
	2016	732.87		732.87		-732.87
	2017	12228.01		12228.01		-12228.01
	2018	12144.61		12144.61		-12144.61
1	2019	80.68	246.24	326.91	2282.29	1955.38
2	2020		246.24	246.24	3036.25	2790.02
3	2021		246.24	246.24	3831.01	3584.77
4	2022		246.24	246.24	4666.18	4419.94
5	2023		246.24	246.24	5526.20	5279.96
6	2024		246.24	246.24	6432.95	6186.71
7	2025		246.24	246.24	7797.98	7551.74
8	2026		246.24	246.24	8144.74	7898.50
9	2027		246.24	246.24	8498.75	8252.52
10	2028		246.24	246.24	8858.59	8612.35
11	2029		246.24	246.24	9225.72	8979.48
12	2030		246.24	246.24	9600.71	9354.48
13	2031		246.24	246.24	9714.69	9468.46
14	2032		246.24	246.24	9785.22	9538.99
15	2033		246.24	246.24	9861.29	9615.05
16	2034		246.24	246.24	9938.73	9692.49
17	2035		246.24	246.24	9992.57	9746.33
18	2036		246.24	246.24	10050.69	9804.46
19	2037		246.24	246.24	10064.11	9817.87
20	2038		246.24	246.24	10078.60	9832.36
21	2039		246.24	246.24	10094.23	9848.00
22	2040		246.24	246.24	10111.12	9864.88
23	2041		246.24	246.24	10129.34	9883.10
24	2042		246.24	246.24	10149.01	9902.78
25	2043		246.24	246.24	10170.25	9924.02
26	2044		246.24	246.24	10193.18	9946.94
27	2045		246.24	246.24	10217.93	9971.69
28	2046		246.24	246.24	10244.65	9998.41
29	2047		246.24	246.24	10273.49	10027.25
30	2048		246.24	246.24	10301.26	10055.02
	TOTAL	**25,569.66**	**7,387.09**	**32,956.74**	**259,271.73**	**226,314.99**

EIRR= 18.97%

Power flow in 2019

Demand growth	0.039

PF	0.9

T/L of Sub-project 1

Voltage	Transmission line	Length (km)	Number of cct	Conductor type	Capaciry (MVA/cct) Continuous	N-1	Power floaw (MW/cct) TMNP	TMDP	HMNP	HMDP	OP	Max	Years to reach capacity	I (A/conductor)	
220 kV	Kirindiwela-Veyangoda	17.5	2	2 x Zebra	484	581	139.9	89	10.1	31.6	59.9	139.9	16	204.0	32.1%
220 kV	Kirindiwela-Padukka (400kV designed)	20.0	2	4 x Zebra	968	1162	94.4	62.7	38	39	38.8	94.4	44	68.8	10.8%
132 kV	Kirindiwela-Kosgama	10.0	2	1 x Zebra	145	174	41.4	42.6	32.4	31.6	6.8	42.6	15	207.0	32.6%

T/L of Sub-project 2

Voltage	Transmission line	Length (km)	Number of cct	Conductor type	Capaciry (MVA/cct) Continuous	N-1	Power floaw (MW/cct) TMNP	TMDP	HMNP	HMDP	OP	Max	Years to reach capacity	I (A/conductor)	
132 kV	Veyangoda-Thulhiriya	28.0	2	2 x Zebra	290	348	12.4	25.2	8.9	21.7	1.5	25.2	47	61.2	9.7%

T/L of Sub-project 4

Voltage	Transmission line	Length (km)	Number of cct	Conductor type	Capaciry (MVA/cct) Continuous	N-1	Power floaw (MW/cct) TMNP	TMDP	HMNP	HMDP	OP	Max	Years to reach capacity	I (A/conductor)	
132 kV	Kolonnawa-Sri J'Pura	6.0	2	1 x Zebra	145	174	68.4	66.7	26.9	20.2	12.0	68.4	3	332.4	52.4%
132 kV	Sri J'Pura-Pannipitiya	6.9	2	1 x Zebra	145	174	46.3	33.0	5.0	13.5	3.3	46.3	13	225.0	35.5%
		12.9													

T/L of Sub-project 5

Voltage	Transmission line	Length (km)	Number of cct	Conductor type	Capaciry (MVA/cct) Continuous	N-1	Power floaw (MW/cct) TMNP	TMDP	HMNP	HMDP	OP	Max	Years to reach capacity	I (A/conductor)	
132 kV	Pannipitiya-Ratmalana	7.0	2	1 x Zebra	145	174	25.0	21.6	25.0	21.6	10.0	25.0	29	121.5	19.2%

T/L of Sub-project 6

Voltage	Transmission line	Length (km)	Number of cct	Conductor type	Capaciry (MVA/cct) Continuous	N-1	Power floaw (MW/cct) TMNP	TMDP	HMNP	HMDP	OP	Max	Years to reach capacity	I (A/conductor)	
220 kV	Kothmale-New Polpitiya	23.0	2	2 x Zebra	484	581	126.8	87.6	109.6	81.6	47.7	126.8	18	184.9	29.1%

T/L of Sub-project 7

Voltage	Transmission line	Length (km)	Number of cct	Conductor type	Capaciry (MVA/cct) Continuous	N-1	Power floaw (MW/cct) TMNP	TMDP	HMNP	HMDP	OP	Max	Years to reach capacity	I (A/conductor)	
132 kV	Polpitiya-Nawalapitiya	7.0	1	1 x Zebra	145	174	41.4	26.7	64.5	34.2	11.7	64.5	5	313.5	49.4%
132 kV	Polpitiya-Moragolla	16.5	1	1 x Zebra	145	174	24.8	16.3	24.4	15.3	8.7	24.8	30	120.5	19.0%
132 kV	Nawalapitiya-Kiribathkumbura	45.0	1	1 x Zebra	145	174	27.5	18.2	50.5	25.6	6.1	50.5	11	245.4	38.7%
132 kV	Moragolla-Kiribathkumbura	45.3	1	1 x Zebra	145	174	24.7	16.3	51.4	42.3	8.7	51.4	11	249.8	39.4%
132 kV	Kiribathkumbura-Ukuwela	30.0	2	1 x Zebra	145	174	11.8	12.2	28.7	12.8	8.4	28.7	26	139.5	22.0%
132 kV	Ukuwela-Naula	45.0	1	1 x Zebra	145	174	37.8	2.5	20.3	27.6	2.3	37.8	19	183.7	29.0%
132 kV	Ukuwela-New Habarana	80.0	1	1 x Zebra	145	174	49.5	6.6	8.6	18.3	7.2	49.5	11	240.6	37.9%
132 kV	Naula-New Habarana	34.0	1	1 x Zebra	145	174	65.5	18.7	6.9	6.3	13.2	65.5	4	318.3	50.2%
												Minimum	4		

$$(\mathrm{P}\times 2)\times(1+0.039)^{n-1} \le \mathrm{Capacity}_{N-1}\times\cos\theta$$

$$n \le \frac{\mathrm{Ln}\left(\mathrm{Capacity}_{N-1}\times\cos\theta/(\mathrm{P}\times 2)\right)}{\mathrm{Ln}(1.039)}+1$$

Power flow in 2019

Demand growth	0.04

PF	0.9

S/S of Sub-project 1

Substation	Voltage	Number of TF	Capaciry (MVA/unit)		Power floaw (MW/All units)						Years to reach capacity	
			Continuous	N-1	TMNP	TMDP	HMNP	HMDP	OP	Max		
Kirindiwela	220/132 kV	2	150	180	82.8	85.2	64.8	63.2	13.6	85.2	16	31.6%
	220/33 kV	2	45	54	10.0	10.0	20.0	10.0	0.0	20.0	23	24.7%

S/S of Sub-project 3

Substation	Voltage	Number of TF	Capaciry (MVA/unit)		Power floaw (MW/All units)						Years to reach capacity	
			Continuous	N-1	TMNP	TMDP	HMNP	HMDP	OP	Max		
Battaramulla	132/33 kV	2	31.5	37.8	13.7	18.7	13.7	18.7	5.5	18.7	15	33.0%

$$P \times (1 + 0.039)^{n-1} \le \text{Capacity}_{N-1} \times \cos\theta$$

$$n \le \frac{\mathrm{Ln}\left(\text{Capacity}_{N-1} \times \cos\theta / P\right)}{\mathrm{Ln}(1.039)} + 1$$