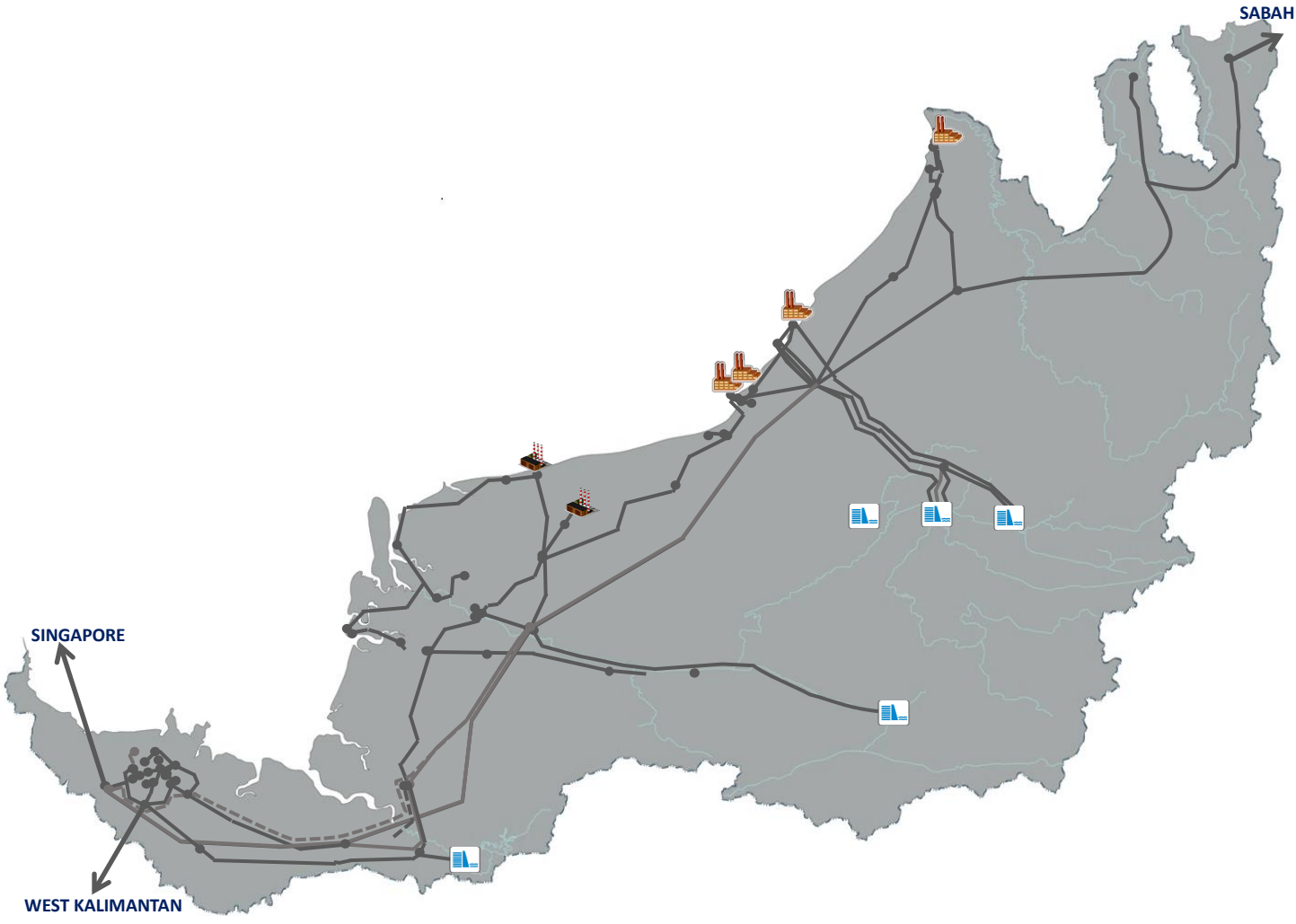
Ministry of Utility and Telecommunication Sarawak

sarawak energy

ELECTRICITY (2022 – 2033) MASTERPLAN



Electricity Master Plan consist of following documents:

I. Generation and Transmission (2024 to 2033) Masterplans
   - Generation Masterplan
   - Transmission Masterplan

II. Distribution (2022 to 2032) Plan
   - Main stations (Kuching, Sri Aman, Sarikei, Sibu, Bintulu & Miri)
   - Small stations (Mukah, Kapit, Limbang & Lawas)

III. Rural Electricity Development Masterplan (REDM) 2030

Generation and Transmission (2024 to 2033) Masterplan

sarawak energy

Generation and Transmission Master Plan (2024 to 2033)

Table of Contents

1.0 Background

Under the Electricity (State Grid Code) Rules, 2003 which came into force on 1st January of 2004, Syarikat SESCO Berhad is required under the Planning Code to submit a 5-year Generation and Transmission Master Plan (GTMP) by end of December every year.

To comply with this, a consolidated Generation and Transmission Master Plan (GTMP) presented herein was produced by Single Buyer (SB) division, System Planning (SP) division, Strategy and Corporate Development department and Transmission System Planning & Development (TSP&D) division, Transmission department.

Subsequently, the 5 Years GTMP has been improved to 10 Years GTMP since 2020 to provide more insights on the enhancement and development of generation and transmission system in Sarawak.

2.0 10 Years Generation Master Plan (10GMP)

This section outlines the 10 years Generation Master Plan 2023. It contains SEB's committed and base case plant up scenario.

2.1 Existing Gross Installed /Available Capacity (2023)

The current gross installed capacity and available capacity of Sarawak consists of SEB-owned power plants, totalling up to 6,115.6 MW and 5,745MW of hydro, coal, gas, and diesel generation, respectively. The detailed power plants are summarized below in Table 2.1.1.

Table 2.1.1 Total Grid-Connected Installed Capacity and Available Capacity of Sarawak

No.	Type of Generation	Power Plant	Gross Installed Capacity (MW)	Available Capacity (MW)	Number of units
1	Hydro	Batang Ai HEP	108	94	4
2		Bakun HEP	2,520	2,520[1]	8
3		Murum HEP	944	944	4
4	Coal	Sejingkat Power Corporation (SPC)	50	40	1
5		PPLS Power Generation (PPLS)	110	80	2
6		Mukah Power Generation (MPG)	270	243	2
7		Balingian Power Generation (BPG)	624	578	2
8	Gas	SEB Bintulu Open Cycle	165	140	5

9		SEB Bintulu Combine Cycle Block	317	280	1
10		SEB Miri Open Cycle	101.6	50	6
11		Tg Kidurong CCGT Block 1 & 2	842	720	2
12	Diesel	SEB Tunku Abdul Rahman (Biawak)[2]	64	56	2
Total			6,115.6	5,745[3]	

Note:

1. *Bakun HEP has the capability to reach 2,520MW provided the Reservoir Water Level (RWL) is at least 225m.*
2. *SPC, SEB Bintulu Open Cycle and SEB Tunku Abdul Rahman (Biawak) is currently standby generations.*
3. *Available Capacity is Net Generator Output after considering generator auxiliary consumption and dependable output.*

2.2 Load Forecast

The grid load forecast consists of two types of loads, namely:

- Organic Load Forecast 2023

  Long-Term Forecast 2023 is 20 years forecast for the Sarawak organic load consisting of domestic, commercial, industrial, and public lighting (excluding bulk load customers). Electricity sales is the basic assumption used to derive the forecast. Forecast Pro software is used as a statistical tool to forecast electricity sales.

- Demand Supply Projection
  - Figure below shows the demand supply model projection from 2024 to 2033, consisting of both Organic Demand and Inorganic Demand.

The grid load forecast can be summarized below in Figure 2.2.1.

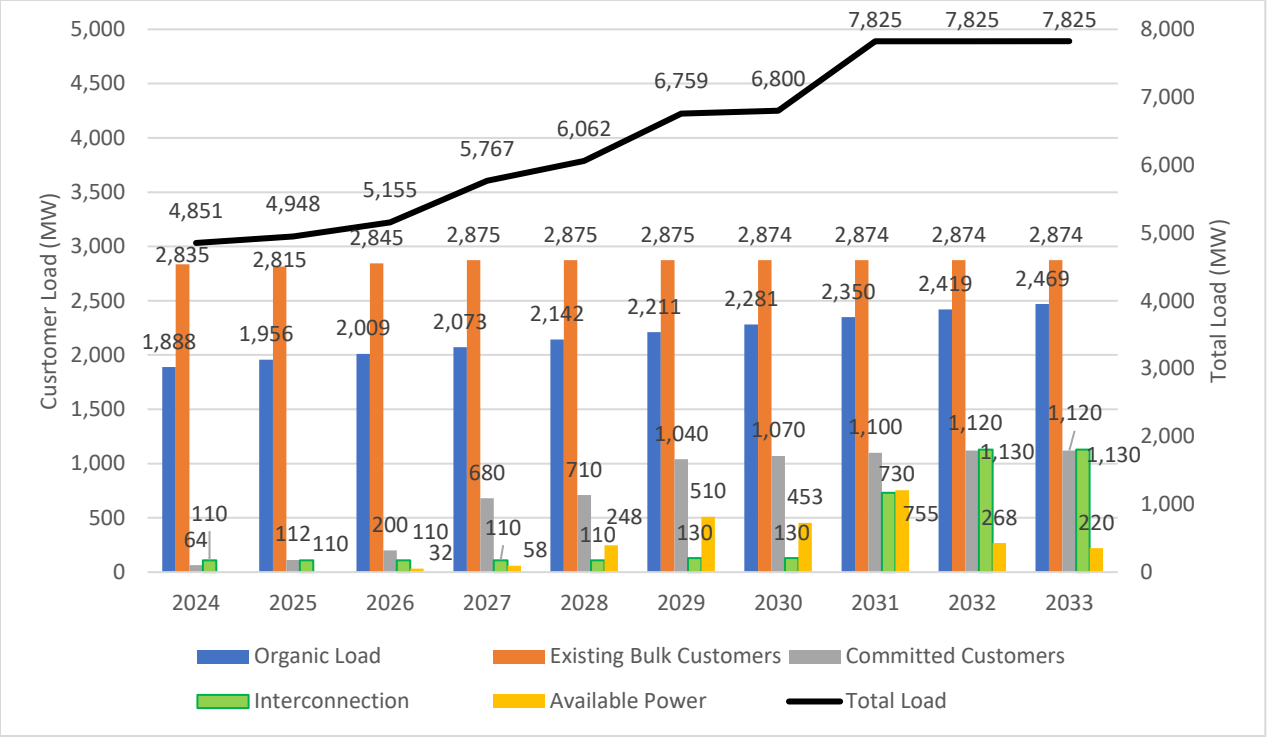


Figure 2.2.1 Load Forecast 2024 to 2033

Note:

1. *Organic Load consist of organic customers with committed Organic's step load customers, i.e. Samajaya's industries.*
2. *Existing Bulk Customers is assumed to include the extension of existing PPA customers, e.g. OCIM Ph1 and Sakura.*
3. *PLN, Sabah, and Singapore are interconnection loads with neighbouring state/countries.*
4. *Total load includes transmission losses and demand response.*

Table 2.2.1: Bulk Customer Projection 2024 to 2033

Customers (MW)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Organic Customers	**1,796**	**1,858**	**1,911**	**1,961**	**2,010**	**2,060**	**2,109**	**2,158**	**2,208**	**2,257**
Organic Step Load, i.e. Samajaya Industries	***92***	***98***	***98***	***112***	***132***	***152***	***172***	***192***	***212***	***212***
Existing Bulk Customers	**2,835**	**2,815**	**2,845**	**2,875**	**2,875**	**2,875**	**2,874**	**2,874**	**2,874**	**2,874**
- Press Metal (Mukah, Ph1, Ph2 and Ph3)	*1,730*	*1,730*	*1,730*	*1,730*	*1,730*	*1,730*	*1,730*	*1,730*	*1,730*	*1,730*
- Pertama Ferroalloy	*170*	*170*	*170*	*170*	*170*	*170*	*170*	*170*	*170*	*170*
- OM Materials (350MW)	*350*	*320*	*320*	*350*	*350*	*350*	*350*	*350*	*350*	*350*
- OCIM P1 and P2 (plus additional 20MW)	*295*	*295*	*295*	*295*	*295*	*295*	*180*	*180*	*180*	*180*
- Sakura	*80*	*80*	*80*	*80*	*80*	*80*	*80*	*0*	*0*	*0*
- PMB Silicon	*129*	*129*	*129*	*129*	*129*	*129*	*129*	*129*	*129*	*129*
- MLNG	*80*	*90*	*90*	*90*	*90*	*90*	*90*	*90*	*90*	*90*
- Shell	*0*	*0*	*30*	*30*	*30*	*30*	*30*	*30*	*30*	*30*
- Expiry of Existing Bulk Customers	*0*	*0*	*0*	*0*	*0*	*0*	*115*	*195*	*195*	*195*
Committed Customers	**64**	**112**	**200**	**680**	**710**	**1,040**	**1,070**	**1,100**	**1,120**	**1,120**
- Longi (Samalaju)	*30*	*40*	*40*	*40*	*40*	*40*	*40*	*40*	*40*	*40*
- Prosperity Maker Limited (PML) (Data Centre)	*27*	*27*	*27*	*27*	*27*	*27*	*27*	*27*	*27*	*27*
- Pertama Ferroalloy (Additional 35MW)	*0*	*20*	*35*	*35*	*35*	*35*	*35*	*35*	*35*	*35*
- OCIM P3 (Additional 200MW)	*0*	*0*	*0*	*200*	*200*	*200*	*200*	*200*	*200*	*200*
- Element 25	*0*	*8*	*8*	*8*	*8*	*8*	*8*	*8*	*8*	*8*
- Wenan	*0*	*0*	*0*	*0*	*10*	*10*	*10*	*10*	*10*	*10*
- Data Centre (NetZero Future Data Park)	*7*	*17*	*40*	*70*	*90*	*120*	*150*	*180*	*200*	*200*
- Hydrogen Industries	*0*	*0*	*50*	*300*	*300*	*600*	*600*	*600*	*600*	*600*

Interconnection	110	110	110	110	110	130	130	730	1,130	1,130
- Kalimantan (PLN)	*80*	*80*	*80*	*80*	*80*	*80*	*80*	*80*	*80*	*80*
- Sabah	*30*	*30*	*30*	*30*	*30*	*50*	*50*	*50*	*50*	*50*
- Singapore	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*600*	*1,000*	*1,000*
Available Power (Minimum Margin of 20%-21%)	**0**	***0***	***32***	**58**	**248**	**510**	**453**	**755**	**268**	**220**

2.3 10 Years Generation Capacity Expansion Plan (2024 – 2033)

There are total of four (4) new power plants and one (1) battery project coming up in the next 10 years, as shown in in Table 2.3.1 below. The 250MW large scale solar (LSS) is the target set according to Post Covid Development Strategy (PCDS) and it is non-committed generations alongside with Trusan2 HEP.

Table 2.3.1: Planned New Gross Installed Capacity in Sarawak

No	Type of Generation	Power Plant	Gross Installed Capacity (MW)	Number of units	Expected COD
1[1]	Energy Storage	Battery Energy Storage System (BESS)	60	1	Q4 2024
2[2]	Solar	Batang Ai Floating Solar	50	1	Q4 2024
3	Gas	Samalaju CCGT Block 1	500[3]	1	2026/2027
		Samalaju CCGT Block 2	500[3]	1	2027/2028
4	Gas	Miri CCGT	421[3]	1	2027
5	Hydro	Baleh HEP	1,285	5	2028/2029
6[4]	Solar	Large Scale Solar	250	1	End of 2030
7[4]	Hydro	Trusan2 HEP	240[3]	3	2031
Total Gross Installed Capacity (MW)			**3,306**		

Notes:

1. *Battery energy storage system is rated at 60MWh.*
2. *Batang Ai floating solar is an IPP and rated at 50MWac.*
3. *The gross Installed capacity is an estimated capacity.*
4. *These are future non-committed generations.*

Older generators such SPC, TAR Open Cycle (GT5 and GT6) as well as Bintulu Open Cycle (GT1 to GT5) will be retained as Standby Power until the expected decommissioning date. These generators are critical and will be used for few purposes such as:

- Peaking capacity when the system demand is approaching system peak;
- Provide spinning reserve when the system is insufficient of spinning reserve;
- Provide emergency capacity during grid emergency condition, e.g., too many generators under forced outages at a time;
- Regional black start units (Bintulu GT1 and GT2 will be used to black start at Bintulu region).

SPC and PPLS will be fully decommissioned upon the completion of Kuching Network Reinforcement projects, and this also tie to the due date of Coal Supply Agreement (CSA). Miri Open Cycle will be retired

after commissioning of Miri CCGT, whereas Bintulu Open Cycle (GT3 to GT5) and TAR (GT5 and GT6) will be retired after commissioning of Baleh HEP. The generation retirement plan is summarized below in Table 2.3.2.

Table 2.3.2: SEB's Generator Retirement Plan

No.	Type of Generation	Power Plant	Gross Installed Capacity (MW)	Number of units	Expected Decommissioning Date
1	Coal[1]	Sejingkat Power Generation (SPC)	50	1	End of 2026
2		PPLS Power Generation (PPLS)	110	2	End of 2026
3	Gas	Miri Open Cycle	101.6	6	End of 2027
4		Bintulu Open Cycle (GT3 to GT5)	99	3	End of 2028
5	Diesel	TAR GT5 and GT6	64	2	End of 2028

Notes:

1. *Potentially may need to defer.*

2.4 10 Years Generation Total Available Capacity (2024 – 2033)

The expected generation Total Available Capacity from 2024 to 2033 are as follows.

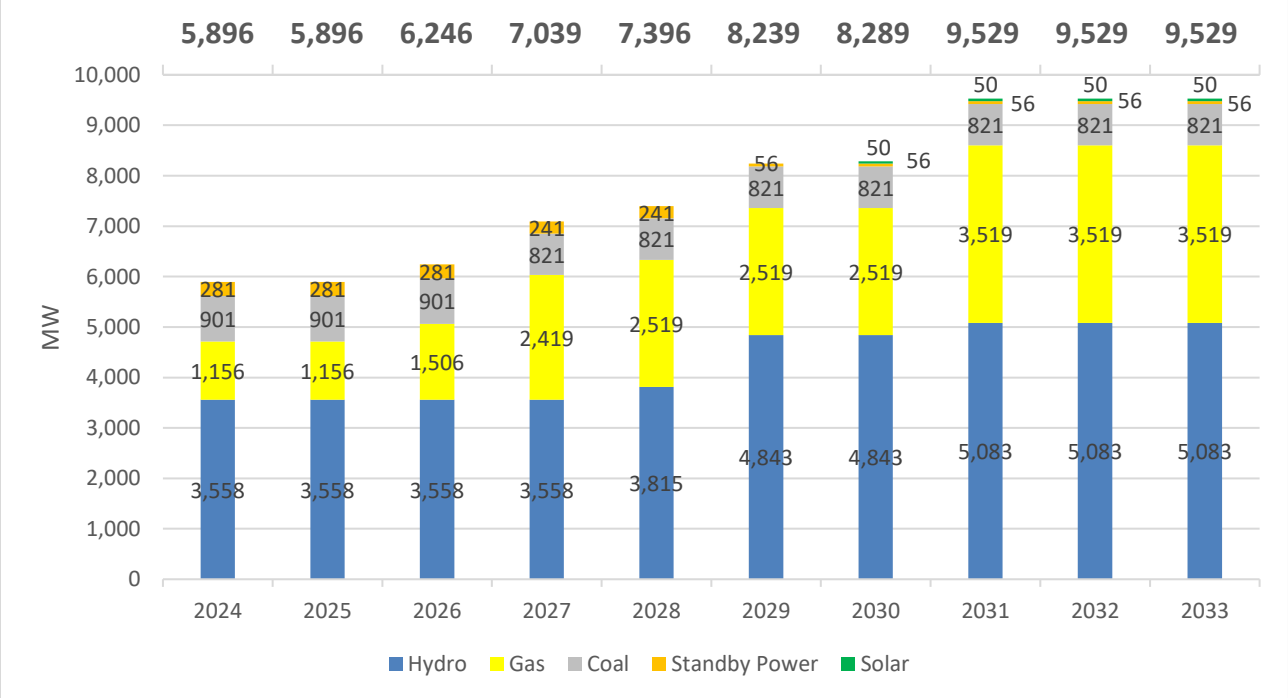


Figure 2.4.1: Generation Total Available Capacity

Note:
Available Capacity is the dependable output (minus auxiliary consumption) and is refers to the available capacity at the end of the year after the additional of new generation plant in that year. The contribution of Solar in available capacity is still subject further studies and will need to review from time to time due to the intermittency behaviours.

2.5 Loss of Load Probability (LOLP)

Loss of loss probability (LOLP) is one of the primary criteria in generation capacity planning from the State Grid Code. It is defined as the probability (fraction of time) that the system demand will not be fully satisfied, or in other words, that the system demand exceeds the available capacity.

The requirement for LOLP in our State Grid Code is 1 day per year, and the current interpretation is equivalent to 24 hours of Loss of Load Hours (LOLH). Based on PLEXOS analysis, this LOLH for our system from 2024 to 2033 is achievable as shown in Table 2.6.1. The LOLH of some years are comparable higher than other year, in this case, Load Reduction is required to be activated to lower down the LOLH. The range of LOLH (hours) is based on 2018 to 2022 historical average generator's Forced Outage Rate (FOR).

2.6 Expected Energy Not Served (EENS)

Expected energy not served (EENS) is also one of the primary criterions in generation capacity planning from the State Grid Code. It represents the portion of the initial system energy that cannot be met by the system's generating units, and it is expressed in GWh.

The requirement of EENS in our State Grid Code is 0.1% per year. Based on PLEXOS analysis, the EENS for our system from 2024 to 2033 are all below the stated requirement.

Table 2.6.1: Expected Energy Not Served (EENS) and Loss of Load Probability (LOLP)

Year	LOLH, Hours[1]	Expected Energy Not Served (EENS)	
		GWh[1]	Limit, GWh
2024	18.5	1.81	36.36
2025	7.5	0.24	38.20
2026	1.5	0.07	39.23
2027	7.5	0.29	42.76
2028	23.0	2.97	46.03
2029	0	0	50.25
2030	9.5	1.53	51.07
2031	0	0	61.27
2032	8.50	0.75	61.80
2033	22.5	1.58	62.10

Notes:
1. *The adequacy assessment is Based on 5 years average generator's Forced Outage Rate (FOR).*
2. *Load Reduction (LR) is required to activate in some years which have higher Loss of Load Hours (LOLH).*

2.7 Available Capacity Reserve Margin

Available Capacity Reserve Margin is another important measurement of sufficient capacity in the power system.

$$\text{Available Capacity Reserve Margin (\%)} = \frac{\text{Total Available Capacity (MW)} - \text{Peak Demand (MW)}}{\text{Peak Demand(MW)}} \times 100\%$$

Initially, a minimum 20% reserve margin target is included to ensure the operation team has sufficient margin to manage planned outages and maintaining the spinning reserve in the system. However, minimum reserve margin is required to increase to 21% in-line with the commissioning of Samalaju CCGT as the sizing of the largest generator in the System will be increased from 413MW (currently Tg. Kidurong CCGT) to 500MW by year 2028.

Figure 2.7-1 outlines the Projected Reserve Margin, Maximum Available Power Reserve Margin, as well as Reserve Margin Target. The projected reserve margin basically outputs the practical selling of available power scenario whereas the maximum available power reserve margin assumed maximum selling of available power for the next 10 years.

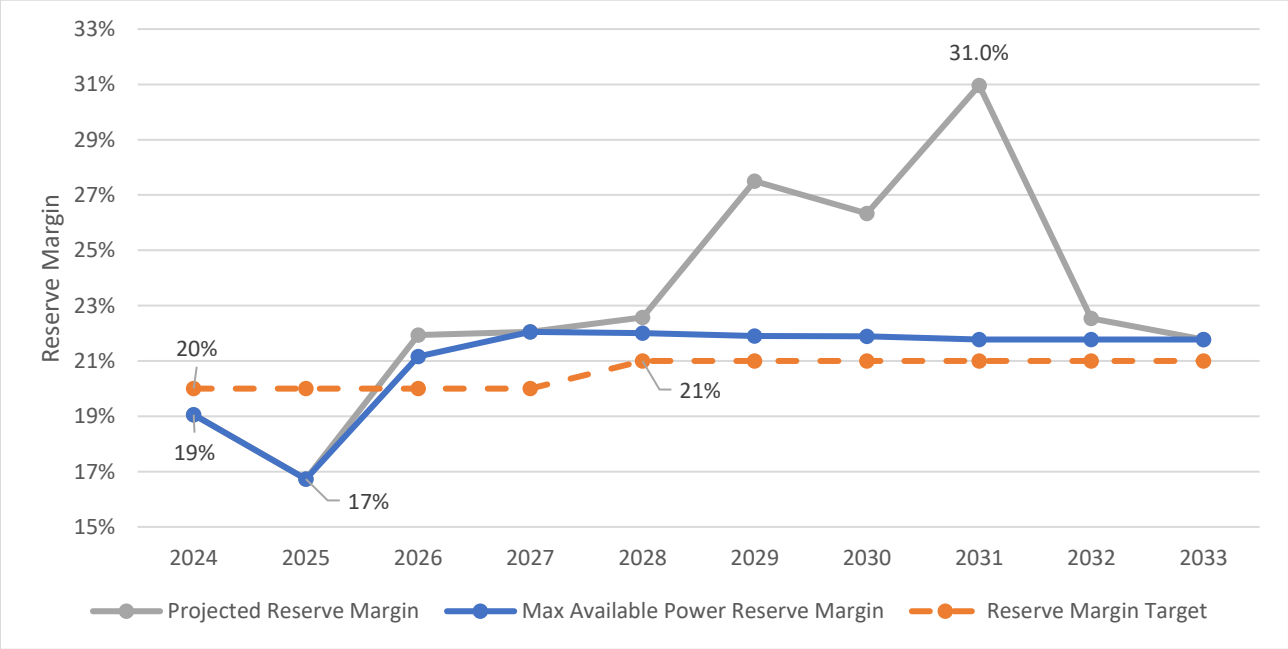


Figure 2.7.1: Projected Reserve Margin

3.0 10 Years Transmission Master Plan (2029 – 2033)

This section outlines the 10 years Transmission Master Plan 2023, produced by Transmission System Planning & Development division and System Planning division, and the prioritisation of candidate transmission projects.

3.1 Existing Transmission Network

Sarawak Energy operating voltage levels are 275kV, 132kV, 33kV, 11kV and 415V. The State Grid comprises of 275 kV and 132 kV transmission system, which connect presently the load centres of Kuching, Sri Aman, Sarikei, Sibu, Mukah, Bintulu and Miri. The Grid Backbone of 275 kV Transmission lines connects the 275kV substations of Matang, Mambong, Entinggan (Kuching), Engkilili (Sri Aman), Lachau, Batang Ai hydroelectric power station, Kemantan (Sarikei), Oya Road, Mapai, Selangau (Sibu), Tatau, Kemena, Kidurong, Similajau, Samalaju (Bintulu), Murum Junction, Murum Hydroelectric power station, Bakun Hydroelectric power station Marudi Junction, Tudan and Bunut (Miri). The new 500kV Grid Backbone is fully completed on Jan 2023, presently energized at 275kV, connecting from Similajau to Mapai, and from Mapai to Tondong. The 132kV transmission network is for sub-transmission to substations within a region.

Figure 3.1.1 shows the existing Sarawak Energy transmission network up to year 2023 whereas Table 3.1.1 shows the summary of Sarawak Energy transmission network assets.

Table 3.1.1: Sarawak Energy Transmission Network Assets

Transmission Network Assets	Detail
Transmission Line Voltage	132kV & 275kV
Length of 500kV Transmission Line	1,031.00 km
Length of 275kV Transmission Line	3,634.46 km
Length of 132kV Transmission Line	1,192.78 km
132kV Underground Cable	46.94 km

There is a total of 44 number of EHV substations connected in the Sarawak Energy transmission grid with a total installed transformers capacity of 13,586.0 MVA.

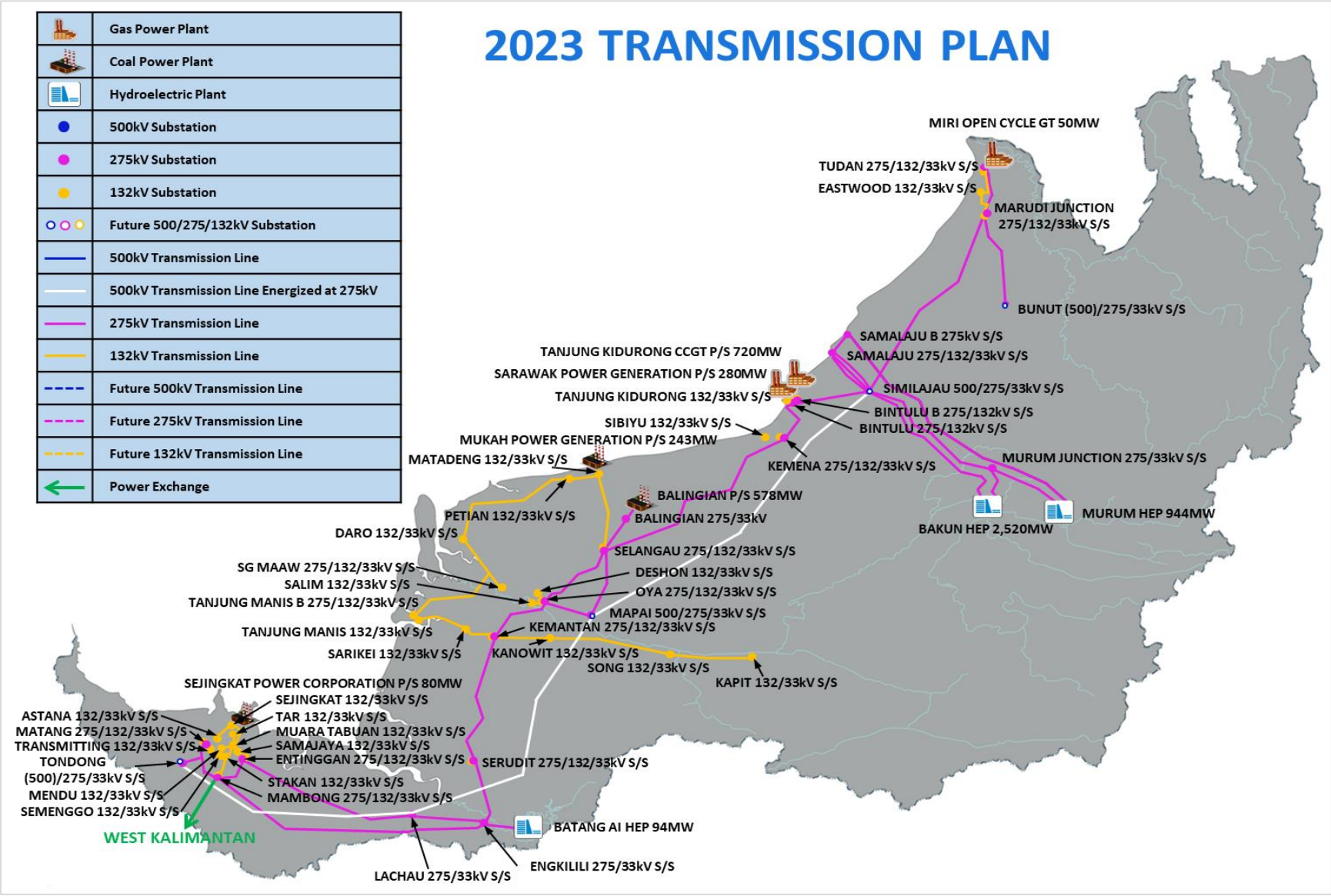


Figure 3.1.1: Sarawak Energy Transmission Network in 2023

3.2 Transmission Project Type and Ranking Classification

The transmission network development projects are classified by their state of completion and their definition are stated in Table 3.2.1.

Table 3.2.1: Project Status Classifications

Project Type	Definition
Possible Transmission Project	• Projects identified as possible options for future grid upgrade. • Required to carry out details analysis to determine the preferred project option.
Proposed Transmission Project	• Projects for which detailed analysis has been carried out and identified a preferred transmission development option. • Proposed to Sarawak Energy management for approval. • Proposed to SCORE customer for their connection agreement.
Committed Transmission Projects	• Projects for which has been approved by Sarawak Energy management and the budget is available.
Commenced Transmission Project	• Carried out pre-Engineering activities i.e soil investigation, line route surveys, environmental & social impact assessment exercise. • Projects contract is awarded to contractors.
Completed Transmission Project	• Projects that have recently been completed and are commissioned and operating.

The transmission network development plan is classified into four priorities/ categories. Table 3.2.2 below defines the transmission project type and priority.

Table 3.2.2: Transmission Project Type and Priority Definition

Priority	Definition
P1	**Projects with Significant Grid Impacts** • Power Evacuation from new generation facility. • Mitigating potential risk of grid system wide blackout.
P2	**Projects with Regional Impact** • **Grid Code compliance**
P3	**Projects with Long Term Impact** • Load dependent • To be re-evaluated after more clarity on development
PX	**Projects required for New Customers (bulk/ interconnection)** • **Bulk Customer driven project**

Priority 1 (P1) – Transmission Projects with Significant Grid Impacts

The transmission projects listed under this priority are of the highest importance as they have significant impact to the grid system.

These impacts cover the following:

- **Power evacuation from new generation facility.**
- **Mitigating potential risk of grid system wide blackout.**

Table 3.2.1.1 shows the summary of P1 transmission development plan over the next ten years.

Table 3.2.1.1: Summary of P1 Grid Impact Projects

Project Name	Objective
• **Sejingkat Battery Energy Storage System (60MW/60MWh)** Indicative completion date: February 2024 Project status: Commenced	• To partially mitigate the risk of losing N-1 contingency in Kuching region by performing peak shaving. • To cater for fast spinning reserve, enabling Kidurong CCGT units to ramp up to 400MW and free out 80MW of additional generation capacity (From 2024 – until Baleh HEP is commissioned). • To provide various options/function such as support energy storage for solar farm, spinning reserve, peak shaving for transmission network and voltage support.
• **Lawas 275/33kV Substation (2 x 120MVA)** • **Long Luping-Lawas 275kV Transmission Line (2 x 600MVA, 63km)** • **Medamit-Long Luping 275kV Transmission Line (2 x 600MVA, 68km)** • **Bunut-Medamit 275kV Transmission Line (2 x 600MVA, 170KM)** Indicative completion date: May 2024 Project status: Commenced	• To connect Lawas regional network and allow the closure of Lawas diesel power station. • To allow the integration of future hydro schemes into the grid. • To strengthen the supply to villages at that areas. • To cater for future export to Sabah.
• **Lawas to Sarawak/ Sabah Border 275kV double circuit Transmission Line (2 x 600MVA, 24km)** Indicative completion date: May 2024 Project status: Commenced	• To establish the interconnection between Sarawak and Sabah.
• **275kV (500kV) Transmission Line from Similajau-Bunut (2 x 2,200MVA, 106km)** Indicative completion date: Q4 2024 Project status: Commenced	• To increase network capacity and security to Miri for future load growth. • To strengthen the reliability of supply in the southern zone of Miri. • To allow the closure of Pujut power station. • To enable the integration of Limbang and Lawas network to the grid and

	future interconnection to Sabah and Brunei. • To develop infrastructure for power evacuation from future hydro plants via Bunut substation.
• **Limbang Town 275/33kV Substation (2 x 60MVA)** • **Medamit-Limbang Town 275kV Transmission Line (2 x 600MVA, 60km)** Indicative completion date: Q1 2025 Project status: Commenced	• To replace existing Limbang diesel plant. • To allow for integration of future hydro plant into the grid.
Kuching Network Reinforcement Project: • **Entinggan B – Tg. Bako 275kV double circuit transmission line (2 x 1,200MVA, 25km)** • **Double circuit loop-in-out from existing Engkilili/Lachau-Entinggan 275kV Transmission line to Entinggan B 275/(132)/(33)kV Substation (2 x 600MVA, 1.72km)** • **Tg. Bako 275/132/33kV Substation (2 x 240MVA)** • **Entinggan B 275/33kV Substation** • **Double circuit loop-in-out of existing Sejingkat-Muara Tabuan 132kV transmission line into proposed Tg. Bako 275/132/33kV substation (2 x 250MVA, 0.12km)** Indicative completion date: Q4 2025 Project status: Committed	• To cater for Kuching organic load, Samajaya and new industrial estate. • To resolve Entinggan – Samajaya 132kV line overloading constraints. • To strengthen the transmission network for the planned SPC plant retirement
• **Samalaju B-Samalaju CCGT 275kV double circuit Transmission Line (2 x 1,200MVA, 6km)** • **Reconstruct gantry for two Samalaju CCGT bays at Samalaju B 275kV GIS Substation** Indicative completion date: Q2 2026 Project status: Committed	• To integrate Samalaju Combine Cycle plant (2 x 500MW) into Sarawak Grid system.
• **Installation of STATCOM (+240MVar, -240MVar) reactive compensation device at Tg. Bako 275kV substation.** Indicative completion date: Q2 2026 Project status: Committed	• To mitigate voltage instability problem in Kuching. • To provide dynamic reactive support in Kuching.
• **Mapai 500/275kV AIS Substation** • **Baleh-Mapai 500kV double circuit Transmission Line (2 x 2,200MVA, 180km)** Indicative completion date: Q4 2026 Project status: Commenced	• To integrate Baleh Hydroelectric power plant (5 x 257 MW) into Sarawak Grid system.
• **Tudan-Miri CCGT 275kV double hybrid circuit – Line (2 x 600MVA, 5.9km) & Underground Cable (5.2km)** Indicative completion date: Q1 2027 Project status: Proposed	• To integrate the Miri Combine Cycle plant (1 x 413MW) into Sarawak Grid system.

• **Murum Junction-Bakun 275kV- 3rd and 4th Transmission Line (2 x 1,200MVA, 21km)** Indicative completion date: Q4 2027 Project status: Committed	• To serve as second injection into Murum Junction substation, relieving the loading of existing Murum Junction-Bakun lines and provide N-1-2 reliability between Bakun and Murum Junction. • To integrate future Bakun Hydro Generator expansion plan such as Bakun Unit 9.
• **Kuching CCGT - Tg. Bako 275kV TL (2 x 1,200MVA, 15km)** Indicative completion date: 2030 Project status: Proposed	• To integrate Kuching Combined Cycle Power Plant (2 x 500MW) into Sarawak Grid system.
Trusan HEP Power Evacuation Scheme **<u>Option 1</u>** • **Lawas 275kV Substation Extension (2 bays)** • **Trusan HEP – Lawas 275kV TL (2 x 600MVA, 33km)** **<u>Option 2</u>** • **Tengoa 275/33kV Substation (2 x 30MVA, 9 bays)** • **Trusan HEP – Tengoa 275kV TL (2 x 600MVA, 13km)** • **LILO Bunut-Limbang to Lawas 275kV TL into Tengoa 275kV Substation (2 x 600MVA, 3km)** **<u>Option 3</u>** • **Long Luping 275/33kV Substation (2 x 60MVA, 11 bays)** • **Trusan HEP – Long Luping 275kV TL (2 x 600MVA, 30km)** • **LILO Bunut-Limbang to Lawas 275kV TL into Long Luping 275kV Substation (2 x 600MVA, 3km)** Indicative completion date: 2031 Project status: Proposed	• To integrate Trusan Hydroelectric Power Plant (3 x 80MW) into Sarawak Grid system.

3.2.1 Priority 2 (P2) – Transmission Projects with Regional Impact

The transmission projects under this priority have regional/ area impact leading to the non-compliance of the Grid Code under normal and contingency conditions if the project is not implemented. They are vital from the compliance and technical perspective to provide stable and reliable power to the respective regions.

These impacts cover the following:

- **Grid Code compliance**

Table 3.2.2.1 shows the summary of P2 transmission development over the next ten years.

Table 3.2.2.1: Summary of P2 Regional Impact Projects

Project Name	Objective
WESTERN REGION	

• **Serudit – Sri Aman 132kV double circuit Transmission Line (2 x 250MVA, 45km) – energized at 33kV** Indicative completion date: Q1 2024 Project status: Commenced	• Loss of N-1 reliability for Betong 10MVA 275/33kV transformer. • Insufficient distribution security and capacity for Betong-Debak-Pusa areas. • Insufficient transmission security and capacity for future Lachau, Sri Aman, Serudit, Saratok and Sarikei load demand growth.
• **MJC 132/33kV Substation (2 x 120MVA)** • **Matang-MJC 132kV double circuit hybrid line turn in (2 x 125MVA, 3km)** Indicative completion date: Q1 2026 Project status: Committed	• To cater for the loss of N-1 reliability for Semenggo 80MVA 132/33kV transformers. • To cater for forecasted load growth at MJC area.
• **Serian 275/33kV Substation (2 x 60MVA)** • **Serian Double Circuit Loop-in-and-out of Engkilili-Mambong Transmission Lines (2 x 600MVA, 3km)** Indicative completion date: Q4 2027 Project status: Proposed	• To cater for emerging load growth at Serian area. • To cater for the loss of N-1 reliability at Mambong 132/33kV 80MVA transformers.
CENTRAL REGION	
• **Sg. Merah 132/33kV Substation (2 x 80MVA)** • **Sg. Maaw-Sg. Merah 132kV Hybrid Line (14km)** Indicative completion date: Q4 2024 Project status: Commenced (Sub); Commenced (Hybrid Line)	• To relieve Deshon 132/33kV transformer loading. • To cater for the future development around Teku-Sg Merah-Rantau Panjang area.
Mapai-Serudit-Lachau 275kV TL Reorganization • **Mapai - Serudit - Lachau 275kV line reorganization (2 x 600MVA, 181km)** • **Mapai, Serudit, Lachau 275kV Substation Extension and Entinggan B Modification Works** Indicative completion date: 2029 Project status: Proposed	• To mitigate Serudit – Kemantan – Oya 275kV line overloading issue during N-1 of Oya – Serudit 275kV transmission line. • To support the retirement of SPC. • To evacuate power into Western region. • To provide third 275kV injection into Kuching and avoid the dependency on Engkilili 275kV substation.
BINTULU REGION	
Kemena & Sibiyu Area Network Reinforcement Plan • **Kemena 275kV Substation Extension** • **Sibiyu 132/33kV GIS Substation (2x120MVA)** Project status: Completed • **Kemena-Sibiyu 132kV double circuit Transmission Line (2x250MVA, 6km)** Indicative completion date: Q1 2024 Project status: Commenced	• Key developments in the next few years will be concentrated in the central region of Bintulu. • Insufficient transmission security and capacity for future Bintulu city area load growth. • To cater for the upcoming new zone substations • To bring bulk power into the central region.

NORTHERN REGION	
• **Niah 275/33kV Substation (2 x 30MVA)** • **Niah Double Circuit Loop-in-and-out of Marudi Junction-Similajau Transmission Lines (2 x 600MVA, 4km)** Indicative completion date: Q3 2026 Project status: Commenced	• To cater for emerging load growth at Niah area. • To comply with 33kV voltage statutory requirement. • To resolve reliability issue on existing 33kV line along Similajau to Miri coastal road.

3.2.2 Priority 3 (P3) – Transmission Projects with Long Term Impact

The transmission projects under this priority are mainly load dependant and will be re-evaluated when there is more clarity on the load development.

These impacts cover the following:

- **Load dependent**
- **To be re-evaluated after more clarity on development**

Table 3.2.3.1 shows the summary of P3 transmission development over the next ten years.

Table 3.2.3.1: Summary of P3 Long Term Impact Projects

Project Name	Objective
WESTERN REGION	
• **Semariang 132kV substation (2 × 120MVA)** • **Matang – Semariang 132kV U/G Cable (2 × 140MVA, 13km)** Indicative completion date: 2029 Project status: Proposed	• To mitigate distribution protection grading issues, as there are four tiers of 33kV substations after Astana 33kV substation. • To cater for organic load growth and provide sufficient capacity to Semariang areas.

3.2.3 Priority X (PX) - Transmission Projects required for New Customers (bulk/ interconnection)

The transmission projects under this priority are mainly customer driven. Hence, the development of these projects will be depending on the successful negotiation and subsequent materialization of the loads.

The PX projects are listed in the following scenarios:-

i) Singapore Export Scenario
ii) Bintulu & Likau Supply Scenario
iii) Samalaju Supply Scenario
iv) Samajaya and Technology Park Supply Scenario

Table 3.2.4 shows the summary and scenario of PX transmission development over the next ten years.

Table 3.2.4.1: Summary of PX Projects – Singapore Export Scenario

Project Name	Objective

Existing Tondong - Mapai TL 500kV Upgrade (Phase I) • **To develop a new Tondong 500kV substation** • **To upgrade existing Mapai – Tondong 500kV transmission line** Indicative completion date: 2029 Project status: Proposed **Kuching Link 275kV (Phase I)** • **To develop Tondong – Entinggan B 275kV double circuit transmission lines with associated substation extension works** Indicative completion date: 2029 Project status: Proposed	• To increase capacity and security of supply towards western region and to accommodate the future load growth at the Samajaya Free Industrial Zone. • To strengthen the reliability of supply to Kuching. • To supply power to Singapore
Tondong - Mapai 3rd & 4th 500kV TL (Phase II) • **To develop Mapai – Tondong 500kV 3rd and 4th transmission line with the associated substation extension works** Indicative completion date: 2031 Project status: Proposed	• To increase capacity and security of supply towards western region and to accommodate the future load growth especially at the Samajaya Free Industrial Zone. • To strengthen the reliability of supply to Kuching. • To supply power to Singapore
Similajau - Mapai 500kV Upgrade (Phase II) • **To develop new Similajau 500kV substation** • **To upgrade existing Mapai – Similajau 500kV transmission line with all associated substation extension works** Indicative completion date: 2031 Project status: Proposed	• To provide capacity and security of supply towards western and central regions. • To strengthen the reliability of supply to western and central regions. • To relieve Bintulu to central region transmission line constraint. • To supply power to Singapore.

Table 3.2.4.2: Summary of PX Projects – Bintulu & Likau Supply Scenario

Project Name	Objective
• **Bintulu B 132kV GIS Substation (2x 240MVA)** Indicative completion date: Q4 2024 Project status: Commenced • **Bintulu B-Shell SK318 132kV Underground cable/ Hybrid with 132kV Overhead transmission line (2 x 140MVA, 3km)** Indicative completion date: Q1 2025 Project status: Committed	• To supply Shell SK318. • To replace existing Bintulu 132kV substation in the future.

Load shifting from existing Bintulu A 275/33kV Transformer to Bintulu B 275/132/33kV Transformer • **Load shifting works:** - **Bintulu A 275/33kV transformers load to supply from Bintulu B 275/132/33kV auto-transformers.** Indicative completion date: Q4 2024 Project status: Committed	• Reconditioning and Retrofitting Works of Bay D1 & D5 (MLNG Supply Project) at Bintulu A 275kV which required to shift the load connected at Bintulu A 275/33kV to Bintulu B 275/132/33kV auto-transformer. • Bintulu A 275kV Transformer – Name plate dated as December 1990. • Bintulu A 275/33kV Transformer No.2 emergency shutdown due to BUCHA alarm operated on 26 August 2022 and the faulty transformer is permanently removed from the grid. The tertiary winding of Bintulu A 275/132/33kV Transformer No.2 is temporary used as temporary replacement.
• **Supply from Bintulu A 275kV Substation to MLNG via a new 275kV over headline (2 x 600MVA, 0.5km)** Indicative completion date: October 2024 Project status: Commenced	• To supply MLNG (Malaysia LNG Sdn Bhd), a liquefied natural gas manufacturer.
Decommissioning Plan for Bintulu A 275/132kV Substation • **Generators shifting works:** - GT 7 and GT 8 to Bintulu B 132kV substation - GT 9 to Bintulu B 275kV substation - Decommissioning of GT 5 • **Load shifting works:** - 132kV Tg Kidurong underground cable feeders to Bintulu B 132kV Substation. - Supply MLNG from Bintulu B 275kV. Indicative completion date: 2029/ After Commission of Baleh HEP Project status: Committed	• Bintulu A 275kV Switchgear: • 1st Phase (5 bays) – 38 years since year 1990. • 2nd Phase (6 bays) – 32 years since year 1996. • 3rd Phase (1 bay) – 19 years since year 2009. • Budgetary cost of RM3.9million per bay quoted by the manufacturer for this customized refurbishment work (which cover CB, DS and ES but exclude busbar, CT, and IVT) is relatively high compared to a new equipment cost per bay at the new Bintulu B 275kV Substation.
• **Likau 275/132/33kV GIS Substation (2x 240MVA)** • **Bintulu B-Likau 275kV Transmission Line (2x 1200MVA, 1km)** Indicative completion date: Depend on the load Growth at vicinity of Likau area / Sarawak Petrochemical Industrial Park (SPIP) (Q1 2026) Project status: Committed • **Likau-PTTEP 275kV Underground Cable (2 x >200MVA, 1.85km)** Indicative completion date: Development Oriented Project Project status: KIV	• To cater for industrial development at Bintulu/Likau area.

• **Likau 275kV GIS s/s extension (2 Bays)** • **Samalaju B 275kV GIS s/s extension (2 Bays)** • **Likau - Samalaju B 275kV line (2 x 1,200MVA, 54km)** Indicative completion date: Development Oriented Project Project status: Proposed	• To meet N-1 reliability criteria during loss of one Bintulu B – Similajau 275kV line. • To provide additional supply capacity to the potential off-takers at Tg. Kidurong PETCHEM Industrial Park.

Table 3.2.4.3: Summary of PX Projects – Samalaju Supply Scenario

Project Name	Objective
• **Samalaju B – LONGi 132 Underground Cable (2 x 140MVA, 1.5km)** • **Re-testing of existing two bays at Samalaju B 132kV GIS substation** Indicative completion date: 2027 Project status: Proposed	• To provide adequate transmission security and capacity for LONGi Score customer • To cater for potentially supply up to 120MVA in future
• **Samalaju B-Wenan Steel 275kV double circuit hybrid transmission line (2x 1200MVA, 2.2km & 2 x 600MVA, 2.6km)** Indicative completion date: 2028 Project status: Proposed	• To provide adequate transmission security and capacity for Wenan Steel Score customer. • To prepare for the connection of Samalaju B to the planned future Samalaju C substation via 275kV Quad drake conductor.
• **Samalaju C 275kV GIS Substation** • **Samalaju D 275kV GIS Substation** • **Samalaju B – Samalaju C 275kV Line (2 x 1,200MVA, 3km)** • **Samalaju C – Samalaju D 275kV Line (2 x 1,200MVA, 3.5km)** • **Samalaju CCGT – Samalaju D 275kV Line (2 x 1,200MVA, 2km)** • **Loop in out Samalaju CCGT – Samalaju B 275kV Line into Samalaju D Substation (2 x 1,200MVA, 6.5km)** Indicative completion date: Development Oriented Project Project status: Proposed	• To provide additional transmission capacity for the potential off-takers at Samalaju Industrial Park. • To integrate Samalaju CCGT (up to 3rd Block) into Samalajau Industrial Park.

Table 3.2.4.4: Summary of PX Projects – Samajaya and Technology Park Supply Scenario

Project Name	Objective
• **Data Park (Netzero) 275/132/33kV Substation (4 x 120MVA & 2 x 240MVA)** • **Double Circuit Loop-in-and-out of Entinggan B-Tg Bako 275kV Transmission Lines (2 x 1,200MVA, 6km)** Indicative completion date: 2028/ 2029 Development Oriented Project Project status: Proposed	• To supply to the proposed Netzero Future Data Park

• **Samajaya B 132/33kV Substation (2 x 120MVA, 16 bays)** • **Tg. Bako – Samajaya B 132kV UG Cable (2 x 250MVA, 5km)** • **Samajaya A - Samajaya B 132kV UG Cable (2 x 250MVA, 3km)** Indicative completion date: Development Oriented Project Project status: Proposed	• To cater for the load growth at Samajaya Free Industrial Zone. • To relieve existing Samajaya 132/33kV 120MVA transformer loading.
• **Tg. Bako 275/132/33kV 3rd Transformer (1 x 240MVA)** Indicative completion date: 2031 Project status: Proposed	• To cater for load growth at Samajaya Free Industry Zone area. • To fulfil voltage requirement in Kuching while supplying additional load.
Kuching 132kV Reorganization **<u>Phase I</u>** • **Technology Park 275/132/33kV (2 x 240MVA, 9 bays)** • **Line Turn in and out from Entinggan B - Tg. Bako 275kV (2 × 1,200MVA, 6km)** • **Technology Park - Samajaya 132kV UG Cable (2 x 250MVA, 14km)** • **Existing Entinggan - Samajaya 132kV TL & Samajaya - Muara Tabuan 132kV TL reorganized into Entinggan - Muara Tabuan 132kV TL** Indicative completion date: Development Oriented Project Project status: Proposed **<u>Phase II</u>** **Demak Laut Option** • **Demak Laut 275/132/33kV (2 x 240MVA, 9 bays)** • **Sejingkat 132kV Substation Extension (2 bays)** • **Tg Bako - Demak Laut 275kV TL (2 x 1,200MVA, 15km)** • **Demak Laut - Sejingkat 132kV TL (2 x 250MVA, 5kM)** Indicative completion date: Development Oriented Project Project status: Proposed **Santubong Option** • **Santubong 275/132/33kV (2 x 240MVA, 9 bays)** • **Matang - Santubong 275kV Transmission Line (600MVA) (19km)** • **Matang 275kV Substation Bay Extension (2 bays)** Indicative completion date: Development Oriented Project Project status: Proposed	• To cater for the Kota Samarahan Industrial Estate development such as Sarawak Bio-industrial Park, Bioprocess Commercial Centre and future Kota Samarahan LRT Station integration. • To cater for future step loads at Samajaya Free Industrial Zone (SFIZ). • To increase Kuching 132kV network reliability. • To optimize transmission asset utilization for future load growth. • To cater for the integration of Kuching CCGT.

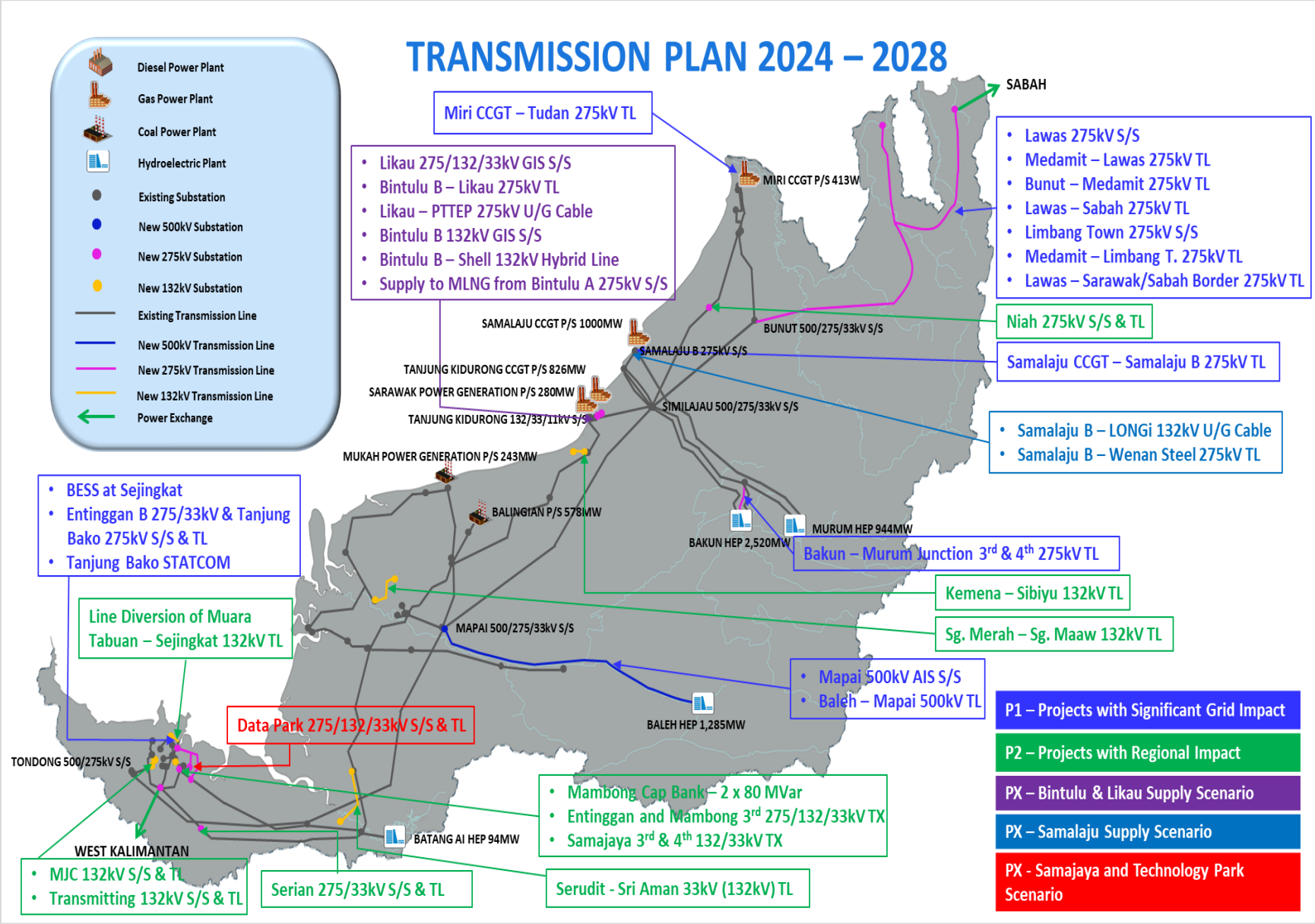


Figure 3.2.1: Sarawak Energy Transmission Network Development Plan 2024 – 2028

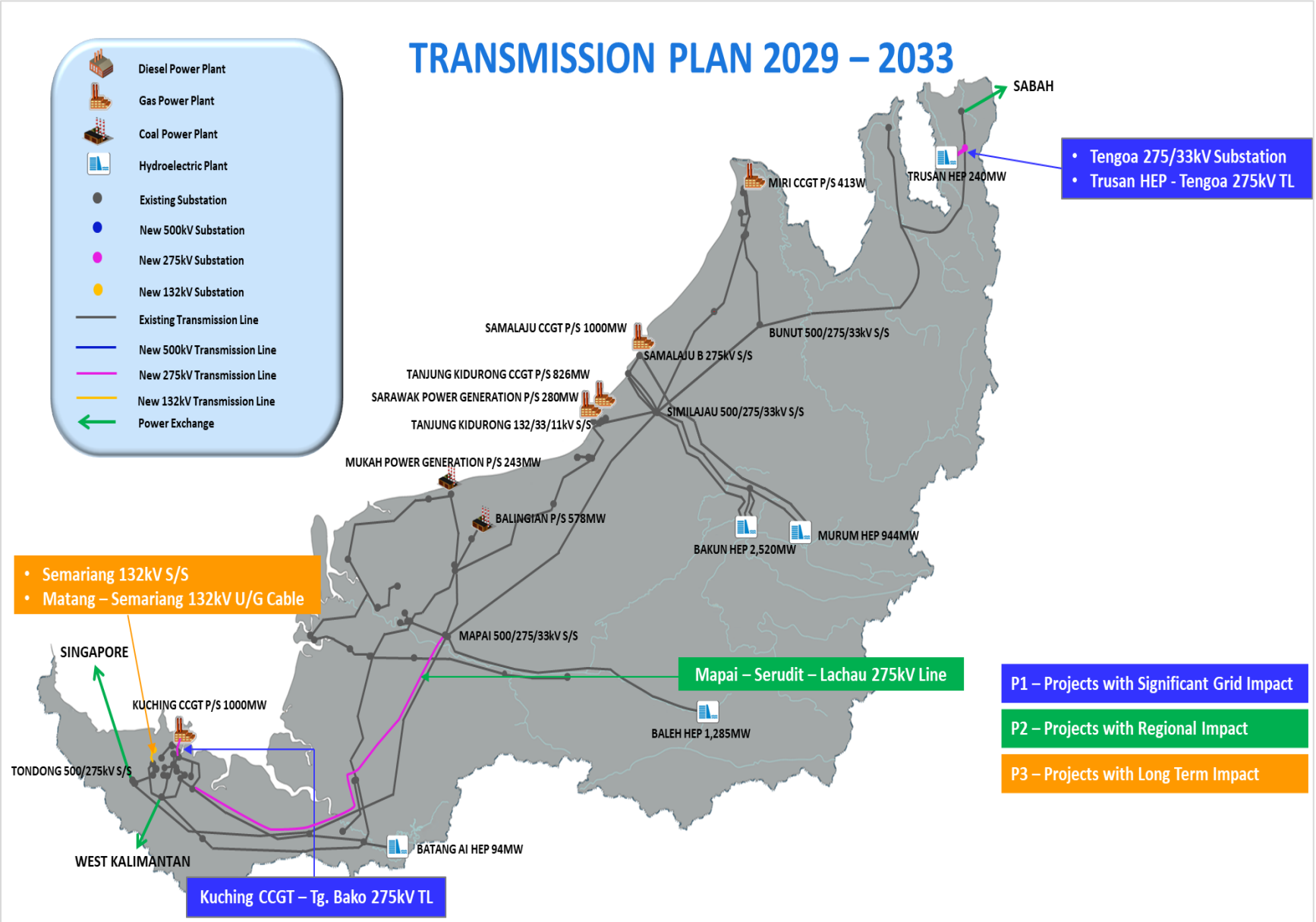


Figure 3.2.2: Sarawak Energy Transmission Network Development Plan 2029 – 2033

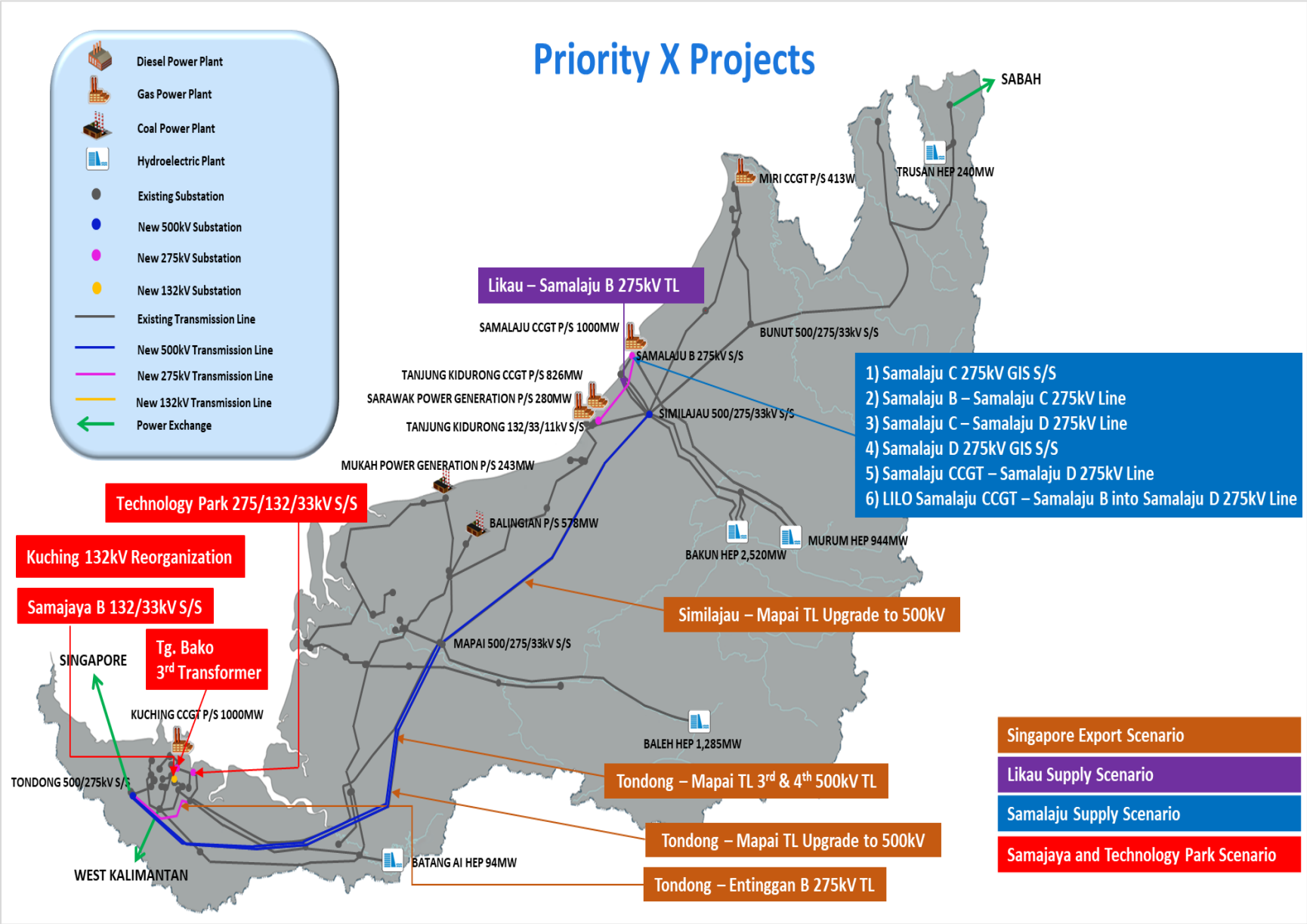


Figure 3.2.3: Sarawak Energy Priority X Projects

Distribution (2022 to 2032) Plan

Distribution Plan 2023

Prepared By:

Distribution Planning and Services Division

FINAL

I. introduction

This report contains the ten-year network development plan for:

i. The main station (Kuching, Sri Aman, Sarikei, Sibu, Bintulu & Miri) distribution system, from year 2023 to year 2032.
ii. The Small station (Mukah, Kapit, Limbang & Lawas) distribution system, from year 2022 to year 2031.

The study aims to identify the reinforcement works necessary for the existing distribution system and to determine the required network augmentation to meet the expected load demand. The planning criteria, such as load flow criteria and system configuration, will be stated in this report. Based on the study's findings, this report outlines the recommendations for the systematic and economic expansion or replacement of equipment and facilities, both in the short and long term, to ensure an acceptable reliability level for the supply.

II. Load Flow Criteria

Single contingency criterion (N – 1) is adopted for the distribution planning. Full power supply is to be provided under all load conditions if one single distribution element (transformer or circuit) is out of service. However, for suburban or rural distribution systems, N-1 with switching or no N-1 is adopted depending on the criticality of the load.

In order to better define the system reliability, three (3) levels of system reliability have been identified based on the contingency criterion and shall be termed as **Reliability Level**:

Table 18: System Reliability Level

Reliability	Contingency Criteria	Application	Description
Level 1	N-1 without switching	Urban areas with high load density	A system that can withstand the loss of single distribution element (transformer or circuit) with no power supply interruption to customers and no overload in the system at all times under all load conditions.
Level 2	N-1 with switching	Suburban areas with medium load density	A system that can withstand the loss of single distribution element (transformer or circuit) with only short power outage to the system. Manual switching is required to restore power supply.
Level 3	No N-1	Rural areas	A system that has no alternative source of supply, thus possible of total power loss while the system is under repair.

The criterion on voltage profile for 33kV and 11kV buses in accordance with the Electricity Rules 2003 (State Grid Code) is as follows:

- ± 5% of nominal voltage
- ± 10% of the nominal voltage under outage or contingency conditions

Main Station Distribution Plan (2023 – 2032)

1.0. Kuching

1.1. Kuching Existing System

Kuching distribution network currently can be grouped into thirteen (13) subsystems based on the main injection point as detailed below.

Table 1.1: Kuching 2022 Distribution System

No	EHV Substation	Zone Substation Supplied	Non-coincidental Load 2022 (MW)	% Load
1	Matang 275/33kV 2 x 120MVA	Matang B, Satok, Mosque, Medan Raya	61.00	54.2%
2	New Matang 275/132/33kV 2 x 80MVA	Malihah, Metrocity, MJC	58.00	77.2%
3	Astana 132/33kV 2 x 120MVA	Astana, Semariang, Santubong, Aminuddin Baki, Darul Hana	51.97	46.1%
4	Sejingkat 132/33kV 2 x 80MVA	Sejingkat, Sejingkat 1, Sejingkat 2, Sejingkat 3, Sejingkat 4, Port Senari, Deep Sea Port, Isthmus	35.91	47.8%
5	Sejingkat 132/33kV Extension 2 x 120MVA	Demak Indah 33kV, King Hong Steel	60.60	52.9%
6	TAR 132/33kV 2 x 80MVA	TAR, New Priok, Petanak, Bintawa	60.36	80.4%
7	Mendu 132/33kV 2 x 120MVA	Mendu, Tabuan Road, Taman Sri Sarawak, King Centre	38.44	34.1%
8	Entinggan 275/132/33kV 2 x 80MVA	Entinggan, Unimas, KSB, SIMC, MID, Tabuan Tranquility, Asajaya	73.53	97.9%
9	Mambong 275/132/33kV 2 x 80MVA	Sri Arjuna, CMS Clinker Plant, Serian, Tapah	77.20	102.8%
10	Semenggo 132/33kV 2 x 80MVA	Semenggo, Boulevard, 12th Mile, Kim Hin, Sentosa	58.20	77.5%
11	Stakan 132/33kV 2 x 80MVA	Stakan, Airport 2, Batu Kitang, Transmitting, AEON	54.76	72.9%

12	Muara Tabuan 2 132/33kV 2 x 80MVA	Muara Tabuan New, Bypass, Airport, Viva City, CityOne, Gala City	57.72	76.9%
13	Muara Tabuan 132/33kV 2 x 80MVA	Samajaya B, X-Fab, LONGi@Comtec Solar, Taiyo Yuden	64.73	86.2%
14	Samajaya 132/33kV 2 x 120MVA	Samajaya, Samajaya A, ILJIN Materials (IMM Technology), Taiyo Yuden, LONGI@MEMC	90.3	80.2%
15	Tondong 275/132/33kV 2 x 80MVA	Tondong, Bau, Lundu	33.71	44.9%

1.2. Kuching Maximum Demand Forecast

The maximum demand forecast for Kuching station from year 2023 up to year 2032 is based on the load growth rate, together with the other known (committed) and projected (not committed) developments. **Figure 1.1** shows the comparison of load forecast made in year 2022 for 2022-2032, and in year 2023 for 2023-2032. It shows that the load forecast is scaled upward in accordance with the load in year 2020.

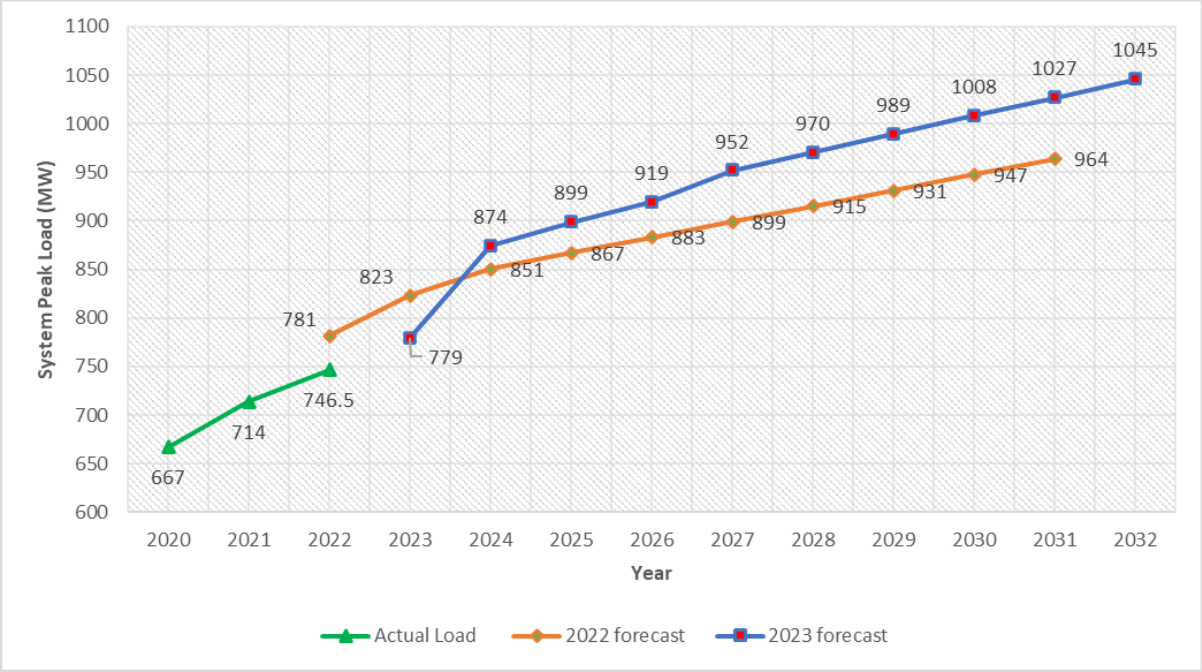


Figure 1.1: Comparison of load forecast made for 2022-2031 and 2023-2032

Table 1.2: Kuching System Peak Load from 2022 to 2032

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Max demand (MW)	746.5	779.0	874.1	898.6	919.4	951.6	970.4	989.2	1007.9	1026.7	1045.5
Forecasted increase in demand (MW)	-	32.6	95.1	24.5	20.8	32.3	18.8	18.8	18.8	18.8	18.8
Load growth	4.6%	4.4%	12.2%	2.8%	2.3%	3.5%	2.0%	1.9%	1.9%	1.9%	1.8%

Kuching recorded a system peak load of 746.5MW in May 2022 as opposed to the forecasted peak load of 781MW.

1.3. Kuching Substation loading

The following table shows Kuching Zone substation loading in year 2022.

EHV Substation	Zone Substation	Transformer Rating	2022 Loading (MW)	2022 Loading (%)
Matang 275/33/11kV 2 x 120 MVA	Matang B 33/11kV	2 x 20/25 MVA	21.0	86.6%
	Satok 33/11kV	2 x 30 MVA	16.8	58.9%
	Mosque 33/11kV	2 x 25 MVA	11.4	47.0%
	Medan Raya 33/11kV	2 x 25 MVA	9.8	40.4%
	Total Zone sub Loading (Total EHV sub loading MW, %)		59.0 (61.0)	(54.2%)

EHV Substation	Zone Substation	Transformer Rating	2022 Loading (MW)	2022 Loading (%)
New Matang 275/132/33kV 2 x 80 MVA	Malihah 33/11kV	2 x 10/15 MVA	11.1	76.3%
	Metrocity 33/11kV	2 x 20/25 MVA	17.6	71.8%
	MJC 33/11kV	2 x 20/25 MVA	22.6	93.2%
	Total Zone sub Loading (Total EHV sub loading MW, %)		51.3 (58.0)	(77.2%)

EHV Substation	Zone Substation	Transformer Rating	2022 Loading (MW)	2022 Loading (%)
Astana 132/33/11kV 2 x 120 MVA	Astana 33/11kV	2 x 30 MVA	23.30	79.3%
	Semariang 33/11kV	2 x 20/25 MVA	19.80	81.6%
	Santubong 33/11kV	2 x 10 MVA	1.30	13.3%
	Aminuddin Baki 33/11kV	2 x 10/15 MVA	1.80	12.0%
	Darul Hana 33/11kV	2 x 20/25 MVA	4.40	18.5%
	Total Zone sub Loading (Total EHV sub loading MW, %)		50.60 (51.97)	(46.1%)

EHV Substation	Zone Substation	Transformer Rating	2022 Loading (MW)	2022 Loading (%)
Sejingkat 132/33/11kV 2 x 80 MVA	Sejingkat EHV 33/11kV	2 x 15/20 MVA	7.07	37.2%
	Sejingkat 1 33/11kV	2 x 10/15 MVA	4.60	31.6%
	Sejingkat 2 33/11kV	2 x 15/20 MVA	6.26	32.9%
	Sejingkat 3 33/11kV	2 x 15/20 MVA	1.50	7.7%
	Sejingkat 4 33/11kV	2 x 20/25 MVA	4.92	20.5%
	Port Senari 33/11kV	2 x 20/25 MVA	6.76	27.6%
	Isthmus 33/11kV	2 x 20/25 MVA	3.30	13.6%
	Total Zone sub Loading (Total EHV sub loading MW, %)		34.41 (35.91)	(47.8%)

EHV Substation	Zone Substation	Transformer Rating	2022 Loading (MW)	2022 Loading (%)
TAR 132/33/11kV 2 x 80 MVA	TAR 33/11kV	2 x 20/25 MVA	17.08	71.9%
	New Priok 33/11kV	3 x 30 MVA	28.47	101.0%
	Petanak 33/11kV	2 x 20/25 MVA	3.80	16.2%
	Bintawa 33/11kV	2 x 15/20 MVA	11.01	57.9%
	Total Zone sub Loading (Total EHV sub loading MW, %)		60.36 (60.36)	(80.4%)

EHV Substation	Zone Substation	Transformer Rating	2022 Loading (MW)	2022 Loading (%)
Mendu 132/33/11kV 2 x 120 MVA	Mendu 33/11kV	2 x 20/25 MVA	8.60	36.6%
	Tabuan Road 33/11kV	2 x 20/25 MVA	16.64	70.1%
	Taman Sri Sarawak 33/11kV	2 x 20 MVA	6.70	35.6%
	King Centre 33/11KV	2 x 20/25 MVA	6.50	27.4%
	Total Zone sub Loading (Total EHV sub loading MW, %)		38.44 (38.44)	(34.1%)

EHV Substation	Zone Substation	Transformer Rating	2022 Loading (MW)	2022 Loading (%)
Entinggan 275/132/33/11kV 2 x 80 MVA	Entinggan 33/11kV	2 x 20/25 MVA	21.10	87.0%
	Unimas 33/11kV	2 x 20/25 MVA	10.20	46.4%
	KSB 33/11kV	2 x 10/15 MVA	5.33	36.6%
	SIMC 33/11kV	2 x 20/25 MVA	9.50	38.4%
	MID KSM 33/11KV	2 x 10/15 MVA	1.20	8.2%
	Tabuan Tranquility 33/11kV	2 x 20/25 MVA	10.60	43.3%
	Asajaya 33/11kV	2 x 10/15 MVA	0.40	2.8%
	Total Zone sub Loading (Total EHV sub loading MW, %)		58.33 (73.53)	(97.9%)

EHV Substation	Zone Substation	Transformer Rating	2022 Loading (MW)	2022 Loading (%)
Mambong 275/132/33kV 2 x 80 MVA	Sri Arjuna 33/11kV	2 x 10/15 MVA	9.90	67.3%
	Serian 33/11kV	2 x 10/15 MVA	9.20	64.6%
	Tapah 33/11kV	2 x 5 MVA	3.30	69.5%
	Total Zone sub Loading (Total EHV sub loading MW, %)		22.40 (77.20)	(102.8%)

EHV Substation	Zone Substation	Transformer Rating	2022 Loading (MW)	2022 Loading (%)
Semenggo 132/33/11kV 2 x 80 MVA	Semenggo 33/11kV	2 x 20 MVA	15.90	82.8%
	Boulevard 33/11kV	2 x 15/20 MVA	7.20	38.3%
	Kim Hin 33/11kV	2 x 20/25 MVA	13.60	57.9%
	12th Mile 33/11kV	2 x 10 MVA	7.90	84.0%
	Sentosa 33/11kV	2 x 10/15 MVA	13.60	94.4%
	Total Zone sub Loading (Total EHV sub loading MW, %)		58.20 (58.20)	(77.5%)

EHV Substation	Zone Substation	Transformer Rating	2022 Loading (MW)	2022 Loading (%)
Stakan 132/33/11kV 2 x 80 MVA	Stakan 33/11kV	2 x 20/25 MVA	3.30	13.8%
	Airport 2 33/11kV	2 x 20/25 MVA	14.50	59.2%
	AEON Central	-	3.80	-
	Transmitting 33/11kV	2 x 30 MVA	21.40	75.1%
	Batu Kitang 33/11kV	2 x 10/15 MVA	11.76	81.7%
	Total Zone sub Loading (Total EHV sub loading MW, %)		54.76 (54.76)	(72.9%)

EHV Substation	Zone Substation	Transformer Rating	2022 Loading (MW)	2022 Loading (%)
Muara Tabuan 2 132/33/11kV 2 x 80 MVA	New Muara Tabuan 33/11kV	2 x 20/25 MVA	12.90	52.7%
	Airport 33/11kV	2 x 20/25 MVA	15.62	65.1%
	Bypass 33/11kV	2 x 20/25 MVA	15.70	66.1%
	Viva City 33/11kV	2 x 20/25 MVA	6.60	27.2%
	Gala City 33/11kV	2 x 10/15 MVA	5.00	34.4%
	Total Zone sub Loading (Total EHV sub loading MW, %)		55.82 (76.86)	(76.9%)

EHV Substation	Zone Substation	Transformer Rating	2022 Loading (MW)	2022 Loading (%)
Muara Tabuan 132/33/11kV 2 x 80 MVA	Samajaya B 33/11kV	2 x 20/25 MVA	14.63	61.6%
	Total Zone sub Loading (Total EHV sub loading MW, %)		14.63 (86.20)	(86.2%)

EHV Substation	Zone Substation	Transformer Rating	2022 Loading (MW)	2022 Loading (%)
Samajaya 132/33/11kV 2 x 120 MVA	Samajaya 33/11kV	2 x 20/25 MVA	3.00	12.4%
	Samajaya A 33/11kV	2 x 15/20 MVA	10.70	58.2%
	Total Zone sub Loading (Total EHV sub loading MW, %)		13.70 (80.16)	(80.2%)

EHV Substation	Zone Substation	Transformer Rating	2022 Loading (MW)	2022 Loading (%)
Tondong 275/132/33kV 2 x 80 MVA	Tondong 33/11kV	2 x 10/15 MVA	1.00	7.0%
	Bau 33/11kV	2 x 10/15 MVA	5.10	35.8%
	Lundu 33/11kV	2 x 5 MVA	3.00	63.2%
	Total Zone sub Loading (Total EHV sub loading MW, %)		9.10 (33.71)	(44.9%)

1.4. Kuching Development Plan

1.4.1. Year 2023

a) Samajaya 3rd and 4th Transformer and Samajaya C 33kV

Samajaya 3rd and 4th transformers and Samajaya C 33kV Substation are proposed to cater for the committed and anticipated new load demand within Samajaya FIZ.

The 3rd and 4th Transformer will come with 120MVA capacity, and connected to a new 33kV Substation named as Samajaya C. The substation will be equipped with 33kV system only, but the civil construction comes with a provision for 11kV system in the future. The substation is scheduled to be completed by October 2023.

b) Entinggan 3rd EHV Transformer and CB extension

Kota Samarahan is a fast-developing suburb of Kuching, with rapid load growth and various ongoing residential and commercial developments expected to come in the next ten years owing to the construction of higher education centres and private medical centre at the area. At present, Kota Samarahan, along with Asajaya, Sadong Jaya and part of Simunjan areas, are all supplied from Entinggan 275/132/33kV.

Prior to the completion of Kuching Network Reinforcement, Entingan 3rd EHV Transformer is crucial to accommodate for the new load from Tabuan Tranquility 33/11kV and act as interim measure to relieve Kuching 132kV Ring. In addition, the existing Entingan 275/132/33kV transformer rated at 240/240/80MVA is highly loaded at the 132kV level and will not be able to cater for any new load.

The scope of this reinforcement project includes the installation of 3rd transformer at existing Entinggan substation, and the extension of one 33kV circuit breaker for the connection of the 3rd EHV transformer. This project is expected to be completed by Q4 2023. With the commissioning of 3rd EHV transformer at Entinggan substation, there will be an additional of 60MVA capacity to be utilized at 33kV level (bus coupler can only carry up to maximum of 140MVA only).

c) Transmitting EHV

Transmitting 132/33kV substation is expected to be ready by October 2023. As Transmitting 132/33kV will source its power from Matang EHV, the completion of the EHV substation is critical to relieve Kuching 132kV ring. Transmitting 132/33kV upon its completion will supply to AEON 33kV, future Batu Lintang 33/11kV, Airport 2 33/11kV and Galacity, thus a total load of 42.4 MW will be shifted out from Kuching 132kV Ring.

d) Lundu reinforcement

One (1) 0.5MVAr capbank is to be installed at Lundu 11kV Bus, and one (1) 2.0MVAr capbank is to be installed at Centex Lundu 11kV Bus to improve the voltage quality at Lundu. These plans shall improve the reactive power flow and subsequently the voltage at Lundu. The existing 11kV capbank from Bau 33/11kV and Bypass 33/11kV respectively is to be utilised for the installation which is to be completed by 2023 and 2024.

Besides that, it is also proposed to lay one (1) no of 630mm2/1C/CU cable from Tondong to Stenggang and one (1) no of 630mm2/1C/CU cable from Tondong to Bau junction by 2024. Subsequently, a new zone substation is proposed to be constructed at Kpg Stenggang vicinity. The 2 nos of 630mm2/1C/CU from Tondong to Stenggang and Bau Junction will be diverted to supply to the new zone substation

and the substation will be supplying to Bau-Lundu OHL as per illustrated in Figure 1.3. The above plans will be able to maintain voltage quality from Bau to Lundu line up to year 2028 during normal condition.

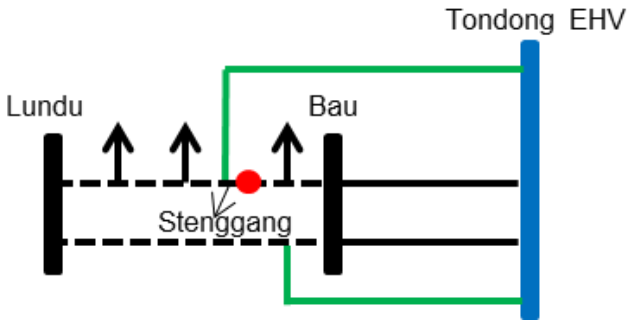


Figure 1.2: Tondong – Lundu interim measure System Configuration

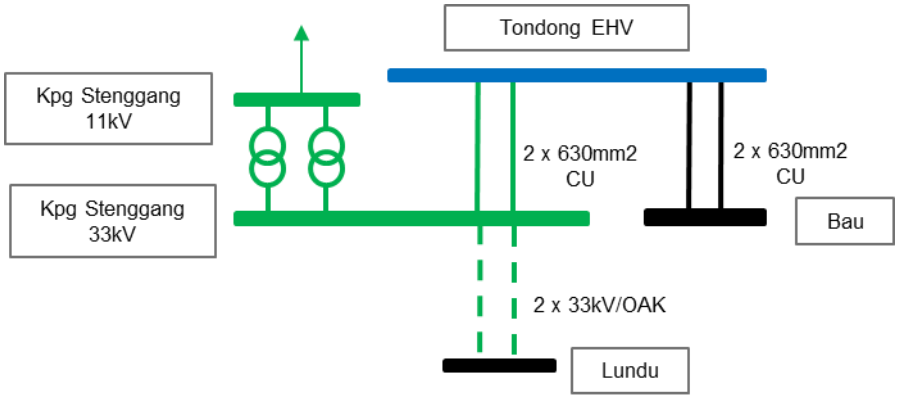


Figure 1.3 Configuration for Kpg Stenggang 33/11kV

With the above interim measures, the double 33kV Twin Ash Monopole lines from Tondong to Lundu shall be completed by 2029 to further maintain the voltage quality. The final scheme with Twin Ash Monopole lines is shown as Figure 1.4 below.

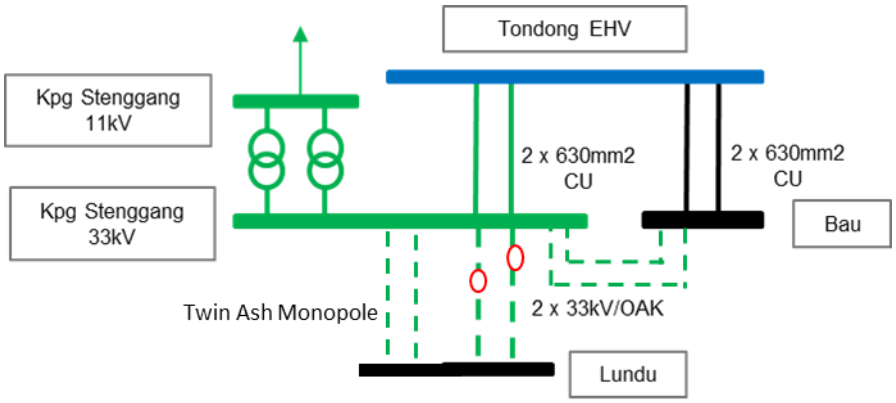


Figure 1.4 Final configuration for Lundu

e) Development of Hikmah Exchange 33kV Substation (2023)

Originally, Hikmah Exchange 33kV switching substation is scheduled to be completed in 2021. The switching substation is developed under turnkey basis to supply to the Hikmah Exchange development with an applied maximum demand of 7MVA. The new substation shall be sourced from Satok 33/11kV via loop in and out the Satok-Mosque double circuits 3 x 630mm2/1C/Al cable. The substation is rescheduled to be completed by Q2 2023.

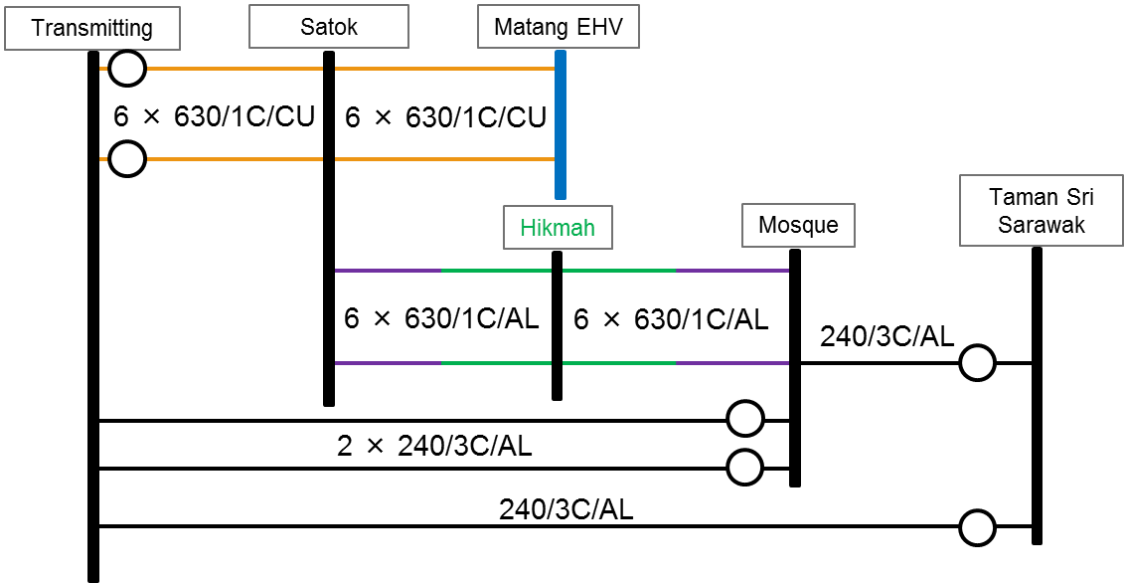


Figure 1.5: Hikmah Exchange 33kV System Configuration

f) MID 33/11kV to Asajaya 33/11kV Underground Cable

Asajaya 33/11kV substation is constructed with provision to be upgraded to 132kV system when it is required to cater for the expansion of distribution network around the area. Asajaya 33/11kV Substation has been temporarily energised in December 2021 using the existing overhead line.

The temporary scheme is not sufficient in mitigating the current supply capacity and reliability concern at Asajaya area. In year 2021, Asajaya and Sebangan lines were loaded to 5.4MW and 3.58 MW. Should one of the lines tripped, the other line will not be able to take the whole load of 12.7MW and will result in load voltage issue too.

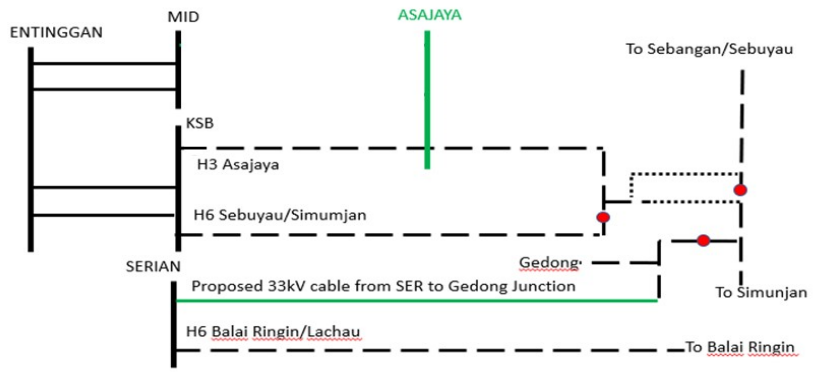


Figure 1.6: Temporary Scheme for Asajaya 33/11kV

The final scheme shall be from MID 33/11kV via double circuits 3 x 630mm^2/1C/Al cable which currently is scheduled to be completed by Nov 2022. Besides that, a few lines extension is proposed to be carried out to improve the supply reliability to Sebangan, Sebuyau and Simunjan area as per illustrated in Figure 1.7. The proposed works below are to be carried out in stages.

(1) & (2) To lay additional line from Asajaya Sub to Sebangan/ Sebuyau.
(3) To lay second circuit to Sebangan/Sebuyau and Simunjan.

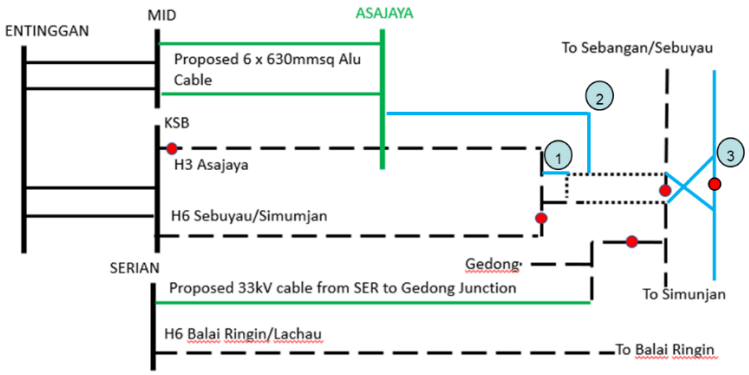


Figure 1.7 Proposed System Configuration for Asajaya 33/11kV

The type of circuit to be used will be depending on the feasibility of the installation on sites.

Asajaya is expecting higher load growth in the next ten years resulting from the bridge that link-up to Kota Samarahan and Simunjan, the ongoing Second Trunk Road project, and the ongoing masterplan study for Gedong.

g) Serian – Gedong Junction 33kV Cable feeder

A 33kV single circuit 240mm^2/3C/Al cable is to be lay from Serian 33/11kV to Gedong Junction to take up about 1.5MW load from existing Serian-Jaong overhead line. The load to be diverted to be supplied from this cable include Gedong Waterwork, which has been facing low voltage issue consistently over these years. The work is expected to complete by Q2 2023.

h) Reconstruction of Batu Kitang 33/11kV substation (Q4 2023)

Batu Kitang 33/11kV is to be equipped with 2 x 20/25MVA transformers to cater for the new load demand from Batu Kitang Waterwork and the replacement of existing outdoor substation. The new substation will still be supplied form Stakan 132kV via existing lines and expected to be ready in Q4 2023.

i) Serian-Tebakang 33kV cable feeder (2023)

The existing Serian H9L5 to Tebakang/Tebedu has recorded a peak load of 5.4MW in year 2022. Any tripping on this feeder will incur high SAIDI and affected large number of customers. It is proposed to lay 33kV 240mm^2/3C/AL cable from Serian 33/11kV to Tebakang to split the feeder and this will also improve the voltage level at Tebedu. The project is expected to complete by Q3 2023.

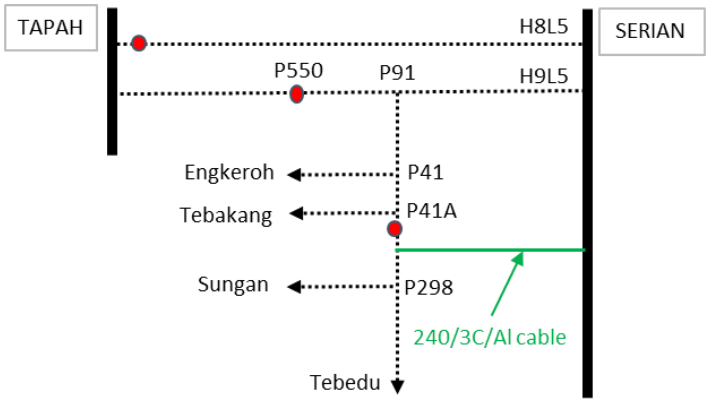


Figure 1.8: Serian-Tebakong Connection Scheme

1.4.2. Year 2024

a) Development of Batu Kawa 33/11kV substation (July 2024)

Batu Kawa 33/11kV is to be developed to supply to one of the fast-growing areas at MJC. With the completion of this substation, it helps to share some load at MJC 33/11kV substation which is highly loaded. Prior to the completion of MJC EHV, the source will be from New Matang 275/132/33kV through MJC 33/11kV (refer **Figure 1.9**). The source of supply for the substation shall be permanently from MJC EHV using double circuits of 3 x 630mm^2/1C/Cu cable.

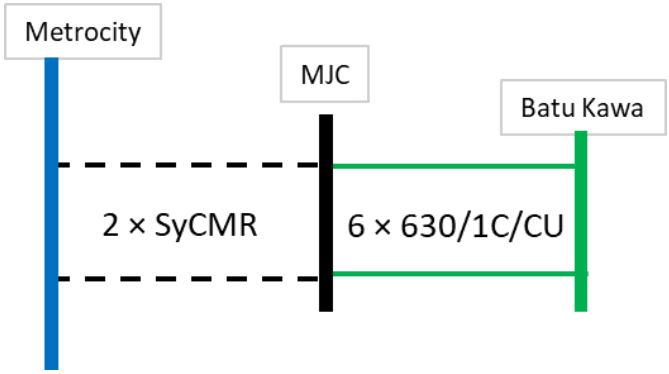


Figure 1.9: Temporary Batu Kawa 33/11kV System Configuration

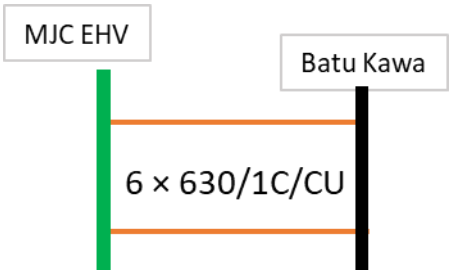


Figure 1.10: Batu Kawa 33/11kV System Configuration

b) Development of PJ Hospital 33/11kV Substation (2024)

PJ Hospital 33/11kV Substation was originally scheduled to be complete in 2015 and it has been delayed for few years and is anticipated to be further. This substation is to be developed under turnkey basis and recently has resumed the equipment installation and replacement due to vandalism as the project has been abandoned for years. PH Hospital 33/11kV is expected to complete in 2024 and will supply the new Petra Jaya Hospital which is expected to complete in year 2027. The source of supply is proposed to be from Medan Raya 33/11kV via double circuits 240mm^2/3C/Al cable.

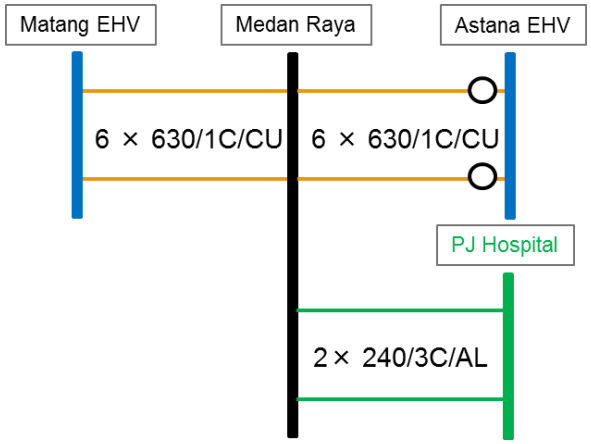


Figure 1.11: PJ Hospital 33/11kV System Configuration

c) Siburan 33/11kV – Tapah 33/11kV Underground Cable

Tapah 33/11kV substation is supplied from new Siburan 33/11kV where the existing 12th Mile – Tapah 33kV overhead line is loop in and out at the substation. Due to the limitation with the capacity at the incoming overhead lines, all the load connected to Tapah – Serian Baki line is sourcing power supply from Serian 33/11kV. This has further load-up Mambong 275/33kV substation, and the heavily loaded Mambong – Serian 33kV monopole line.

In addition, in year 2023, Siburan – Tapah 33kV lines are expected to be highly loaded. Hence, it is proposed to lay double circuits 33kV 630mm^2/1C/Al underground cable from Siburan 33/11kV to Tapah 33/11kV. The project is expected to complete by Q4 2024. Siburan – Tapah lines will be disconnected from Tapah 33/11kV to free up the 33kV switchgears at Tapah 33/11kV to cater for the connection.

By doing so, the existing 33kV Serian – Tapah (Baki line) overhead line can be shifted to be supplied from Tapah 33/11kV, thus relieve the total load connected to Mambong substation and the total power flow through the Mambong-Serian 33kV monopole line. This shall improve the voltage profile at Serian 33/11kV substation too.

1.4.3. Year 2025

a) Commissioning of Tanjong Bako 275/132/33kV Substation (Q4 2025)

As part of Kuching Network Reinforcement, Tanjong Bako 275/132/33kV is targeted to be commission by Q4 2025. With the commissioning of this EHV substation, Tabuan Tranquality 33/11kV and SIMC 33/11kV will be supplied from this EHV and take up a total of 22.78MW from New Muara Tabuan EHV and Entingan EHV.

b) Development of Moyan 33/11kV substation (2025)

Currently Moyan is supplied from MJC 33/11kV via extension of 11kV line. Hence, Moyan 33/11kV is proposed to be constructed to cater for the emerging load growth at the area. Initially, Moyan 33/11kV is to be supplied from MJC 33/11kV via existing MJC – Malihah and MJC – Bau 240mm^2/3C/Al cable. The two circuits of overhead line connecting Malihah 33/11kV and Tondong 33/11kV shall be diverted to the substation.

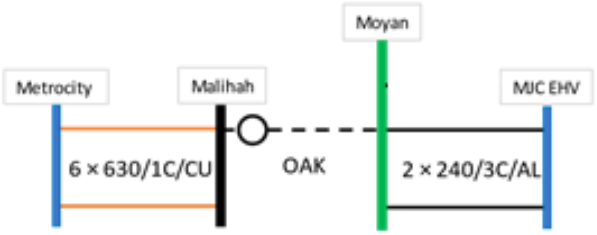


Figure 1.12: Initial Moyan 33/11kV System Configuration

However, DP&S has proposed for Moyan 33/11kV to be supplied from Matang EHV via double circuit of 240mm2/AL from Malihah 33/11kV. The proposal is in view of MJC- Metrocity line will be loaded at 103.6% in 2026 during N-1 and MJC EHV will only complete in 2026. This configuration will help to relief MJC – Metrocity line and provide alternative load diversion during the conversion of the line from 33kV to 132kV.

Figure below shows the new configuration for Moyan 33/11kV. The new proposed configuration will be able to resolve overloading issue at MJC-Metrocity line.

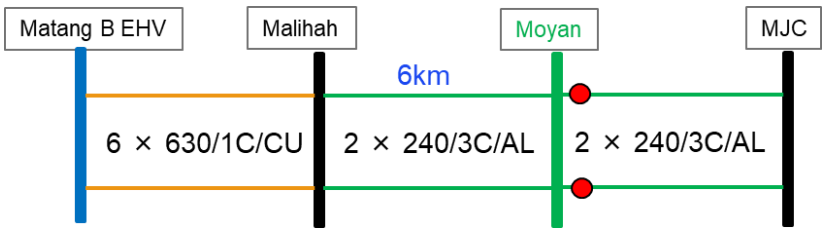


Figure 1.13 Revised Moyan 33/11kV system configuration

c) Development of Batu Lintang 33/11kV substation (2025)

Batu Lintang 33/11kV substation was originally scheduled to be completed by 2024. However, the land title/ ownership of the substation land yet to be transferred to SEB thus delaying the commencement of construction works. Batu Lintang 33/11kV is proposed to be developed to cater for the load demand from Paragon mixed development and Timberland private hospital at Jalan Batu Lintang. The source of supply shall be from Transmitting EHV via double circuits 3 x 630mm^2/1C/Cu cable. This new substation will also take around 4MW of existing Transmitting 33/11kV loading and shall supply Timberland Medical Center once commissioned.

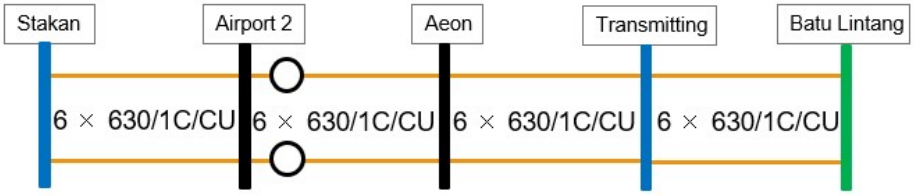


Figure 1.14: Batu Lintang 33/11kV System Configuration After Commissioning of Transmitting EHV

d) Development of Pending 33/11kV substation (2025)

A new 33/11kV substation is proposed to be developed in Pending area to cater for the organic load growth and new developments along Jalan Datuk Marican Salleh and Kuching City Square. The substation construction work has been delayed for a year as comprehensive study has been carried out to determine the best scheme of supply to the substation. The main source for Pending 33/11kV is from Muara Tabuan 2 132/33/11kV substation via double circuit 3x630mm^2/1C/Cu/cable with the entire circuit length of approximately 3km.

In addition, it is proposed to provide pending 33/11kV substation with a second source of supply from TAR 132/33kV substation via single circuit of 1C 630mm^2 Al. cable. The circuit shall utilize the existing spare switchgear at TAR 33/11kV that was previously used by the step-up transformer from the generator. A minor retrofitting work at the existing Control Relay Panel is required to convert the switchgear from a genset incomer to a feeder.

Upon completion, Pending 33/11kV shall take the load from TAR 33/11kV and Sg. Priok 33/11kV which currently supplied from TAR 132/33kV. This helps to reduce the loading connected to TAR 132/33kV transformer which is expected to be loaded to 66.39MW or 88.4% of the transformer rating in year 2025. With Pending 33/11kV in place, the reinforcement at TAR 132/33kV can be put on hold till after year 2032.

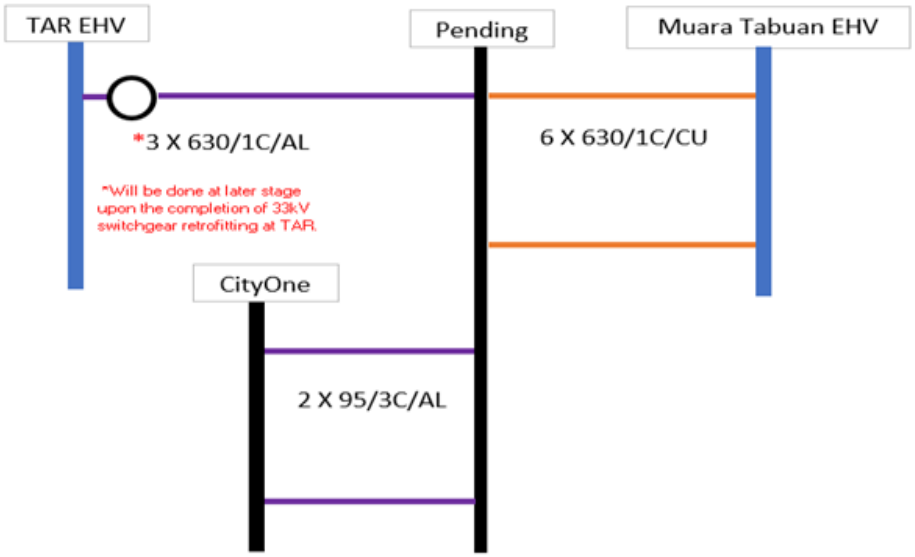


Figure 1.15: Pending 33/11kV System Configuration

e) Reconstruction of 12th Mile 33/11kV Substation

12th Mile 33/11kV substation is currently undergoing re-construction due to ageing equipment which is more than 40 years old. In order to make way for the reconstruction of 12th Mile 33/11kV substation, all the feeders has been diverted to the mobile substations on temporary basis. As one standard mobile substation is only equipped with three (3) nos of 33kV CBs, two (2) units of mobile substation are required. The construction of a new 33/11kV substation takes about 3 years to complete. During this period, 12th Mile 33/11kV can only maintain N-1 with switching as the two separate 33kV bus is not connected.

12th Mile Indoor 33/11kV substation is expected to complete in 2025. Upon its completion, all the feeders at the mobile switchgear panel shall be diverted back to the new indoor substation with 20/25MVA transformers.

f) Upgrading of Tapah 33/11kV substation

In order to further reduce the existing overhead line load between Tapah – Siburan and Tapah -Serian, it is proposed to uprate the existing Tapah transformers of 5MVA to 10/15MVA rating.

In year 2023, it is expected Tapah 33/11kV to be loaded at 3.41MW or 71.8% of its rated capacity. With the commissioning of new Tapah 10/15MVA transformers, various 33/11/.433kV tee-off transformers along Tapah - Baki line is to be diverted to be supplied directly from the substation.

1.4.4. Year 2026

a) Development of Berlian Stabil 33/11kV substation (2026)

Entinggan 33/11kV transformer is expected to be loaded to 23.91MW or 98.6% of the transformer rating in year 2026. As such, a full-fledged zone substation is to be built as Berlian Stabil 33/11kV to take up the load at Samarindah and Berlian Stabil own developments. This substation shall cater for the development along Kuching Outer Ring Road toward 15th Mile.

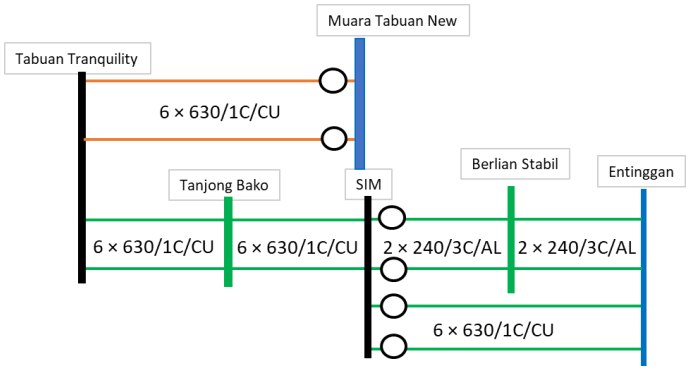


Figure 1.16: Berlian Stabil 33/11kV System configuration

The substation shall be supplied through looping in and out the existing double circuits of 240mmsq/3C/Al cable from Entinggan EHV to SIMC 33/11kV as there will be no spare switchgear available for Berlian Stabil 33/11kV from Entinggan. Once the substation is commissioned, it is expected to take up around 5MW from Entinggan 33/11kV transformer and relieve the transformer.

b) Development of Landeh 33/11kV (2026)

Landeh 33/11kV substation is proposed to be constructed in view of the substantial load demand growth at 10th Mile area. Landeh 33/11kV shall be able to relieve Semenggo 33/11kV transformer which is about 18.02 MW or 97% of the transformer rating by year 2026. The source of Landeh 33/11kV will be from Semenggo 33/11kV via loop in and out of Semenggo-12th Mile double circuits 3 x 630mm^2/1C/Al Cable. Upon its completion, Landeh 33/11kV will take up 7MW from Semenggo 33/11kV.

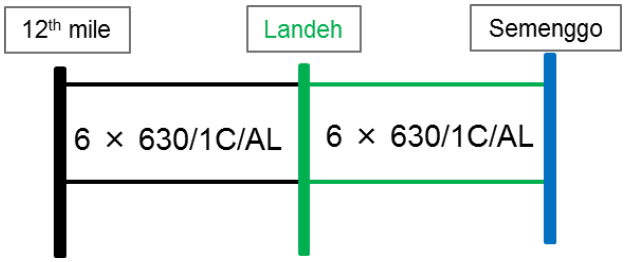


Figure 1.17: Landeh 33/11kV System Configuration

c) Commissioning of MJC 132/33kV Substation (2026)

MJC 132/33kV is expected to be ready by year 2026. The existing Metrocity-MJC 132kV tower lines currently energised at 33kV shall be diverted to Matang 275/132kV to energise MJC 132/33kV substation. MJC 33/11kV shall be supplied by the new MJC 132/33kV transformers. With the commissioning of MJC 132/33kV, sufficient capacity is available to cater for the increasing load demand and new developments at Batu Kawa and Jalan Stephen Yong.

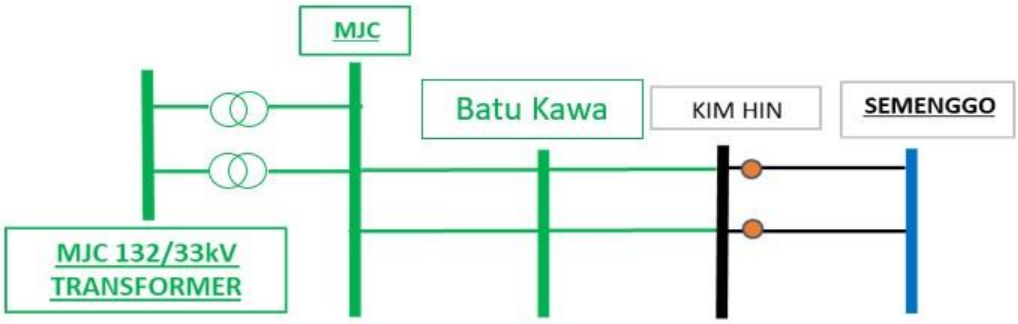


Figure 1.18: MJC EHV System Configuration

On the other hand, Semenggo 132/33kV transformer is expected to be loaded at 64.01MW(85.24%) and 65.96(87.82%) of the transformer rating in year 2025 and 2026 respectively. With the proposed double circuits 3 x 630mm^2/1C/Al cable from Batu Kawa 33/11kV to Kim Hin 33/11kV, it will enable the load transfer of Kim Him substation from Semenggo 132/33kV to MJC 132/33kV. The load transfer is only possible after the commissioning of MJC 132/33kV. MJC 132/33kV substation shall take up 33.2MW and 15.4MW from New Matang 275/132/33kV and Semenggo 132/33kV respectively.

1.4.5. Year 2027

a) Commissioning of Serian 275/33kV Substation (2027)

Serian 275/33kV is expected to complete in year 2027. The substation shall relieve Mambong 275/132/33kV transformer which is expected to be loaded at 89MW or 118.7% in year 2027. The substation is expected to take up about 30MW of load from Mambong 275/132/33kV.

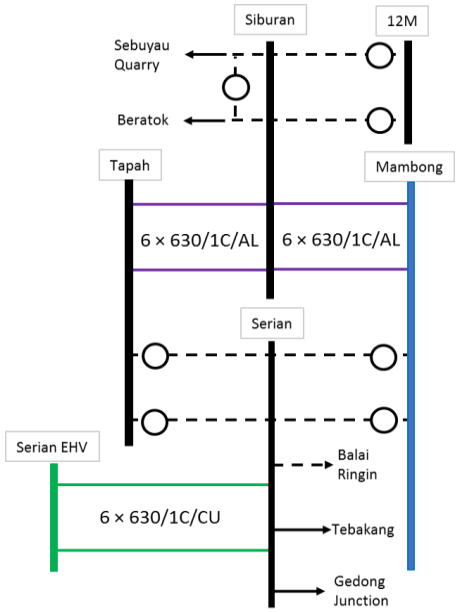


Figure 1.19: Serian EHV System Configuration

b) Development of Siniawan 33/11kV

Siniawan 33/11kV substation is proposed to be developed to improve the system reliability at Siniawan and the surrounding area by clearing up Bau to Batu Kitang overhead line from the tie-off substation load. Siniawan 33/11kV shall be supplied by Bau 33/11kV via loopin-and-out from the Batu Kitang-Bau 3 x 630mm^2/1C/Al cable with and new circuit to be laid from Bau 33/11kV.

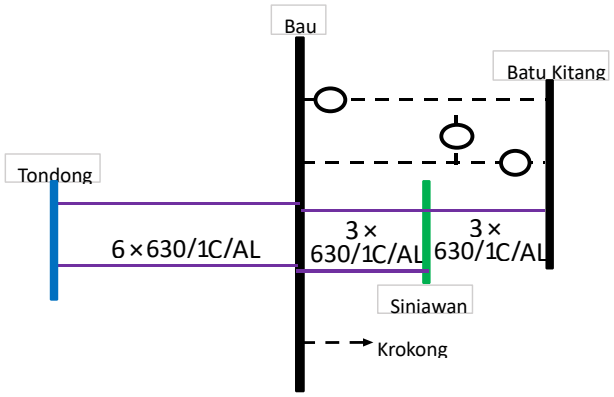


Figure 1.20: Siniawan 33/11kV System Configuration

1.4.6. Year 2028

a) Commissioning of Semariang 132/33kV substation (2028)

Semariang is expected to continue to grow as various residential and commercial developments are currently underway, and more developments are expected to commence in the next ten years. It is forecasted that the Semariang area will be loaded up to 26MW in year 2029, and the existing Astana – Semariang double circuits of 33kV 3 x 630mm^2/1C/Al cable will be close to losing N-1 contingency. In addition, with the ongoing Santubong Peninsular Masterplan currently in the planning stage, it is forecasted the load will further grow.

There will be three tiers of zone substation after Astana 33/11kV, namely Semariang, Aminuddin Baki and Santubong, which will result in the risks of protection mis-coordination for downstream fault. Currently these substations are adopting compromised coordination time interval.

It is proposed that Semariang 132/33kV to be constructed in the vicinity to cater for the development. As there is no spare circuit breaker available at the existing Semariang 33/11kV, it is proposed to build a new 33kV substation with the provision for 132/33kV transformers injection.

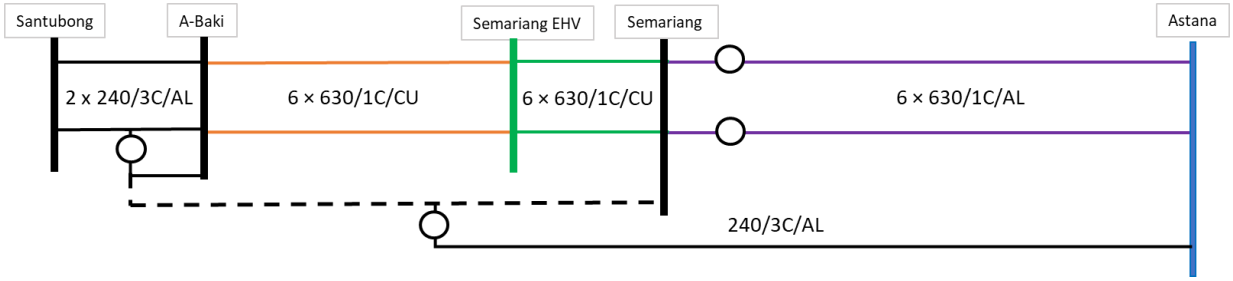


Figure 1.21: Semariang EHV System Configuration

1.4.7. Year 2029 – 2032

System study for long term plan from year 2029 to 2032 is discussed in this chapter. Several transmission and zone substations are proposed under long term plan.

a) Development of Nanas Road 33/11kV substation (2030)

Nanas Road 33/11kV substation is proposed to cater for the organic growth at Jalan Nanas, Jalan Rubber, Jalan Pisang and Sg. Maong areas. The substation location is ideal to relief Satok 33/11kV and Mosque 33/11kV for future load growth in the CBD area. It is proposed that the source of supply to be from Satok 33/11kV via loop-in-and-out of the Satok – Matang single circuits 3 x 630mm^2/1C/Cu cable previously laid for Transmitting diversion and to lay another circuit from of 3 x 630mm^2/1C/Cu to Nanas Road.

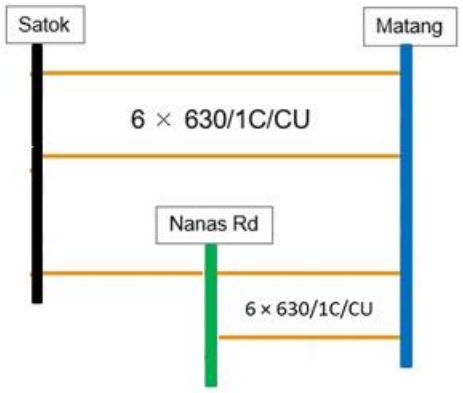


Figure 1.22: Nanas Road 33/11kV System Configuration

b) Development of Gedong Junction 33/11kV substation (2030)

Presently, the peak load for the 33kV overhead line feeder toward Balai Ringin and Lachau is approximately 5.1MW. The load growth is expected to reach 6.5MW in year 2030. Despite the changing of NOP from Jaong to Simunjan Junction in year 2020, the line is still anticipated to be heavily loaded.

In order to reduce the load on the overhead line, a 33/11kV substation is proposed to be developed near to Gedong Junction. The 11kV load around the area can be diverted to the new 33/11kV substation thereby providing a more reliable supply. Gedong Junction is also the location where the overhead line to Simunjan is connected. Therefore, it will be possible to split Gedong/Simunjan from the Balai Ringin feeder. The Gedong/Simunjan feeder will act as a backup source for Simunjan and Sebangan/Sebuyau.

The source of supply for Gedong Junction 33/11kV is proposed to be from Serian 275/33kV substation via double circuits 3 x 630mm^2/1C/Al cable. However as a part of reinforcement plan to clear up the Serian-Tapah line, there is a single circuit 240mm^2/3C/Al cable to be laid and expected to completed by year 2023. In consideration of the load growth under long term, it is possible to use the new cable and lay another circuit of 240mm^2/3C/Al to be the main source of supply provided that the capacity is sufficient by year 2030. The final connection scheme to be finalized at later date.

c) Development of Baki 33/11kV substation (2030)

With the rapid development in Baki and Tarat area along Jalan Kuching Serian, it is proposed to develop a 33/11kV substation in the vicinity to cater for the load growth. The new substation will also improve the reliability of the supply. Presently, these areas are getting supply from the Tapah-Serian 33kV overhead line and will be reorganised to supply directly from Serian 33/11kV transformer. The source of supply is proposed to be from Serian via loop-in-and-out from the Mambong-Serian monopole line.

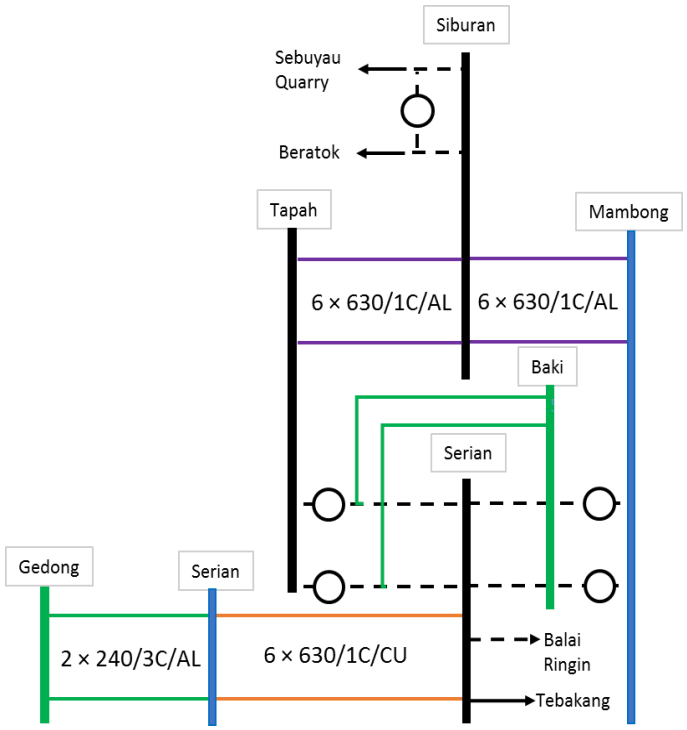


Figure 1.23: Baki 33/11kV and Gedong Junction 33/11kV System Configuration

d) Commissioning of Kpg Stenggang-Lundu 33kV Twin Ash monopole (2029)

Kpg Stenggang – Lundu 33kV 33kV Twin Ash monopole is expected to be ready by year 2029. This line will provide a clean source directly from Kpg Stenggang 33/11kV which is supplied from Tondong 275/33kV. It will mitigate the supply reliability concern in Lundu and Sematan area as well as to improve the voltage performance. This tower shall be sufficient to cater the load growth in Lundu together with consideration of partial load from Lundu Masterplan (6MVA) till year 2034.

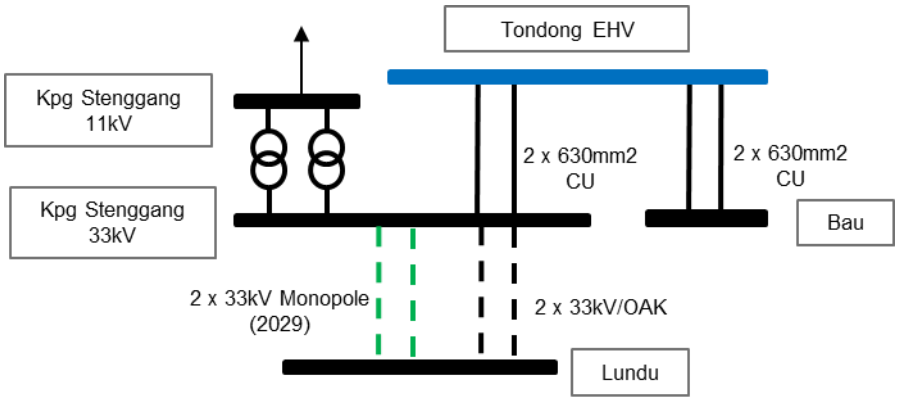


Figure 1.24: Kpg Stenggang - Lundu 33kV Twin Ash Monopole

2.0. Sri Aman

2.1. Sri Aman Existing System

Sri Aman distribution network is supported by four (4) bulk power injection points which are Engkilili 275/33kV Substation, Lachau 275/33kV Substation, Serudit 275/132/33kV Substation and Sarikei 132/33kV Substation.

Engkilili 275/33kV is supplying to Sri Aman town, Temudok, Lubok Antu and Betong junction areas. For Lachau 275/33kV, it supplies towards Lachau, Pantu, Jaong and part of Balai Ringin up to Kampung Abit. Serudit 275/132/33kV is supplying the load demand at Betong town, Tanu, Spaoh, Debak and Pusa areas. The areas like Saratok, Roban and Kabong are still supplying from Sarikei 132/33kV and will only be shifted to Sri Aman tentatively by year 2027 with the completion of Serudit-Saratok 33kV monopole lines.

Generally, the distribution network can be grouped based on the current network as listed below:

Table 2.1: Existing EHV Substation with Zone Substation

Item	EHV Substations (Injection Points)	Zone Substations Supplied	Area Supplied	Non-coincidental Peak Load 2022 (MW)
1	Engkilili 275/33kV	Engkilili 33/11kV Temudok 33/11kV Sri Aman 33/11kV	Sri Aman town, Temudok, Lubok Antu, Betong junction	25.2
2	Lachau 275/33kV	Bait Ili 33/11kV Lachau Town 33/11kV Empili 33/11kV Simunjan Junction 33/11kV Kpg Abit 33/11kV	Lachau, Pantu, Jaong, Simunjan, Balai Ringin, Kampung Abit	5.8
3	Serudit 275/132/33kV	Jungkong 33/11kV Pusa 33/11kV Spinang 33/11kV	Betong town, Tanu, Spaoh, Debak, Pusa	17.7
4	Sarikei 132/33kV	Saratok 33/11kV	Saratok, Roban, Kabong	5.8

2.2. Sri Aman Maximum Demand Forecast

Figure 2.1 below shows the projected maximum demand for Sri Aman distribution system from year 2023 to 2032 which is derived based on load growth percentage (%), as well as the known and projected step load.

The load forecast conducted in year 2022 is also appended as shown in blue line while year 2023 is appended in red line. The peak load recorded in year 2022 is 55.5MW which is 3.5MW higher than the previous forecasted load. The increase of load is due to load transfer via shifting of the Normal Open Point (NOP) from Lachau EHV towards Serian station while Serudit EHV towards Saratok junction.

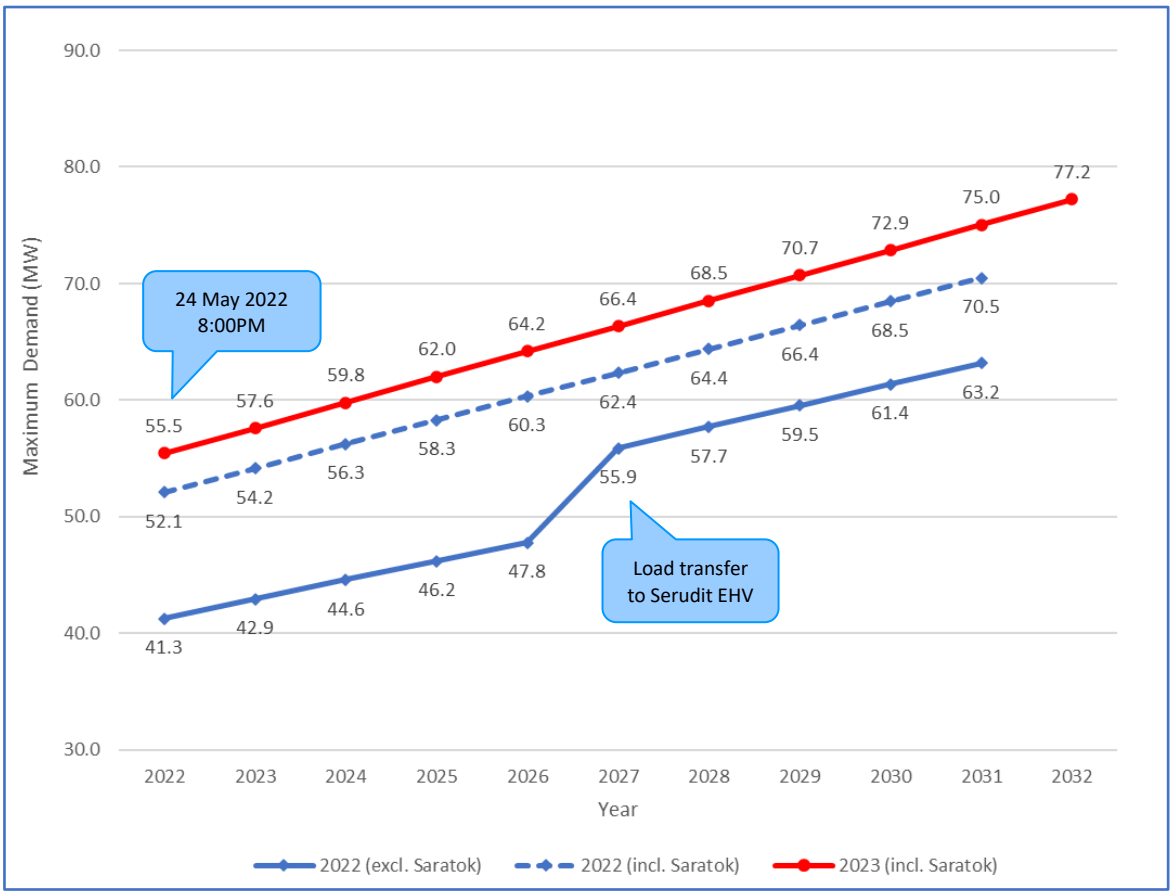


Figure 2.1: Projected maximum demand for Sri Aman distribution system from year 2023 to 2032

Table 2.1 shows the growth rate for Sri Aman station from year 2023 to 2032.

Table 1.1: Growth Rate for Sri Aman from Year 2023 to 2032

Year	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Growth Rate (%)	3.8%	3.8%	3.7%	3.5%	3.4%	3.3%	3.2%	3.1%	3.0%	2.9%

2.3. Sri Aman Substation Loading

Table 2.2: Zone Substation Peak Load

Substation	Transformer Rating (MVA)	Peak Load as Recorded in 2022 (MW)	Percentage Loading (%)
Engkilili 33/11kV	5MVA	1.2	24%
Temudok 33/11kV	10/15MVA	6.0	41%
Sri Aman 33/11kV	10MVA	**10.3**	**110%**
Jungkong 33/11kV	10/15MVA	3.8	26%
Pusa 33/11kV	2.5MVA	3.7	149%
Saratok 33/11kV	5MVA	3.7	76%

Based on the substation loading tabulated, it can be concluded that all zone substations in Sri Aman station are operating at System Reliability Level 1 in year 2022, except for Sri Aman 33/11kV which has recorded a peak load of 10.3MW or 110% in year 2022.

2.4. Sri Aman Development Plan

2.4.1. Year 2023

a) Construction of Pusa 33/11kV

The existing Pusa 2 x 2.5MVA 33/11kV transformers have recorded a total peak load of 3.7MW or 149.5% in year 2022. An operational measure by monitoring the transformer loading and manage the load transfer to the existing 1MVA 33/11kV transformer whenever required.

The new Pusa 33/11kV is expected to take up 3.9MW from the existing Pusa 33/11kV substation. The existing 33kV feeder supplying to Spinang area will be reorganized and diverted to the new Pusa 33/11kV.

b) Construction of 33kV Overhead Line from Selepong to Temudok 33/11kV

Due to the delay in the construction of Serudit-Sri Aman 132kV line and completion of Pan Borneo Highway along Lachau-Sri Aman Junction stretch, it was proposed to construct a single circuit of 45km 33kV OAK 7/4.65 overhead line from Lachau 275/33kV to Temudok 33/11kV.

This project is divided into two (2) phases as below:

1) Phase 1: To construct 33kV overhead line from Lachau EHV to Selepong with the installation of one (1) no. 5MVA 33/11kV at Selepong by year 2021.

2) Phase 2: Construction of 33kV overhead line from Selepong to Temudok 33/11kV by year 2022.

With the completion of this 33kV line, Melugu, Entulang and part of Temudok area with the total original intended load diversion of 5MW expected to be diverted and supplied from Lachau 275/33kV, which will temporarily restore N-1 contingency for Engkilili-Temudok 33kV overhead lines as well as to mitigate the low voltage issue at Temudok 33/11kV and Sri Aman 33/11kV. However, as the project

goes along, it is estimated it could only take up 2MW of load from Temudok which is not sufficient to restore N-1 contingency for Engkilili-Temudok 33kV overhead line.

The phase 1 of the project has been completed in Q1 2023 and it only able to take 1MW from Engkilili-Temudok 33kV lines. Based on the load forecast, the Engkilili-Temudok 33kV lines are anticipated to load up to 17.7MW in year 2023.

Phase 2 of the project has been decided to put on hold, as Phase 2 will not be able to cater for any new additional load transfer from Engkilili to Temudok line. Phase 2 is expected to commence in 2024.

Figure 2.2: Line Route from Lachau EHV to Temudok 33/11kV

c) Installation of 2.5MVA 33/11kV Transformer at Brayun

The load growth at Sri Aman Town has increasing drastically due to the development of Sri Aman Hospital and some other quarries for Pan Borneo Highway construction.

Hence it is recommended to install one (1) no. of 2.5MVA 33/11kV transformer at Brayun, which is within the vicinity of the existing Sri Aman 33/11kV substation as shown in ***Figure 2.3***. This will temporarily relieve highly loaded Sri Aman 33/11kV transformers by shifting feeder M5L5 with loading of 1.5MW to the temporary 2.5MVA Transformer. This work is considered critical and shall be completed by Q4 2023.

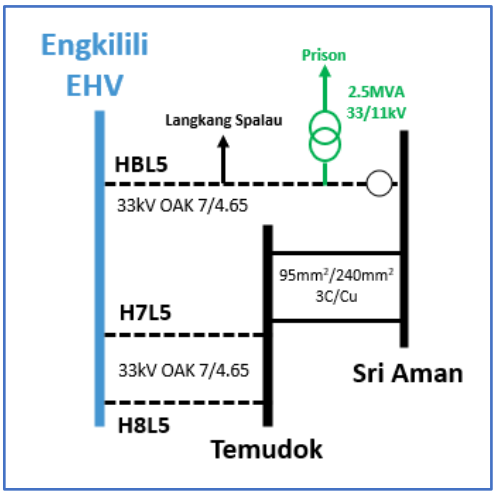


Figure 2.3: Temporary Measure to Relieve Highly Loaded Sri Aman 33/11kV

d) Upgrading of Saratok 33/11kV Transformer

Saratok 33/11kV transformers has been forecasted to lose its N-1 contingency and was proposed to be upgraded to 10/15MVA. Based on the latest load forecast, Saratok 5MVA 33/11kV transformer is anticipated to lose N-1 contingency in year 2029 during peak load. Therefore, the transformer shall be upgraded to 10/15MVA to prevent the substation downgraded to System Reliability Level 2.

During the interim period, a temporary solution is proposed in order to mitigate Saratok 33/11kV to lose its N-1 contingency by installing one (1) no. of 2.5MVA 33/11kV transformer and RMU by 2023 to secure the reliability of supply to Saratok.

2.4.2. Year 2024

a) Construction of Double Circuit of 132kV Lines from Serudit EHV to Sri Aman 33/11kV (To Be Energized at 33kV)

Prior to the completion of Serudit-Sri Aman double circuit 132kV lines, Engkilili-Temudok 33kV lines will continue to lose N-1 contingency with a peak load of 17.7MW or 121.6% in year 2023 and Engkilili EHV transformer will be loaded up to 26.2MW @ 93.3% in year 2024.

The completion of Serudit-Sri Aman double circuit 132kV lines is to be completed by Q2 2024.

With the completion of the 132kV lines, Sri Aman and Temudok will restore its N-1 status and able to meet the statutory voltage requirement. The 132kV lines will take up a total load of 15.8MW from Sri Aman 33/11kV and Temudok 33/11kV. The relieved Engkilili-Temudok 33kV overhead lines shall be kept as an alternative supply to Temudok and Sri Aman during contingency.

b) 33kV Cable Laying from Serudit EHV to Debak Junction

There is a delay in the construction of the double circuit 33kV twin ASH monopole line from Serudit 275/132/33kV to Saratok 33/11kV due to the difficulty of obtaining wayleave approval from Jabatan Kerja Raya (JKR) Sarawak.

As an interim solution, it is proposed to lay a single circuit of 20km 240mm²/3C/AL/XLPE 33kV underground cable from Serudit 275/132/33kV to Debak Junction. This cable will take the load from Debak Junction toward Saratok, whereas the existing overhead lines shall supply Spaoh and Debak areas. In the event supply loss from Sarikei EHV, this line may take up the load from Saratok as a contingency measure.

c) Installation of Voltage Regulator at Lachau-Jaong 33kV Overhead Line

The Normal Open Point (NOP) was previously shifted from Sri Aman-Serian boundary towards Balai Ringin in order to utilize Lachau EHV transformers as well as to relieve the highly loaded Mambong-Serian 33kV monopole line and subsequently improve the voltage profile at Serian 33/11kV.

Lachau-Jaong 33kV overhead line has recorded a peak load of 5.6MW in year 2022. The voltage profile after Sri Aman/Serian boundary is 0.94p.u. However, it is not possible to shift the NOP back to Sri Aman-Serian boundary as Serian 33/11kV will also face low voltage issue. Therefore, it is required to install one (1) no. 33kV Voltage Regulator (VR) at Lachau-Jaong 33kV overhead line and complete by year 2024 to improve the voltage profile.

2.4.3. Year 2025

a) Installation of 5MVA 33/11kV Transformer at Sri Aman 33/11kV

After completion of 2.5MVA 33/11kV transformer installation at Brayun by Q4 2023, Sri Aman 33/11kV transformers will continue to lose N-1 contingency with the projected load of 9.5MW or 101.1% in year 2024.

Therefore, it is proposed to install one (1) no. of 5MVA 33/11kV transformer near to Sri Aman 33/11kV Substation and take the loading from feeder M8L5 and MAL5 with a total load of 2MW. However, there is no available circuit breaker in Sri Aman 33/11kV. Therefore, to accommodate the connection of the 5MVA Transformer, it is proposed to disconnect the existing 95mm^2/3C/AL/XLPE 33kV feeder (H2L5) and re-terminate to the existing 33kV overhead line (H6L5) as shown in ***Figure 2.4***. The installation works is expected to complete by 2025.

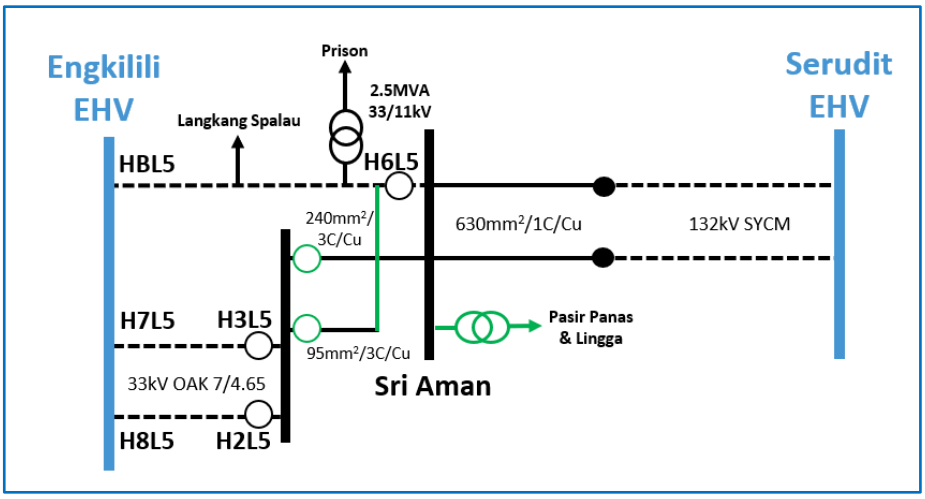


Figure 2.4: Installation of 5MVA 33/11kV Transformer at Sri Aman 33/11kV

b) **33kV Circuit Breaker Replacement Expansion at Saratok 33/11kV**

The additional of four (4) nos. 33kV circuit breaker (CB) at Saratok 33/11kV substation is required for:

1) Two (2) nos. for the 33kV monopole lines from Serudit EHV to Saratok 33/11kV which is expected to complete by year 2027.
2) Two (2) nos. for system reorganization upon commissioning of 33kV monopole lines from Serudit EHV to Saratok 33/11kV.

With the new configuration, the existing 33kV overhead lines will be sectionalised i.e. Saratok-Pusa Line 1 & 2 and Saratok-Sarikei Line 1 & 2. The new NOP will be determined and relocate the existing two (2) sets of voltage regulator (VR) for optimum voltage performance.

As the existing two (2) nos. 33kV CB is also aging, it is proposed to replace the CB together with the CB extension works and targeted to complete by year 2025.

2.4.4. Year 2026

a) 33kV Circuit Breaker Extension at Serudit 33/11kV

It is necessary to carry out circuit breaker (CB) extension as the existing four (4) nos. spare CB at Serudit 33/11kV are required to cater for the following projects:

1) Double Circuit of 132kV tower lines from Serudit EHV to Sri Aman 33/11kV (to be energized at 33kV).
2) Single circuit of 240mm²/3C/AL/XLPE 33kV underground cable from Serudit EHV to Debak Junction.

As there is only one (1) no. of CB available after the completion above projects, the extension of two (2) nos. of CB is expected to complete by 2026 prior to the commissioning of the following projects:

1) Double circuit of 33kV twin ASH monopole line from Serudit EHV to Saratok 33/11kV
2) Single circuit of 630mm²/1C/CU/XLPE 33kV underground cable from Serudit EHV to the proposed Lubau Water Treatment Plant 5MVA 33/11kV substation (customer driven).

2.4.5. Year 2027

a) Construction of Sri Aman B 33/11kV

It is proposed to construct a new 33/11kV substation named Sri Aman B in order to restore the existing Sri Aman 33/11kV Substation N-1 status.

With the completion of Sri Aman B 33/11kV:

1) reorganize the existing Sri Aman distribution network and transfer part of the load from the existing Sri Aman 33/11kV to Sri Aman B 33/11kV to relieve the highly loaded transformers.
2) provide additional connection points as there are numerous residential and commercial developments within the vicinity of Sri Aman Town.

There are two (2) options of land for the construction of Sri Aman B 33/11kV as shown in ***Figure 2.5***.

Option 1: The existing Sri Aman quarter's land on Lot 908, Block 3, Undup Land District
Option 2: New land acquisition on Lot 544, Block 5, Undup Land District.

Figure 2.5: Location of New Sri Aman B 33/11kV

The existing quarter's land on Lot 908 is preferable as the location is closer to Sri Aman load centre and the existing Sri Aman 33/11kV. However, there are two (2) issues to be addressed before proceeding with the construction of Sri Aman B 33/11kV on Lot 908:

1) The land is deemed swampy with old quarter piling underneath.
2) The conditions as stated in the land title is "only for residential purposes".

The funding for construction of Sri Aman B 33/11kV is sourced from Kementerian Kemajuan Desa dan Wilayah (KKDW). KKDW has principally approved the proposed scheme and currently pending approval from Ministry of Finance (MOF).

Sri Aman B 33/11kV is expected to complete by year 2027 and subsequently decommissioning the 2.5MVA and 5MVA 33/11kV transformer at Brayun and Sri Aman 33/11kV.

b) Construction of 33kV Twin ASH Monopole Line from Serudit EHV to Saratok 33/11kV

There is a project to construct double circuit of 33kV twin ASH monopole line from Serudit 275/132/33kV to Saratok 33/11kV to resolve the system constraint at Saratok area. With the completion of this project, a total projected load of 12.1MW can be transferred from Sarikei EHV to Serudit EHV.

2.4.6. Year 2028

a) Construction of Lingga 33/11kV

Lingga 33/11kV is proposed to be constructed in line with the development of paddy granary at Lingga and Stumbin areas, with an estimated load demand of 8.9MW. This development is driven by Ministry of Agriculture and Food Security.

Lingga area is currently supplied by 11kV overhead line (M8L5) from Sri Aman 33/11kV and forecasted to load up to 1.5MW in year 2028. The existing 11kV overhead line will not be able to cater for the new development due to the long distance with limited feeder capacity resulting in significant voltage drop.

It is proposed to supply Lingga 33/11kV via the proposed 33kV MVCC under RMK-12, subjected to the implementation timeline of MVCC by Rural Electrification Scheme (RES) Department.

2.4.7. Year 2029 – 2032

a) Installation of Voltage Regulator at Banting Junction

Based on load flow study, Lingga 33/11kV 5MVA substation will experience low voltage at 0.94p.u during peak load (normal condition) in year 2030. Therefore, it is proposed to install one (1) no. voltage regulator (VR) at Banting Junction to ensure the voltage profile at 33kV network system is able to comply with the statutory requirement.

b) Construction of Kabong Mini Substation

Currently, Kabong area is supplied from Sarikei EHV via single 2.5MVA 33/11kV transformer. Under long-term planning, Kabong mini substation is proposed to improve the system reliability at Kabong and its surrounding areas. The mini substation will be equipped with two (2) nos. 5MVA 33/11kV transformers with auto-recloser and sourced from the existing 33kV overhead line.

c) Construction of Sri Aman EHV

There is a proposal to construct Sri Aman 132/33kV substation to cater for the potential load growth within Sri Aman Town itself. Currently all the bulk power injection (Lachau 275/33kV, Engkilili 275/33kV and Serudit 275/132/33kV) is located relatively far from the main load centre i.e. Sri Aman Town.

However, the actual construction timeline for Sri Aman 132/33kV is largely determined by the rate of load growth at the surrounding area such as Sri Aman Masterplan.

Based on the organic load forecast, Serudit-Sri Aman 132kV tower lines (to be energized at 33kV) will have sufficient capacity to cater for the organic load growth beyond year 2032. Thus, Sri Aman 132/33kV is put under conceptual plan and the needs to develop will be assessed on yearly basis.

3.0. Sarikei

3.1. Sarikei Existing System

Sarikei distribution network is supported by four (4) bulk power injection points which are Sarikei 132/33/11kV, Kemantan 275/132/33/11kV, Tanjung Manis 132/33/11kV and Tanjung Manis B 132/33kV.

In year 2022, Sarikei 132/33/11kV is supplying 62% of the load demand for Sarikei which included Nyelong, Sarikei Town, Sarikei Light Industry, Repok, Selalang, Bayong, Kabong, Saratok and Pusa junction. Whereas Kemantan 275/132/33/11kV is supplying Bintangor Town, Kelupu, Sg. Pasi, Meradong, Julau, Pakan and part of Paradom areas. Tanjung Manis 132/33/11kV and Tanjung Manis B 132/33kV are supplying toward Tanjung Manis Industry, Shipbuilding, POIC, Selumit, Serdeng, Pulau Bruit, Rejang and Belawai areas.

Generally, the distribution network can be grouped based on the current network as listed below:

Table 3.1: Existing EHV Substation with Zone Substation

Item	EHV Substations (Injection Points)	Zone Substations Supplied	Area Supplied	Non-coincidental Peak Load 2022 (MW)
1	Sarikei 132/33/11kV	Nyelong 33/11kV Sarikei Light Industry 33/11kV *Saratok 33/11kV* *(under Sri Aman station)*	Sarikei Town, Light Industries, Repok Road, Nyelong Bypass and Selalang up to Roban and Saratok	36.6MW
2	Kemantan 275/132/33/11kV	Bintangor 33/11kV Julau 33/11kV Pakan 33/11kV	Meradong, Julau, Pakan, Bintangor, Kelupu, Paradom and part of Sarikei outskirts including Bulat Road and Sg Pasi	13.3MW
3	Tanjung Manis 132/33/11kV	TPZ1 33/11kV TPZ2 33/11kV Selumit 33/11kV POIC 33/11kV Shipbuilding 33/11kV	Tanjung Manis, shipbuilding area, Serdeng, Kg Saai and Pulau Bruit	7.8MW
4	Tanjung Manis B 132/33kV	Tanjung Manis B 33kV switching	Belawai and Rejang	1.8MW

3.2. Sarikei Maximum Demand Forecast

Figure 3.1 below shows the projected maximum demand for Sarikei distribution system from year 2023 to 2032 which is derived based on load growth percentage (%), as well as the known and projected step load.

The load forecast conducted in year 2022 is also appended as shown in blue line while year 2023 is appended in red line. The peak load recorded in year 2022 is 43.3MW which is the same as the previous forecasted load.

It is shown that the forecasted peak demand decreased from 64.2MW in year 2026 to 59.9MW in year 2027 due to the diversion of Saratok 33/11kV Substation and Pusa junction to Serudit 275/132/33kV Substation upon completion of Serudit-Saratok 33kV monopole line in year 2027.

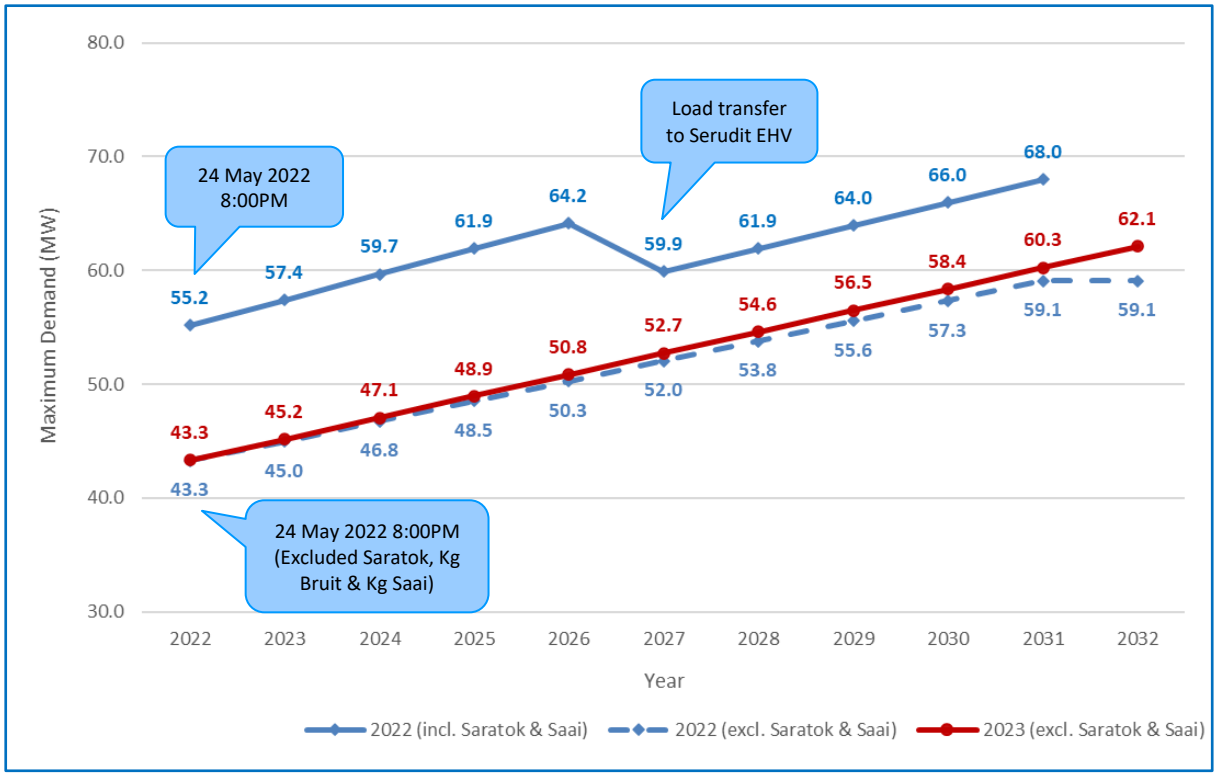


Figure 3.1: Projected maximum demand for Sarikei distribution system (include Tg. Manis) from year 2023 to 2032

Table 3.2 shows the growth rate for Sarikei station from year 2023 to 2032.

Table 3.2: Growth Rate for Sarikei from Year 2023 to 2032

Year	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Growth Rate (%)	4.3%	4.2%	4.0%	3.9%	3.7%	3.6%	3.5%	3.3%	3.2%	3.1%

3.3. Sarikei Substation Loading

Table 3.3: Zone Substation Peak Load

Substation	Transformer Rating (MVA)	Peak Load as Recorded in 2022 (MW)	Percentage Loading (%)
Sarikei 33/11kV	10/15MVA	6.9	47%
Nyelong 33/11kV	10/15MVA	11.4	79%
Sarikei Light Industry 33/11kV	10/15MVA	5.1	35%
Kemantan 33/11kV	10/15MVA	1.2	8%
Bintangor 33/11kV	5MVA	4.3	86%
Tanjung Manis 33/11kV	10MVA	1	10%
TPZ1 33/11kV	1 x 10/15MVA	0.5	4%
TPZ2 33/11kV	1 x 10/15MVA	0.2	2%
Selumit 33/11kV	20/25MVA	0.2	1%
POIC 33/11kV	20/25MVA	0.4	2%
Shipbuilding 33/11kV	25MVA	0.9	5%

Based on the substation loading tabulated, it can be concluded that all zone substations in Sarikei station are operating at System Reliability Level 1 in year 2022, except for TPZ1 33/11kV and TPZ2 33/11kV as both substation are equipped with single 33/11kV transformer only. Both substation are lightly loaded and can back-up each other via the existing 11kV network.

3.4. Sarikei Development Plan

3.4.1. Year 2023

a) Conversion of Sarikei Town 33/11kV Outdoor Substation

Sarikei Town 33/11kV was decommissioned in year 2019 to give way for the construction of a new indoor substation with a higher transformer capacity of 20/25MVA. All 33kV and 11kV loads have been shifted to Nyelong 33/11kV. The substation construction works are currently in progress and expected to be completed and commissioned by Q3 2023.

The new Sarikei Town 33/11kV indoor substation shall be supplied from Sarikei 132/33/11kV. Upon commissioning, this new substation will take about 6MW of loads from Nyelong 33/11kV.

b) Improve System Reliability for Sarikei Light Industry 33/11kV

Sarikei Light Industry 33/11kV was previously supplied from Sarikei 33/11kV feeder H8L5 via 33kV overhead line and back-up by 33kV overhead line from Kemantan B 33/11kV feeder H7L5. In order to upgrade Sarikei Light Industry 33/11kV from System Reliability Level 2 to Level 1, it is proposed to lay double circuit of 33kV 240mm^2/3C/AL/XLPE underground cable from Sarikei 132/33/11kV to Sarikei Light Industry 33/11kV.

As there is no spare 33kV circuit breaker (CB) at Sarikei Light Industry 33/11kV and Sarikei 132/33/11kV, the following works shall be carried out in order to cater to the connection:

c) Improve System Reliability at Selalang Area

Selalang Town is currently supplied from Sarikei 132/33/11kV via feeder HBL5 with 35km of single circuit 33kV 7/.183 overhead line and backup by feeder H9L5 from the same substation with NOP at ABI X60358 before Selalang Junction.

As there are frequent outages at Selalang Town, it is proposed to create a direct backup link from Kabong Junction to Selalang Town by erecting an additional 5.5km of 33kV overhead line from Jalan Selalang to Seridoh and to replace all the existing connected 11/.433kV transformers to 33/.433kV transformers. This new overhead line will serve as a direct clean 33kV overhead line link to Kabong with NOP in between. With such system configuration, Selalang Town will be upgraded to System Reliability Level 2. The overhead line extension project is expected to complete by Q4 2023.

3.4.2. Year 2024 – 2028

a) Construction of Kelupu 33/11kV Substation

Based on the load forecast, the existing Bintangor 2 x 5MVA auto-recloser (AR) controlled 33/11kV transformers will be loaded up to 4.9MW or 98% of its rated capacity in year 2028. Besides, there are various mixed developments in Bintangor and Sungai Pasi areas with a total estimated load of 6.7MW received.

Therefore, it is proposed to construct Kelupu 33/11kV to ensure there is sufficient capacity and feeders to cater to the load growth at Bintangor and Sungai Pasi areas. The existing Bintangor 33/11kV will be decommissioned upon full load diversion to the new Kelupu 33/11kV.

With the commissioning of 33kV MVCC to Pakan 33/11kV, all Kemantan 33kV circuit breakers (CB) will be fully utilized. Thus, the existing Kemantan H6L5 and H7L5 feeders shall be disconnected and linked up sources from Kelupu 33/11kV. The free up 33kV feeders will be used as outgoing sources to Kelupu 33/11kV via double circuit 630mm^2/1C/AL/XLPE underground cable.

The land acquisition for Kelupu 33/11kV was completed in 2017. However, the construction of Kelupu 33/11kV is currently put on halt as there is a batching plant located inside the substation's land. Therefore, SEB is in the midst to liaise with Land & Survey Sarikei for the alienation offer and subsequent issuance of land title upon payment. Once this process is completed, we can proceed with dismantling the batching plant for the new substation construction works.

The new Kelupu 33/11kV is expected to complete tentatively by 2026 subject to the land alienation offer and issuance of land title by Land & Survey Sarikei. As an interim measure, SEB will required to manage Bintangor 33/11kV load within its N-1 by operational mitigation via 11kV load transfer to Bukit Gernih 5MVA 33/11kV.

b) Reconstruction of Sarikei 33/11kV Substation (within Sarikei 132/33/11kV)

The construction of new 33/11kV substation is critical as Sarikei 132/33/11kV is the main injection point which supports 70% of the total Sarikei town load. The existing GEC 33kV outdoor switchgears and EPE 11kV switchgears have been in operation for 30 years (since 1993) and reached the recommended Asset Economic Life of 35 years and 30 years respectively. Furthermore, the existing 33kV busbar is underrated at 1250A and unable to evacuate the full capacity of upgraded 2 x 80MVA transformers. Therefore, it is proposed to reconstruct Sarikei 33/11kV in the existing substation as there is sufficient space within the same compound.

Sarikei 33/11kV new indoor substation is expected to complete tentatively by 2026. During the interim period, SEB will monitor closely the condition of this ageing switchgear and carry out the necessary maintenance work as and when required.

3.4.3. Year 2029 – 2032

a) Construction of Bayong 33kV Switching Substation

Bayong area including Bayong Water Treatment Plant currently supplying from Sarikei 33/11kV feeder HAL5, via a single circuit of 240mm^2/3C/AL/XLPE underground cable, and back-up by the 33kV overhead line feeder HBL5 (existing) and H9L5 (work in progress) from the same substation.

It is proposed to construct Bayong 33kV switching substation complete with Communication and SCADA Facility to improve the supply reliability at Bayong area and Bayong Water Treatment Plant. The 33kV switching substation will be built with the provision of an 11kV system for future expansion.

The long overhead line feeders HBL5 and H9L5 from Sarikei 33/11kV will be looped in and out from Bayong 33kV switching substation upon its completion. With this reinforcement, the power supply to Selalang, Roban and Kabong will not be interrupted if one of the feeders tripped. The need of constructing Bayong 33kV switching substation shall be reviewed on a yearly basis. This substation has been included as part of the Rural Electrification Development Masterplan as well.

b) Construction of Selalang 33/11kV Substation

The existing 33kV overhead line supplying to Selalang junction is about 20km long, and the line is further extended into Jalan Selalang about 15km.

Therefore, it is proposed to construct Selalang 33/11kV to improve the operation efficiency at Selalang Junction up to Roban Town as there is operation concern with the current system configuration in terms of fault segregation during breakdown. Besides, it is required to travel long distances when performing switching. The new substation shall be supplied by looping in and out from the existing 33kV feeders HBL5 and H9L5 from Sarikei 33/11kV.

As the two substations i.e. Bayong 33kV switching substation and Selalang 33/11kV are in close proximity, the priority is to construct Bayong 33kV switching substation and to defer the construction of Selalang 33/11kV beyond 2032.

c) Construction of Sungai Pasi 33/11kV Substation

Sungai Pasi is one of the growth areas in Bintangor where there are a few mixed developments to be constructed along Bintangor-Sungai Pasi Road. The initial phases of these developments will be supplied from the new Kelupu 33/11kV. Based on the assessment of the current system, locality and accessibility to Bintangor load centre, the construction of Kelupu 33/11kV is preferable than Sungai Pasi 33/11kV despite the land issue.

The need of constructing Sungai Pasi 33/11kV shall be reviewed on a yearly basis. The actual construction timeline is basically dependent on load growth rate of the surrounding area. Sungai Pasi 33/11kV shall be supplied from the new Kelupu 33/11kV via double circuit of 33kV 240mm^2/3C/AL/XLPE underground cable. The existing overhead line is proposed to loop in and out from the new Sungai Pasi 33/11kV.

4.0. Sibu

4.1. Sibu Existing System

Currently, Sibu distribution network is supplied by seven (7) EHV substations, namely Oya 275/132/33kV, Deshon 132/33kV, Salim 132/33kV, Selangau 275/132/33kV, Mapai 275/33kV, Sg. Maaw 132/33kV and the recently completed Kanowit 132/33kV.

Deshon 132/33kV gives supply up to 49% of Sibu demand which include Sg. Merah, Bandung, Kpg. Datu and Pahlawan areas, whereas Salim 132/33kV gives supply toward upper Lanang up to Town areas. The suburban areas such as Ulu Oya Road, Paradom, Sibujaya and Sibu Airport is mainly supplied by Oya 275/132/33kV, and Kanowit up to Nanga Ngungun is supplied from Kanowit 132/33kV substation since end of year 2021. For outskirt areas, there are Selangau 275/132/33kV which is supporting loads from Stapang to Selangau Town up to Sg. Arip, while Mapai 275/33kV supplying loads from During Junction toward Nibong Tada area. Lastly, Sg. Maaw 275/132/33/11kV is supplying toward Ensurai and Sg. Maaw area (right opposite Sibu Town).

Generally, the distribution network can be grouped based on the current network as listed below:

Table 4.1: EHV substation with zone substation

Item	EHV Substations (Injection Points)	Zone Substations Supplied	Area Supplied	Non-coincidental Peak Load 2022 (MW)
1	Deshon 132/33kV	Deshon 33/11kV Kpg. Datu 33/11kV Bandung 33/11kV New Sg. Merah 33/11kV Rantau Panjang 33/11kV Ulu Sungai Merah 33/11kV	Delta Mall, Sibu 101 Sentosa Commercial Centre, Swan Square, Star Mega Mall, Bandung, Rejang, Kampung Datu, Sg. Merah, Ulu Sungai Merah, Rantau Panjang, Pasai Siong	64.9MW
2	Salim 132/33kV	Salim 33/11kV Upper Lanang 33/11kV Alan 33/11kV Town 33/11kV Pahlawan 33/11kV Archer 33/11kV	Medan Mall, Pekan Sibu, Sibu Town Square Commercial Centre, Upper Lanang, Salim-Stabau, Wisma Sanyan, Town Square, Sibu Medical Centre, WKH housing	67.2MW
3	Oya 275/132/33kV	Oya 33/11kV Sibu Jaya 33/11kV Sibu Airport 33/11kV Paradom 33/11kV	Sibu Jaya, Sibu Airport, Oya, Kemuyang, Army Camp,	23.4MW
4	Sg. Maaw 132/33kV	Sg. Maaw 33/11kV Ensurai 33/11kV	Sg. Sadit, Sg. Kunyit	9.1MW
5	Mapai 275/33kV	-	Nibong Tada Sg. Nibong	1.4MW

6	Selangau 275/132/33kV	-	Selangau Town, Part of Stapang, Bukit Engkerbai, Jalan Spring- Bintulu	4.0MW
7	Kanowit 132/33kV	Kanowit 33/11kV Nanga Ngungun 33/11kV	Kanowit, Ulu Majau, Ulu Ranan, Nanga Ngungun	3.2MW

4.2. Sibu Maximum Demand Forecast

Figure 4.1 below shows the projected maximum demand for Sibu distribution system from year 2023 to 2032 which is derived based on load growth percentage (%) and projected step load.

The recorded 2022 peak load in Sibu is 174.2MW and it is having the same load growth pattern with the load forecasted in 2021.

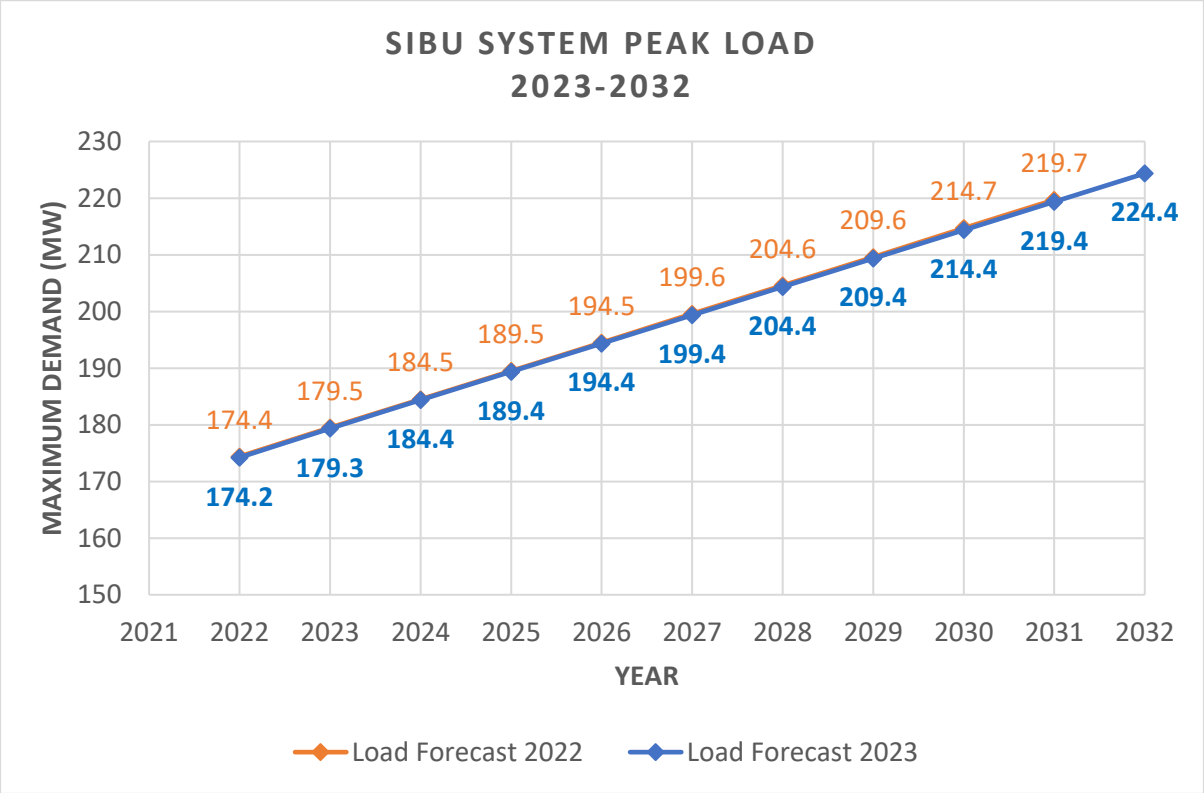


Figure 4.1: Projected maximum demand for Sibu distribution system from year 2023 to 2032

Table below show the growth rate for Sibu station from year 2023 to year 2032.

Table 4.2: Growth rate for Sibu from year 2023 to year 2032

Year	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Growth Rate (%)	2.9%	2.8%	2.7%	2.6%	2.6%	2.5%	2.4%	2.4%	2.3%	2.3%

4.3. Sibu Substation Loading

Table 4.3: Zone Substation Peak Load

Substation	Transformer rating(MVA)	Peak load recorded as at 2022(MW)	Percentage loading (%)
Deshon 132/33kV	20/25MVA	15.6	64%
New Sungai Merah 33/11kV	20/25MVA	17.9	76%
Rantau Panjang 33/11kV	10/15MVA	4.9	34%
Bandung 33/11kV	20/25MVA	11.7	49%
Kpg. Datu 33/11kV	20MVA	9.7	53%
Pahlawan 33/11kV	30MVA	11.9	42%
Archer 33/11kV	20/25MVA	3.3	14%
Salim 132/33kV	20/25MVA	12.2	51%
Alan 33/11kV	20/25MVA	11.5	48%
Town 33/11kV	20/25MVA	13.5	57%
Upper Lanang 33/11kV	20/25MVA	10.8	46%
Oya 33/11kV	20/25MVA	8.2	34%
Paradom 33/11kV	5MVA	0.2	4%
Sibu Jaya 33/11kV	20/25MVA	5.4	23%
Sibu Airport 33/11kV	10/15MVA	3.4	23%
Sungai Maaw 33/11kV	10/15MVA	2.0	13%
Ensurai 33/11kV	10MVA	1.8	18%
Kanowit 33/11kV	10/15MVA	1.3	9%
Ulu Sg. Merah 33/11kV	20/25MVA	5.1	21%

Based on the substation loading tabulated, it can conclude that all the zone substations in Sibu are operating at System Reliability Level 1 in year 2022.

4.4. Sibu Development Plan

4.4.1. Year 2023

a) To create 33kV backup link between Sg. Maaw 132/33kV and Shipbuilding 33/11kV, Sarikei

Currently Jalan New Bawang Assan is supplied from Shipbuilding 33/11kV via single circuit of 47kM 33kV overhead line. The line is operating at System Reliability Level 3, thus it is proposed to create an alternative source of supply from Sg. Maaw 132/33kV substation, which is located only 15kM away. This 33kV link will improve the system reliability to Reliability Level 2.

The line erection is currently in progress and expected to be completed by Q4 2023.

b) Refurbishment of Town 11kV Switchgear

Town 33/11kV only loaded at 13.5MW during peak load in year 2022 and its 11kV outgoing feeders are linked to various number of zone substations, i.e.: Archer 33/11kV, Pahlawan 33/11kV, Kpg. Datu 33/11kV, Bandung 33/11kV and Upper Lanang 33/11kV. Thus, all the 11kV load are temporary divert to the connected substations via the links and allowing Town 11kV system to temporary shutdown for switchgear replacement works.

The 11kV switchgear replacement work is currently ongoing and expected to be completed by Q4 2023.

4.4.2. Year 2024 – 2025

a) Development of New Sg. Merah B 132/33kV

New Sg. Merah B 132/33kV substation is sited within Sg. Merah old power station and side-by-side with existing New Sg. Merah 33/11kV. New Sg. Merah B 132/33kV substation had completed but yet to be put in operation due to the still pending for of the completion for Sg. Maaw – New Sg. Merah B 132kV transmission line which is expected to be completed by Q4 2024.

Upon the commissioning of New Sg. Merah B 132/33kV, Rantau Panjang 33/11kV, New Sg. Merah 33/11kV and Ulu Sg. Merah 33/11kV will be supplied from this new EHV substation. The 33kV feeder reorganization work to be tie in with the commissioning of New Sg. Merah B 132/33kV.

Once the feeder reorganization completed, it is also proposed to loop-in-out existing Deshon - New Sg. Merah 800mm^2/CU/1C/XLPE cable to Ulu Sg. Merah 33/11kV. This link will be kept as normal open point during normal operating time and will be switch-in when there is any contingency at upstream substations.

b) Construction of Kemuyang 33/11kV

A new resettlement area is expected to be developed at Kemuyang area with an applied load of 5MW. The development mainly consists of residential and shophouses commercial premises. The existing Kemuyang area which currently loaded to 1MW is supplied from Oya 33/11kV MBL5 feeder via 8kM of 11kV 7/4.65 Simalec (AAAC) radial overhead line.

With the completion of Kemuyang 33/11kV, it will able to provide higher reliability of power supply and sufficient supply capacity to cater for the new development.

Kemuyang 33/11kV is currently under construction, and it is targeted to complete by Q1 2024. The substation shall be supplied from Oya 275/132/33kV substation via double circuit of 630mm^2/AL/1C/XLPE cable.

c) Upgrading of Stabau 33/11kV 2.5MVA transformer to 5MVA

Located along Jalan Kong Yit Khim, Stabau is currently supply from Salim 33/11kV M7L5 feeder with an alternative source of supply from Sibu Airport H8L5 feeder via one 33/11kV 2.5MVA transformer. With a total distance of 25km, Jalan Kong Yit Khim is connecting Salim to Durin where the area is supplied via 11kV Normal Overhead line.

As an overhead line, the supply is vulnerable to external disturbances especially during bad weather. In addition, Sibu Airport H8L5 with 2.5MVA transformer will not be able to cater for the additional 2MW of Salim M7L5 load during contingencies which leave the load at Stabau and especially Salim Water Treatment without N - 1.

Hence, as a prelim mitigation, it is proposed to upgrade Stabau 2.5MVA 33/11kV Transformer to 5MVA. This shall upgrade the reliability level at area from level 3 to Level 1.

4.4.3. Year 2026

a) Construction of TAR 33/11kV

There are numerous commercial developments such as Sibu Central, Sing Kwong Shopping Mall, Everwin and etc. sited along Jalan Tun Ahman Zaidi Adruce (TAZA) with total applied load of 15MW. Therefore, TAR 33/11kV has been proposed to cater for the anticipated demand and to prevent Salim 33/11kV substation from overloading.

With the completion of TAR 33/11kV, it is proposed to lay single circuit of 33kV 630mm2/AL/1C/XLPE from Deshon 132/33kV to act as alternative source of supply. Construction of TAR 33/11kV is currently in progress and expected to be completed by Q1 2026.

4.4.4. Year 2027

a) Reconstruction of Upper Lanang 33/11kV (2027)

It is proposed to relocate the mobile substation at Bandung 33/11kV to Upper Lanang 33/11kV for the substation reconstruction. It is proposed to divert all the existing cable to the mobile substation then dismantle the existing outdoor substation equipment to give way to the construction of indoor zone substation.

Figure 4.2: Proposed Location for mobile substation

The indoor substation construction work is expected to be commenced by 2024, upon the cable diversion completed and its takes approximately 3 years to complete.

4.4.5. Year 2028

a) Reconstruction of Ensurai 33/11kV into 11kV D-Sub (2028)

Ensurai 33/11kV is an outdoor substation which currently supplying toward Sg. Kunyit and Sg. Sadit areas with total load of 7.1MW (inclusive 1.8MW 11kV load) in year 2022. With Sg Maaw 33/11kV Substation located 7.5km away from Ensurai 33/11kV and currently lightly loaded at 2MW, it is proposed to reconstruct Ensurai 33/11kV into 11kV D-sub but with provision of 33kV switchgear room.

Upon the completion of indoor zone substation, the existing Sg. Maaw – Ensurai 33kV 630mm^2/CU/1C/XLPE cable to be joint with existing Sg. Maaw – Bandung 33kV single Ash monopole. The existing 33kV H7L5 Sg. Sadit feeder to be extended and terminated to Sg. Maaw 33/11kV while H6L5 feeder will be remain linked with H7L5 feeder.

During interim period, it is proposed to backup Ensurai 33/11kV by creating 11kV links to Sg. Maaw 33/11kV.

4.4.6. Year 2029 – 2032

a) Construction of Jalan Pito 33/11kV

Jalan Pito 33/11kV is to be constructed in line with the proposed mixed commercial and residential development at Jalan Pito (Jalan Aman) to cater for the estimated demand of 10MW.

Jalan Pito 33/11kV Substation will be supplied from Deshon 132/33kV substation via loop-in-out Pahlawan 33/11kV – Salim 33/11kV using 33kV 630mm^2/CU/1C/XLPE cable.

b) Construction of Stabau 11kV D-sub

Considering the criticality of the loads and the needs to improve the supply reliability at the area, it is proposed to build a 11kV D-Sub at Bukit Penyau area. The 11kV D-Sub to be constructed with provision of 33kV switchgear room and 33/11kV transformer yard. With this configuration, Salim 33/11kV transformer can be fully utilised and the 11kV feeder at Bukit Penyau can be reorganized as well.

c) Construction of Selangau 33kV Switching Substation

Currently Selangau-Bintulu area is supplied from Selangau 275/132/33kV H7L5 feeder via a single circuit of 60kM long overhead line with multiple long RES tie off-line

Therefore, it is proposed to construct Selangau 33kV Switching Substation. The substation building shall be constructed with provision for future 11kV equipment. Besides, the switching substation is to be equipped with Supervisory Control And Data Acquisition (SCADA) and Communication (COMM) system. With these facilities, the substation shall able to improve the effectiveness of operation work such as fault segregation and switching activities during contingency condition.

The new substation will be supplied from Selangau 275/132/33kV via two overhead feeders, i.e: one is the existing 33kV H7L5, and the other newly proposed 33kV OAK overhead line.

5.0. Bintulu

5.1. Bintulu Existing System

Bintulu distribution network is supported by eight (8) numbers of bulk power injection points (BIPs), which are Bintulu A 275/33kV, Kidurong 132/33kV, Kemena 275/33kV, Similajau 275/33kV, Samalaju A 132/33kV, Samalaju B 132/33kV, Murum Junction 275/33kV and Tatau 275/33kV substation. The distribution network can be grouped based on the transmission substation, as listed below:

Table 5.1: Existing EHV Substation with zone substation

No.	EHV Substation (BIP)	Zone Substations Supplied	Area Supplied	Non-Coincidental Peak Load in 2022 (MW)
1	Bintulu A 275/33kV	• Bintulu Power Station 33kV • Medan Jaya 33/11kV • Bayvilla 33/11kV • Tg Batu 33/11kV • Kidjun 33/11kV • RH BEO 33/11kV	Kidjun - Samalaju road, Jalan Tun Hussien Onn, Medan Sentral, Parkcity Commercial Centre, The Spring	115.9
2	Tg Kidurong 132/33kV	• Kidurong 33/11kV • Housing 33/11kV • UPM 33/11kV • Bintulu Port 33/11kV	Bintulu Port, Tg. Kidurong, Jalan Kidurong and Jalan Nyabau	50.1
3	Kemena 275/33kV	• Kemena Indoor 33/11kV • Town 33/11kV • Paragon 33/11kV • Jepak 33/11kV • Bintulu New Airport 33/11kV • Allamanda 33/11kV	Kemena, Jepak, Ulu Sebauh, Airport, Paragon, Old Bintulu Commercial Centre, Sebauh, Paragon Commercial Centre, Bintulu – Miri old road toward 18th mile, Mile 5, Jalan Sibiyu	80.0
4	Similajau 275/33kV	• Sebauh 33/11kV	Sebauh, Sg. Asap, Tubau, part of Bintulu – Niah Road	15.2
5	Samalaju A 132/33kV	• Samalaju Central 33/11kV • Samalaju Port 33/11kV	Samalaju Industrial Park	9.0
6	Samalaju B 132/33kV	-	Nyalau area	2.0
7	Murum Junction 275/33kV	• Belaga 33/11kV (COD: Q4 2023)	Sg. Asap Resettlement, Jalan Belaga, Uma Penan, Long Amo	3.3
8	Tatau 275/33kV	• Tatau 33/11kV	Tatau local sub	0.5

5.2. Bintulu Maximum Load Forecast

The maximum demand for the Bintulu distribution system is forecast based on the load growth rate shown in Table 3. The load growth rates, which includes the known and projected step load.

Table 5.2: Load Growth Rate for Bintulu from year 2023 to year 2032

Year	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Growth Rate (%)	3.2	3.6	3.0	2.9	2.8	2.8	2.7	2.6	2.5	2.5

Figure 5.1 shows the forecasted coincidental maximum demand for the Bintulu distribution system from year 2021 to 2032.

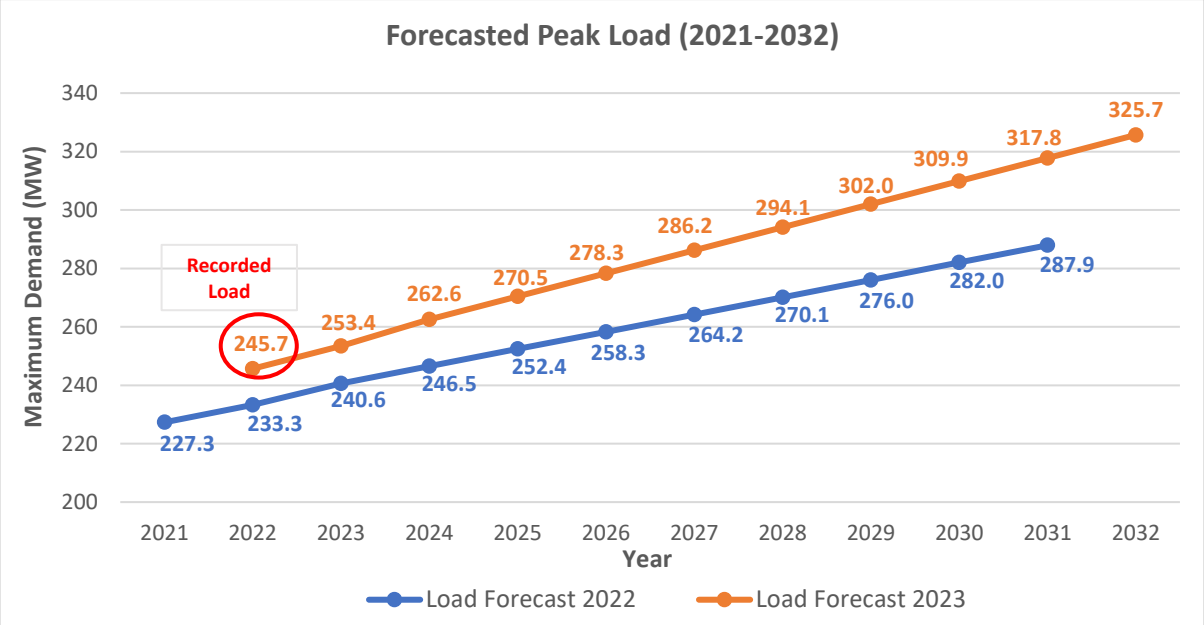


Figure 5.1: Forecasted Coincidental Peak Load of Bintulu Station (2021-2032)

From Figure 5.1, it is shown that the forecasted peak load for 2022 at 233.3MW is lower than the actual recorded peak load at 245.7MW. This is because the forecasted peak load was exclusive of the Samalaju A 132/33kV, Samalaju B 132/33kV, Similajau 275/33kV, and Murum Junction 275/33kV substations' loads, which were eventually included in the actual peak load for 2022. Bintulu Station is forecast to reach a peak load of 253.4MW in 2023.

5.3. Bintulu Substation Loading

Table 5.3 shows the zone substation 33/11kV transformer's loading when only one transformer is used to cater the peak load in 2022.

Table 5.3: Zone Substation 33/11kV transformer's loading in year 2022

Zone Substation	Transformer Rating (MVA)	Recorded Peak Load in 2022 (MW)	Percentage Loading (%)
Medan Jaya 33/11kV	20/25	14.2	60.0
Bayvilla 33/11kV	20/25	1.80	7.60
Tg Batu 33/11kV	20/25	12.6	52.4
Kidjun 33/11kV	20/25	17.6	75.5
Borneo Edible Oil 33/11kV	10/15	3.10	21.9
Kidurong 33/11kV	20/25	18.8	80.2
Housing 33/11kV	10/15	7.40	50.6
UPM 33/11kV	20/25	13.3	54.7
Bintulu Port 33/11kV	20/25	7.10	30.0
Town 33/11kV	20/25	8.00	33.3
Paragon 33/11kV	20/25	9.40	38.8
Jepak 33/11kV	30/35	18.4	58.7
Kemena Indoor 33/11kV	15	9.30	64.4
Bintulu New Airport 33/11kV	5	0.68	14.3
Allamanda 33/11kV	20/25	14.6	59.5
Sebauh 33/11kV	10/15	1.00	6.70
Tatau 33/11kV	10/15	0.50	3.30
Samalaju Central 33/11kV	20/25	3.60	15.9
Samalaju Port 33/11kV	10/15	3.10	21.6

It can be concluded from Table 2 that all the zone substations operate with the N-1 contingency criterion at Reliability Level 1 in 2022.

5.4. Bintulu Development Plan

5.4.1. Year 2023

a) Diversion of loads from BPS 33kV Substation

There is no sufficient capacity to cater for the loads at BPS 33kV substation at Reliability Level 1 during peak load conditions.

Hence, the following load diversion is proposed:

i). In Q2 2023, Daiken at 7.1MW is diverted from Kidjun 33/11kV to Bintulu Port 33/11kV substation.

ii). In Q2 2023, around 1.46MW is diverted from Kidjun 33/11kV H7L5 OHL feeder to Samalaju A 132/33kV H3L5 OHL feeder by changing the NOP from P411 to P193.

iii). In Q1 2024, to divert Medan Jaya 33/11kV, Bayvilla 33/11kV, Tg Batu 33/11kV and Spring 33kV substation at 38.3MW from BPS 33kV to Sibiyu 132/33kV substation.

iv). To divert RH BEO 33/11kV at 3.1MW from Kidjun 33/11kV to Bintulu Port 33/11kV substation. The load diversion was initially expected to be completed in August 2023 but was delayed to Q1 2024.

v). In Q2 2027, to divert Sarawak Petchem feeder and Kidjun 33/11kV H7L5 OHL feeder at 23.4MW from BPS 33kV to Likau 132/33kV substation.

In addition, MLNG at 20.3MW is expected to be diverted to be supplied from 275kV level in Q4 2024.

After the load diversion, Bintulu B 275/132/33kV 80MVA autotransformer is expected to be loaded at 59.9MW (80.8%) in 2027 and operate back with N-1 at Reliability Level 1. Subsequently, the GTs will be decommissioned and dismantled with the completion of Baleh Hydroelectric Plant.

b) Reconstruction of BPS 33kV Substation

Bintulu Power Station 33kV substation, which was commissioned in 1990, has been in operation for 33 years. The substation is installed with a 33kV double busbar system with twenty-four (24) numbers of indoor ABB SF6 switchgear. The 33kV switchgears are underrated causing BPS 33kV substation has been operating with an open bus coupler configuration for 11 years to maintain the fault current within the permissible level.

On June 20, 2019, the proposal to reconstruct the BPS 33kV substation with a single busbar system with twenty-seven (27) nos. of 33kV switchgear rated at 40kA.The new BPS 33kV substation is located adjacent to the existing BPS 33kV substation and is expected to be completed in Q3 2023.

All the incoming and outgoing feeders of the existing BPS 33kV substation will be diverted to the new substation by Q4 2023. Subsequently, the existing BPS 33kV substation will be decommissioned and dismantled.

Prior to the commissioning of Bintulu B 275/132/33kV substation with an expected completion date in Q3 2024, the new BPS 33kV substation will be temporarily sourced from Bintulu A 275/33kV substation with both the 120MVA transformer and 80MVA autotransformer connected in parallel.

c) Replacement and upgrading of Kemena Indoor 33/11kV transformers

Kemena Indoor 33/11kV 15MVA transformers are in a critical state with a high probability of failure. Kemena Indoor 33/11kV transformer is loaded at 9.3MW (64.4%) in 2022.

In view of the heavily loaded and poor condition of the existing transformers, the transformers are to be replaced and at the same time upgraded to 20/25MVA transformers to cater for future load growth.

The reinforcement work is targeted to be completed in Q4 2023.

d) Reconnect Kemena Indoor 33/11kV – UPM 33/11kV Link

The lattice tower connecting UPM 33/11kV and Kemena Indoor 33/11kV substation was dismantled, leaving only a few stretches of lattice and monopole line on site due to soil erosion issues.

33kV monopole is to install from P110-P111 (next to JPJ office, Bintulu-Tatau Road), and lay 0.7km of double circuit 33kV/1C/630mm2/Al/XLPE UG cable from the monopole to the existing lattice tower.

The reinforcement work will create a backup link between UPM 33/11kV and Kemena Indoor 33/11kV substation and is targeted to be completed in Q4 2023.

e) Reorganisation of Tatau 33kV Network to Tatau 275/33kV Substation

A low voltage issue was identified at the Tatau OHL line, and subsequently, a voltage regulator was installed at the line in year 2018.

As a permanent solution to address the constraint, Tatau 275/33/11kV substation was developed under Project Rakyat in 2020 to improve the system reliability at Tatau and its vicinity. Tatau 275/33kV and Tatau 33/11kV substations have been commissioned since November and December 2021, respectively. Tatau 33/11kV 10/15MVA transformer is loaded at 0.5MW (3.3%) in 2022.

The load diversions are as follows:

- Around 0.3MW from Bintulu New Airport H6L5 feeder to Tatau H6L5 feeder.
- Around 3.3MW from Bintulu New Airport H6L5 feeder to Tatau H8L5 feeder.
- Around 1.3MW from Bintulu New Airport H7L5 feeder to Tatau H7L5 feeder.
- Around 4.0MW from Bintulu New Airport H7L5 feeder to Tatau H9L5 feeder.

The load reorganisation is expected to be completed in Q2 2023. After the load diversion, Tatau 275/33kV 60MVA transformer is forecasted to be loaded at 9.7MW (17.4%) in 2023.

5.4.2. Year 2024

a) Development of Sibiyu 132/33kV Substation

The key developments in recent years have been concentrated in the central zone of Bintulu. The expansion of the existing 33kV distribution network from the existing BIPs, such as Bintulu A 275/33kV, Tg Kidurong 132/33kV, or Kemena 275/33kV, to the central zone is not viable from an operational perspective due to the long distance and BIPs' transformer capacity constraints.

The development of Sibiyu 132/33kV substation is to establish a new bulk injection point at the central zone of Bintulu.

The substation was physically completed without being commissioned in December 2021 due to the delay in the completion of the 6 km-long Kemena-Sibiyu 132kV double circuit transmission line caused by the wayleave issue. The transmission line is expected to be completed in Q1 2024, and subsequently, allow Sibiyu 132/33kV substation to be commissioned.

Upon commissioning of Sibiyu 132/33kV substation, there will be load reorganisation as follows:

- To divert substations at 38.3MW from BPS 33kV substation to be supplied from Sibiyu 132/33kV substation.
- To divert Taman Lucky 33/11kV, Paragon 33/11kV and Allamanda 33/11kV substations at 34MW from Kemena 275/33kV substation to be supplied from Sibiyu 132/33kV substation.

After the load reorganization, the configuration will be as per Figure 6, and Sibiyu 132/33kV 120MVA transformer is forecasted to be loaded at 69.7MW (62.7%) in 2024.

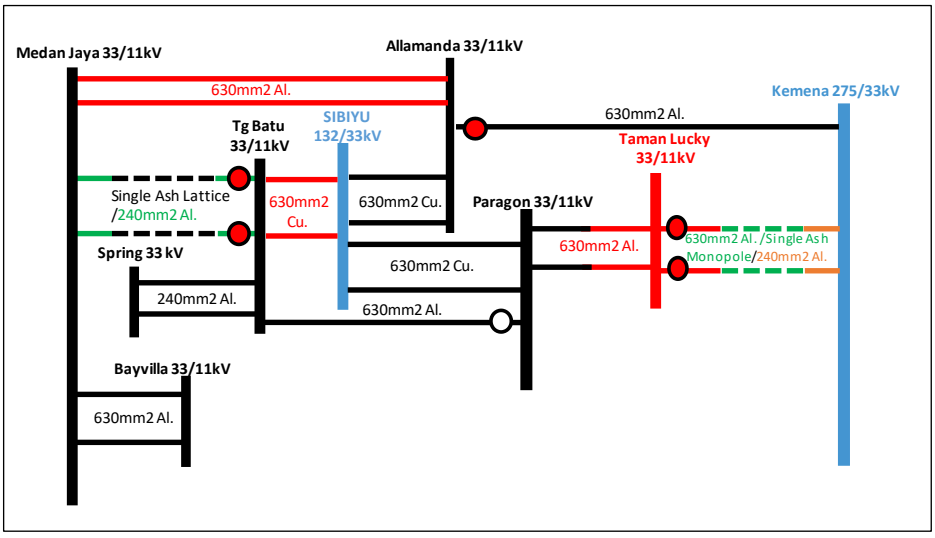


Figure 5.2: Network reorganisation after commissioning of Sibiyu EHV Sub

b) Development of Bintulu B 275/132/33kV Substation

Bintulu A 275/33kV substation will be replaced by Bintulu B 275/132/33kV substation with two (2) 80MVA autotransformers.

The development of Bintulu B 275/132/33kV was proposed due to the cost for the refurbishment work at Bintulu A 275/33kV substation is relatively high compared to a new equipment cost per bay for a new substation. The construction of Bintulu B 275/132/33kV substation is targeted to be completed in Q3 2024.

In addition, MLNG at 20.3MW will be diverted to be supplied at 275kV level in Q4 2024.

c) Development of Taman Lucky 33/11kV Substation

The construction of Taman Lucky 33/11kV was proposed to replace aging Town 33/11kV substation.

Taman Lucky 33/11kV is to be constructed with two (2) nos. of 20/25MVA transformers and new switchgears at a standard short circuit rating of 31.5kA for 33kV switchgear and 25kA for 11kV switchgear. The new substation is expected to be completed in Q3 2024 and will be supplied from Paragon 33/11kV by laying double circuit 33kV/630mm2/Al/XLPE UG cable and joint with the existing Paragon – Town 33kV 630mm2/Al/XLPE UG cables.

Upon commissioning of Taman Lucky 33/11kV substation, the load diversion of Town 33/11kV substation is as per below:

- To divert 4.50MW from Town 11kV outgoing feeders (>M4L5, M5L5, M7L5, M9L5, MBL5, MEL5) to Taman Lucky 33/11kV substation.
- To divert 1.44MW from Town 11kV M6L5 feeder to Tg Batu 33/11kV M4L5 feeder.
- To divert 2.46MW from Town 11kV MAL5 feeder to Paragon 33/11kV substation.

Subsequently, Town 33/11kV will be decommissioned and can be converted to 11kV distribution substation for local power distribution purposes.

d) Development of Kidurong B 11kV Substation

Kidurong 33/11kV substation 25MVA transformer is forecasted to be loaded at 23.7MW (101.1%) and lose N-1 contingency criterion in 2030.

Hence, the development of Kidurong B 11kV substation with two (2) 10/15MVA 33/11kV transformers and new 11kV switchgears was proposed. The new substation is located within the existing Kidurong 33/11kV substation's compound and shall be sourced from Tg Kidurong 132/33kV substation. The new substation is expected to be completed in Q3 2024.

In 2020, a 5MVA 33/11kV transformer has been installed at Kidurong 33/11kV substation as an interim measure to reduce Kidurong 33/11kV substation's loading. The transformer is loaded at 0.6MW (13.0%) as in 2022.

Upon the commissioning of Kidurong B 11kV substation, it is proposed to divert at least 6MW of the existing 11kV load from Kidurong 33/11kV to Kidurong B 11kV substation to maintain the Reliability Level 1 at Kidurong 33/11kV substation. After the load diversion, Kidurong 33/11kV substation is forecasted to be loaded at 17.2MW (73.4%) in 2032.

e) Installation of Capacitor Bank at Jepak 33/11kV substation

Jepak 33/11kV substation has recorded low power factor for 3 consecutive years, as shown in Table 5.4.

Table 5.4: Recorded Power Factor at Jepak 33/11kV Substation

Year	Power Factor
2020	0.89
2021	0.88
2022	0.90

In Q1 2023, the Distribution Protection, Control, and Instrumentation (DPCI) division has installed a PQ recorder on Transformer 2 at the substation, and the results showed high reactive power and a low power factor of 0.89. It is suspected that the high reactive power is contributed by 3-phase motors installed in the industrial areas that are connected to Jepak 33/11kV substation's 11kV busbar.

Hence, a budget allocated to install a capacitor bank at Jepak 33/11kV substation for reactive power compensation to improve the power factor with the expected completion date in Q4 2024.

f) Existing system configuration – Sebauh

The Sebauh 33/11kV substation with two (2) nos. of 10/15MVA transformers was commissioned without SCADA in December 2020. The substation is loaded at 1.0MW (6.7%) in 2022.

Sebauh 33/11kV substation is supplied via a single circuit overhead line 33KV/OAK 7/4.65 (7/.183) of Similajau 275/33kV H8L5 feeder. The overhead line is also connected to UPM 33/11kV H8L5 feeder with a normal open point during normal operation conditions and acts as a backup supply.

The substation's permanent source of supply is double circuit of a combination of 32km MVCC line and 20km 33kV/3C/240mm2/Al/XLPE cable from Similajau 275/33kV substation. The cable laying is targeted to be completed in August 2023, and the FTT for SCADA is targeted to be completed by Q1 2024.

5.4.3. Year 2025

a) Development of Kemena 275/33kV – Taman Lucky 33/11kV Link

Town 33/11kV substation will be decommissioned. Hence, it is proposed to utilise the existing cable and lines that were previously used to supply Town 33/11kV from Kemena 275/33kV substation as an alternative source to Taman Lucky 33/11kV substation.

A double circuit 33kV 630mm2/Al UG cable from Taman Lucky 33/11kV to Town 33/11kV as shown in the red line will be laid, and joint with the existing line shown in orange line in Figure 5.3. The reinforcement work is targeted to be completed in Q4 2025.

Figure **5.3**: Existing and proposed cable route

b) Development of Allamanda 33/11kV – Taman Lucky 33/11kV Link

It is proposed to utilise the existing 33kV 630mm2/Al cable that was previously used to supply Allamanda 33/11kV from Town 33/11kV substation to create a second circuit of backup supply for Allamanda 33/11kV from Taman Lucky 33/11kV substation.

A single circuit 33kV 630mm2/Al cable from Taman Lucky 33/11kV to Town 33/11kV will be laid and joined with the existing cables. The reinforcement work is targeted to be completed in Q4 2025.

5.4.4. Year 2026

a) Diversion of loads from Medan Jaya 33/11kV and Allamanda 33/11kV substation

Sibiyu 132/33kV – Allamanda 33/11kV substation double circuit 33kV 630mm2/Cu/1C/XLPE cable is forecast to be loaded at 39.2MW (50.9%) and lose N-1 contingency criterion in 2028.

Hence, it is proposed to divert at least 6.2MW of load from Medan Jaya 33/11kV and Allamanda 33/11kV substation. The load diversion is as follows:

- To divert 3.2MW from Medan Jaya 33/11kV to Taman Lucky 33/11kV.
- To divert 3.0MW from Allamanda 33/11kV to Taman Lucky 33/11kV**.**

The diversion is expected completion date in Q4 2026.

5.4.5. Year 2027

a) Development of Likau 275/132/33/11kV Substation

Likau 275/132/33/11kV substation is one of the reinforcements to relief and restore N-1 contingency criterion of the highly loaded Bintulu B 275/132/33kV autotransformers.

In 2015, Likau 33/11kV substation, previously known as Kinda 33/11kV was proposed to relieve existing Kidjun 33/11kV substation and the incoming cables from BPS 33kV substation. SPA approval for the land acquisition for Kinda 33/11kV with measurement of 150m x 150m inclusive of land for EHV

substation was granted in year 2016. However, the land has been traded off with the current location for Likau 275/132/33/11kV substation to incorporate the proposed development of the Industrial Park.

Upon commissioning of Likau 275/132/33/11kV substation, the following load diversion will be done:

- To divert of 23.4MW from BPS 33kV to Likau 132/33kV substation.
- To divert Samalaju A 132/33kV H3L5 OHL feeder at 2.9MW to be supplied from Likau 132/33kV substation.

After the load diversion, Likau 132/33kV 80MVA transformer is forecasted to be loaded at 27.3MW (36.9%) in 2027.

In addition, there have been various firms and proposed industrial developments in the vicinity of the proposed Likau 275/132/33/11kV substation, such as mix development at Lot 161 (10MVA), KINDA (6.35MVA), Investor No 9 (unknown load demand) and so on. It is anticipated that the demand for electricity will increase within the industrial park due to streetlighting, booster pumps, traffic lights, signboards and the downstream industries and commercial activities generated from the petrochemical masterplan.

Apart from the highly loaded Bintulu B 275/132/33kV substation, another EHV substation located 4km away, Kidurong 132/33kV substation, will be loaded at 80.5MW (72.4%) in 2032. Therefore, Likau 275/132/33/11kV substation is important to cater for future load demands and improve supply reliability in the vicinity.

Likau 275/132/33/11kV substation is expected to be completed in Q1 2027.

b) Development of Nyabau 33/11kV Substation

There is a proposal to construct Nyabau 33/11kV substation to replace Housing 33/11kV substation due to the ageing and underrated fault rating switchgears.

The construction of Nyabau 33/11kV substation was proposed in conjunction with the proposed mixed development on Lot 3113, Block 26, Kemena land district, Bintulu, to cater for the large-scale mix developments at Nyabau Junction, including Nyabau Height and Kidurong Central projects.

The new substation will be sourced from Tg Kidurong 132/33kV substation by laying a double circuit 33kV 630mm^2/Cu/1C/XLPE UG cables from Nyabau 33/11kV to Housing 33/11kV substation and straight through joints with the existing Kidurong 132/33kV – Housing 33/11kV substation 33kV 630mm^2/Cu/1C/XLPE cables.

Nyabau 33/11kV substation is expected to be completed in Q1 2027, subject to the land being handover to SESCO by September 2023. Subsequently, the existing incoming and outgoing feeders at Housing 33/11kV will be diverted to Nyabau 33/11kV substation.

c) Reconstruction of Kemena Indoor 33/11kV Substation

There is a proposal to reconstruct Kemena Indoor 33/11kV substation due to the ageing and underrated fault rating switchgears.

To reconstruct Kemena Indoor 33/11kV substation into a 3-storey building with new switchgears at a standard short circuit rating of 31.5kA for 33kV switchgear and 25kA for 11kV switchgear within the existing substation's compound. The reconstruction will commence after the transformer's replacement work.

It is expected completion date for the reconstruction work is Q1 2027.

The existing incoming and outgoing feeders at Kemena Indoor 33/11kV will be diverted to the new Kemena Indoor 33/11kV substation. Subsequently, the existing substation will be decommissioned and dismantled.

d) Development of Jepak 11kV Distribution Substation

The existing Jepak 33/11kV 30/35MVA transformer is loaded at 18.4MW (58.7%) in 2022. However, Jepak 33/11kV substation is unable to cater to any new 11kV customers connections as there are zero 11kV spare feeders and no space for switchgear extension.

Hence, it is proposed to construct Jepak 11kV distribution substation complete with communication and SCADA facilities, located 1.51km from Jepak 33/11kV substation, to optimise the utilisation of the 30/35MVA transformers at Jepak 33/11kV substation.

The construction of Jepak 11kV Distribution substation was proposed in conjunction with the proposed 3 Towers (Tower A, B and C) development at Block 37, Kemena Land District at Jalan Bintulu – Sibu, Bintulu, with an applied load at 4,349kVA. The 50m x 50m land for the construction of this new substation is currently undergoing subdivision and alienation process by the customer.

The new distribution substation is expected to be completed date in Q2 2027, subject to the subsite handover to SESCO in 2023.

The new substation will be supplied from Jepak 33/11kV substation by laying double circuit 11kV 630mm^2/Cu/1C/XLPE UG cables. As there is zero spare 11kV switchgear and no space for switchgear extension at Jepak 33/11kV substation, load reorganisation at Jepak 33/11kV substation is required to spare out another two (2) nos. of 11kV switchgear.

Upon commissioning of Jepak 11kV distribution substation, some of Jepak 33/11kV substation existing 11kV loads will be diverted to this new substation.

5.4.6. Year 2028

a) Reconstruction of UPM 33/11kV Substation

There is a plan to reconstruct UPM 33/11kV substation due to aging outdoor switchgears.

Previously, it was mistaken that the land belonged to the federal and was subleased to SESCO. However, no sublease agreement was found. Recently, it was discovered that the land belongs to Universiti Pertanian Malaysia.

Figure 5.4: Land acquisition area for UPM 33/11kV

The new substation is expected to be completed in Q2 2028, subject to land issue solved in 2023. Upon commissioning of the new UPM 33/11kV substation, all the incoming and outgoing feeders of existing UPM 33/11kV will be diverted to the new substation.

5.4.7. Year 2029 – 2032

a) Development of Housing 11kV Distribution Substation

With Nyabau 33/11kV substation in place, existing Housing 33/11kV substation will be decommissioned and can be converted to 11kV distribution substation complete with communication and SCADA facility for local power distribution purposes.

The expected completion date for Housing 11kV distribution substation is in the year 2029-2032.

b) Development of Town 11kV Distribution Substation

With Taman Lucky 33/11kV substation in place, existing Town 33/11kV substation will be decommissioned and can be converted to 11kV distribution substation completes with communication and SCADA facility for local power distribution purposes.

The expected completion date for Town 11kV distribution substation is in the year 2029-2032.

c) Utilisation of Bayvilla 33/11kV Substation

The Bayvilla 33/11kV 20/25MVA transformer is loaded at 1.8MW (7.6%) in 2022. The substation was commissioned in 2020 to supply the Boulevard Shopping Mall and Hotel.

There are 4 zone substations in the vicinity of Bayvilla 33/11kV substation and loaded between 33.3% to 60.0% as shown in Table 6.

Table5.5: Zone Substation's Loading

Zone Substation	Recorded Load (2022)	
	MW	%
Medan Jaya 33/11kV	14.2	60.0
Tanjung Batu 33/11kV	12.6	52.4
Town 33/11kV	8.00	33.3
Allamanda 33/11kV	14.6	59.5

Hence, it is recommended to use Bayvilla 33/11kV substation to cater for the new organic developments in the vicinity. Loading up Bayvilla 33/11kV through load diversion is only recommended if the load diverted is from Allamanda 33/11kV or Medan Jaya 33/11kV substation due to the Sibiyu 132/33kV – Allamanda 33/11kV cables constraint.

d) Development of Samalaju Light Industry 33/11kV Substation

Samalaju Light Industry 33/11kV substation, previously known as Samalaju No. 3 33/11kV, was proposed to cater for the upcoming developments in the north-eastern part of SIP. Currently, there is no established 11kV system in the area to support the demand of small and medium industries.

This new substation shall be supplied from Samalaju B 132/33kV substation via double circuit of 33kV 630mm^2/Cu/1C/XLPE cables. The expected completion date of the substation is in 2029-2032.

The construction timeline of the substation shall be advanced when necessary, depending on the load's growth in the vicinity.

e) Development of Samalaju Township 33/11kV Substation

The development of Samalaju New Township 33/11kV substation was proposed for the Samalaju Township development.

Currently, a single 5MVA 33/11kV transformer has been installed on site to cater for the first phase of development of about 2.8MVA.

The full-fledged Samalaju Township 33/11kV substation will only be developed when necessary, depending on the load's growth in the vicinity. This new substation shall be supplied from Samalaju B 132/33kV substation via double circuit of 33kV 630mm^2/Cu/1C/XLPE cables. The expected completion date of the substation is in 2029-2032.

The construction timeline of the substation shall be advanced when necessary, depending on the load's growth in the vicinity.

6.0. Miri

6.1. Miri Existing System

Miri distribution network is divided into three zones which are northern, central and southern zone. Northern zone of Miri mostly consists of industrial estate, shipyard industry and oil and gas industry. Central zone is where most of the commercial activities are carried out such as retail businesses, multi-storey shopping malls and hotels whereas southern zone of Miri consists of residential properties and the development of eco-tourism.

Presently, there are five (5) bulk power injection points at Miri, which are Tudan 275/33kV, New Tudan 275/132/33kV, Eastwood 132/33kV, Marudi Junction 275/33kV and Pujut Power Station 33kV. The Tudan 275/33/11kV and New Tudan 275/132/33kV substation are supporting load demand at northern zone of Miri. Load demands situated at Central zone of Miri is supplying by Eastwood 132/33kV and Pujut Power Station 33kV. The power station also supported by Tudan 275/33kV via double circuit of 33kV lattice tower lines. Lastly, Marudi Junction 275/33kV is supplying load demand at southern zone of Miri.

The distribution network can be grouped based on the current network as listed below:

Table 6.1: EHV substation with zone substation

Item	EHV Substations (Injection Points)	Zone Substations Supplied	Area Supplied	Non-coincidental Peak Load 2022 (MW)
1	Tudan 275/33kV	Kuala Baram A 33/11kV Kuala Baram B 33/11kV Tudan 33/11kV Pujut 33/11kV Krokop 33/11kV	Kuala Baram, Tudan , Senadin, Pujut, Krokop, Piasau, Jee Foh, Boulevard, Bintang Commercial Centre	91.5MW
2	Pujut Power Station 33kV			
3	New Tudan 275/132/33kV	Lutong 33/11kV PermyJaya 33/11kV	Lutong, Piasau, Bandar Baru PermyJaya	36.2MW
4	Eastwood 132/33kV	Eastwood 33/11kV Miri Town 33/11kV Marina Bay 33/11kV Luak Bay 33/11kV Bakam 33/11kV	Eastwood Valley Industrial Park, Town, Marina Bay, Luak Bay, Bakam, Jalan Eastwood	47.2MW
5	Marudi Junction 275/33kV	Lambir 33/11kV Miri Airport 33/11kV Taman Tunku 33/11kV Niah 33/11kV	Lambir waterwork, Marudi, Niah, Bekenu, Bakong, Airport, Taman Tunku, Riam	45.9MW

6.1.1. Niah Existing System

There are four (4) main feeders supplying to Miri outstation area, which are feeder HDL5 at Marudi Junction 275/33kV, feeder H6L5 at Luak Bay 33kV, feeder H7L5 at Similajau 275/33kV and feeder HGL5 at Samalaju B 275/132/33kV. These feeders are supplying to areas as shown in table below:

Table 6.2: Areas supplied for feeder Marudi Junction (HDL5), Luak Bay (H6L5) and Similajau (H7L5)

No.	Feeder	Areas supplied
1.	Marudi Junction 275/33kV (HDL5)	Bekenu, Bakong, Subis, Ulu Niah
2.	Luak Bay 33/11kV (H6L5)	Bungai, Saeh, Sepupok
3.	Similajau 275/33kV (H7L5)	Niah Town, Rh. Madinah
4.	Samalaju B 275/132/33kV (HGL5)	Kpg Iran, Sepupok Junction

The total combined peak load for Marudi Junction HDL5 overhead line and Luak Bay H6L5 overhead line is reaching **22.1MW** in year 2022. The system is now operating at System Reliability Level 2 with the alternative backup source from Similajau H7L5 and Samalaju B HGL5 feeders.

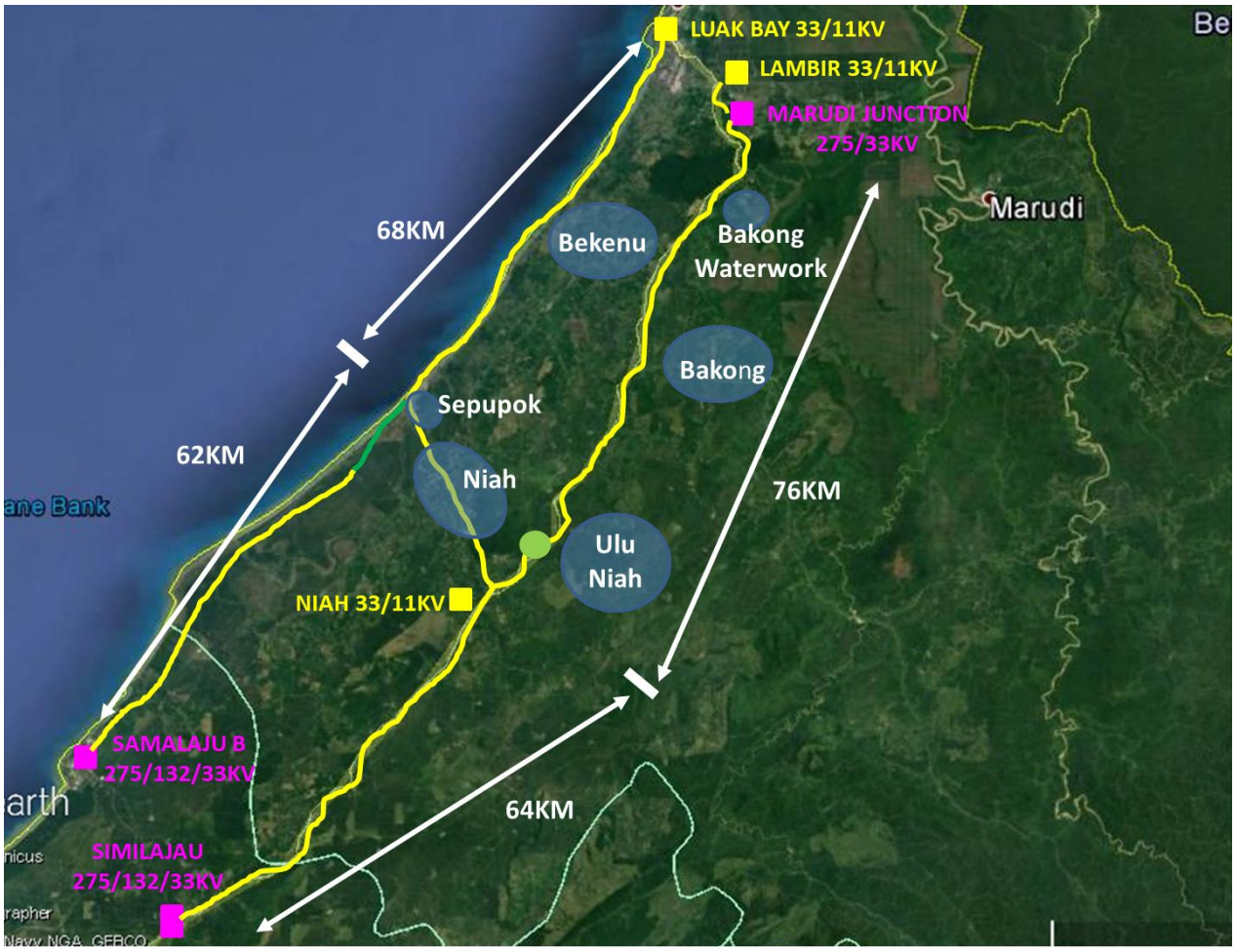


Figure 6.1: Locality for Niah

6.2. Miri Maximum Demand Forecast

Figure 6.2 shows the projected maximum demand for Miri distribution system from year 2023 to 2032 which is derived based on load growth percentage (%), as well as the known and projected step load.

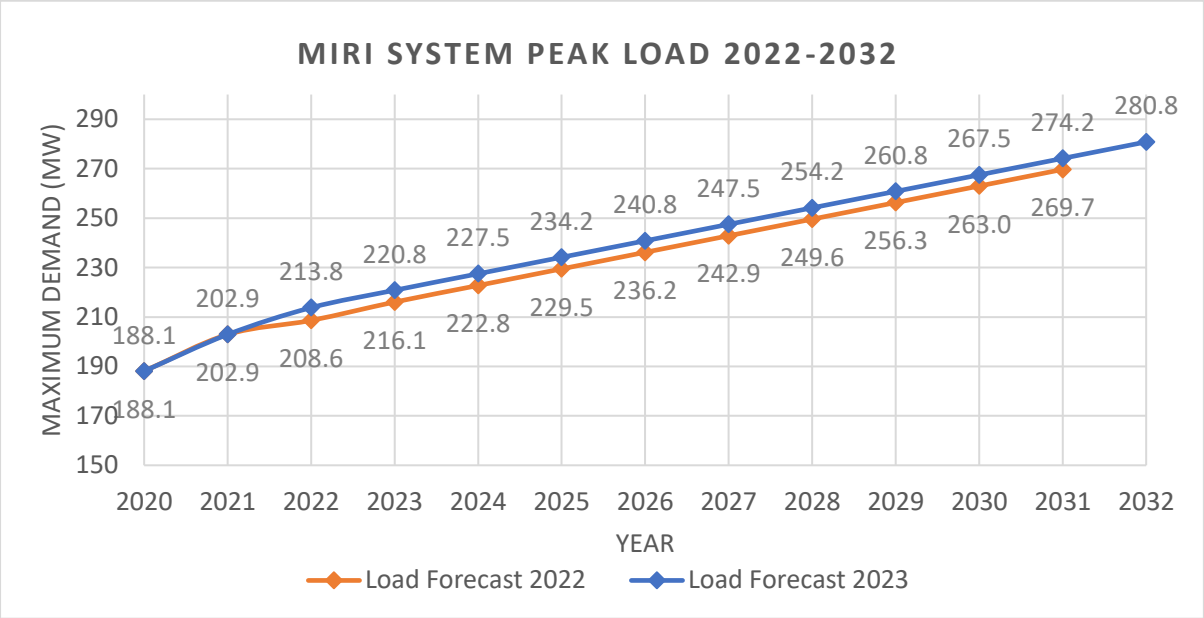


Figure 6.2: Projected maximum demand for Miri distribution system from year 2023 to 2032

Load forecast conducted in year 2022 is also appended as shown in red line. It is noticed that the peak load recorded in May 2022 is 213.8MW which is slightly higher than the previous forecast at 208.6MW.

Table below show the growth rate for Miri station from year 2023 to year 2032.

Table 6.3: Growth rate for Miri from year 2020 to year 2029

Year	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Growth Rate (%)	3.3%	3.0%	2.9%	2.8%	2.8%	2.7%	2.6%	2.6%	2.5%	2.4%

6.3. Miri Substation Loading

The following table shows Miri Zone substation loading in year 2022.

Table 6.4: Zone Substation Peak Load

Substation	Transformer rating (MVA)	Peak load recorded as at 2022(MW)	Percentage loading (%)
Tudan 33/11kV	**20/25MVA**	**21.7**	**97%**
Kuala Baram B 33/11kV	10/15MVA	3.2	24%
Kuala Baram A 33/11kV	15MVA	5.8	43%
Piasau 33/11kV	20/25MVA	11.5	51%
Pujut 33/11kV	30/35MVA	24.5	91%
Krokop 33/11kV	20MVA	16.9	94%
PermyJaya 33/11kV	20/25MVA	19.0	84%
Lutong 33/11kV	20/25MVA	17.2	76%
Senadin 33/11kV	20/25MVA	-	-
Eastwood 33/11kV	20/25MVA	2.9	13%
Miri Town 33/11kV	20/25MVA	14.2	63%
Marina Bay 33/11kV	15/20MVA	10.6	59%
Luak Bay 33/11kV	**10/15MVA**	**13.2**	**98%**
Marudi 33/11kV	5MVA	3.9	87%
Miri Airport 33/11kV	20/25MVA	15.8	70%
Taman Tunku 33/11kV	20/25MVA	13.0	58%
Lambir 33/11kV	10/15MVA	5.7	42%
Bakam 33/11kV	20/25MVA	-	-
Niah 33/11kV	15/20MVA	1.0	6%

Almost Loss System Reliability Level 1

Based on the substation loading tabulated, it can be concluded that all 33/11kV substations in Miri Station are operating at System Reliability Level 1 in year 2022. However, it is noted that there are two substations, namely Tudan 33/11kV and Luak Bay 33/11kV are currently highly loaded and is anticipated to loss the system Reliability Level 1 in year 2023 onward. Therefore, the mitigation plan is required to address the highly loaded power transformer which is further explain in this report.

6.4. Miri Development Plan

6.4.1. Year 2023

a) Construction of Bakam 33/11kV Containerised Substation

Last year, Luak Bay 33/11kV recorded peak load at **98%** of its transformer capacity and it is anticipated to **loss N-1 status** in **2023.** In addition, in view to the upcoming development at Bakam and Tukau area, Bakam 33/11kV containerized substation which located along Miri-Bintulu Coastal Road is strategic to cater for the anticipated growth as well as mitigating the high load Luak Bay 33/11kV substation.

The construction of Bakam 33/11kV substation had completed in year 2022 and currently is energized via loop in and out the existing 33kV Luak Bay – Niah overhead line. The permanent sourced will come from Luak Bay 33/11kV via double circuit of **33kV 630^2/AL/1C/XLPE** cable which is expected to be ready by **Q2 2023**. Bakam 33/11kV will takes up approximately 3MW of Luak Bay 11kV load and supplying to 33kV Niah feeder of approximately 3MW too (from Kuala Bakam up to Beraya).

b) Diversion of Piasau 33/11kV to Tudan 275/33kV

Currently, Piasau 33/11kV is temporarily energized via loop in and out existing 33kV Lutong-Pujut cable. The permanent source of supply will be coming from Tudan 275/33kV via double circuit of **630^2/CU/1C/XLPE** cable. The cable laying work is currently in progress and expected to be completed by **Q3 2023**.

On the other hand, the Tudan – Pujut circuit of Twin ASH recorded peak at almost **50%** of its rated capacity (45MVA). The link is expected to **loss N-1 status** by the year **2024** based on the load projection. Thus, it is recommended to transfer Pujut 11kV load to Piasau 33/11kV substation to mitigate the highly loaded of the Tudan – Pujut link. With 33kV and 11kV reinforcements and reorganisation and in place, the system reliability toward Piasau will be improved to system reliability level 1.

6.4.2. Year 2024 – 2028

a) Development of Jee Foh 33/11kV

Jee Foh 33/11kV substation is proposed to replace Krokop 33/11kV, that the electrical equipment is ageing and obsolete. In addition, Jee Foh 33/11kV shall be equipped with higher transformer rating, i.e., 2 x 20/25MVA to cope with the organic growth at Miri City area. Krokop 33/11kV substation has been losing N-1 contingency since late 2010s. A number of reinforcement projects were carried out to relieve the substation loading, including the installation of one 33/11kV 5MVA transformer within Krokop substation compound and various 11kV load transfer to Marina Bay 33/11kV and Lutong 33/11kV substation. Therefore, it is critical to complete Jee Foh 33/11kV substation without further delay in order to minimise the risk of outage due to equipment breakdown at Krokop 33/11kV. Jee Foh 33/11kV substation shall be supplied from Miri Town 33/11kV via double circuit of **33kV 630^2/AL/1C/XLPE** cable.

With the completion of Jee Foh 33/11kV, all the 11kV feeders at Krokop 33/11kV will be transferred to the newly completed substation. By then it is possible to de-commission ageing Krokop 33/11kV without jeopardizing the reliability at central part of Miri. It is also recommended to keep Krokop 33/11kV substation land for future use considering the strategic location. Jee Foh 33/11kV is in progress and expected to be completed by year 2025.

b) Development of South Lake 33/11kV

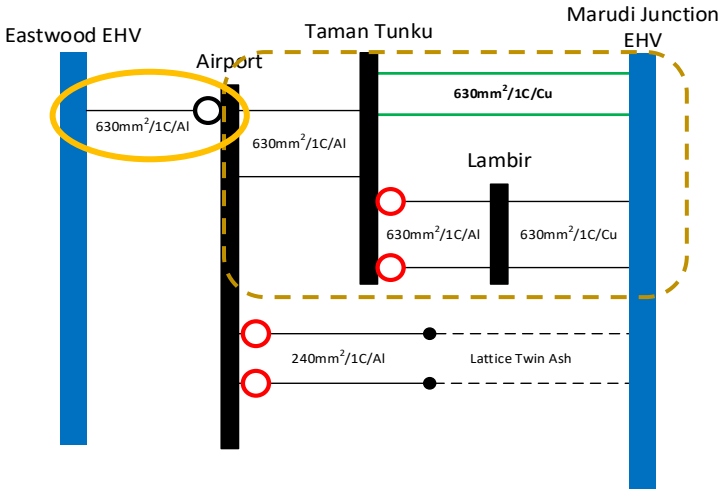
By year 2024, Tudan 33/11kV substation is anticipated to **loss N-1 status** and the interim solution is to transfer **3MW – 4MW** from Tudan 33/11kV to Senadin 33/11kV; which will mitigate the highly loaded of Tudan 33/11kV power transformer. However, the substation is forecasted to **loss its N-1 status** again in **year 2027** due to the rapid development that is taking place at South Lake area. Presently, the recent completed housing development at South Lake is supplied from Permyjaya 33/11kV substation and the power transformer is currently highly loaded, **85% of its capacity**.

Therefore, South Lake 33/11kV substation is required to be constructed to accommodate for the existing and new development growth demand, relieving the strain at Permyjaya 33/11kV and creating available capacity for load transfer at 11kV level between Tudan 33/11kV and Permyjaya 33/11kV. Ultimately, this would help to alleviate the high load experienced by the Tudan 33/11kV substation. The South Lake 33/11kV substation is expected to be in place by the year 2027.

c) Diversion of Taman Tunku 33/11kV to Marudi Junction 275/33kV

Currently, Airport 33/11kV substation is supplied from Marudi Junction EHV substation via Lattice Twin Ash line with the backup link of 2 circuit 630mm^2/1C/AL/XLPE from Taman Tunku 33/11kV. As updated by Miri Regional Office, the Lattice Twin Ash, incoming capacity of Airport 33/11kV is limited to **17MW** and this has become the bottleneck despite the power transformer is rated at 20/25MVA. In year 2022, Airport 33/11kV substation recorded peak at 98% against the incoming capacity.

To accommodate the anticipated organic growth in the vicinity area, it is proposed to lay **2 circuit of 630mm^2/1C/CU/XLPE** from Marudi Junction 275/33kV substation to Taman Tunku 33/11kV substation. With this, Taman Tunku 33/11kV substation shall be the 1st tier substation from the EHV and the existing Taman Tunku 33/11kV to Airport 33/11kV circuit of 630mm^2/1C/Al/XLPE shall be the primary source to Airport 33/11kV substation. This reorganization shall make the Airport 33/11kV substation as the 2nd tier substation which will mitigate any potential risk on protection grading issue. This would also enhance the capacity of the incoming to Airport 33/11kV substation and ensuring it can cater the growing demand as well maintain its reliability status.

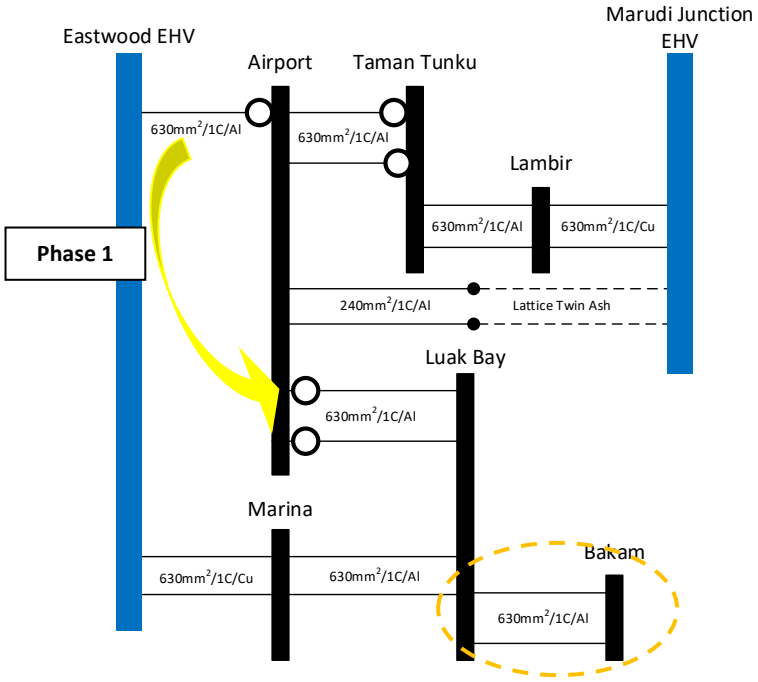


It is also to be noted that there will be no 33kV backup for the southern zone (Marudi Junction, Lambir, Taman Tunku and Airport) as the single circuit of **630mm^2/1C/AL/XLPE** from Eastwood 132/33kV to Airport 33/11kV (marked in circle above) **will be diverted to** Luak Bay 33/11k 33/11kV substation. Therefore, it is proposed to lay one new circuit of **630mm^2/1C/Cu/XLPE** from Eastwood 132/33kV to

Airport 33/11kV substation to increase the resilience and redundancy backup at the 33kV level and the cable is expected to be in place in year 2029.

d) Diversion of Luak Bay 33/11kV to Eastwood 132/33kV

Currently, Luak Bay 33/11kV is supplied from Marina Bay 33/11kV and back-up by Miri Airport 33/11kV during contingency shown in figure below.

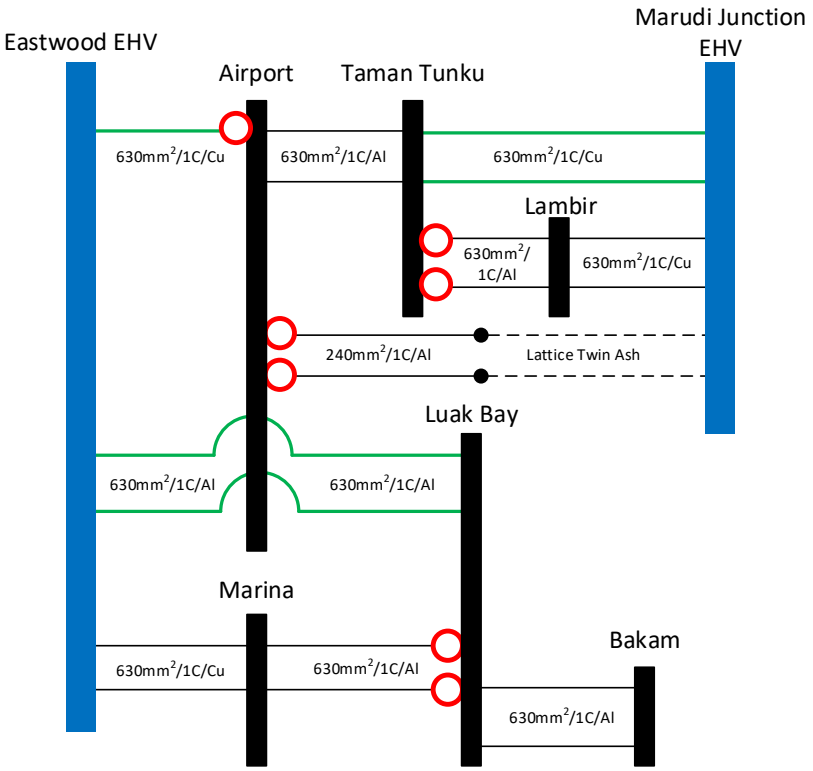


The new substation, Bakam 33/11kV shall then be supplied from Luak Bay 33/11kV upon its completion, thus making it as the 3rd tier substation which resulting in the risks of protection miscoordination for downstream faults.

Therefore, there is a proposal to divert the existing Luak Bay 33/11kV to be supplied directly from Eastwood 132/33kV and make it as 1st tier substation. The proposal is possible by making use of the existing 33kV Miri Airport-Luak Bay feeders in order to optimize the existing asset, reduce project cost and shorten the project period too. This project is critical to minimize the risk of tripping due to ineffective of protection scheme. This project will divided in two (2) phases as below:

i. Phase 1:
To straight-through joint the existing Eastwood-Miri Airport with Miri Airport-Luak Bay cable

ii. Phase 2:
To lay single circuit of 33kV 630mm²/AL/1C/XLPE cable from Eastwood 132/33kV to Miri Airport 33/11kV, and then straight-through joint with the existing Miri Airport-Luak Bay cable.



Upon the completion of the whole project, Luak Bay 33/11kV substation will be supplied from Eastwood 132/33kV by **Q2 2023.**

e) Construction of Niah 275/33kV

Niah, together with other township such as Bekenu, Sepupok, Ulu Niah and Bakong are located in between Miri and Bintulu. The load demand from the township is growing as a result of electrification and increasing usage of electrical equipment.

Despite the fact that there are already four (4) existing 33kV 7/4.65 overhead line from Marudi Junction275/33kV, Luak Bay 33/11kV, Similajau 275/33kV and Samalaju B 275/132/33kV, this area still facing frequent power outage due to the long overhead line and low voltage issue during contingency.

Therefore, it is proposed to establish a new bulk power injection at Niah to resolve the long outstanding reliability and power quality issue. Currently, Niah 275/33kV is in progress of tender adjudication and target to award the tender by end of 2022. Based on the latest schedule provided by Project Delivery (PD), Niah 275/33kV is expected to be completed by year 2026. Upon completion of Niah 275/33kV, Niah 33/11kV and its existing 33kV lines shall be diverted to be supplied from Niah 275/33kV.

f) Construction of Bakong Waterwork 33/11kV

Existing Bakong Waterwork is supplied via one AR-controlled 5MVA 33/11kV substation, sourced from HDL5 feeder of Marudi Junction 275/33kV Substation. Jabatan Bekalan Air Luar Bandar (JBALB), has submitted their request for an additional estimated maximum demand of 5.6MVA to cater for the plant extension at Sungai Bakong and Batang Baram. A full-fledge substation, Bakong Waterwork 33/11kV is required to cater for the development. The new substation shall be equipped with **2 x 10/15MVA 33/11kV transformer** and shall be supplied from Marudi Junction 275/33kV via the laying of single circuit **33kV 240mm²/AL/3C/XLPE** cable. The existing overhead line HDL5 feeder from Marudi Junction

275/33kV shall be kept at NOP and served as backup source of supply for Bakong Waterworks 33/11kV during contingency.

This project is to be carried out under turnkey basis and expected to be completed by **Q3 2023.**

g) Relocate existing Voltage Regulator to Niah

With the completion of the Bakong Waterwork 33/11kV and Bunut 275/33kV substation, it is recommended for Niah 33/11kV to be supplied from Marudi Junction 275/33kV via HDL5 feeder and it is proposed to relocate the existing Volage Regulator at P525 toward Serunggut area to further enhance the voltage profile for Niah at above 0.95p.u. The relocation of the VR shall be further study once Tinjar, Bakong and Beluru loading had been transferred to Bunut 275/33kV and Bakong Waterwork 33/11kV substation.

6.4.3. Year 2029 – 2032

a) Reconstruction of Krokop 33/11kV

The existing Krokop 33/11kV substation will be decommissioned by year 2026 upon all the load diverted to the Jee Foh 33/11kV substation. Based on the projected load, Pujut 33/11kV is anticipated to loss N-1 status by year 2029 and reconstruction of Krokop 33/11kV substation will mitigate the Pujut 33/11kV power transformer high load. The reconstruction of Krokop 33/11kV shall be commence in year 2026 and expected to be ready for operation in 2029 to provide capacity to support the projected organic growth in the vicinity area.

b) Reconstruction of Kuala Baram A 33/11kV

It is required to reconstruct Kuala Baram A 33/11kV in view to the existing substation is an outdoor substation and switchgear is obsolete. The existing land size has adequate space to construct a full-fledged substation. The new substation is expected to be ready by the year 2029.

c) Establishment of New Tudan 11kV System

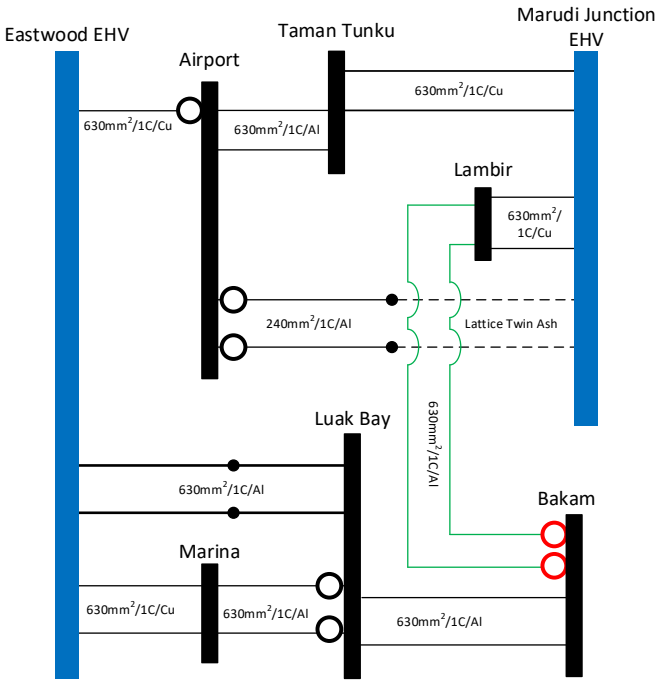
Based on the load forecast 2023, Lutong 33/11kV are expected to be loaded at 20MW / 89% in year 2032. Thus, it is essential to establish New Tudan 11kV system to ensure sufficient capacity for future development at Lutong and Tudan area.

New Tudan 33kV substation has already build with provision of 11kV control room, switchgear room and transformer plinth. Thus, it is proposed to equip the substation with 33/11kV power transformers at New Tudan 33kV substation. The proposal shall be reviewed annually, taking into consideration the projected organic growth in Lutong and Tudan area. As the existing substation is made ready to facilitate such expansion, the project implementation can be implemented in short durations.

d) Proposed reorganization of 33kV link at Southern Zone and Coastal Zone

Even with the system reinforcement, it is crucial to highlight that as the load increase, the single circuit of 630mm^2/1C/XLPE/Cu from Eastwood 132/33kV to Airport 33/11kV substation will be unable to meet the demand in the southern zone during a contingency, resulting in the possibility of load shedding within the system. Therefore, it is necessary to establish a 33kV link between the Eastwood 132/33kV to Marudi Junction 275/33kV. The proposed solution is to utilizing the existing **LAM-TTK link** and straight through join with **2 circuit of 630mm^2/1C/AL/XLPE** laid from Bakam 33/11kV substation

(shown in figure below). This circuit will allow Eastwood 132/33kV to support Marudi Junction 275/33kV and vice versa.



f) Proposed construction of Lopeng Tengah 33/11kV

Based on the load forecast, Luak Bay 33/11kV are expected to be loaded at 12.2MW / **91%** and in year 2032. Therefore, Lopeng Tengah 33/11kV is proposed to be constructed to accommodate the expected organic growth as well to prevent the possible overloading of the existing Luak Bay 33/11kV substation.

The new substation shall be supplied from Eastwood 132/33kV and with the completion of the substation, load reorganization toward Marina Bay 33/11kV and Luak Bay 33/11kV will be take place. The proposal shall be reviewed annually, taking into consideration the projected organic growth in Marina and Luak area.

Small Station Distribution Plan (2022 – 2031)

7.0. Mukah

7.1. Mukah Existing System

Mukah distribution network is supplied by four (4) injection points, namely Petian 132/33/11kV, Matadeng 132/33kV, Daro 132/33/11kV, and Balingian 275/33kV. Petian 132/33/11kV supplies Mukah Town and its surrounding outskirt towns such as Dalat, Oya, and Igan. Matadeng 132/33kV supplies Sarawak Coal Resource (SCR), Mukah Estate, Balingian Town, and its surroundings. Next, Daro 132/33/11kV supplies Daro, Kpg. Tian, Matu, and Kuala Matu. Lastly, Balingian 275/33kV supplies Balingian Coal Fire Power Plant and Coal Stockyard.

Generally, the distribution network can be grouped based on the current network as listed below:

Table 7.1: EHV substation with zone substation

Item	EHV Substations (Injection Points)	Zone Substations Supplied	Area Supplied	Non-coincidental Peak Load 2021 (MW)
1	Petian 132/33/11kV	Petian 33/11kV Mukah Town 33/11kV Polytechnic 33/11kV	Mukah Town, Dalat, Oya and Igan	20.2MW
2	Matadeng 132/33kV	-	SCR, Mukah Estate and Balingian Town	2.4MW
3	Daro 132/33/11kV	Daro 33/11kV	Daro, Kpg. Tian, Matu and Kuala Matu	6.7MW
4	Balingian 275/33kV	Balingian 33/11kV	Balingian Coal Fire Power Plant and Coal Stockyard	1.1MW

7.2. Mukah Maximum Demand Forecast

Figure 7.1 below shows the projected maximum demand for Mukah distribution system from year 2022 to 2031 which is derived based on load growth percentage (%), as well as the known and projected step load.

Load forecast conducted in year 2021 is also appended as shown in red line. The recorded peak load for year 2021 is 27.1MW which is higher than the previous forecasted load of 25.1MW.

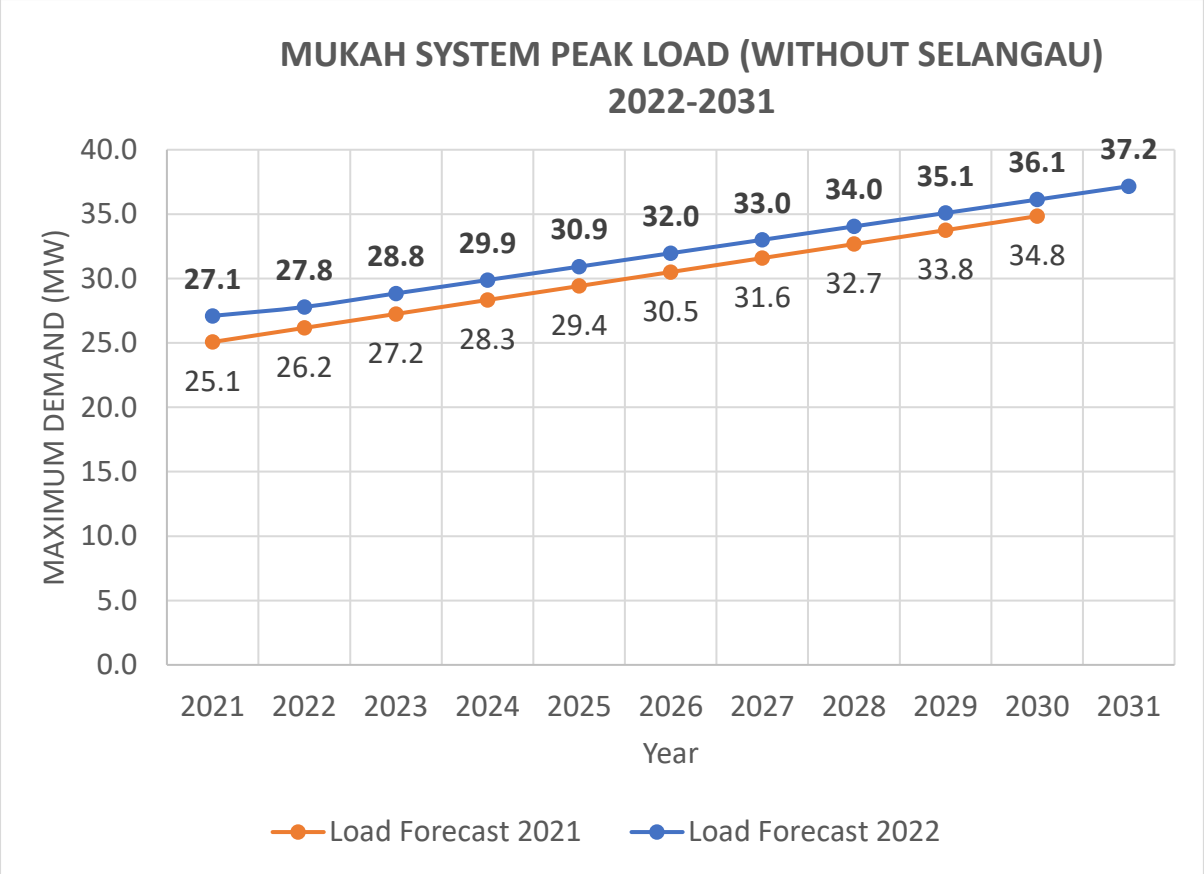


Figure 7.1: Projected maximum demand for Mukah distribution system (without Selangau) from year 2021 to 2031

Table below show the growth rate for Mukah station from year 2022 to year 2031.

Table 7.2: Growth rate for Mukah from year 2022 to year 2031

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Growth Rate (%)	2.5%	3.8%	3.6%	3.5%	3.4%	3.3%	3.2%	3.1%	3.0%	2.9%

7.3. Mukah Substation Loading

Table 7.3: Zone Substation Peak Load

Substation	Transformer rating(MVA)	Peak load recorded as at 2021(MW)	Percentage loading (%)
Petian33/11kV	10/15MVA	3.7	26%
Mukah Town 33/11kV	15/20MVA	7.4	39%
Polytechnic 33/11kV	15MVA	2.4	17%
Daro 33/11kV	5MVA	2.4	51%
Balingian 33/11kV	20/25MVA	0.6	4%
Dalat 33/11kV (temporarily energized since 21.09.2021)	10/15MVA	0.0	0%

Based on the substation loading tabulated, it can be concluded all zone substations in Mukah Station are operating at System Reliability Level 1 in year 2021.

7.4. Mukah Development Plan

7.4.1. Year 2023

a) Improve System Reliability toward Pulau Bruit

Pulau Bruit was supplied via double circuit of submarine cable from Shipbuilding 33/11kV Substation before one of the cables was found faulty in 2019. Currently the power supply to Pulau Bruit depends on the remaining single circuit of submarine cable and back-up by a diesel generator which is temporarily transferred from Kapit Power Station as an interim measure. However, the generator can only cater the load along Pulau Bruit Main Road from Semop to Penuai with the supply capacity of 200kW – 300kW only.

It is then proposed to create additional source of supply to Pulau Bruit via Daro 132/33/11kV Substation. A new circuit from Daro 132/33/11kV substation to Pulau Bruit inclusive of underground and submarine cable is now under construction and targeted to be completed by Q4 2023.

This new feeder from Daro 132/33/11kV will be established as the main source of supply for Pulau Bruit while the existing supply from Shipbuilding 33/11kV Substation will act as a backup supply. Upon completion of this reinforcement work, the distribution system at Pulau Bruit will be upgraded to System Reliability Level 2.

b) Conversion of Petian 33/11kV Substation into 11kV D-Sub

Based on DAMP 2020, both Petian 33/11kV 10/15MVA transformers are identified as asset with low Transformer Health Index of 3. In other words, the transformers are reaching the end-of-service life and there is a high risk of failure at any time soon.

Therefore, it is proposed is to lay double circuit of 11kV 185mm2/AL/3C/XLPE cable from Petian 33/11kV to Mukah Town 33/11kV.

7.4.2. Year 2028 – 2031

a) Construction of Rinwood 33/11kV Substation

A distributed generation (DG) plant is expected to be developed at Rinwood Palm Oil Estate, about 12kM away from Mukah Town 33/11kV Substation and 18kM away from Matadeng 132/33kV Substation. In order to deliver the energy from DG plant to the grid, a point of common coupling (PCC) is required.

A 33/11kV substation is thus required at Rinwood to serve as PCC. However, the construction of the proposed Rinwood 33/11kV substation is subjected to the development of the DG plant.

Recently, the consultant was mentioned the target completion of the development is around Q2 2024 but the application is still under planning and design stage. The scheme of supply also yet to be finalised.

b) Development of AgriTech A 33/11kV substation

The proposed AgriTech A 33/11kV is proposed to cater for the Mukah Science Park with the anticipated load of 15MVA. The AgriTech A 33/11kV shall be supplied from Petian 132/33kV substation via 630mm^2/1C/Cu/XLPE cable.

c) Development of ICT 33/11kV substation

The ICT 33/11kV substation is proposed to cater for the ICT industry (within Mukah Town) with the expected load of 10MVA. It has provision to be upgraded to EHV substation in order to provide ample capacity and high security of supply to ICT industry of Mukah Smart City development.

d) Development of Food City 33/11kV substation

Food City 33/11kV substation is to be developed in order to cater for the Mukah Food City and Revitalizing Fish Industry. In additional, this substation shall also cater for the organic load growth on the east side of Mukah. The proposed Food City 33/11kV substation will be supplied from Mukah Town 33/11kV.

e) Development of Education Hub 33/11kV substation

Education Hub is one of the segments in Mukah Smart City development. With the anticipated load demand of 20MVA during phase 2, it is recommended to develop one zone substation to provide electrical supply to the development, the proposed Education Hub 33/11kV substation will be supplied from AgriTech EHV substation.

8.0. Kapit

8.1. Kapit Existing System

Selirik 33/11kV Substation was completed on 29th October 2021. It has taken up 3MW with the load transfer from Kapit Power Station 11kV.

Kapit network system is supplied by Kapit Power station 11kV, Kapit 33/11kV Substation (Beleteh) and Selirik 33/11kV Substation. These zone substations are supplying Kapit Town, Selirik, Beleteh and Nanga Mujong. The source of supply for these zone substations is from Kapit 132/33kV Substation.

With the commissioning of 2nd Song 132/33kV transformer on 19th June 2020, Song area is supplied by a full fledge Song 33/11kV Substation equipped with 2 x 2.5MVA 33/11kV transformers. ***Figure** 8.1* show the existing network system configuration for Kapit and Song.

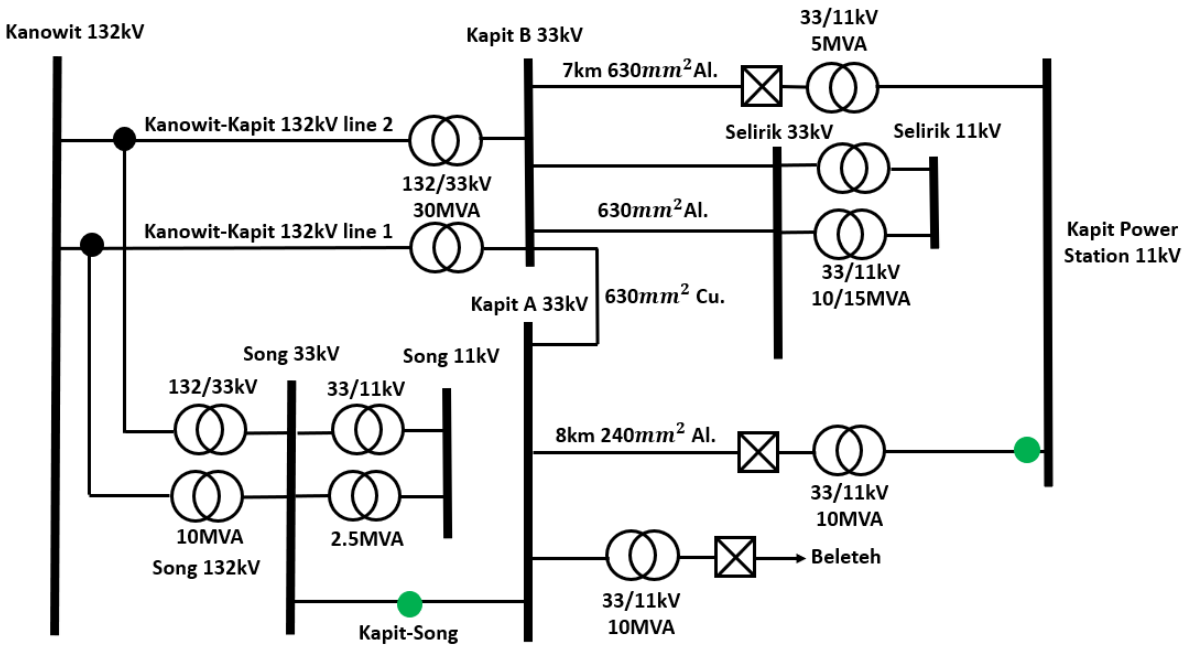


Figure 8.1: Existing System Network Configuration for Kapit and Song

In general, the distribution network can be grouped based on the current network as listed below:

No.	EHV Substation (Injection Point)	Zone Substation (2021)	Area Supplied	Non-coincidental Peak Load 2021
1	Kapit 132/33kV	Kapit Power Station 11kV Kapit 33/11kV Selirik 33/11kV	Kapit Town Selirik Beleteh Mujong	9.8 MW
2	Song 132/33/11kV	Song 33/11kV	Song Town	1.6 MW

8.2. Kapit Maximum Demand Forecast

The maximum demand forecast for the Kapit system from year 2022 to 2031 is developed based on the organic load growth rate, together with the other known (committed) and projected (not committed) development.

Figure 8.2 below shows the projected maximum demand for Kapit (including Song) from year 2022 to 2031. The load forecast conducted in year 2021 is also appended (blue line) for ease of reference. It is shown that the actual peak load recorded in 2021 is 11.33W as compared to previous forecast of 10.88MW. This growth is mainly contributed by a few projects commissioned by Rural Electrification Scheme (RES) Department for longhouses.

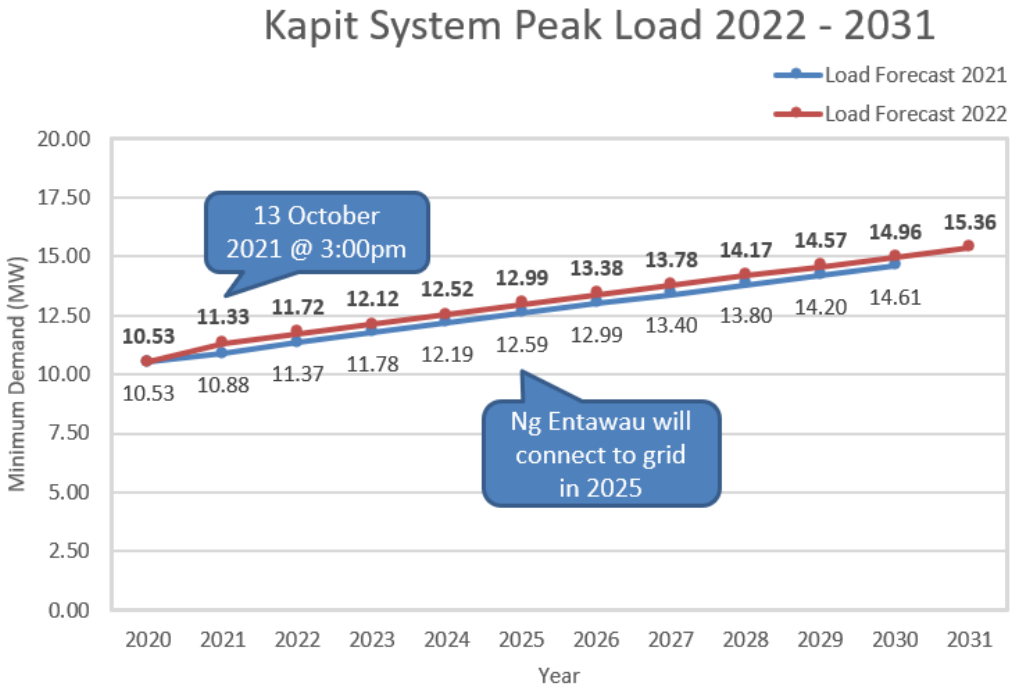


Figure 8.2: Projected Maximum Demand for Kapit (including Song) from 2022 – 2031

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Growth Rate (%)	3.5	3.4	3.2	3.8	3.0	3.0	2.9	2.8	2.7	2.6

Table8.2: Load growth rate provided

8.3. Kapit Development Plan

8.3.1. Year 2023-2031

a) Development of New Beleteh 33/11kV Substation

Beleteh 33/11kV substation is to be constructed in year 2028 instead of the original proposed year 2025 with the consideration of the following:

i) There are 11kV links in between Kapit Power Station 11kV, Beleteh 33/11kV and Selirik 33/11kV Substation and provide N-1 with switching in 11kV system in the event of contingency.

ii) The 2 x 10/15MVA transformers at Selirik 33/11kV Substation is forecasted to be lightly loaded due to slow growth in Kapit. Therefore, it is recommended to optimize Selirik 33/11kV Substation prior to any new investment, and this shall in turn improve our Return on Assets (ROA).

iii) No application received for the commercial or industrial developments such as food processing light industrial and shophouses nearby new Beleteh 33/11kV substation as of today date. The total estimated load is around 3.7MW. (Refer to ***Figure 8.3***)

iv) Initially will be incurred during period of year 2024 to year 2025, has been shifted to period of year 2027 to year 2028.

The need to construct the new Beleteh 33/11kV substation shall be reviewed on yearly basis.

Figure 8.3: Locality Map Shown the Commercial Development Nearby New Beleteh 33/11kV Substation

9.0. Limbang

9.1. Limbang Existing System

The existing Limbang distribution system mainly consists of 11kV network. There are a total of eight (8) circuits of 11kV feeders at Limbang Diesel Power Station as listed in ***Table 9.1,*** inclusive of the underway new 11kV feeder (MNT0 11/33kV Sub) with expected completion by October 2022.

Table 9.1: 11kV Feeders at Limbang Diesel PS

No.	Name of feeder	Category	Descriptions
1	MGL5 Federal Sub	11kV Feeder	Federal feeder supplying toward Batu Biah area which mainly consists of low-cost housing, Bangkita and Market.
2	MCL5 Jabatan Laut Sub	11kV Feeder	Jabatan Laut feeder supplying toward Airport and Rangau area which mainly consist of Rancangan Perumahan Rakyat (RPR) housing.
3	M6L5 Old Power Station	11kV Feeder	Old Power Station feeder supplying toward old power station and the power is then further distributed to commercial area such as Bazaar and Tamu.
4	M2T0 11/33kV Sub	11/33kV Transformer	11/33kV step-up transformer supplying toward Palas 33/11kV and Tower Nanga Medamit 33/11kV.
5	M3L5 Taman Damai	11kV Feeder	Taman Damai overhead feeder stretches up to Pandaruan Checkpoint.
6	M5L5 Sg. Kudong	11kV Feeder	Sg. Kudong feeder supplying toward Desa pebahanan, Kpg, Sengkarai and Kpg. Binjai.
7	MDL5 Plaza	11kV Feeder	Plaza feeder supplying to Plaza via Linpaki Bypass Road.
8	MNT0 11/33kV Sub (Laku Plant)	11/33kV Transformer	11/33kV step-up transformer supplying toward Laku Plant 33/11kV.

9.2. Limbang Maximum demand Forecast

The forecasted maximum demand for Limbang from year 2020 to year 2031 is shown in ***Figure 3***. The forecasted peak load is derived based on the load growth percentage as listed in ***Table 5***, as well as the known and projected step load.

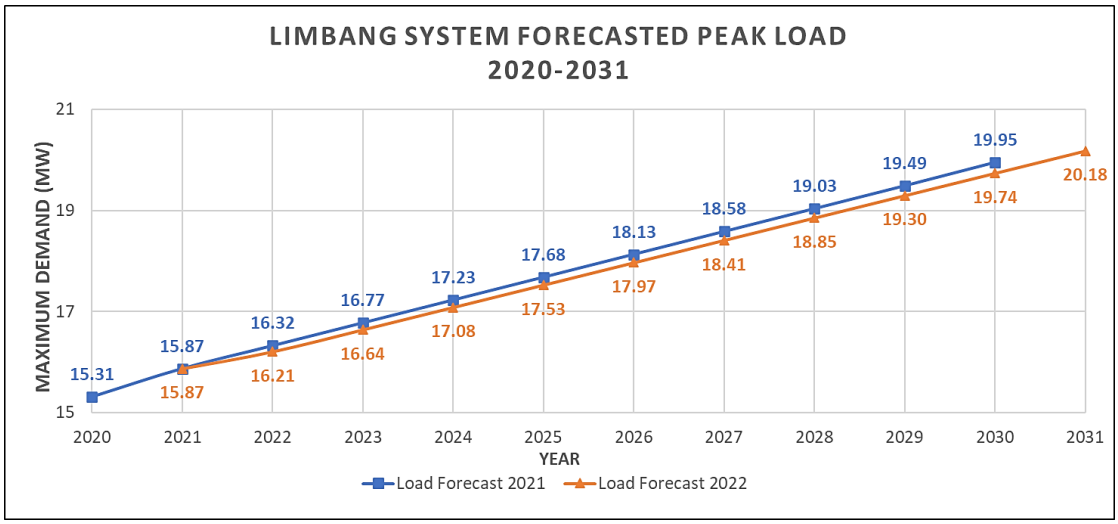


Figure 9.1: Forecasted Peak Load for Limbang from Year 2020 to 2031

Limbang load demand is expected to increase by 2.1% in year 2022 as compared to the recorded peak load of 15.87MW in year 2021. Therefore, the forecasted peak load for Limbang for year 2022 is 16.21MW.

Table 9.2: Limbang Load Growth Rate (2022-2031)

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Growth Rate (%)	2.1	2.7	2.7	2.6	2.5	2.5	2.4	2.3	2.3	2.2

9.3. Limbang Development Plan

9.3.1. Year 2023 (before grid connection)

a) Construction of Second (2nd) Circuit 33kV System from Limbang Power Station to Kubong Junction

Presently, a single 33kV overhead line is used to supply toward Kubong, Medamit and Tedungan areas. Consequently, any fault occurrence or shutdown of the overhead line will contribute to prolong outage prior to the completion of repairing works. Therefore, it is critical for construction of another length of 33kV circuit with a step-up transformer as per ***Figure 9.2***.

It was proposed to lay another length of 11kM 33kV OHL with a 11/33kV 10MVA step-up transformer with the following purposes:

1. To divert some of the load from the existing single 33kV OHL.
2. To improve the reliability of the supply.
3. To provide N-1 contingency criterion.

The reinforcement work was initially targeted to complete by Q4 2023.

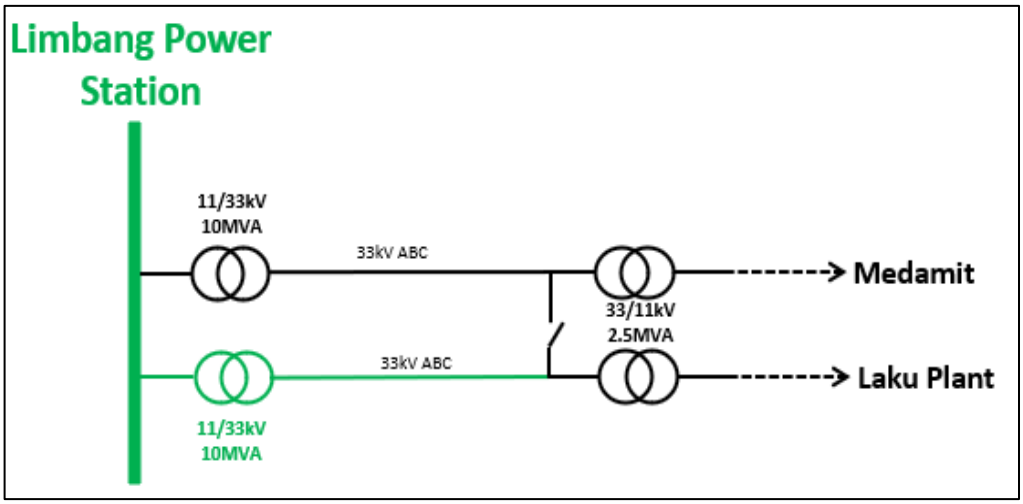


Figure 9.2: SLD with 33kV Reinforcement Work

b) Construction of Second (2nd) Circuit 11kV System from JKR Depot to ICQS Pandaruan

Pandaruan area is currently supplied from M3L5 Taman Damai feeder through the existing 11kV spur OHL. The feeder is also supplying to JKR depot, SMKA Limbang, SK Batu 4, SK Pahlawan, Pandaruan pumphouse, Pandaruan ICQS, Kpg Pahlawan, Kpg Tabahan, Kpg Sembiling, Kpg Benuas, Kpg Tuna and Pandaruan new housing area with total population approximately 4,500 people. Should the 11kV line is out of service, the whole area will be affected by long power interruption until reparation works completed. Hence, a new 11kV ABC is proposed to provide a reliable supply to the areas.

It is also proposed lay another length of 11kV circuit from JKR Depot to ICQS Pandaruan. The reinforcement work was initially targeted to complete by Q4 2023.

c) Construction of Limbang Town 275/33/11kV

The construction works for Limbang Town 275/33/11kV is expected to complete by Jan 2023 and shall replace the existing Limbang Diesel Power Station upon its completion as the bulk power injection point for Limbang distribution system. The substation is equipped with 2x60MVA 275/33kV transformer, 2x30MVA 33/11kV transformer, 9 nos. of 33kV feeder and 15 nos. of 11kV feeder.

9.3.2. Year 2024 – 2027 (Grid Connection)

a) Reconfiguration of Limbang Diesel Power Station

Once Limbang is connected to the grid, Limbang distribution network will be reconfigured to cater for the load demand at Limbang area without depending on the diesel generation.

Limbang distribution network will be reconfigured as follow:

i) Conversion of Limbang Diesel Power Station into 11kV D-Sub

As the existing Limbang Diesel Power Station will be decommissioned concurrent with the grid connection to Limbang, it is proposed to convert the existing Limbang Power Station to 11kV Distribution Substation. A double circuit of 6km 11kV 3C/300mm^2/Cu cable shall be laid from Limbang Town 33/11kV to Limbang Power Station 11kV D-Sub under. With the conversion of the Limbang Diesel Power Station to 11kV D-Sub, several existing 11kV feeders (MGL5, MDL5, M6L5) at Limbang Diesel Power Station and feeder 436 at Old Power Station shall be shifted to Limbang Town 33/11kV to divert a minimum of 7-8MW load from Limbang Diesel Power Station as per ***Figure 9.3***.

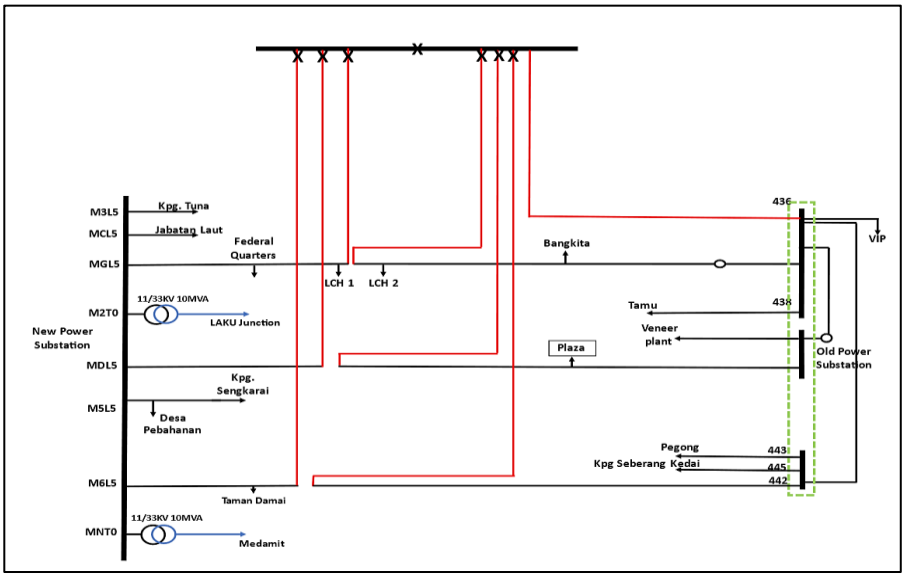


Figure 9.3: Cable Reorganization for Limbang Diesel Power Station after Grid Connection

ii) Decommissioning of 11/33kV step-up transformers at Limbang Power Station

Presently, Medamit, Palas and Laku Plant areas is supplied by the existing Limbang Power Station via the 11/33kV 10MVA step-up transformers. Upon the completion of Limbang Town 275/33/11kV, the step-up transformers shall be decommissioned and dismantled. The 33kV feeders at Medamit, Palas and Laku Plant areas will be diverted to Limbang Town 275/33/11kV as per ***Figure 9.4***.

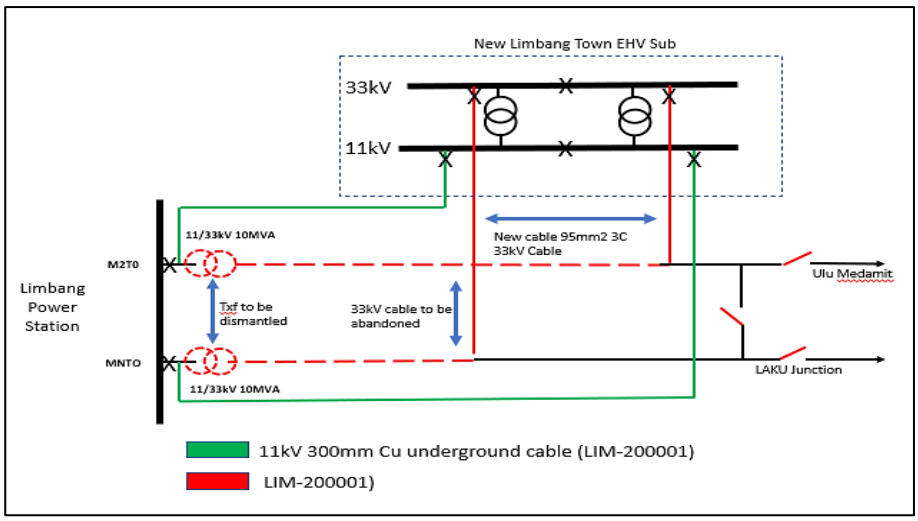


Figure 9.4: Decommissioning of Txf and Cable diversion of feeders (M2T0 & MNT0)

b) Construction of Limbang Integrated Administrative Centre (IAC) 33/11kV

The construction of IAC 33/11kV is proposed to cater for the development of Integrated Administrative Centre owned by the State Government with the applied load of 5.2MVA and other future development nearby such as waterfront.

The IAC 33/11kV Substation is located at the Northern part of the Limbang and with integration of SCADA facilities shall improve the system operation toward the Northern area of Limbang. Limbang IAC 33/11kV Substation will be equipped with 2 x 10/15MVA 33/11kV transformer, 7 nos. of 33kV switchgears and 9 nos. of 11kV switchgears with source of supply from Limbang Town 275/33/11kV via double circuit of 3x630mm^2/Cu/1C/XLPE cable.

Limbang IAC 33/11kV Substation is expected to complete by year 2025. The proposed scheme was Integrated Administrative Centre (IAC) to be temporarily supplied by tapping from Limbang Town 11kV feeder via loop in and out 185mm2/3C/Al cable as per ***Figure 9.5*** prior to completion of Limbang IAC 33/11kV Substation.

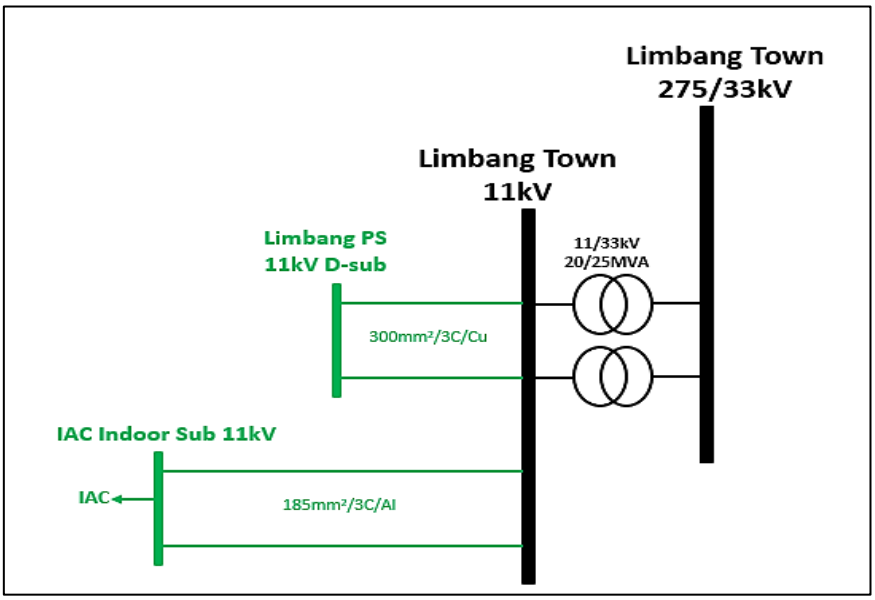


Figure 9.5: The tapping of power supply for IAC from Limbang Town 33/11kV

9.3.3. Year 2028 – 2031

a) Construction of Limbang South 33/11kV

The construction of Limbang South 33/11kV zone substation was initially proposed in Distribution Planning Report 2014 under long-term plan with the purpose to strengthen the reliability of supply in Limbang. With IAC 33/11kV substation expected to be completed in year 2025 and will cater for the impending load in Limbang including the applied load of 5.2MVA for Integrated Administrative Centre, the construction of Limbang South 33/11kV is no longer necessary and shall be further deferred until there is a need in the future.

Refer to ***Table 9.6***, it is forecasted by year 2031, the 33/11kV 25MVA transformer at Limbang Town 33/11kV will be loaded at 74.93% with IAC 33/11kV substation come in by year 2025. The construction of Limbang South 33/11kV shall be done when necessary to strengthen the reliability of supply in Limbang.

Table 9.6: Transformer Loading at Limbang Town 33/11kV

Percentage of Loading (%)	
Year	**Limbang Town 33/11kV Txf**
2025	65.07
2026	66.71
2027	68.36
2028	69.96
2029	71.64
2030	73.29
2031	74.93

Presently, the land scouting is in progress. Once the location is identified, the land shall be kept as a land bank and subsequently used for the zone substation construction when necessary.

10.0. Lawas

10.1. Lawas Existing System

Lawas currently is operating as a non-grid connected system, supplied by the local generation via Lawas Diesel Power Station, and supported by Kota II, Sg. Kota and Kalamuku Hydropower Stations. The main hub for power distribution in Lawas includes Loagan Salam 33/11kV, Pulau Salam 33kV and Main Distribution 33/11kV:

- Loagan Salam supplying to Kastam sub and Eng Huat Garden
- Pulau Salam supplying Merapok area, Sundar and Awat-awat area
- Five circuits of 11kV feeders for Main Distribution sub which is supplied from Lawas Power Station 11kV:
  - MEL5: JKR feeder act as back-up supply to Trusan area.
  - MHL5: RKB overhead feeder stretches up to Banting, Kuala Lawas and Punang areas.
  - M5L5: Masjid feeder consist of mainly underground cable network. The feeders are supplying to government administrative offices and commercial areas.
  - M9L5: Kalamuku feeder is supplying to rural areas toward Kalamuku. The feeder is connected and supplied by Kalamuku Mini Hydropower Station during normal operating condition.
  - M4L5: Taman Classic feeder supplying to hotel and some federal offices.

10.2. Lawas Maximum Demand Forecast

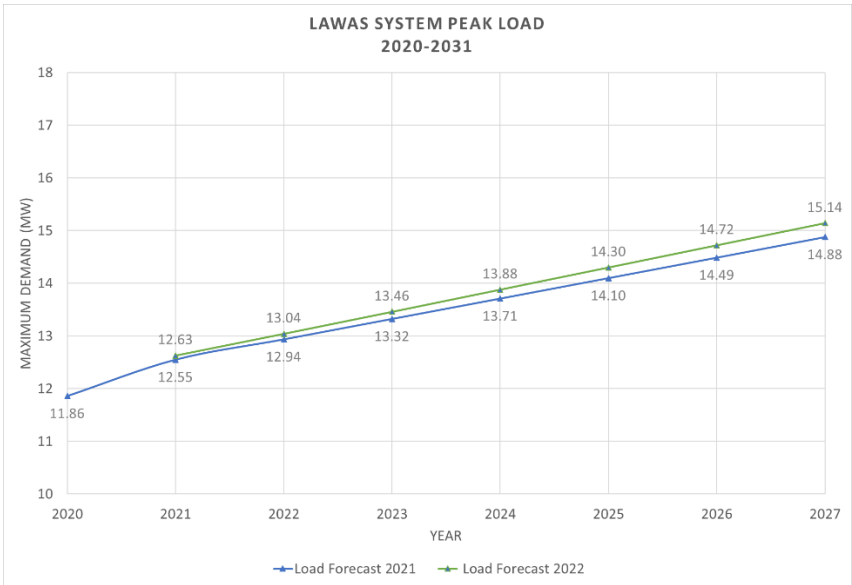


Figure 10.1 Projected Maximum Demand for Lawas Station from Year 2020 to 2027

Figure 10.1 shows the projected maximum demand for Lawas station from year 2020 to year 2027 which is derived based on load growth percentage (%), as well as the known and projected step load.

Table below show the organic growth rate for Lawas station from year 2022 to year 2027.

Table 10.1: Growth Rate from year 2022 to year 2027

Year	2022	2023	2024	2025	2026	2027
Growth Rate (%)	3.3%	3.2%	3.1%	3.0%	2.9%	2.9%

The recorded peak load for Lawas in year 2021 was 12.63MW. Based on the growth rate, Lawas load is expected to increase by 3.3% in year 2022 as compared to year 2021.

10.3. Lawas Development Plan

10.3.1. Year 2023 – 2026

a) Construction of Lawas Town 275/33kV

There will be a new EHV substation to be constructed in Lawas under the grid extension proposal, namely Lawas Town 275/33kV substation. Lawas Town 275/33kV substation will be replacing Lawas Diesel Power Station to serve as a new bulk injection point for Lawas distribution system.

Currently, Lawas Town 275/33kV is under construction and expected to complete by Q4 2022 but the 275kV incoming lines will only be completed by Q2 2024. Upon grid connection in Q2 2024, Lawas distribution network will be reconfigured as follow:

i. Cable laying from Lawas Town 275/33kV to Loagan Salam 33/11kV

Upon completion of Lawas Town 275/33kV, Loagan Salam shall act as the new hub for power evacuation and the point of synchronization for all power generation. Thus, it is proposed to lay double circuit of 33kV 630mm^2/1C/Cu/XLPE cable from Lawas Town 275/33kV to Loagan Salam 33/11kV.

With this reinforcement, Lawas distribution system shall be able to cater for the load growth without depending on diesel generation. It shall be noted that Kota II Hydropower Station will continue to operate as a supplementary supply to Lawas town via Loagan Salam 33/11kV substation.

ii. Conversion of Lawas Power Station into 11kV D-Sub

The existing Lawas Power Station shall be closed after the completion of the Lawas Town 275/33kV. Thus, it is proposed to convert the existing Lawas Power Station to 11kV Distribution Substation and supplied from Loagan Salam 33/11kV via loop in and out existing 11kV 300mm^2 /3C/Cu/XLPE Lawas Power Station - MDS cable.

The 33kV outdoor equipment of the Main Distribution 33kV substation will be dismantled & removed eventually.

iii. Decommissioning of 2 x 11/33kV step-up transformer at Pulau Salam 33kV

Pulau Salam will be supplied from Loagan Salam 33/11kV via existing double circuit of 33kV 630mm^2/1C/Al/XLPE cable. Thus, the existing 2 x 11/33kV 10MVA step-up transformer shall be decommissioned and dismantled.

iv. Dismantle partial of the 33kV overhead line from MDS 33kV to Sg. Kota Hydropower Station

The 33kV overhead line toward Sg. Kota Hydropower Station is prone to land corrosion. Currently, the 33kV line is required for black-start the generator at Sg. Kota or Kota II Hydropower Stations during contingency.

With the completion of Lawas Town 275/33kV, Kota II and Sg. Kota Hydropower Stations will be able to back supply from Loagan Salam 33/11kV. Therefore, the 33kV overhead line is not necessary and shall be dismantled.

10.3.2. Year 2027 – 2031

a) Construction of Lawas Damit 33/11kV

Currently, there are two (2) substations constructed along the same road toward Lawas Power Station which is Pulau Salam 33kV and Loagan Salam 33/11kV. As there is limited road reserved, it is difficult for cable laying works to be carried out.

Hence, it is recommended to construct a new 33/11kV substation at Jalan Lawas Damit which is about 8kM from Lawas Town 275/33kV and 4kM from Lawas Town area. This new 33/11kv substation will be able to cater for the future development at Lawas town area.

Rural Electricity Development Masterplan (REDM) 2030

RURAL ELECTRICITY DEVELOPMENT MASTERPLAN (REDM) 2030

Towards a Developed State by 2030

Version 1.0, September 2022

Prepared by: Sarawak Energy (RES) Sendirian Berhad

Custodian: Rural Power Supply Division,
Ministry of Utility and Telecommunication, Sarawak

EXECUTIVE SUMMARY

This Rural Electricity Development Masterplan (REDM 2030) is a 10-year plan for the development of Sarawak's rural electricity infrastructure to achieve full electrification and propel Sarawak towards a developed State by 2030. Rural electricity infrastructure in Sarawak began intensive development in 2009 when the Federal Government identified rural electrification as one of the initiatives under the National Key Result Area (NKRA). Following intensification and acceleration by the Sarawak Government through the Ministry of Utility & Telecommunication and Sarawak Energy, more than 115,000 rural households were electrified through various programmes such as the Rural Electrification Scheme (RES), Sarawak Alternative Rural Electrification Scheme (SARES) and Hybrids by 2018. Through this initiative, Sarawak's rural electrification coverage rose from 56.0% in 2009 to 90.2% in 2018.

Further significant change from 2018 occurred with the introduction of *Projek Rakyat* by the Sarawak Government in 2018, where RM2.37 billion was allocated to accelerate rural electrification in Sarawak via the Rural Electrification Master Plan (REMP) 2018. The REMP aimed to fully electrify the State by 2025. With *Projek Rakyat* in place, rural electricity coverage surged to 95.3% in 2020 with about 14,500 rural households electrified between 2019 and 2020.

Besides aggressively extending the grid into the interior, the REMP has also improved the capacity and reliability of rural electricity infrastructure. The State distribution network has been severely overstretched due to the extensive expansion of distribution lines into rural areas with the increase of rural loads over the years. Under the REMP 2018, the Rural Power Supply Scheme (RPSS) was introduced to construct EHV and MV substations at strategic rural locations, bringing grid supply nearer to rural communities. Two EHV substations and 10 MV substations were proposed under *Projek Rakyat* and are currently in various construction stages with some already completed. To further reinforce the system's reliability, the Medium Voltage Covered Conductor (MVCC) line was introduced as the main type of distribution line connecting EHV substations to selected rural areas, replacing conventional bare aluminium medium voltage conductors and aerial bundled cables as a more robust system with less interruption.

In the future when all rural villages and households have access to reliable, 24/7 electricity supply and Sarawak realises full electrification, the constructed rural grid systems will still require reinforcements to meet increasing load demand as well as higher reliability and quality requirements as Sarawak and its people develop. The grid systems also need to be expanded to remote locations where villages and households are currently supplied using off-grid solutions temporarily.

Unfortunately, these system reinforcements and expansion initiatives cannot be commercially justified from sales of electricity alone as electricity consumption is generally low in rural areas relative to more densely populated urban centres. Other sources of funding will be necessary and other factors would need to be considered to prioritise future investments in the electricity supply infrastructure in Sarawak's rural interiors. The REDM 2030 documents considerations beyond full electrification in the following five key focus areas:

- System reinforcement
- Sustainability
- Grid penetration and extension to non-grid areas
- Supporting government's development agenda and powering other utilities
- Economic development

REDM 2030 outlines proposed rural electricity infrastructure development projects based on the above-mentioned key focuses. The masterplan depicts an overall conceptual design which shall be reviewed from time to time. The list of proposed projects shall be expanded or reduced from time to time depending on the prevailing political, economic, social, and technical conditions.

1 Table of Contents

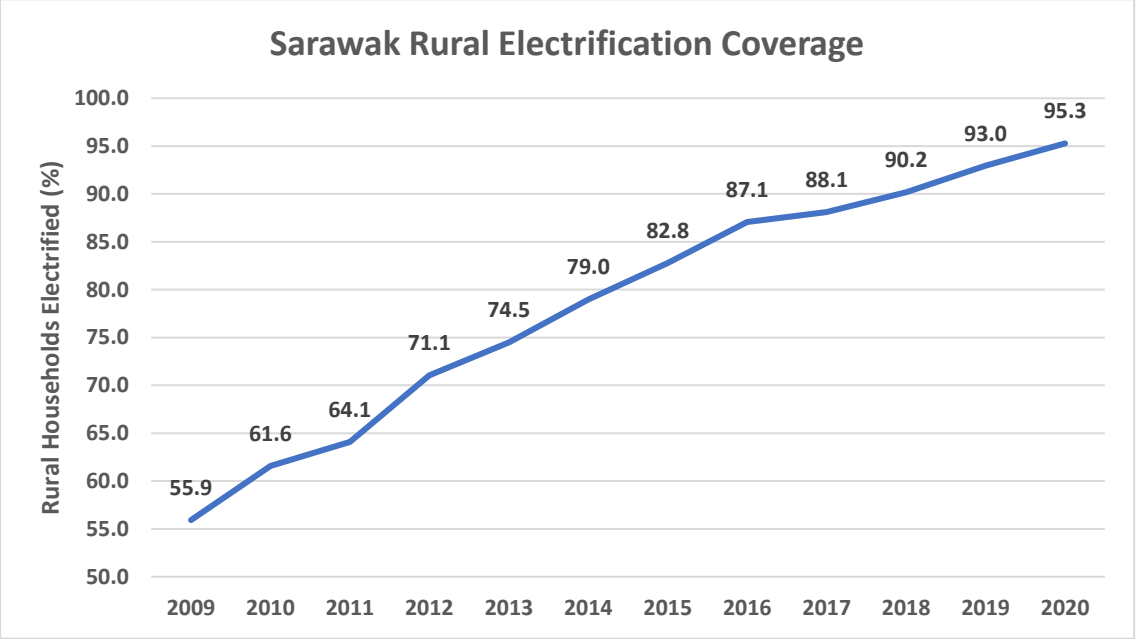
LIST OF ABBREVIATIONS

ABC	Aerial Bundled Cable
AR	Auto-Recloser
CB	Circuit Breaker
EHV	Extra High Voltage
HEP	Hydroelectric Plant
MV	Medium Voltage
MVCC	Medium Voltage Covered Conductor
OHL	Overhead Lines
PCDS	Post-Covid Development Strategy 2030
PV	Photovoltaic
RECODA	Regional Corridor Development Agency
REDM	Rural Electricity Development Masterplan 2030
REMP	Rural Electrification Masterplan 2018
RES	Rural Electrification Scheme
RPSS	Rural Power Supply Scheme
RMK-12	12th Malaysian Plan
RMK-13	13th Malaysian Plan
SARES	Sarawak Alternative Rural Electrification Scheme
UG	Underground Cable
VR	Voltage Regulator

2 INTRODUCTION

The Federal and State governments have allocated about RM6 billion since 2009 for rural electrification initiatives in Sarawak. By early 2021, more than 130,000 households in over 5,500 rural villages have benefitted from various rural electrification initiatives. Of the 130,000 electrified households, about 115,000 are Grid-connected whereas 16,000 are supplied via off-grid solar systems and a handful via off-grid micro-hydro systems. Figure 1 shows the increase in Sarawak's rural electrification coverage from 2009 until 2020.

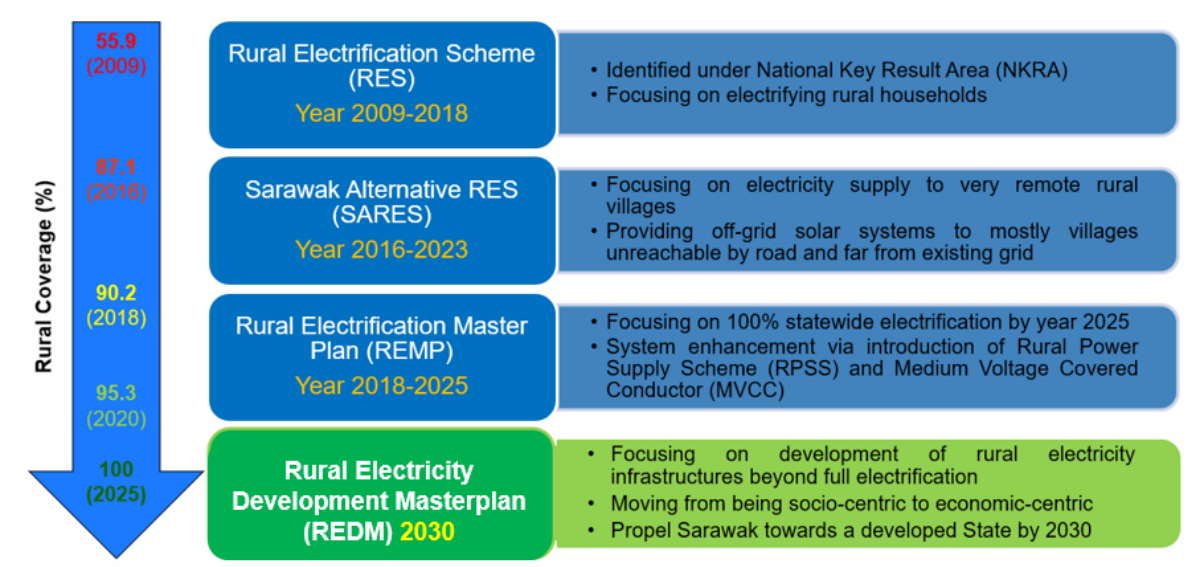
Figure 1: Sarawak Rural Electrification Coverage



Although the COVID-19 pandemic and its associated movement control orders have hampered the acceleration initiatives of rural electrification in Sarawak since March 2020, the rural electrification rate was at 97.9% by end of 2022 and is expected to gradually increase to 99.5% by 2023. Full electricity coverage is expected to be achieved before 2025.

With strategies to achieve full electrification already in place, Sarawak is now entering the next phase of rural electricity infrastructure development in line with the key focus areas identified for the next 10 years. Figure 2 shows the different stages and initiatives towards 100% electrification and beyond.

Figure 2: Rural Electrification Initiatives



REDM 2030 builds upon the successful implementation of the Rural Electrification Masterplan (REMP) 2018, which aimed to fully electrify Sarawak. It focuses on the development of Sarawak's rural electricity infrastructure to propel Sarawak towards a developed State by 2030 through five key focus areas:

1. System reinforcement
2. Sustainability
3. Grid penetration and expansion to non-grid areas
4. Supporting the Government's agenda and powering other utilities
5. Economic Development

REDM 2030 depicts an overall conceptual design which shall be reviewed from time to time and the list of proposed projects shall be expanded or reduced depending on prevailing political, economic, social and technical conditions, taking into consideration the following critical factors:

- Availability of funds
- Technical feasibility
- Accessibility and site conditions

REDM 2030 shall be the reference for future rural electricity infrastructure projects to be implemented within *Rancangan Malaysia Ke-12* (RMK-12) *and Rancangan Malaysia Ke-13* (RMK-13). It complies with Sarawak Energy's short, medium and long-term plans under the company's internal planning activities, including the following:

- 10-Year Generation and Transmission Master Plan
- Kuching Distribution Plan
- Sri Aman Distribution Plan
- Sarikei Distribution Plan
- Sibu Distribution Plan
- Bintulu Distribution Plan
- Miri Distribution Plan
- Mukah Distribution Plan

- Kapit Distribution Plan
- Limbang Distribution Plan
- Lawas Distribution Plan

The proposed initiatives and projects also take into consideration the needs of various State-level socio-economic development plans, including but not limited to the following:

- Post-COVID-19 Development Strategy (PCDS) 2030
- Green Technology Masterplan Malaysia 2017-2030
- Malaysia Renewable Energy Roadmap
- Sarawak Tourism Masterplan
- Sri Aman Development Masterplan
- Mulu Development Masterplan
- Serian-Gedong Masterplan
- Mukah Masterplan
- Bintulu Masterplan
- Limbang Development Masterplan
- Tunoh Development Masterplan

3 KEY FOCUS AREAS

3.1 System Reinforcement

Since the implementation of rural electrification in 2009, more than 100,000 households in rural Sarawak have been connected to the grid through grid line extensions into interior villages. The rural electrification strategy back then was to electrify as many rural households as possible to increase rural electricity coverage. Since then, the performance of the rural distribution system was compromised as many rural distribution lines were overextended beyond the recommended lengths of 20km for 11kV and 60km for 33kV lines. On top of that, increase in rural load demand has also caused transformers to overload. As a result, the distribution system's reliability has deteriorated, and immediate measures must be taken to reinforce the system.

System reinforcement plans shall focus on improving the system reliability by introducing new EHV and MV substations at strategic rural locations to reduce the length of distribution lines between electricity sources and rural loads. This initiative shall also look into providing N-1 contingency to reduce the frequency and duration of supply interruptions in critical areas as the rural communities deserve an equitable quality of electricity supply like their urban counterparts. Reorganisation of distribution systems in certain rural areas shall also be looked into to improve operational issues.

3.2 Sustainability

We aim to improve electricity supply for the 16,000 rural households currently supplied via off-grid standalone solar systems (SARES) and solar-diesel generator hybrid systems. Initially, these communities were supplied with electricity via off-grid solutions as they are either inaccessible by land or situated very far from the existing grid. One of the disadvantages of these systems is that the batteries for energy storage and other PV system components require periodical replacements due to their short lifespans. Besides that, SARES beneficiaries also have their daily consumption limited to 3kWh due to the high cost of the solar system. For hybrid systems, transporting diesel fuel to remote stations remains an uphill and costly task.

With the extension of rural distribution grids spurred on by rural road development, about 4,000 of these households in areas such as Julau, Pakan, Sebauh and Long Lama are now within reach of the grid system. These households shall be earmarked for connection to the distribution grid in the near future. With this initiative in place, these communities shall be provided with unlimited 24-hour reliable electricity from the grid. This will also ease operation and maintenance works in the future and reduce operation costs in the long-term.

However, there are still currently 12,000 households that will be beyond the reach of the distribution grid over the next 10 years. For these communities, the replacement of batteries and solar components will continue, accompanied by an effective maintenance plan to ensure the sustainability of these off-grid electricity supply systems.

3.3 Grid Penetration and Extension to Non-Grid Areas

The initiatives under this focus area aim to extend existing grids to rural areas where grid facility is limited or currently unavailable. By extending the grid into these areas, remote communities currently supplied through off-grid solutions can be connected to the grid system in the foreseeable future. Areas earmarked for this initiative are Paloh in the Sarikei Division, Bario in the Miri Division and Bukit Mabong in the Kapit Division. This will also enable diesel power stations such as Paloh Diesel Power Station and Nanga Entawau Diesel Power Station to be shut down. For places like the Bario region, existing solar hybrid stations can be gradually integrated into their grid systems.

3.4 Supporting the Government's Agenda and Other Utilities

Many rural areas in Sarawak have been identified by the State Government as rural growth nodes, tourist spots, industrial zones, agriculture potentials and development centers. Various development plans such as the Sri Aman Development Masterplan and Sarawak Corridor of Renewable Energy (SCORE) have been developed by government agencies such as Sri Aman Development Agency (SADA) and Regional Corridor Development Authority (RECODA) respectively. The State Government has also launched the Post COVID-19 Development Strategy 2030 which aims to spur economic growth in urban centres and rural areas for the State to achieve developed status by 2030.

Although grid supply is already available to villages and households in these areas, there are substantial developments that require the upgrading of existing rural electricity infrastructure. For off-grid areas, strategic planning has to be developed to ensure that these areas will be connected to the grid in the near future.

The development of rural electricity infrastructure will also focus on providing electricity supply to other utilities such as telecommunication and rural water supply. Reliable electricity supply is crucial to power rural infrastructure, such as telecommunication towers and rural water supply stations. Since existing rural electrification initiatives only target domestic households, many government premises in rural areas still rely on diesel generators for electricity. REDM initiatives will aim to electrify other premises such as rural clinics, government offices, community halls and places of worship.

3.5 Economic Development

This initiative under REDM 2030 will look into the possibility of expanding the rural grids to neighbouring villages and towns in Kalimantan. Currently there are three cross-border distribution level electricity supply connections to Kalimantan, namely Biawak-Sajingan, Tebedu-Entikong and Lubok Antu-Badau. With the State grid system expanding to border towns and villages, there are other new connection points to consider such as Ba'kelalan–Kalimantan Utara (Long Bawan) and Telok Melano–Temajuk.

This initiative will also focus on electricity supply to timber camps, plantations, and mills in the interior areas across the State. Many plantations have provided wayleave approval and the necessary road access for constructing grid lines to remote villages. The same grid system can also be used to provide electricity to the quarters, offices, and other facilities within the plantations. These are potential industrial customers that will help to improve the financial viability of rural electricity systems.

4 ELECTRICITY ORDINANCE, RULES AND REGULATIONS

Syarikat Sesco Berhad (SESCO) is a fully-owned subsidiary of Sarawak Energy and the sole licensee for the transmission, distribution, and retail of electricity in Sarawak as well as a licensee for generation. Generation licences are issued to others for self-generation, standby or for sale to SESCO. Sarawak's electricity industry is regulated under the provisions of the following legal frameworks:

1. Electricity Ordinance, 2007 (Chapter 50)
2. Sarawak Electricity Supply Corporation (Successor Company) Ordinance, 2004 (Chapter 59)
3. The Electricity Rules, 1999
4. The Electricity (State Grid Code) Rules, 2003

Under the State Grid Code Rules, a generation masterplan is prepared by Single Buyer which is currently undertaken by Sarawak Energy for the Regulator's Office. The transmission and distribution masterplans are prepared by Transmission Network Service Provider (TNSP) Network Planner and Distribution Network Service Provider (DNSP) which are units within Sarawak Energy Berhad.

Upon completion of any project related to the supply of electricity, SESCO shall eventually be the asset owner under the provisions of the license issued to SESCO to ensure its obligation under the license to provide supply to all customers throughout Sarawak.

5 OVERVIEW OF SARAWAK ELECTRICITY GRID SYSTEMS

The Sarawak State Electricity Grid System can be broadly divided into three regions, namely the Southern, Central and Northern Regions. The Southern Region covers all areas south (or west) and includes the Betong Division. The Central Region ranges from the coastal areas of the Sarikei and Mukah Divisions to the interior hinterland of the Kapit Division. Finally, the Northern Region extends from the Bintulu Division to the Limbang and Lawas Districts.

The major contrast between these regions is the maturity or comprehensiveness of the grid systems in their respective areas. The development of the Sarawak State Grid started in the mid-1980s with the construction of the Batang Ai Hydroelectric Plant, hence the electricity network is wide – covering extensive areas in the Southern Region. Besides connecting Kuching city to the power plant, electricity grids have also been extended to other towns and surrounding rural areas in the region since the 1990s. As such, a mature network of electricity grids interconnecting the rural villages exists. However, with old and aging equipment, the systems need upgrading and reinforcement to meet the increasing load demands and requirements for higher reliability and better quality.

Although the State Grid was extended to Sibu in mid-1990s, electricity supply connection to the peripheral towns and rural areas only started in the late 2000s with the construction of Mukah's coal power generations. The transmission grid lines had been extended across the Tanjung Manis coastal areas to Kapit and are now extending further inland to the Bukit Mabong District through the construction of Baleh Hydroelectric Power Project. Through the *Projek Rakyat* initiatives, which started in 2018, the rural areas are being connected with grids where land access is available while off-grid SARES schemes are being provided as interim solutions until land access becomes available for grid connection. Hence, grid extension to rural areas shall need to continue to take advantage of the EHV transmission infrastructure constructed in conjunction with the coal and hydropower generation plants.

Similarly, even though both Bintulu and Miri cities were connected to the State Grid in the mid-1990s, rural areas in the Northern Region are still relatively lacking in grid infrastructure. The commissioning of the Bakun and Murum Hydroelectric Plants in the early 2010s enabled electricity grids to be extended to the surrounding areas. However, the nearby town of Belaga is only expected to be connected in 2022. The ongoing Northern Agenda project shall connect Limbang and Lawas by end of 2024. Grid extensions to the corresponding rural areas have only started under the recent *Projek Rakyat* initiatives. Vast areas in the Tatau, Marudi and Telang Usan Districts still rely heavily on off-grid solutions. Hence, grid transition shall be the major initiative in the Northern Region wherever EHV grid infrastructures are being completed and whenever land access becomes available.

Table 1 below shows the investments made by Sarawak Energy in transmission and distribution infrastructure, which also provided increased capacity and improved reliability to surrounding rural areas. The investments made over recent years as well as the plans for the coming years mimic the maturity levels and needs of the respective regions as described above. About RM500 million was invested to expand and enhance the grid systems in the Southern Region in recent years and there is a commitment to invest another RM1.2 billion in the coming years. In conjunction with the extensive infrastructure and improved economic situation, less than RM500 million is proposed to fund the

remaining isolated non-profitable projects to meet rural needs in the Southern Region over the next 10 years.

On the other hand, the Central Region has seen a significant number of investments in its transmission and distribution systems. About RM1.6 billion worth of projects have been commissioned in recent years, benefitting rural electricity systems across the region. Hence, with a relatively younger grid infrastructure, a smaller amount of about RM400 million worth of projects are to be implemented by Sarawak Energy in the coming years. Similarly, with many rural electricity systems commissioned recently under the *Projek Rakyat* initiative, nearly RM1 billion has been requested, primarily to sustain the operation and maintenance of off-grid systems in the remote parts of the Song, Kapit and Bukit Mabong districts.

In the Northern Region, the transmission and distribution grid systems are still very limited and confined to the areas around Miri. Sarawak Energy's Northern Agenda aims to expand the transmission grid to link up with Limbang and Lawas, but it largely bypasses the vast expanse of Baram as well as the Telang Usan district. Nevertheless, Sarawak Energy is increasing its investments in the expansion and enhancement of the Northern Region's grid systems. However, a large amount of funding is required to sustain the operation of the many off-grid SARES schemes and Hybrid stations across the Baram interior. This involves the costly replacement or upgrading of batteries and inverter systems. A significant amount also needs to be set aside to transition the many off-grid schemes to become grid connected through further expansion of the transmission and distribution grid systems.

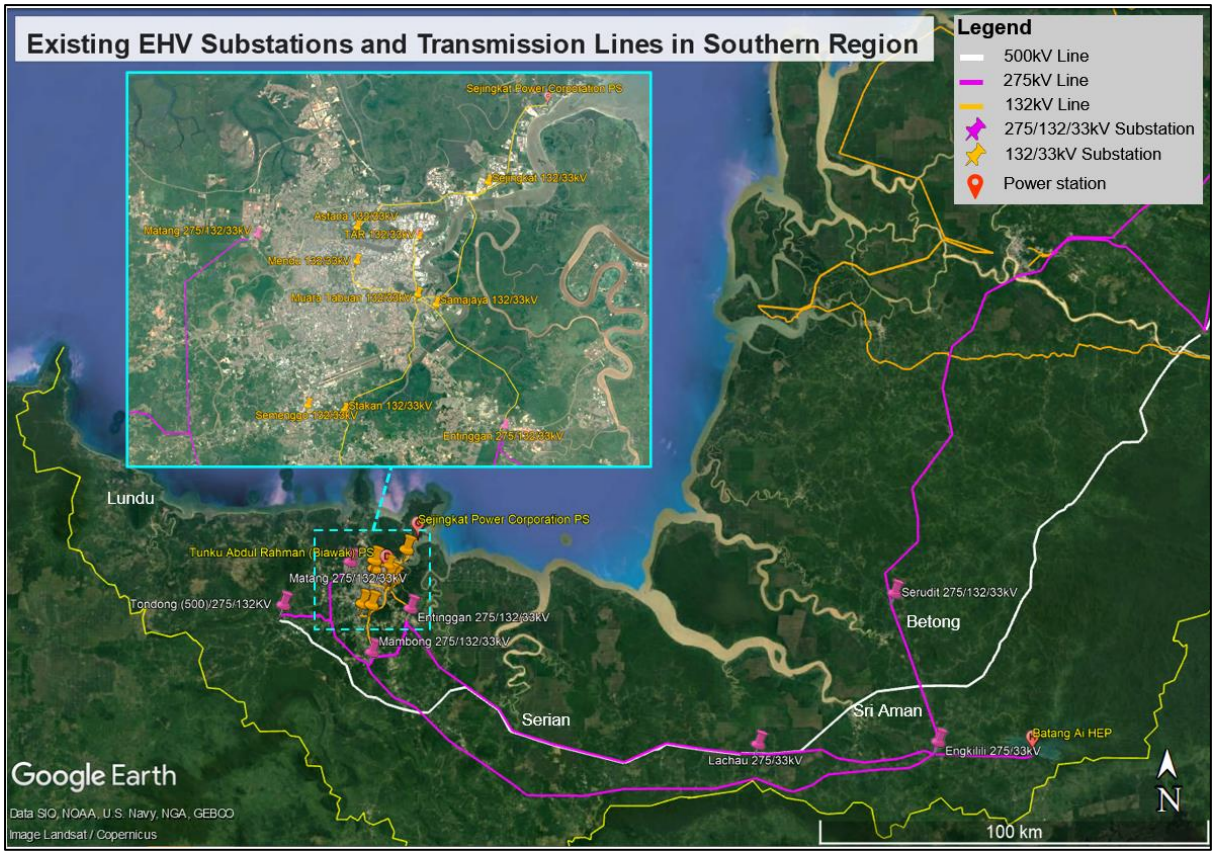
Table 1: Summary of Investments and Proposals for Rural Electricity Systems

Regions	Recently commissioned Sarawak Energy projects that benefit rural customers		Ongoing/future Sarawak Energy projects that benefit rural customers		Proposed rural electricity system projects for REDM	
	Quantity	Value (RM 'mil)	Quantity	Value (RM 'mil)	Quantity	Value (RM 'mil)
Southern	27	522	29	1,249	20	452
Central	51	1,605	18	345	23	961
Northern	13	219	9	473	34	2,258
Total	**91**	**2,346**	**56**	**2,067**	**77**	**3,671**

6 SOUTHERN REGION

The Southern Region has the most well-developed electricity grids in the State and can be further divided into five zones: Kuching, Samarahan, Serian, Sri Aman and Betong. There are a total of 14 EHV substations in this region, serving a total peak load of around 714MW at the Kuching station and 39.8MW at the Sri Aman station, as recorded in 2021. The locations of these EHV substations and associated transmission lines are illustrated in Figure 3 below. In terms of network coverage, all areas in Kuching, Samarahan and Serian are fully grid connected. However, there are areas in Sri Aman and Betong – the remote Ulu Ai, Ulu Engkari and Ulu Lemanak areas specifically – that still depend on off-grid systems. However, the ongoing implementation of Last Miles projects under *Projek Rakyat* is expected to cover all accessible areas by 2023 while SARES and Hybrid schemes shall be confined to a small number of inaccessible villages only.

Figure 3: Existing EHV substations and transmission lines in Southern Region



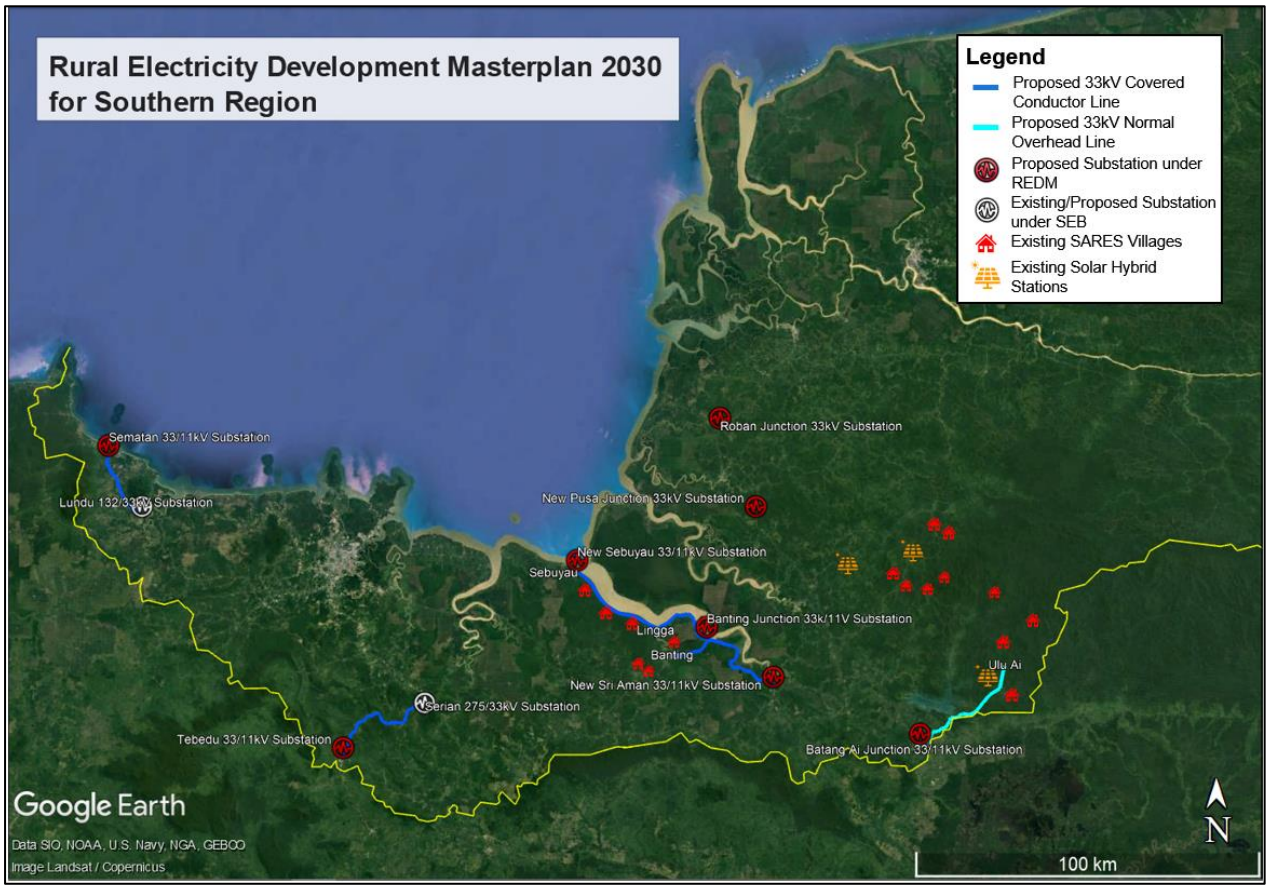
In recent years, Sarawak Energy commissioned a total of 27 projects across the five southern zones that have improved reliability and access to electrical supply for rural customers. This was about RM500 million investment. In addition, 29 more projects costing an estimated RM1.2 billion are being planned by Sarawak Energy to further expand the transmission and distribution networks, indirectly benefitting rural customers. Table 2 summarises the respective numbers and value of both completed and future projects, as well as proposed projects under the REDM.

Table 2: Completed Sarawak Energy projects and proposals for rural areas in Southern Region

Zones	Recently commissioned projects that benefit rural customers		Ongoing/future projects that benefit rural customers		Proposed rural electricity system projects for REDM	
	Quantity	Value (RM 'mil)	Quantity	Value (RM 'mil)	Quantity	Value (RM 'mil)
Kuching	7	297.26	7	426.96	3	66.00
Samarahan	3	16.25	3	232.7	4	63.40
Serian	2	10.67	7	244.65	3	78.00
Sri Aman	8	39.96	5	260.2	7	188.70
Betong	7	158.43	7	84.24	3	56.00
Total	27	**522.57**	29	**1248.75**	**20**	**452.1**

For the REDM, a total of 20 grid expansion and reinforcement projects are proposed for the Southern Region as illustrated in Figure 4 below. The details and purpose of each project will be explained, elaborating on the development needs of the rural electricity supply systems in their respective zones of Kuching, Samarahan, Serian, Sri Aman and Betong.

Figure 4: Locations of proposed projects under Southern Region



6.1 Kuching Zone (Bau/Lundu)

The Kuching Zone enjoys the most well-developed and comprehensive electricity grid systems in Sarawak, with the latest addition being the Tondong EHV substation in 2022 at the city's western end. Besides providing an additional power injection point for Kuching city, this substation shall raise the capacity and improve the reliability of electricity supply to customers in the Bau and Lundu areas. Besides Tondong substation, Sarawak Energy has also implemented six other system reinforcement projects at Bau and Lundu, as summarised in Table 3.

Table 3: Recently completed system reinforcement projects in Bau and Lundu

No.	Projects	Completed	Cost (RM 'mil.)
1	To lay 12km single circuit 1C/630mm^2/Al cable from BTK 33kV to P.89, Siniawan	2016	4.7
2	To establish connection between Bau Line 1 and Line 2 – Lundu Line 1 and Line 2 via 33kV 3C/240mm2/Al cable	2017	0.11
3	To install one set of three (3) units 33kV 200Amp voltage regulator on Bau-Lundu Line 2	2018	0.71
4	To extend Batu Kitang-Siniawan 1C/630mm^2/Al cable to Bau 33/11kV Substation	2021	4.64
5	275kV Transmission Line turning the existing Mambong-Matang into Tondong Substation	2022	61.0
6	Tondong 275kV (future 500/275kV) Substation (2 x 240MVA)	2022	216.0
7	To lay double circuit 1C/630mm^2/Al from Tondong 275/132/33kV to Bau 33/11kV Substation	2022	10.1
Total			**297.26**

It was forecasted that by 2023, the grids at the Bau and Lundu areas will face major system constraints due to increasing demand from existing and new customers. Hence, system reinforcement works have been focused at these two areas since 2016, and Sarawak Energy has implemented seven projects amounting to RM297 million to relieve system constraints.

Lundu, Sematan and the surrounding areas have recorded a peak load of approximately 11.5MW in 2021 and this is expected to increase further at an average growth rate of 3.0% per annum from various commercial developments at the Lundu – Sematan coastal area. In addition, load demand is expected to increase in the near future following the construction of the Pan Borneo Highway improving access to Lundu, new RES connections to rural areas including Telok Melano and the operation of the new Lundu CENTEXS Training Centre. Further to this, the State Government's initiative to develop the tourism industry under the Masterplan for the Development of Lundu – Sematan Coastal Area (2014 – 2030) has forecasted a load demand of up to 12.3MW by 2030.

As Lundu is supplied through a 33kV long line from Bau and subsequently to Sematan, there is a need to construct another power injection or source to support current networks and cater for future development. Thus, EHV and MV substations with transmission and distribution lines from the Tondong substation are being planned to improve system reliability and electricity quality in the

surrounding areas. Under Sarawak Energy's plan, seven projects amounting to RM427 million are being planned to improve the system as tabulated in Table 4.

Table 4: List of projects to be constructed by Sarawak Energy in Bau and Lundu

No.	Name	Implementation Year	Cost (RM 'mil.)
1	33kV CBs extension at Bau 33/11kV & Lundu 33/11kV Substations	2021	4.63
2	Capbank installation at Lundu 33/11kV (0.5MVAR) Substation	2022	0.05
3	33kV 2nd Source from Lundu -Sematan	2023	0.68
4	Tondong – Lundu 33kV Line	2022	77.9
5	Siniawan 33/11kV Substation	2024	18.0
6	Tondong – Lundu 132kV Tower Line	Beyond 2030	210.0
7	Lundu 132/33kV Substation	Beyond 2030	115.7
Total			**426.96**

Meanwhile, there are three projects totalling RM66 million being proposed under the REDM for the Kuching Zone, as listed in Table 5 below.

Table 5: List of rural electricity projects proposed under REDM for Kuching

No.	Name	Implementation Year	Cost (RM 'mil.)
1	33kV Covered Conductor Lines from Lundu to Sematan	2030	28.0
2	Sematan 33/11kV Substation	2030	18.0
3	Last Miles Renewal & Expansion	By 2030	20.0
Total			**66.0**

6.1.1 33kV Covered Conductor Lines from Lundu to Sematan

This project will connect the proposed Sematan 33/11kV Substation to the Lundu 132/33kV Substation. The proposed overhead line construction shall be a double circuit covered conductor with an estimated length of 35km. Figure 5 shows the location of the proposed Sematan 33/11kV Substation as well as the 33kV Covered Conductor Lines from Lundu to Sematan.

Figure 5: Location of Sematan 33kV Substation and 33kV Covered Conductor Lines from Lundu to Sematan.

6.1.2 Sematan 33/11kV Substation

The Sematan 33/11kV Substation is a proposed system reinforcement project to support expected new developments around the Sematan, Telok Melano and Tanjung Datu areas. In the long term, the load demand in the Sematan area is expected to further increase with the development of tourist activities and resorts. Additionally, there is potential to expand the line from Telok Melano to Temajuk, an Indonesian village located near the border. Moreover, with the implementation of this substation, it is possible to further extend the existing line at Sajingan, Kalimantan. The proposed source for this substation shall be the proposed Lundu 132/33kV Substation.

6.1.3 Last Miles Renewal and Expansion in Bau and Lundu

The RES systems at Bau and Lundu are among the oldest in Sarawak. With aging equipment and load growth, it is necessary to replace or upgrade a significant portion of these lines and equipment. It is proposed to allocate RM20 million for the implementation of renewal and expansion projects here.

6.2 Samarahan Zone

At present, Kota Samarahan, along with Asajaya, Sadong Jaya and part of the Simunjan area, including Sebuyau and Sebangan, are all supplied by the Entingan EHV Substation. Asajaya is expected to have higher load growth in the next 10 years resulting from the completion of a bridge linking Kota Samarahan and Simunjan, bringing development to the area. Under long-term planning, it is proposed to build an EHV substation to cater for the load growth at Asajaya as well as network expansion in the Sebangan and Simunjan areas. Sarawak Energy's recently completed and committed future projects are listed in Table 6 and Table 7 below.

Table 6: Recently completed system reinforcement projects in Samarahan

No.	Projects	Completed	Cost (RM 'mil.)
1	To install one set of three (3) units 33kV 200Amp voltage regulator on KSB – Sebuyau line	2017	0.02

2	To lay double circuit 1C/630mm2/Al cable from Entinggan 33/11kV to KSB 33/11kV Substation	2018	3.30
3	Asajaya 33/11kV Substation	2021	12.93
Total			**16.25**

Table 7: List of projects to be constructed by Sarawak Energy in Samarahan

No.	Name	Implementation Year	Cost (RM 'mil.)
1	33kV Underground Cable from MID 33/11kV Substation to Asajaya 33/11kV Substation	2022	20.10
2	Technology Park – Asajaya 132kV Transmission Line	Beyond 2030	125.90
3	Asajaya 132/33kV Substation	Beyond 2030	86.70
Total			**232.70**

At the same time, it is anticipated that there will be new developments surrounding the Sebuyau area once the second trunk road connecting Lingga and Sebuyau is completed by 2025. In view of this, it is proposed that a power line to Sebuyau be constructed through the Sri Aman/Lingga substation as a supporting source since the existing Sebuyau/Sebangan source is supplied via a long 33kV line, approximately 60km from Entinggan. In addition, the 33kV substation at Sebuyau needs to be reorganised and improve the quality of the existing 11kV network by uprating it to 33kV to meet new load demands in the vicinity. For the Samarahan zone, there are a total of four projects with an estimated cost of RM63 million being proposed under REDM, as listed in Table 8 and described below.

Table 8: List of rural electricity projects proposed under REDM for Samarahan

No.	Name	Implementation Year	Cost (RM 'mil.)
1	New Sebuyau 33/11kV Substation	2025	18.00
2	33kV Covered Conductor Lines from Lingga to Sebuyau	2025	24.00
3	Last Miles Renewal and Expansion	By 2030	20.00
4	Renewal or grid transition of SARES systems	By 2030	1.40
Total			**63.40**

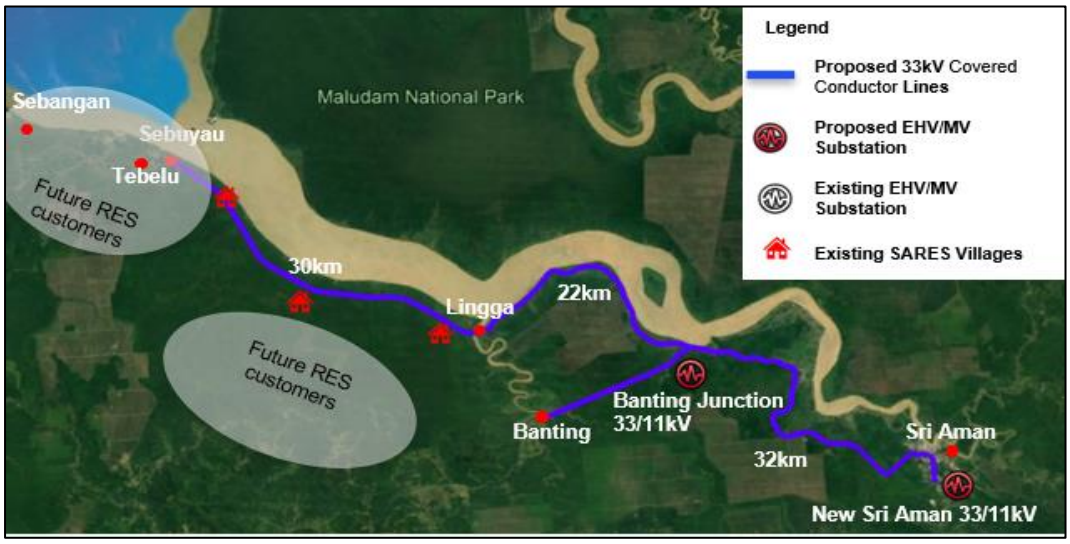
6.2.1 33kV Covered Conductor Lines from Lingga to Sebuyau

Customers in the Sebuyau area are supplied through a spur line from Sebuyau 5MVA 33/11kV substation and Tebelu 2.5MVA 33/11kV where the source is taken from a long overhead line from Entingan EHV substation that is approximately 60km long.

With the ongoing plan to construct a second trunk road from Sebuyau town to Lingga before 2025, it is foreseen that there will be significant economic growth in the Sebuyau and Lingga areas. In anticipation of associated demand growth, it is proposed to upgrade the Sebuyau distribution system by constructing a new 33kV source via double circuit covered conductor lines as a contingency. The 33kV grid extension will continue from the proposed Sri Aman-Lingga double circuit lines (*refer to 7.41*

33kV Covered Conductor Lines from Sri Aman to Lingga and Banting). The reinforcement plan also aims to extend the grid to several SARES villages and any future RES customers along the second trunk road. The 33kV covered conductor lines will be installed from Lingga and subsequently, to the new Sebuyau 33/11kV substation.

Figure 6: Extension of 33kV Covered Conductor Lines from Lingga to Sebuyau Along the Second Trunk Road



6.2.2 New Sebuyau 33/11kV Substation

A full-fledged 33/11kV substation is proposed at Sebuyau in conjunction with the proposed 33kV Covered Conductor Lines from Lingga to Sebuyau to provide a new injection and reinforce the supply to rural areas at Sebuyau, Tebelu and Sebangan. The proposed substation is equipped with 10/15MVA transformers and is to be fed by the proposed 33kV Lingga-Sebuyau line.

6.2.3 Last Miles Renewal and Expansion in Samarahan

The RES systems in Samarahan are relatively old compared to other areas. With aging facilities and load growth, it is necessary to replace or upgrade a significant portion of these lines and equipment. It is proposed to allocate RM20 million for implementing renewal and expansion projects.

6.2.4 Renewal and Equipment Replacement of SARES systems in Samarahan

In Samarahan, there are two villages with 19 households supplied by the SARES solar scheme. The projects were implemented in stages from 2021 until 2022. The battery shall be due for replacement in 2026, with an estimated cost of RM400,000.

In the longer term, these two villages will be connected to the grid via the proposed 33kV Covered Conductor Lines from Lingga to Sebuyau. The cost of connection is estimated at RM1 million.

6.3 Serian Zone

Serian town is currently supplied via an 18-year-old, 20-km long double circuit 33kV tower lines from Mambong EHV substation, and there have been no major grid developments in recent years. However, many RES projects were completed six years ago, supplying 24-hour electricity to all villages in the division and surrounding districts. Nevertheless, Sarawak Energy recently completed two projects as listed in Table 9. In addition, Sarawak Energy is planning to implement seven more projects, amounting close to RM250 million, in the coming years as tabulated in Table 10.

Table 9: Recently completed system reinforcement projects at Serian

No.	Projects	Completed	Cost (RM 'mil.)
1	To optimise the capacity of existing double circuit Mambong-Serian tower lines by replacing the existing OAK OHL, replacing the underrated 33kV cable link to substation via 33kV 1C 630mm^2 Al. Cable	2018	1.28
2	Conversion of Serian 33/11kV to indoor substation	2019	9.39
Total			**10.67**

Table 10: List of projects to be constructed by Sarawak Energy in Serian

No.	Name	Implementation Year	Cost (RM 'mil.)
1	Siburan 33/11kV Substation	2022	16.70
2	To lay 33kV single circuit 3C/240mm^2/Al cable from Serian to Gedong Junction	2022	2.90
3	To lay 33kV single circuit 3C/240mm^2/Al cable from Serian to Tebakang	2021	3.60
4	Serian 3MVAr Capbank installation	2023	0.05
5	Serian 275/33kV Substation	2024	178.40
6	Gedong Junction 33/11kV Substation	2026	25.00
7	Baki 33/11kV Substation	2026	18.00
Total			**244.65**

Meanwhile, three projects are proposed under the REDM at a total cost of RM78 million as listed in Table 11 and described below.

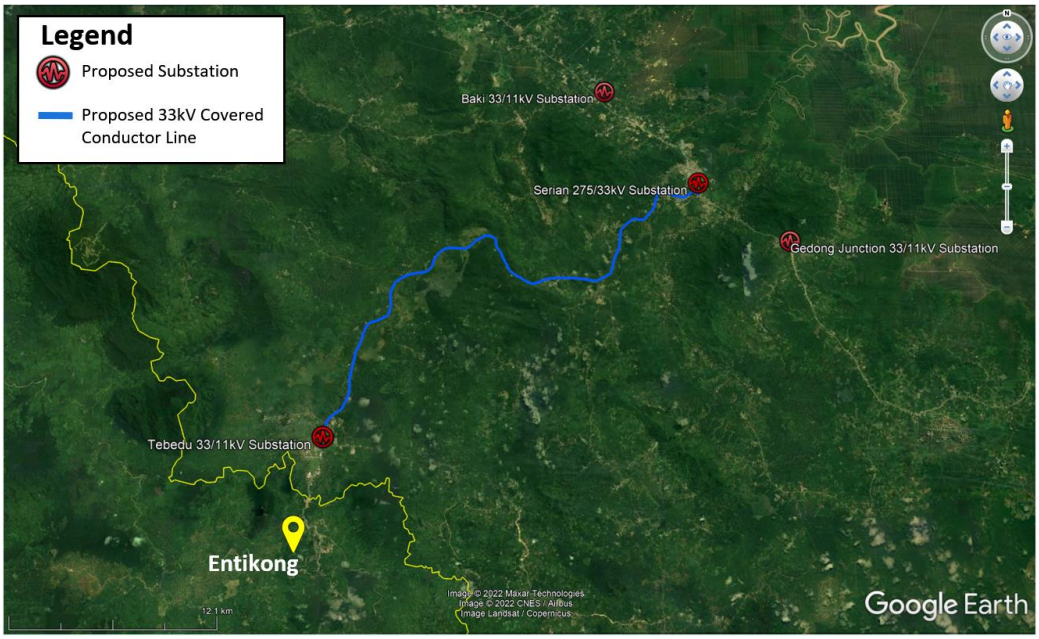
Table 11: List of projects to be proposed under REDM in Serian

No.	Name	Implementation Year	Cost (RM 'mil.)
1	33kV Covered Conductor Lines from Serian to Tebedu	Beyond 2030	40.00
2	Tebedu 33/11kV Substation	Beyond 2030	18.00
3	Last Miles Renewal and Expansion	By 2030	20.00
Total			**78.00**

6.3.1 33kV Covered Conductor Lines from Serian to Tebedu

The proposed 33kV Covered Conductor Lines from Serian to Tebedu are intended to connect the proposed Tebedu 33/11kV Substation with Serian 275/33kV Substation. The line length is about 50km, and it will be constructed as double circuit covered conductor with a provision to maintain one circuit as a clean circuit without any tee-off connection. Figure 7 below shows the proposed line route for the 33kV covered conductor lines from Serian to Tebedu.

Figure 7: Location of 33kV Covered Conductor Lines from Serian to Tebedu and Tebedu 33/11kV Substation



6.3.2 Tebedu 33/11kV Substation

The Tebedu 33/11kV Substation is proposed under the long-term plan to cater for load growth at the Tebedu area and also meet the new load expected from the development of Tebedu Industrial Estate under the Ministry of Industrial Development (MID). Additionally, there is potential to further expand the existing line at Entikong. The source for this substation will be from the proposed Serian 275/33kV Substation.

6.3.3 Last Miles Renewal and Expansion in Serian

The RES systems in Serian are relatively old compared to other areas. Hence, with aging facilities and load growth, it is necessary to replace or upgrade a significant portion of these lines and equipment. It is proposed to allocate RM20 million for the implementation of renewal and expansion projects.

6.4 Sri Aman Zone

A key event in the Sri Aman Zone is the commissioning of the Serudit EHV substation which will overcome the overcrowding issue at the Lachau and Engkilili EHV substations. There have been several distribution substations constructed over the years as well as EHV and MV power lines via overhead lines and underground cables, enabling the distribution network at Sri Aman to be reorganised to

increase system capacity and enhance system reliability. These efforts will be continued to provide quality electricity supply to meet existing demand and cater to new developments in Sri Aman.

Currently, there are two bulk power injection points supporting the Sri Aman network system: Engkilili EHV substation and Lachau EHV substation. Engkilili EHV substation supplies Sri Aman town, Temudok and Lubok Antu. Lachau EHV substation supplies Lachau town, Pantu, Jaong and part of Balai Ringin. The newly commissioned Serudit EHV substation will also be supporting Sri Aman through the double circuit 132kV lines (energised at 33kV) to the Sri Aman 33/11kV substation, which is under construction and expected to be completed by 2023.

One of the system constraints identified for the Sri Aman network is the heavily overloaded 33kV distribution lines from Engkilili EHV substation to Temudok 33/11kV substation, which feeds Sri Aman as well as customers along the lines including rural areas. The highest demand was recorded at 18.6MW or 121.5% of the conductor's capacity in 2021, which presented a high risk of total blackout for all of Sri Aman. As a temporary mitigation solution, new double circuit 33kV lines from the Lachau EHV substation through Selepong are being constructed to relieve some loads from the Engkilili-Temudok 33kV network, which is expected to be ready by 2022/2023. Concurrently, double circuit 132kV lines (energised at 33kV) from the Serudit EHV substation to Sri Aman 33kV substation are being constructed as a permanent long-term solution and are expected to be in service by 2023. The reinforcement projects will be able to cater to demands for other commercial developments. Table 12 and Table 13 list the reinforcement projects completed since 2015 as well as planned projects until 2030 by Sarawak Energy for the Sri Aman Zone.

Table 12: Recently completed system reinforcement projects at Sri Aman

No.	Projects	Completed	Cost (RM 'mil.)
1	Construction of 33kV line from Engkilili 275/33kV to Sri Aman 33/11kV substation	2017	1.30
2	To lay 240mm^2/3C/AL/XLPE cable from Temudok 33kV to Sri Aman 33kV substation	2018	2.36
3	Conversion of Temudok 33/11kV outdoor into indoor substation	2019	8.40
4	Load re-organisation for Temudok 33/11kV	2019	1.54
5	33kV 240mm^2 underground cable from Saratok 33kV indoor substation to link with Saratok Pusa Line 2 at Saratok Junction	2019	0.97
6	Upgrading Bait Ili 2.5MVA 33/11kV transformer to 5MVA	2020	0.49
7	Lachau 275/33kV 2nd Transformer (1 x 30MVA)	2021	18.00
8	33kV overhead line from Lachau EHV Substation to Temudok 33/11kV Substation	2022	6.90
Total			**39.96**

Table 13: List of projects to be constructed by Sarawak Energy in Sri Aman

No.	Projects	Implementation Year	Cost (RM 'mil.)
1	Laying double circuit of 10km 630mm^2/CU/XLPE cable from Sri Aman EHV to Sri Aman 33/11kV substation	2021	24.30
2	Serudit-Sri Aman 132kV double circuit Transmission Lines (2 x 250MVA, 45km) (future Sri Aman EHV – energised at 33kV)	2021	111.00
3	CB extension at Sri Aman 33/11kV substation	2023	1.30
4	Installation of 5MVA transformer at Sri Aman 33/11kV substation	2024	0.60
5	Sri Aman 132/33kV substation (2 x 120MVA) Serudit – Sri Aman 33kV energised to 132kV transmission line (2 x 250MVA, 45km) Serudit 132kV substation extension (2 Bays)	2027	123.00
Total			**260.2**

Located in the northwest of Sri Aman, Lingga and Banting are rural areas under the REDM. Lingga is a small rural town, currently supplied via a 52km long, 11kV overhead line from the Sri Aman 33/11kV Substation while Banting is a cluster of 10 off-grid longhouses currently supplied by a Sarawak Energy diesel power station. Under the REDM, it is proposed to extend the 33kV system from Sri Aman to improve system reliability while simultaneously catering to new demands along the lines to Lingga and connecting Banting to the grid. A new substation has been proposed at Sri Aman to cater to the new lines to Lingga and Banting. This will also support the distribution network reorganisation and reinforcement projects in the vicinity, especially after the incoming lines from Serudit EHV are in service. Besides that, a substation at the Banting junction is also proposed to strengthen supply to both areas and support the 33kV grid's further expansion to Sebuyau.

Rural areas and villages at Lachau, Batu Lintang and Lubok Antu also require attention to upgrade the electricity supply infrastructure to support local economic growth as well as the expansion of other utilities, such as rural water supply. Under the conceptual plan, there are two reinforcement projects proposed at Lubok Antu. The first proposed project is to extend the 33kV grid to Batang Ai and Ulu Ai along the Sarawak-Kalimantan Border, namely Border Road Segment 3, which is under the Sarawak Border Security Road Programme, to longhouses currently supplied via SARES schemes. There is also a distribution substation proposed in Lubok Antu to provide sufficient supply capacity to extend the local distribution network, support new RES customers and increase the capacity of the cross-border electricity supply connection to Badau, Kalimantan as requested in a new application submitted by Perusahaan Listrik Negara (PLN). There are a total of seven projects amounting to RM189 million being proposed under the REDM as tabulated below.

Table 14: List of projects to be proposed under REDM in Sri Aman

No.	Name	Implementation Year	Cost (RM 'mil.)
1	33kV Covered Conductor Lines from Sri Aman to Lingga and Banting	2023	59.70
2	New Sri Aman 33/11kV Substation	2024	25.00
3	Banting Junction 33/11kV Substation	2024	18.00
4	Last Miles Renewal and Expansion	By 2030	20.00
5	Renewal and Grid Transition for SARES / Hybrid	By 2030	29.00
6	Batang Ai Junction 33/11kV Substation	Beyond 2030	18.00
7	33kV Line from Lubok Antu to Ulu Ai	Beyond 2030	19.00
Total			**188.70**

6.4.1 33kV Covered Conductor Lines from Sri Aman to Lingga and Banting

Electricity at Lingga is currently supplied from the Sri Aman 33/11kV substation via a 52km single circuit 11kV overhead line, while Banting currently depends on a Sarawak Energy diesel power station. New 33kV covered conductor lines are proposed for Lingga and Banting for the following reasons:

a) To upgrade the current 11kV supply network in Stumbin, Bakong and Lingga while providing a N-1 contingency. The new 33kV line also enables the expansion of distribution infrastructure further into remote areas as well as the connection of nearby SARES customers to the grid.

b) To connect 10 longhouses and a school at Banting to the 33kV grid and further expand coverage to SARES customers in the Pantu and Banting areas.

The current loading at both Lingga and Banting primarily comprises village households, schools and small-scale businesses. Therefore, a 33/11kV 5MVA Auto Recloser (AR)-controlled substation is proposed at each area.

The proposed 33kV double circuit covered conductor lines will be supplied from a new 33/11kV substation in Sri Aman and extended to the proposed 33/11kV substation at the Banting Junction. Subsequently, the double circuit lines shall continue to Lingga, in consideration of future expansion to Sebuyau (*refer to 7.2.1 33kV Covered Conductor Lines from Lingga to Sebuyau*) while a single-circuit line shall be extended to Banting. The line route of the proposed 33kV covered conductor lines from Sri Aman to Lingga will be via the existing road or Second Trunk Road. On the other hand, access to Banting will be through a new road currently under construction from Bukit Balau to Banting, which is expected to be ready by 2023.

Figure 8: Proposed Cable Route for Double and Single Circuit Covered Conductor to Lingga and Banting Area

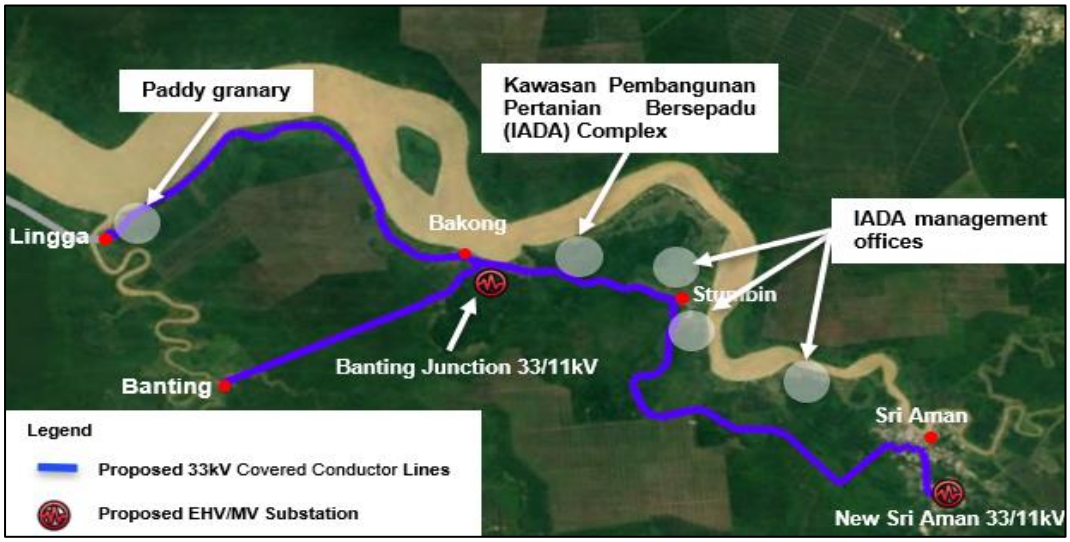
6.4.2 New Sri Aman 33/11kV Substation

There is no 33kV Circuit Breaker (CB) available in the existing Sri Aman 33/11kV substation for the proposed double circuit 33kV covered conductor lines from Sri Aman to Lingga and Banting. Due to space constraints in existing substations, switchgear extension is not possible. Thus, it is proposed to construct a new full-fledged 33/11kV substation in Sri Aman to feed the 33kV feeder lines to RES customers and future RES development.

6.4.3 Banting Junction 33/11kV Substation

A new 33/11kV substation is required at the Banting junction in line with the proposed 33kV covered conductor line from Sri Aman to further expand coverage to Lingga and Banting. In addition, the new substation will improve the system reliability by providing N-1 contingency for the existing 11kV system. In addition, the proposed infrastructure shall also support the Ministry of Agriculture and Food Industries (MAFI) in their development of paddy granaries and supply its management offices at Lingga, Bakong, Stumbin and Sri Aman with an estimated load demand of 9MVA. The current distribution network will not be able to cater to these new developments due to the limited line capacity and expected voltage drop when a large quantum of load is connected to the line. Hence, a full-fledged 33/11kV substation equipped with 10/15MVA transformers is proposed to be installed at the Banting junction.

Figure 9: To Propose a New 33/11kV substation at Banting Junction



6.4.4 33kV Normal Overhead Line from Lubok Antu to Ulu Ai

Under the Sarawak Border Security Road Programme, there is a proposal to extend the road from Lubok Antu passing through Batang Ai and Ulu Ai along the Sarawak-Kalimantan Border, namely Border Road Segment 3. There are four longhouses supplied via SARES schemes located along the proposed road. It is proposed to develop a 33kV overhead line to connect said longhouses to the grid, subject to road availability. In addition, the proposed infrastructure may also provide a second source for RES customers in Lubok Antu, Batang Ai and Ulu Ai.

Figure 10: Extension of 33kV Normal Overhead Line to Ulu Ai Along the Border Road Segment 3

6.4.5 Batang Ai Junction 33/11kV Substation

The existing Lubok Antu mini substation is equipped with one 5MVA Auto Recloser (AR)-controlled circuit breaker to supply Lubok Antu area and Badau, Kalimantan. Currently, there is a new application

submitted by Perusahaan Listrik Negara (PLN), requesting to increase the existing supply capacity to the Badau-Batu Kaya Interconnection. However, there are no 33kV circuit breakers (CBs) available for future extension.

Therefore, it is proposed to construct a new full-fledged 33/11kV substation equipped with two 10/15MVA transformers to provide sufficient supply capacity to extend the local distribution network, support rural customers, and provide a cross-border electricity supply connection to Badau, Kalimantan. The transformers' rating can be upgraded, subject to development and customer requirements.

Figure 11: The location of the new 33/11kV substation is proposed to be at the Batang Ai Junction

6.4.6 Last Miles Renewal and Expansion in Sri Aman

The RES systems in Sri Aman are relatively mature. Hence, with aging facilities and load growth, it is necessary to replace or upgrade a significant portion of these lines and equipment. It is proposed to allocate RM20 million for the implementation of renewal and expansion projects.

6.4.7 Renewal and Grid Transition for SARES / Hybrid in Sri Aman

In the Sri Aman zone, there are 21 villages with 314 households utilising SARES schemes that were energised from 2016 until 2022. There are also three solar hybrid stations, namely at Rh Dau, Nanga Menjuau; Ulu Skrang; and Nanga Delok, Lubok Antu. These stations were commissioned between the 2015 to 2019.

One village in the Sebuyau/Lingga cluster has been identified as being possibly grid-connectable via the proposed 33kV Covered Conductor Lines from Lingga to Sebuyau, which is planned to be constructed along the proposed Second Trunk Road Package B, stretching along Sebuyau, Lingga, Sri Aman and Betong.

Out of five villages under the Pantu/Banting cluster, Rh Jacob Bedindang has been identified for possible connection to the grid. This is subject to the availability of a feeder road from Bukit Balau to

Banting whereas the remaining four villages are not accessible by road and do not have road plans at this moment. If a road is built in the future, it is possible to connect these villages by extending the overhead line from the proposed Sri Aman to the Banting 33kV covered conductor line. Alternatively, they can be connected by extending the existing overhead line from Kampung Semulong.

SARES villages in the Ulu Skrang cluster are mostly accessible by gravel or logging roads and it is possible to connect them to the grid by extending the existing overhead line from the Murat Junction. However, the existing road condition needs to be assessed before proceeding with project implementation. Currently, there is no road plan in this area. Rh Bandang was connected to the grid in 2020. Whereas Rh Gait and Rh Balisan will be connected under Last Mile project under *Projek Rakyat*. The remaining seven villages will be gradually connected to the grid by 2030.

Meanwhile, five SARES villages and four corporate social responsibility (CSR) solar villages under the Ulu Ai/Ulu Engkari cluster are currently inaccessible but there is a proposed road project, the Sarawak Border Security Road Programme, in place. If this project is implemented in the future, it is possible that the road will be further extended to other villages in this cluster and the extension of the 33kV normal overhead line from Lubok Antu becomes possible.

The grid transition of Rh Dau Solar Hybrid Station can be completed by 2025 at an estimated cost of RM5.3 million. Nanga Menjuau Solar Hybrid Station is accessible by road and the possibility of a grid connection to these stations seems possible but will need further assessment of the access road's condition. For Nanga Delok Solar Hybrid Station, the possibility of grid connection depends on whether a feeder road is included in the proposed road under the Sarawak Border Security Road Programme.

In total, 13 villages with 189 households in Sri Aman have been identified as grid-connectable by 2030. The cost of these connections is estimated at RM15 million. Eight villages with 125 households will need to depend on SARES schemes for their long-term electricity supply. Until the grid reaches these villages, the solar systems will need proper maintenance – including battery replacement – to ensure continuous and reliable electricity supply. Battery replacement costs for villages with the SARES scheme implemented in Sri Aman is estimated at RM6.4 million, while battery replacement for solar hybrid stations is estimated at RM2.3 million.

6.5 Betong Zone

A key development in the Betong Zone is the commissioning of the Serudit 275kV substation enabling the distribution network at Betong, Tanu, Spaoh, Debak and Pusa to be reorganised, increasing system capacity and enhancing system reliability. Other areas like Roban, Kabong, and Saratok are still supplied via a long 33kV line from the Sarikei EHV substation and will be supplied by the new Serudit EHV substation, scheduled for completion tentatively by 2025. Table 15 and Table 16 show seven completed and seven ongoing or planned reinforcement projects by Sarawak Energy in Betong.

Table 15: Recently completed system reinforcement projects at Betong

No.	Projects	Completed	Cost (RM 'mil.)
1	Construction of 2nd 33kV line from Roban Junction to Roban and Kabong	2018	5.45

2	Construction of 2nd 33kV overhead line from Pusa junction to Saratok 33/11kV substation	2019	2.48
3	Serudit 275/132/33kV substation (2 x 240MVA)	2020	114.00
4	Serudit 275kV Line Turn-in	2020	7.00
5	Construction of Jungkong (Betong Town) 33/11kV substation	2021	11.80
6	Load reorganization for Jungkong 33/11kV substation	2021	1.40
7	Laying double circuit of 630mm^2/Al/XLPE cable from Serudit EHV to Jungkong 33/11kV substation	2022	16.30
Total			**158.43**

Table 16: List of projects to be constructed by Sarawak Energy in Betong

No.	Projects	Implementation Year	Cost (RM 'mil.)
1	New Pusa 33/11kV Substation	2021	13.50
2	Load organisation for Pusa 33/11kV substation	2022	0.54
3	Upgrading of existing transformer to 10/15MVA at Saratok 33/11kV substation	2024	3.80
4	CB extension at Saratok 33/11kV substation	2025	2.50
5	CB extension at Serudit 275/132 33/kV substation	2025	1.30
6	33kV tower line from Serudit EHV to Saratok 33/11kV Substation	2027	52.60
7	Construction of Kabong mini substation	2028	10.00
Total			**84.24**

Although the source of supply will be diverted to the Serudit EHV substation, it is foreseen that the downstream areas of Roban and Pusa will experience low voltage during peak load due to the long overhead lines and the addition of new RES customers. Therefore, two 33kV switching substations are proposed at the junction of each area to improve the voltage profile as well as to cater to new demand from the surrounding areas.

In addition, existing electricity infrastructure for rural areas and villages at Kabong, Pusa, Roban and Saratok require upgrading to power local economic growth and enable the expansion of other utilities, such as rural water supply. Three projects are proposed under the REDM with an estimated cost of RM56 million as shown in the table below.

Table 17: List of projects proposed under REDM in Betong

No.	Name	Implementation Year	Cost (RM 'mil.)
1	Roban Junction 33kV Substation	2026	18.00
2	New Pusa Junction 33kV Substation	2026	18.00
3	Last Miles Renewal and Expansion	2030	20.00
Total			**56.00**

6.5.1 Roban Junction 33kV Substation

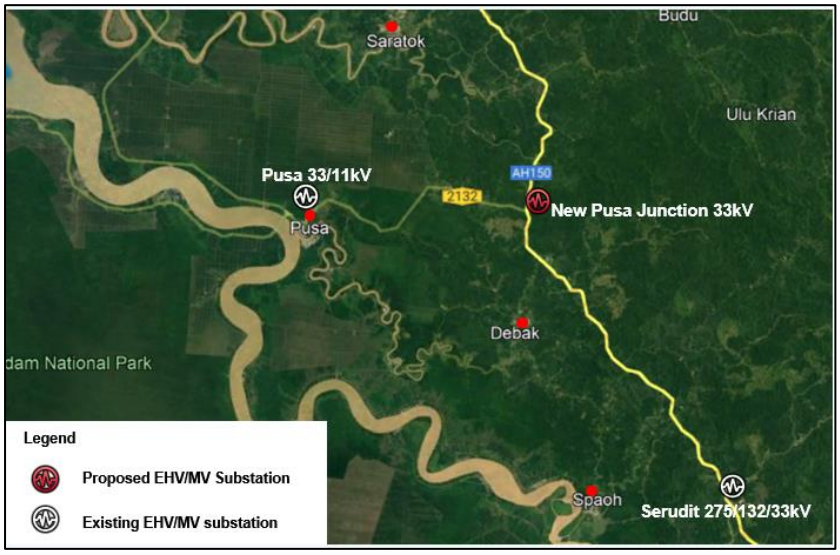
Currently, the Roban area is supplied by the Sarikei EHV Substation via a 5MVA 33/11kV Auto Recloser (AR)-controlled substation. After the commissioning of the 33kV double circuit lines from Serudit EHV substation to Saratok 33/11kV substation by 2025, Roban and Kabong's source of supply will be diverted to the Serudit EHV substation. Due to the long overhead line to Roban and Kabong, it is proposed to construct a switching substation at the Roban junction to improve system reliability and cater to rural customers in the vicinity.

Figure 12: Roban Junction 33kV Substation is proposed due to Long Overhead Line Supplies to Roban and Kabong from the source, Serudit EHV

6.5.2 New Pusa Junction 33kV Substation

Due to a long overhead line of more than 20km from the Serudit EHV substation to Pusa and its interior, a switching substation is proposed at the Pusa junction to improve supply reliability to the rural customers there. The location of the proposed New Pusa Junction 33kV Substation is shown in Figure 13.

Figure 13: A Switching Substation is proposed at the Pusa Junction



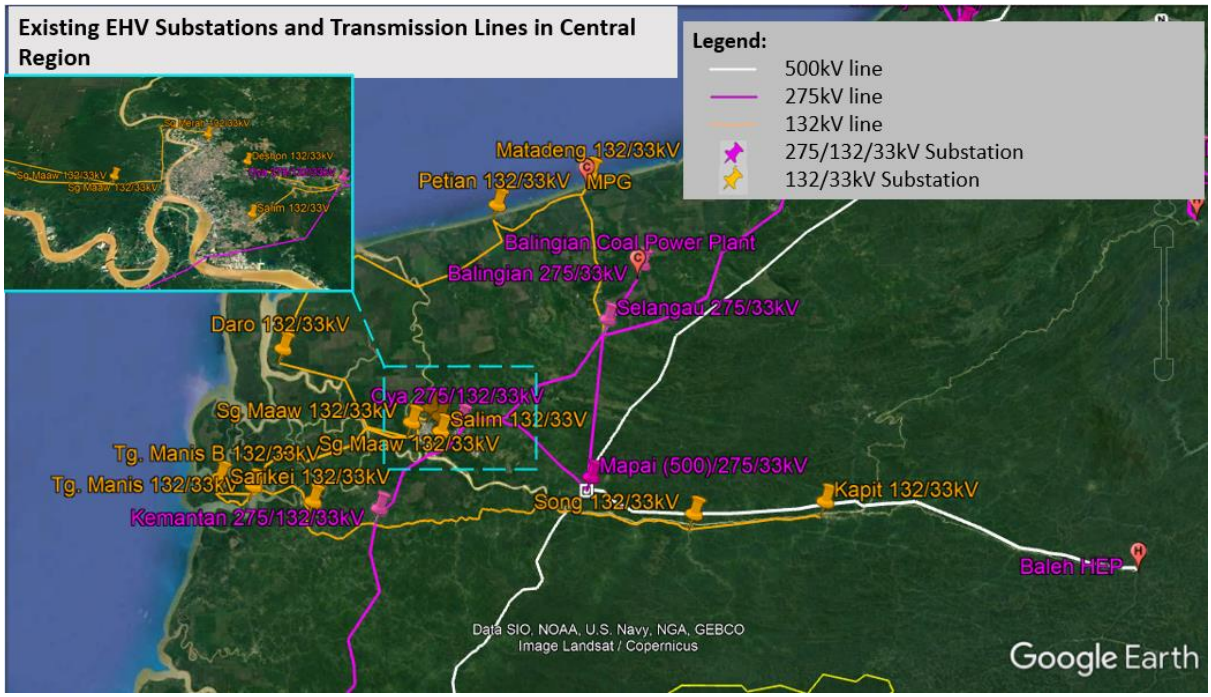
6.5.3 Last Miles Renewal and Expansion in Betong

The RES systems in Betong are relatively mature. With aging facilities and load growth, it is necessary to replace or upgrade a significant portion of these lines and equipment. It is proposed to allocate RM20 million for the implementation of renewal and expansion projects.

7 CENTRAL REGION

The Central Region can be further divided into the four zones of Sarikei, Sibu, Mukah and Kapit. There are a total of 16 EHV substations in this region, serving a total peak load of around 162.2MW in Sibu and 53.1MW in Sarikei, as recorded in 2021. The locations of the existing EHV substations and transmission lines in the Central Region are illustrated in Figure 14. In terms of network coverage, there are still some areas in Sarikei, Sibu, Mukah and Kapit which depend on off-grid systems. However, the ongoing implementation of Last Miles projects under *Projek Rakyat* is expected to cover all accessible areas by 2023 while SARES and Hybrid schemes shall be confined to a small number of inaccessible villages, mainly in the Song, Kapit and Bukit Mabong districts.

Figure 14: Existing EHV substations and transmission lines in Central Region



In recent years, a total of 51 projects were commissioned by Sarawak Energy across the four zones in the Central Region, benefitting rural customers by improving supply reliability and access. The investment cost is around RM1.6 billion. In addition, 18 more projects at an estimated total cost of about RM345 million are being planned by Sarawak Energy to further expand the transmission and distribution networks, which will also indirectly benefit the rural customers.

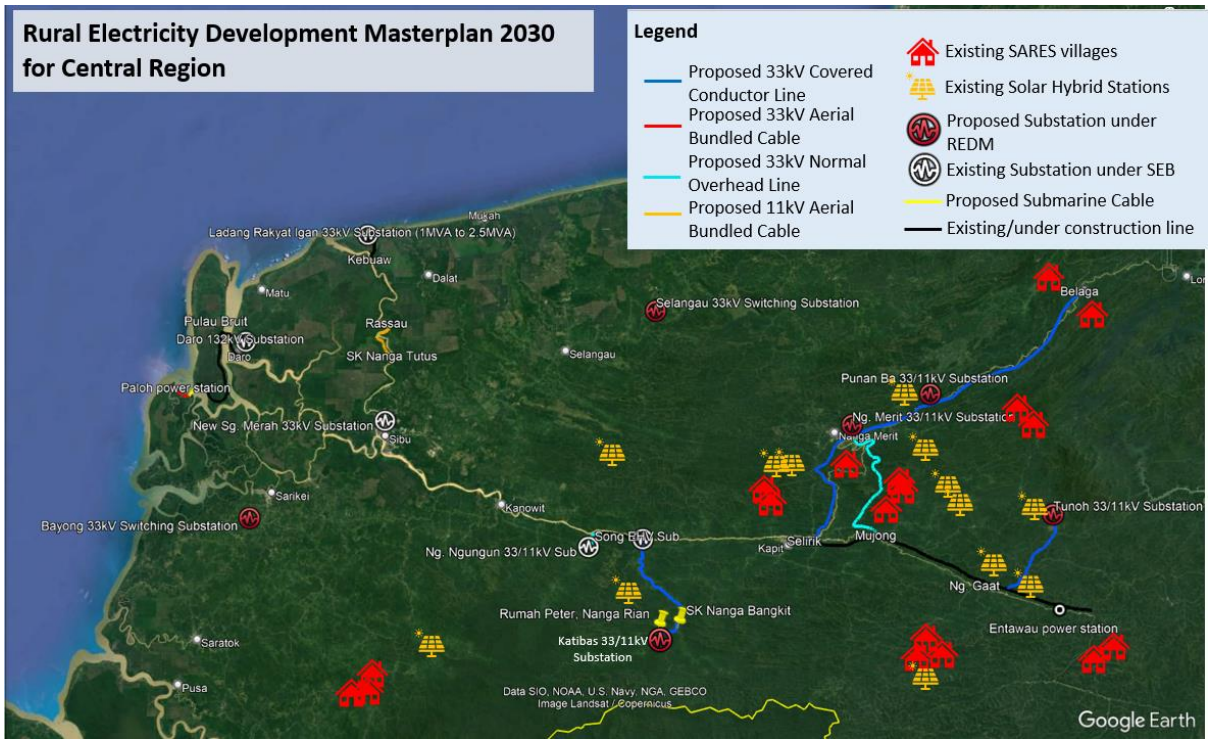
There have also been significant investments in the coastal grid, linking coastal areas from Mukah to Sarikei with generation sources in Mukah. Over RM600 million worth of transmission and distribution projects were commissioned recently, enabling grids to be extended to the most remote areas of Passin and Batang Lassa. In addition, significant investments in transmission systems were made to accommodate the new generation sources at Balingian and to connect the mega hydroelectric power projects in Bintulu to the Kuching load centre. Table 18 summarises the respective numbers and value of both completed and future projects as well as the proposed projects under the REDM.

Table 18: Completed and proposed projects for rural areas in Central Region

Zones	Recently commissioned Sarawak Energy projects that benefit rural customers		Ongoing/future Sarawak Energy projects that benefit rural customers		Proposed rural electricity system projects for REDM	
	Quantity	Value (RM 'mil)	Quantity	Value (RM 'mil)	Quantity	Value (RM 'mil)
Sibu	14	603.44	7	201.65	4	48.30
Sarikei	13	95.79	7	93.23	3	66.90
Mukah	17	658.16	2	11.96	5	27.20
Kapit	7	247.88	2	38.00	11	818.20
Total	**51**	**1605.27**	**18**	**344.84**	**23**	**960.60**

For the REDM, a total of 29 grid expansion and reinforcement projects are proposed for the Central Region as illustrated in Figure 15. The purpose and details of each project will be elaborated on, highlighting their relevance to the development needs of the rural electricity supply systems in Sarikei, Sibu, Mukah and Kapit.

Figure 15: Locations of Proposed Projects under Central Region



7.1 Sarikei Zone

The Sarikei distribution network is supported by four transmission substations, namely the Sarikei 132/33/11kV, Kemantan 275/132/33/11kV, Tanjung Manis 132/33/11kV and Tanjung Manis B 132/33kV substations. The system peak load for the Sarikei stations, including Tanjung Manis, in 2022 was 43.3MW. The Sarikei zone is anticipated to have continuous load growth at an average rate of 3.7% per annum over the study years.

Sarikei 132/33/11kV substation supplies up to 62% of Sarikei's load demand, which includes Nyelong, Sarikei town, the Sarikei Light Industry, Repok, Selalang, Bayong, Kabong, Saratok and Pusa junction. Conversely, the Kemantan 275/132/33/11kV substation supplies Bintangor town, Kelupu, Sungai Pasi, Meradong, Julau, Pakan and part of Paradom areas. The Tanjung Manis 132/33/11kV and Tanjung Manis B 132/33kV substations are supplying load demand from Tanjung Manis Industry, Shipbuilding, the Palm Oil Industrial Cluster (POIC); Selumit; Serdeng; Pulau Bruit; Rejang and Belawai.

The Kemantan 275kV Substation, being one of the injection points in Sarikei, has made it possible to supply more medium voltage substations since its extension and transformer upgrading project was completed in 2018. Hence, Pakan 33/11kV Substation implemented under *Projek Rakyat* in 2021, is supplied by the Kemantan 275kV Substation through 33kV Kemantan – Pakan 33kV Covered Conductor Line projects. Julau 33/11kV Substation was completed and sourced from Kanowit 132kV Substation through 33kV Kanowit – Julau Covered Conductor Line under *Projek Rakyat*.

The Julau 33/11kV and Pakan 33/11kV substations have been temporarily energised via the existing 33kV overhead line at the adjacent areas while waiting for the completion of the covered conductor lines and fibre optic projects for full commissioning. The supply reliability for both the Julau and Pakan areas are expected to improve with the completion of 33kV covered conductor lines from Kanowit and Kemantan respectively. The response time during outages will be improved with the establishment of the Supervisory Control and Data Acquisition (SCADA) monitoring system. In addition, the new substations will come with sufficient supply capacity to cater to new RES customers. The total investment project cost for all the self-funded zone substations and relevant network reorganisation works is about RM76.1 million.

Besides Kemantan 275kV Substation extension and transformer upgrading, Sarawak Energy has implemented 12 other system reinforcement projects in Sarikei, as summarised in Table 19.

Table 19: Recently completed system reinforcement projects in Sarikei

No.	Projects	Completed	Cost (RM 'mil.)
1	Feeder reorganisation at Kemantan 33/11kV Substation	2017	3.45
2	Laying of single circuit 240mm^2 3C/AL/ XLPE cable of 12km (from Sarikei 132/33/11kV Substation to Bayong Junction)	2017	2.00
3	Kemantan 275kV Substation Extension and Transformer Upgrading (2 x 240MVA)	2018	54.00
4	Construction of 2nd overhead line from Shipbuilding to Serdeng	2018	1.18
5	Install 5MVA 33/11kV transformer at Bakong/Meradong Junction	2018	0.43
6	Tanjung Manis 2 33/11kV Substation (within Extra High Voltage substation compound)	2019	19.30

7	Laying of double circuits 630mm^2 1C/ AL/XLPE cables from Sarikei 132/33/11kV Substation to Sarikei Town 33/11kV Substation, replacing the existing 2 x OAK wood pole lines	2019	5.88
8	Installation of new feeder for Belawai from Tanjung Manis B Substation	2019	0.10
9	Combination of two (2) TGM-TPZ1-TPZ2 monopole feeders and laying of single circuit 630mm^2 1C/CU/XLPE cable beneath the monopole	2020	3.18
10	Nyelong 33/11kV Substation	2020	1.25
11	Feeder reorganization at Bintangor 33/11kV Substation	2021	1.08
12	To lay double circuits of 240mm2 3C/AL/XLPE cables from Sarikei 132/33/11kV Substation to Sarikei Light Industry 33/11kV Substation	2022	3.56
13	Feeder reorganisation at Julau 33/11kV Substation	2022	0.38
Total			95.79

To cater for increasing load growth, the Sarikei Town 33/11kV substation is in progress. Similarly, the load growth from the various ongoing mixed developments at the Bintangor and Sungai Pasi areas have justified the construction of the Kelupu 33/11kV Substation to ensure sufficient supply capacity. The reconstruction of Sarikei 33/11kV, within the EHV substation compound, is critical due to the aging switchgears which will soon exceed the recommended asset economic life. Selalang 33/11kV and Sungai Pasi 33/11kV are also planned in the long-term to supply more customers with reliable electricity.

Under Sarawak Energy's plan, 7 projects amounting to around RM93 million are being planned to improve the system as tabulated in Table 20.

Table 20: List of projects to be constructed by Sarawak Energy in Sarikei

No.	Name	Implementation Year	Cost (RM 'mil.)
1	To construct 33kV aerial cable between Selalang and Sungai Pasir	2021	1.32
2	Reconstruction of Sarikei Town 33/11kV Substation	2019	2.79
3	Reconstruction of Sarikei 33/11kV (within Extra High Voltage substation compound)	2023	18.00
4	Relocation of high-tension overhead line at Paloh Station	2023	0.70
5	Construction of Kelupu 33/11kV Substation	2025	31.74
6	Construction of Selalang 33/11kV Substation	2028	20.00
7	Construction of Sungai Pasi 33/11kV Substation	2028	20.00
Total			93.23

Meanwhile, there are three projects totalling RM66.9 million being proposed under the REDM for the Sarikei Zone, as listed in Table 21.

Table 21: List of rural electricity projects proposed under REDM for Sarikei

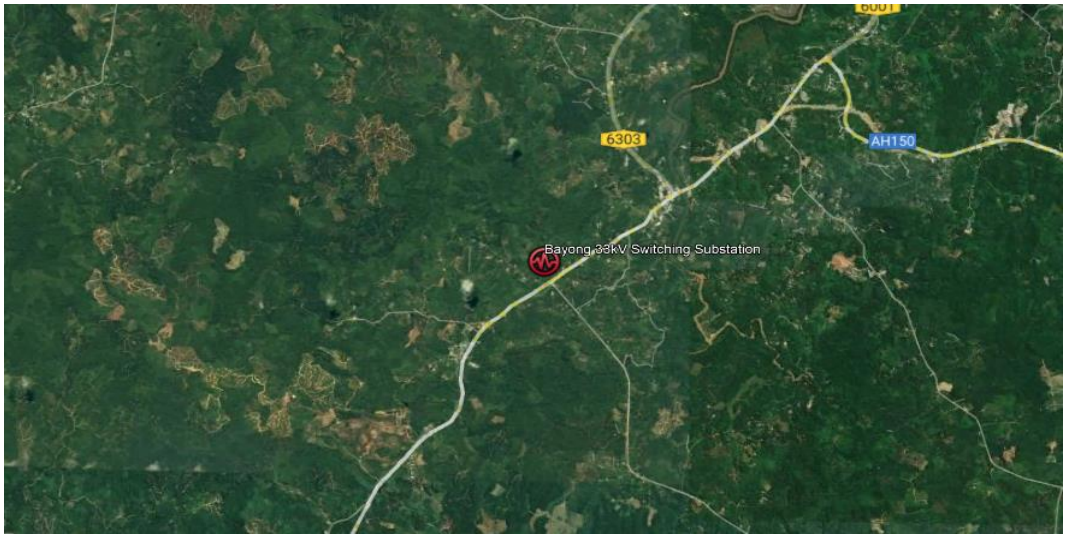
No.	Name	Implementation Year	Cost (RM 'mil.)
1	Bayong 33kV Switching Substation	2026	20.00
2	Last Miles Renewal & Expansion	By 2030	15.00
3	Renewal or grid transition of SARES and Hybrids systems	By 2030	31.90
Total			**66.90**

7.1.1 Bayong 33kV Switching Substation

Currently, Bayong, including the Bayong Waterwork, is supplied by the Sarikei 132/33/11kV Substation and backed-up by the 33kV overhead line feeder from the same substation.

It is proposed to construct a 33kV switching substation with a Supervisory Control and Data Acquisition (SCADA) & Communication (COMM) system at Bayong to improve the reliability of supply to the water treatment plant at the Roban, Kabong and Selalang areas. With this reinforcement, Selalang, Roban and Kabong will not be interrupted if one of the existing feeders to Bayong trips.

Figure 16: Location of the Proposed Bayong 33kV Switching Substation



7.1.2 Last Miles Renewal and Expansion in Sarikei

Rural electrification projects in Sarikei began implementation in the early 1990s. The systems are among the oldest in Sarawak. Hence, with aging facilities and load growth, it is necessary to replace or upgrade a significant portion of these lines and equipment. Recognising that there are fewer villages and households in Sarikei compared to areas in the Southern Region, it is proposed to allocate RM15 million for the implementation of renewal and expansion projects here.

7.1.3 Renewal or Grid Transition of SARES and Hybrids systems in Sarikei

In the Sarikei Zone, there are 25 villages with 445 households in the Julau, Pakan and Bintangor districts under the SARES scheme, which was commissioned from 2018 until 2022. In addition, Julau's SK Nanga Ju Solar Hybrid Station was commissioned in January 2018. The station supplies one village of 42 households as well as the nearby school.

By 2030, it is expected that some villages in Julau and Pakan currently using SARES systems will be grid connected, including Rumah Gerasi, Nanga Ju which is currently supplied by SK Nanga Ju Solar Hybrid Station. Five villages with 139 households are already grid connected under *Projek Rakyat*, while the remaining 17 villages and 270 households will be connected before 2030. At an estimated connection cost of RM80,000 per household, the total cost for the interconnections is RM25.8 million. Rh Nyaiyang and Rh Nyalih will be long-term SARES villages.

Depending on battery lifespan, battery replacements for nine villages are not required while the other 16 villages with 247 households will require battery replacements at an estimated cost of RM5 million.

The required battery replacement for SK Nanga Ju Solar Hybrid station battery replacement is estimated to cost RM1.1 million.

7.2 Sibu Zone

Currently, the Sibu distribution network is supplied by seven EHV substations, namely Oya 275/132/33kV, Deshon 132/33kV, Salim 132/33kV, Selangau 275/132/33kV, Mapai 275/33kV, Sungai Maaw 132/33/11kV and the recently completed Kanowit 132/33/11kV substations. The Kanowit 132/33/11kV substation is a new EHV injection point under *Projek Rakyat*. The Sibu Zone is anticipated to have continual load growth at an average rate of 2.6% per annum.

The Deshon 132/33kV Substation supplies up to 49% of Sibu's demand, including the Sungai Merah, Bandung, Kampung Datu and Pahlawan areas whereas Salim 132/33kV supplies Upper Lanang up to the town areas. Suburban areas such as Ulu Oya Road, Paradom, Sibu Jaya and Sibu Airport are mainly supplied by Oya 275/132/33/11kV while the Kanowit area has been diverted from the Sibu Airport 33/11kV to the new Kanowit 132/33kV since the end of 2021. For the outskirts, Selangau 275/33kV is supporting loads from Stapang and Selangau Town up to Sungai Arip while Mapai 275/33/kV supplies loads from Durin Junction to the Nibong Tada area. Lastly, Sungai Maaw 275/132/33/11kV is supplying to the Ensurai and Sungai Maaw areas.

Nanga Ngungun 33/11kV Substation, implemented under *Projek Rakyat* in 2020, is energised via the 33kV Covered Conductor Lines from the Kanowit Nanga Ngungun and Fibre Optic Project which was recently completed and commissioned.

Sarawak Energy is constructing a number of new substations to fulfil the load demand in the Sibu zone. We have subsequently progressed efforts to drive network reorganisation of the substations to improve reliability of supply to the relevant areas. There are also new substations, Kemuyang 33/11kV and Stabau 33/11kV, which will be constructed by Sarawak Energy to provide higher reliability of power supply and sufficient supply capacity to our rural customers.

Table 22 and Table 23 show 14 completed and seven ongoing or planned reinforcement projects by Sarawak Energy in Sibu.

Table 22: Recently completed system reinforcement projects in Sibu

No.	Projects	Completed	Cost (RM 'mil.)
1	Install 2nd no. of 5MVA transformer at Sibu Jaya Substation	2016	1.13
2	Development of Mapai 275/33kV Substation	2017	274.10
3	Mapai-Oya 275kV Transmission Line	2017	87.84
4	Mapai 33kV Switching Substation	2017	10.52
5	Divert Nibong Tada feeder into Mapai 33kV Substation	2018	0.49
6	Construction of Second 33kV Overhead line and Underground Cable to Kanowit	2018	6.35
7	Development of Sungai Maaw 275/132/33/11kV Substation	2019	73.01
8	Laying of 6 X 1C 630mm^2 33KV CU underground cable from Oya 132/33kV Substation to Sibu Jaya 33/11kV Substation	2019	32.97
9	Laying of 33kV 1C 630mm^2 AL underground cable from Sibujaya 33/11kV Substation to 33/11kV New Airport Substation	2019	6.06
10	To lay double circuit of 630mm^2/1C/Cu/XLPE cable from Sungai Maaw EHV Substation to Ensurai 33/11kV Substation	2019	10.05
11	Construction of Sibu Jaya 33/11kV substation	2019	0.25
12	To reorganize 33kV feeder at Mapai 275/33kV Substation	2022	0.23
13	To divert all the 33kV and 11kV Kanowit load into Kanowit 132/33/11kV Substation	2022	2.19
14	Sungai Merah (Formerly known as Teku) 132/33kV GIS Substation (2 x 80MVA) & Sungai Maaw 132kV Substation Extension	2022	98.25
Total			**603.44**

Table 23: List of projects to be constructed by Sarawak Energy in Sibu

No.	Projects	Implementation Year	Cost (RM 'mil.)
1	To divert Ulu Sungai Merah 33/11kV, New Sungai Merah 33/11kV and Rantau Panjang 33/11kV to be supplied from New Sungai Merah B 132/33kV Substation.	2017	10.53
2	To link up Shipbuilding 33/11kV with Sungai Maaw 132/33kV via 14km of 33kV overhead line	2023	1.71
3	To lay 33kV double circuit of 630mm^2/CU/1C/XLPE cable from Oya 275/132/33/11kV Substation to Kemuyang 33/11kV Substation	2023	3.26

4	Sungai Maaw-Sungai Merah 132kV double circuit Hybrid Line	2023	127.75
5	Construction of Kemuyang 33/11kV Substation	2020	32.40
6	Upgrading of Stabau 33/11kV 2.5MVA transformer to 5MVA	2024	1.00
7	Construction of Stabau 33/11kV Substation	2028	25.00
Total			**201.65**

Four projects are proposed under REDM with an estimated cost of RM48.3 million as shown in the table below.

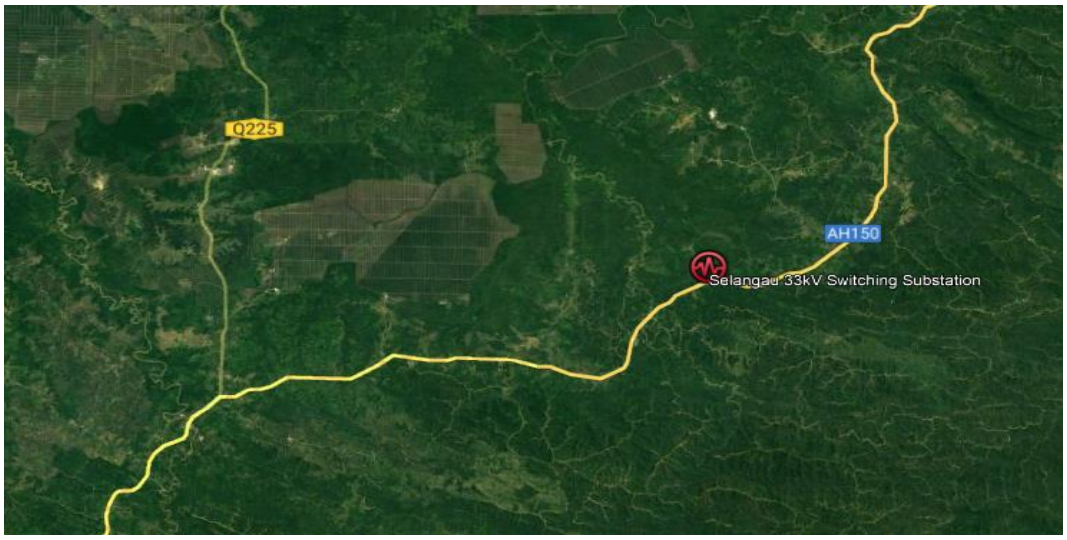
Table 24: List of rural electricity projects proposed under REDM for Sibu

No.	Name	Implementation Year	Cost (RM 'mil.)
1	Selangau 33kV Switching Substation	2026	20.00
2	33kV Normal Overhead Line from Nanga Ngungun to Song	2026	4.80
3	Last Miles Renewal and Expansion	By 2030	15.00
4	Renewal or grid transition of SARES and Hybrids systems	By 2030	8.50
Total			**48.30**

7.2.1 Selangau 33kV Switching Substation

Currently, the Selangau-Bintulu area is supplied by the Selangau 275/33kV feeder of a single circuit 60km long overhead line. It is proposed to construct a 33kV switching substation with the SCADA & COMM system at Selangau to resolve operation issues with a single long 60km overhead feeder from Selangau EHV Substation. This feeder is currently the worst performing feeder. As such, the proposed substation will aim to improve the effectiveness of operation works with these facilities, enhancing the efficiency of fault segregation and switching activities during contingency conditions.

Figure 17: Location of the Proposed Selangau 33kV Switching Substation



7.2.2 33kV Normal Overhead Line from Nanga Ngungun to Song

Currently the source for Nanga Ngungun 33kV Substation is Kanowit EHV Substation. It is proposed to link Nanga Ngungun to Song via the connection between Song EHV Substation and Nanga Ngungun 33kV Substation via a 33kV normal overhead line. This will strengthen the supply to Nanga Ngungun 33kV Substation and Song town. The estimated distance is approximately 12km and a 33kV normal overhead line will be constructed.

Figure 18: Proposed 33kV Normal Overhead Line from Nanga Ngungun to Song

7.2.3 Last Miles Renewal and Expansion in Sibu

The rural electricity systems in Sibu are among the oldest in the Central Region. With aging facilities and load growth, it is necessary to replace or upgrade a significant portion of these lines and equipment. It is proposed to allocate RM15 million for the implementation of renewal and expansion projects.

8.2.4 Renewal or Grid Transition of SARES and Hybrids systems in Sibu

In the Sibu Zone, there are only two villages with 48 households under the SARES programme, and they were both energised in 2022. For these two villages, SARES will be a long-term solution as they are not accessible by road and there is no plan to extend the existing road to these villages. The SARES battery replacement for these two villages is estimated at RM1 million and is expected to be necessary towards the end of this decade.

Under *Projek Rakyat*, villages under the Nanga Jagau resettlement were connected to the RES grid in May 2023. Therefore, the 273kW diesel station have been decommissioned.

As of mid-2022, the SK Sungai Arau Solar Hybrid Station under the Kementerian Pembangunan Luar Bandar (KPLB) programme will support four villages with 75 households as well as SK Sungai Arau once it has been fully constructed and commissioned. The KPLB-appointed contractor is encountering some

issues in the completion of this project, and it is uncertain when the villages and school can be energised. However, there is a possibility that all four villages will become accessible soon with the ongoing road extension works, making it possible to connect them to the grid. The estimated cost to connect the Sungai Arau villages is RM7.5 million.

7.3 Mukah Zone

Currently, the Mukah distribution network is supported by four transmission substations, namely the Petian 132/33kV, Matadeng 132/33kV, Balingian 275/33kV and Daro 132/33/11kV substations. Petian 132/33kV substation is supplying Mukah town and surrounding towns like Oya, Dalat and Igan. The Matadeng 132/33kV substation supplies Sarawak Coal Resources (SCR), Mukah Estate, Balingian town and its surroundings. The Balingian 275/33kV substation supplies Balingian Coal Fire Power Plant and Coal Stockyard. Meanwhile, Daro 132/33/11kV substation supplies Daro, Kampung Tian, Matu and Kuala Matu. The Mukah Zone is anticipated to have a continual load growth at an average rate of 3.6% per annum.

With Sarawak Energy funding, the Daro 132/33/11kV substation was completed and commissioned in 2019. In addition, there were projects to erect a second circuit of 33kV overhead line from Senau to Igan as well as Sacofa Igan to Igan Ferry Point. With the completion of both projects, the system constraints at the Oya, Igan, Matu and Daro areas can be resolved.

In addition to the Daro 132/33/11kV Substation, there are other EHV substations constructed with Sarawak Energy funding to provide strong injection points to the distribution network in the Mukah Zone: the Balingian 275/33kV Substation and Sungai Maaw 132/33kV Substation.

The Dalat 33/11kV Substation, implemented under *Projek Rakyat* in 2021, shall source its supply from the Petian 132/33/11kV Substation via a double circuit of 33kV covered conductor lines, which has been completed recently. The purpose of this substation is to cater to the future load growth of Dalat town and its surrounding areas.

The master plan of Mukah Smart City Development is currently in the early stages of study. This conceptual plan will support the State Government's vision to develop Sarawak through the SCORE Agenda.

Key Demand Segment	**Description**
Mukah Science Park	R&D facilities for the AgriTech research hub, biotech cluster and aquaculture research hub
ICT Industry	Industrial/data centre, ICT infrastructure, commercial and education centre
Food City & Aquaculture Activities	Poultry processing plant, fish processing plant, small and medium-sized enterprises (SME) food estate and ornamental fishes farm and hatcheries

Education Hub	Research university facilities, skilled training institution, primary/secondary boarding school

In order to support the anticipated load of Mukah Smart City development, the following reinforcement works are planned by Sarawak Energy.

(i) Upgrading of Petian 132/33kV transformers (2 x 120MVA)
(ii) Balingian 275kV Substation Extension
(iii) Matadeng B 275/132/33kV Substation (2 x 240MVA)
(iv) Balingian-Matadeng B 275kV Double Circuit Transmission Line (2 x 600MVA, 34km)
(v) Matadeng C 275/132/33kV Substation (2 x 240MVA)
(vi) Matadeng B – Matadeng C 275kV Double Circuit Transmission Line (2 x 600MVA, 7km)
(vii) ICT 132/33kV Substation (2 x 40MVA)
(viii) Matadeng B – ICT 132kV Double Circuit Tranmission Line (2 x 250MVA, 29km)
(ix) Agritech 132/33kV Substation (2 x 80MVA)
(x) Loop-in-out Petian Daro 132kV Transmission Line in Agritech Substation (2 x 250MVA, 10km)

Table 25 and Table 26 shows seventeen completed and two ongoing or planned reinforcement projects by Sarawak Energy in Mukah.

Table 25: Recently completed system reinforcement projects at Mukah

No.	Projects	Completed	Cost (RM 'mil.)
1	Upgrading of Dalat 33/11kV transformers	2016	1.09
2	Upgrading of Pergau 33/11kV transformer	2017	0.52
3	Construction of 2nd 33kV overhead line (OAK 7/4.65) from Oya to Igan • Phase 1: From Oya Junction to Igan • Phase 2: From Igan to Pergau	2017	1.48
4	• Balingian 275/33kV Substation (2x 30MVA) • Balingian-Selangau 275kV Transmission Line	2018	151.00
5	To construct 2nd 33kV overhead line from Saai to Penuai but energised in 11kV (9km)	2019	1.87
6	Construction of Balingian 132/33kV Substation	2019	9.93
7	Sungai Maaw-Tanjung Manis B 275kV double circuit Transmission Line (2 x 600MVA, 75.91km)	2019	94.00
8	• Petian 132/33kV Substation Extension • Daro 132/33kV Substation (2 x 40MVA) • Sungai Maaw 132/33kV Substation (2 x 80MVA)	2019	121.00
9	To lay 33kV 240mm2/ AL cable from SK Semop to Saai Power Station (12km)	2019	5.34
10	Daro 33/11kV Re-organize & Local Substation	2019	0.53
11	Daro-2nd Line 33kV between Matu & Daro	2019	4.18

12	Construct 2nd 33kV overhead line from Ferry Semop to SK Semop (6km)	2020	0.92
13	Mukah- 2nd Line 33kV between Senau & Igan	2020	1.90
14	Replacement Dalat Indoor Vacuum Circuit Breaker Distribution Substation	2020	2.57
15	Mukah- 2nd 33kV underground cable from Sacofa Igan to Ferry Igan	2020	1.76
16	Petian-Daro-Sungai Maaw 132kV double circuit transmission Line (2 x 250MVA, 172.2km)	2021	259.00
17	Reorganize 33kV & 11kV high tension underground cable at Dalat 33/11kV Substation	2022	1.07
Total			**658.16**

Based on the transformer condition assessment conducted by Sarawak Energy, it was found that the existing transformers at Petian 33/11kV Substation are reaching their end-of-service life and have a very high risk of failure. However, Sarawak Energy adopted an alternative way by laying underground cable from Mukah Town 33/11kV to Petian 132/33/11kV to resolve the issue. Meanwhile, Pulau Bruit is supplied by the Shipbuilding 33/11kV Substation via a double-circuit submarine cable, where one cable was found to be faulty. Therefore, it is proposed to create a link from Daro 132/33/11kV Substation to Pulau Bruit to act as a primary source.

Table 26: List of projects to be constructed by Sarawak Energy in Mukah

No.	Projects	Implementation Year	Cost (RM 'mil.)
1	Laying of submarine cable from Daro 132/33/11kV to Pulau Bruit	2022	9.98
2	Laying of underground cable from Mukah Town 33/11kV to Petian 132/33/11kV	2023	1.98
Total			11.96

Five projects are proposed under the REDM with an estimated cost of RM27.2 million as shown in Table 27.

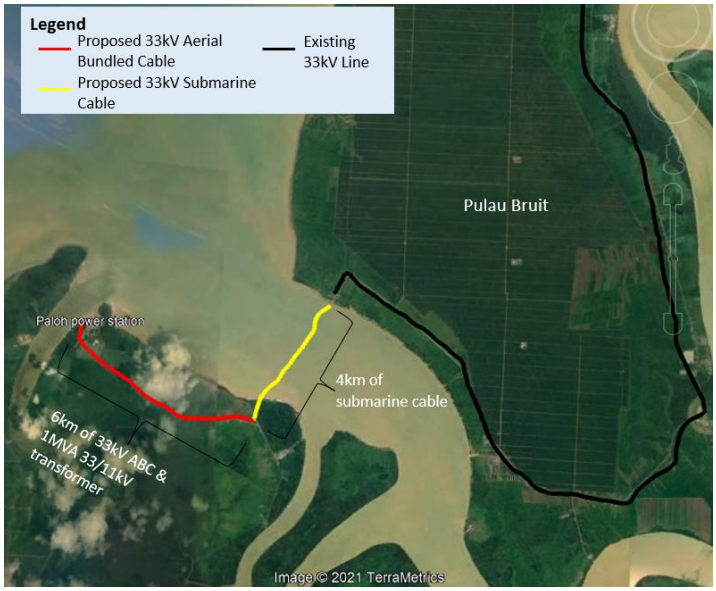
Table 27: List of projects to be proposed under REDM in Mukah

No.	Name	Implementation Year	Cost (RM 'mil.)
1	Grid transition for Paloh Diesel Power Station	2026	9.00
2	11kV Submarine Cable from Kebuaw to Ladang Rakyat Igan	2026	1.50
3	11kV Aerial Bundled Cable line from Rassau to New Sungai Merah	2026	6.40
4	Last Miles Renewal and Expansion	By 2030	10.00
5	Renewal of SARES systems	By 2030	0.30
Total			**27.20**

7.3.1 Grid Transition of Paloh Diesel Power Station

The Paloh Diesel Power Station with a total capacity of 487kW supplies 337 households at Kampung Paloh, situated at the estuary of Batang Rejang. With an ongoing project to install an additional feeder from the Daro EHV substation to Pulau Bruit by 2022 ongoing, Kampung Paloh, which is opposite the river, can be connected to the grid too. This requires connection via submarine cable and ABC, and subsequently a 1MVA 33/11kV transformer to step down the voltage for rural connection. Once the customers are all connected to the grid, Paloh Diesel Power Station can then be decommissioned.

Figure 19: Proposed Line Tapping from the Existing Line at Pulau Bruit



7.3.2 11kV Submarine Cable from Kebuaw to Ladang Rakyat Igan

Currently, Kebuaw only has a single source of supply from Sungai Kut, compromising reliability of supply to this area. There is a school as well as several villages in the area. This project is proposed to provide an alternative source of supply for RES customers at Kebuaw by extending the line from Ladang Rakyat Igan through Kampung Sah via submarine cable. The transformer at Ladang Rakyat Igan is required to be upgraded from 1MVA to 2.5MVA for this purpose.

Figure 20: The Route Connecting Kebuaw to Ladang Rakyat Igan Substation

7.3.3 11kV Aerial Bundled Cable Line from Rassau to New Sungai Merah

Currently, Rassau is connected to electricity via a long 11kV ABC line from Sungai Kut, which is sourced from the Petian 33kV Substation. The peak load at Rassau is 300kW. The single source of supply coupled with long line extension causes the line to be vulnerable to disturbances and tripping.

The proposed 11kV ABC Line from Rassau to New Sungai Merah will serve as an alternative source of supply for existing customers from Rumah Penguang, Sungai Pinang, Kampung Bungan Kecil, Kampung Bungan Besar and Kampung Rassau and future RES customers in Rassau. The proposed line will link Rassau with New Sungai Merah 33kV Substation via Nanga Tutus.

Figure 21: The Route Connecting Rassau to SK Nanga Tutus

7.3.4 Last Miles Renewal and Expansion in Mukah

While the rural electricity systems in Mukah are relatively new with several RES Last Miles projects implemented in the last five years, there is a need to replace older systems or upgrade certain lines and equipment as continuous load growth is expected in the area.

7.3.5 Renewal or Grid Transition of SARES Systems in Mukah

An allocation of RM10 million is proposed for implementing renewal and expansion projects.

Rumah Tujoh at Sungai Anak, Balingian is the only village in the Mukah Zone that has been energised under the SARES programme since 2021. Although this 11-household village is accessible by road, connecting Rumah Tujoh to the grid is not financially viable due to its long distance from the nearest grid. Therefore, the recommendation is to retain the SARES scheme as a long-term solution for Rumah Tujoh. A battery replacement for Rumah Tujoh's current power system is due around 2026 and is estimated to cost RM300,000.

7.4 Kapit Zone

Currently, Kapit's entire network system is supported by two 33/11kV substations, namely Kapit Power Station and Kapit 33/11kV Substation. These substations are supplying Kapit town, Selirik, Beleteh and Nanga Mujong. The source of supply for both zone substations is from the Kapit 132/33kV Substation. In 2020, the system peak load for Kapit station, including Song, was 10.5MW.

The commissioning of Song 132/33/11kV Substation took place in 2020 and this was followed by the commissioning of the Selirik 33/11kV substation in 2021. Both substations further improved the supply reliability at Song and Kapit towns and the surrounding areas. Under long-term planning, the Beleteh 33/11kV Substation will be built next to the existing Kapit B 132/33/11kV Substation, tentatively by 2027.

The construction of a 33kV double-circuit covered conductor lines from the Selirik 33/11kV Substation to Baleh HEP has physically completed and is expected to be energised by Q4, 2023. Once the line is completed, Nanga Entawau which currently relies on a local diesel power station will be able to connect to the grid and the diesel power station will be retired. This development will enable the electrification of 43 villages along the Baleh River as well as grid-connect another 132 villages which are far from the river when new roads are constructed or existing roads are upgraded in the future.

The Tunoh Master Plan is the long-term development plan for the Tunoh area. Based on this study, the total load demand for the Bukit Mabong District including the Tunoh township, from 2022 to 2030 is projected to be approximately 14.51MW. In addition, the Kapit Division Strategic Transformation Plan 2020-2025 was released by Resident Office Kapit in 2019, covering the development of residential, commercial and industry fields

Table 28 and 29 show seven completed and two ongoing or planned reinforcement projects implemented by Sarawak Energy in Kapit.

Table 28: Sarawak Energy's recently completed system reinforcement projects in Kapit

No.	Projects	Completed	Cost (RM 'mil.)
1	Second line/transformer bay at existing Kapit 132/33kV Substation (1 x 30MVA)	2018	67.00
2	2nd feeder of 33kV 1C 630mm^2 Al. underground cable from Kapit 132/33kV to Kapit Power Station along Airport Road and installation of additional 5MVA 33/11kV transformer	2019	2.89
3	Song 132kV Substation	2019	35.00
4	Song 132kV Turn-in	2019	37.00
5	Song-Temporary Supply to Song Via Genset	2020	2.52
6	Development of Selirik 33/11kV Substation equipped with 2 x 10/15MVA transformers	2021	18.47
7	33kV Covered Conductor Lines from Kapit to Baleh	2022	85.00
Total			247.88

Table 29: A List of projects to be constructed by Sarawak Energy in Kapit

No.	Projects	Implementation Year	Cost (RM 'mil.)
1	Development of New Beleteh 33/11kV equipped with 2 x 10/15MVA transformers	2024	18.00
2	To demolish and rebuild Kapit Power Station into a new zone substation equipped with 2 x 10MVA transformers	Beyond 2030	20.00
Total			**38.00**

The eleven projects proposed under REDM, with an estimated cost of RM818.2 million, are shown in Table 30.

Table 30: A List of projects to be proposed under REDM for Kapit

No.	Name	Implementation Year	Cost (RM 'mil.)
1	(a) 33kV Normal Overhead Line from Nanga Mujong to Nanga Merit	2025	28.50
	(b) 33kV Covered Conductor Lines from Selirik to Nanga Merit	2024	40.00
	(c) Nanga Merit 33/11kV Substation	2025	18.00
2	(a) 33kV Covered Conductor Lines from Belaga to Punan Bah	2023	64.00
	(b) 33kV Covered Conductor Lines from Punan Bah to Nanga Merit	2026	20.00
	(c) Punan Bah 33/11kV Substation	2025	18.00
3	(a) 33kV Covered Conductor Lines from Tunoh Junction to Tunoh	2024	40.00
	(b) Tunoh 33/11kV Substation	2024	18.00

4	Grid extension to Entawau	2025	2.20
5	(a) 33kV Covered Conductor Lines from Song to Katibas	2026	56.0
	(b) Katibas 33/11kV Substation	2026	18.0
6	Last Miles Renewal and Expansion	By 2030	10.00
7	Upgrading of SARES Schemes to Hybrid Stations	By 2030	80.4
8	Renewal or Grid Transition of SARES Systems in Song	By 2030	34.60
9	Renewal or Grid Transition of SARES and Hybrids Systems in Ulu Rejang (Selirik-Merit)	By 2030	144.70
10	Renewal or Grid Transition of SARES and Hybrids Systems in Baleh	By 2030	203.40
11	Renewal or Grid Transition of SARES Systems in Kapit	By 2030	22.40
Total			**818.20**

7.4.1 Selirik – Nanga Mujong – Nanga Merit Interconnecting Loop

7.4.1.1 33kV Normal Overhead Line from Nanga Mujong to Nanga Merit

The electricity for households, schools and clinics in Nanga Merit is currently supplied by a solar hybrid station. To provide the community with more reliable electricity supply, it is proposed that the 33kV grid from the ongoing 33kV Covered Conductor Line project from Selirik to Mujong be extended to Nanga Merit.

The distance is approximately 70km and the construction is proposed to be a 33kV Normal Overhead Line, followed by a short length of submarine cable across Batang Rejang.

If realised, this line will benefit 26 villages with a total of 591 households, which currently rely on SARES or solar hybrid schemes for electricity supply. The proposed line will also act as a backup to the proposed 33kV Covered Conductor Lines from Selirik to Nanga Merit. This will enable electricity supply to adjacent government premises such as offices, schools, clinics, and houses of worship.

7.4.1.2 33kV Covered Conductor Lines from Selirik to Nanga Merit

These lines are proposed as the main long-term source of electricity supply to Nanga Merit. Its construction along the newly approved road with the name, “Projek Membina Jalan Nanga Tulie ke Rumah Bujah, Nanga Pelagus, Bahagian Kapit, Sarawak”, will be undertaken by the Malaysian Public Works Department (JKR) while the Regional Corridor Development Authority (RECODA) will continue from there with the name “SCORE - Rekabentuk dan Kerja-Kerja Awalan bagi Pembinaan Jalan Akses ke Samarakan/Sangan/Nanga Merit/Kapit (Fasa 2)”. The estimated distance is approximately 50km and double circuit 33kV Covered Conductor lines will be constructed.

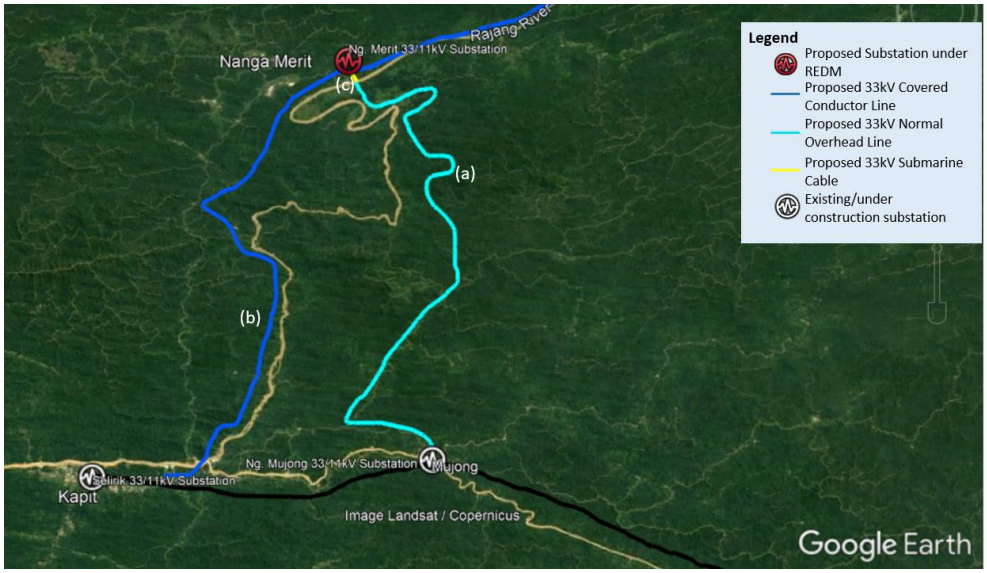
These proposed lines will enable villages along the route that currently rely on SARES or solar hybrid schemes to be connected to the grid and enjoy unlimited and reliable electricity supply.

7.4.1.3 Nanga Merit 33/11kV Substation

A proposed 33/11kV substation that will be strategically located at Nanga Merit enables the termination of the above two lines from Mujong and Selirik. This substation will serve as the interfacing point for the long distribution lines from Mujong and Selirik, as well as the similarly long line from Punan Bah and Belaga.

Besides ensuring supply reliability, the planned substation is essential to supply electricity to schools and clinics in the area. With the incoming lines and substation at Nanga Merit, the solar hybrid station which is currently the sole supply source for Nanga Merit can be decommissioned .

Figure 22: (a) 33kV Normal Overhead Line from Nanga Mujong to Nanga Merit and (b) 33kV Covered Conductor Lines from Selirik to Nanga Merit, with respect to the (c) Nanga Merit 33/11kV Substation



7.4.2 Belaga – Punan Bah – Nanga Merit Interconnecting Loop

7.4.2.1 33kV Covered Conductor Lines from Belaga to Punan Bah

The villages at Punan Bah depend on a solar hybrid station as their sole source of electricity supply. For long-term supply reliability, the proposal is to link the area with two sources of electricity supply from Nanga Merit and Belaga.

The distance is approximately 80km and double circuit 33kV Covered Conductor lines are proposed to be constructed. The proposed line route will be along Jiwa Murni Road from Belaga to Punan Bah.

7.4.2.2 33kV Covered Conductor Lines from Punan Bah to Nanga Merit

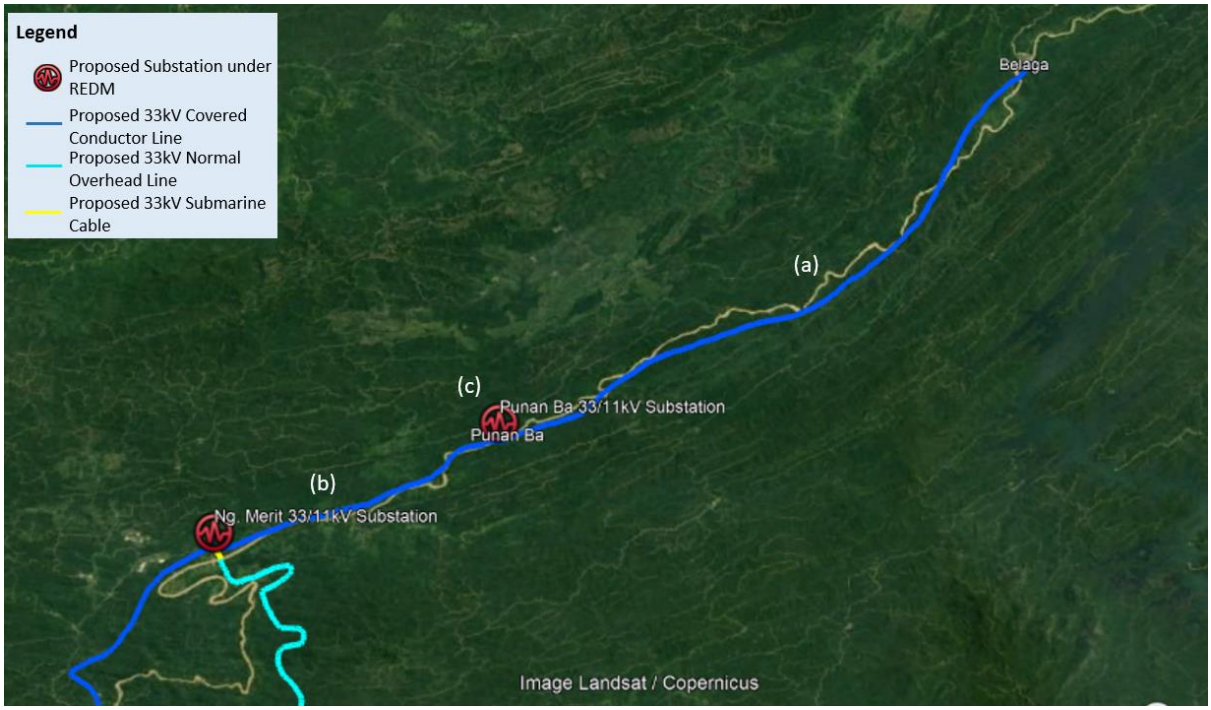
As a continuation of the 33kV Covered Conductor lines from Belaga to Punan Bah, this line extends up to Nanga Merit, approximately 25km away. Double circuit 33kV Covered Conductor Lines will be constructed.

The proposed line route will be along Jiwa Murni Road from Punan Bah to Nanga Merit and it will provide ample capacity to grid-connect all the villages along the route that are currently supplied by SARES schemes.

7.4.2.3 Punan Bah 33/11kV Substation

The proposed connection of the two lines from Nanga Merit and Belaga to this substation as the common interfacing point will enable the decommissioning of the solar hybrid station at Punan Bah. The substation will also improve system reliability while minimising supply interruption and its impacts.

Figure 23: (a) 33kV Covered Conductor Lines from Belaga to Punan Bah and (b) 33kV Covered Conductor Lines from Punan Ba to Nanga Merit, with respect to the (c) Punan Bah 33/11kV Substation



7.4.3 Tunoh Grid Connection

7.4.3.1 33kV Covered Conductor Lines from Tunoh Junction to Tunoh

Currently, Tunoh town and its surrounding villages are supplied by a solar hybrid station. The proposal to grid-connect Tunoh through 33kV Covered Conductor Lines from Selirik to Baleh, which are currently under construction, is crucial to support future economic developments in the Tunoh township.

In addition, the supply scheme to Tunoh can be upgraded to 132kV with a supply source from the Baleh HEP if this 33kV line is found to be insufficient to cater to load growth. The estimated line length is approximately 50km and double circuit 33kV Covered Conductor Lines will be constructed.

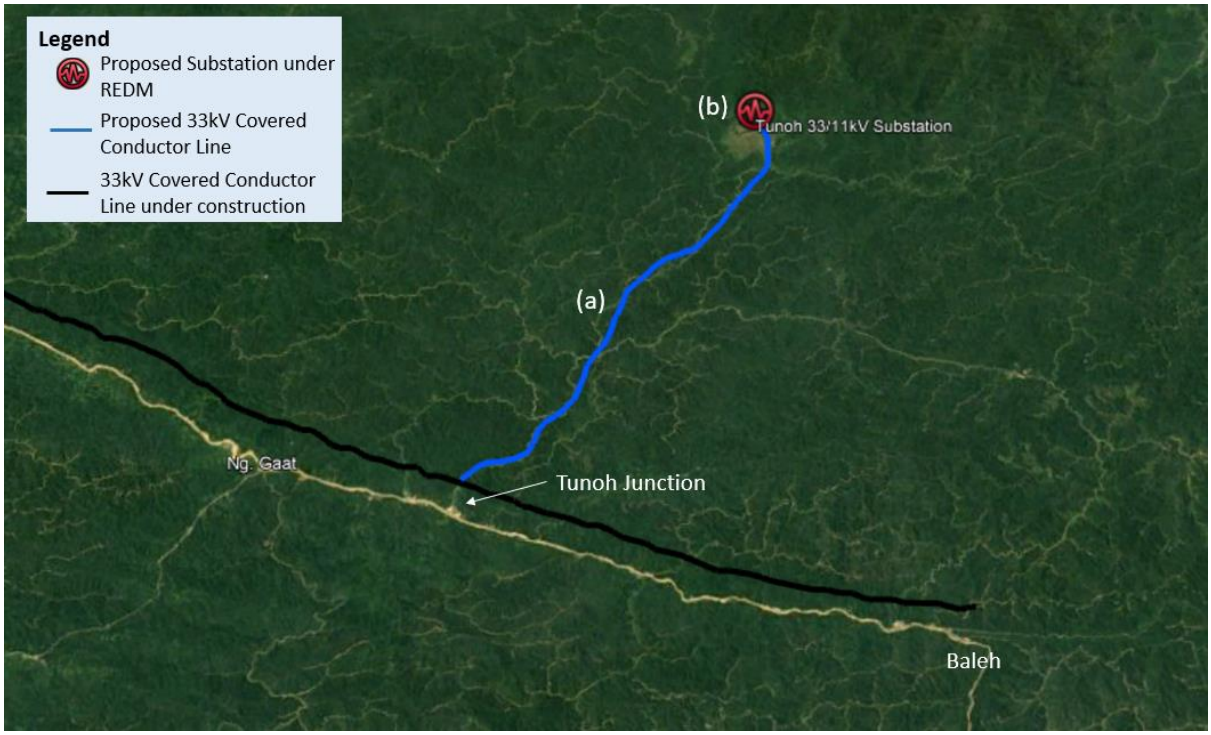
Currently, road access is limited to an active logging road and this project's implementation is dependent on a new road being constructed to the Tunoh township.

7.4.3.2 Tunoh 33/11kV Substation

The proposed Tunoh 33/11kV Substation will provide for future load growth and enhance reliability of supply to Tunoh and its surrounding areas, supporting the development plan of Tunoh and Bukit Mabong by the Upper Rejang Development Agency (URDA).

Presently, Tunoh is supplied by a solar hybrid station with a maximum capacity of 288kWp of solar photovoltaic (PV) panels. The backup power supply comes from two standby gensets with a capacity of 300kVA and 350kVA respectively to support the solar PV panels when they are not generating sufficient electricity.

Figure 24: (a) 33kV Covered Conductor Lines from Tunoh Junction to Tunoh with respect to (b) Tunoh 33/11kV Substation

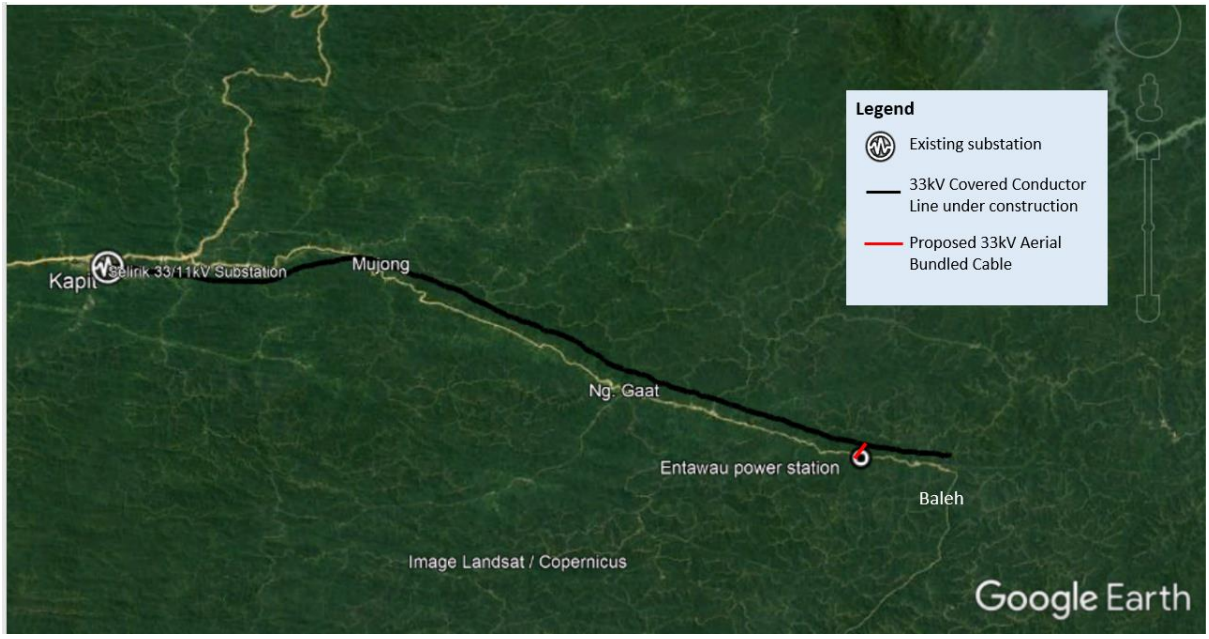


7.4.4 Grid Extension to Entawau

This proposed grid extension will enable the shutting down of Entawau Diesel Power Station by connecting Entawau's villages and households to the grid. The construction of new 33kV Covered Conductor Lines from Selirik to Baleh, passing through Entawau, is one of Sarawak Energy's Corporate Social Responsibility (CSR) projects.

The estimated line length is 5km of 33kV ABC line and a 160kVA 33/.433kV step down transformer will be constructed to supply the villages.

Figure 25: Tapping Selirik - Baleh 33kV Covered Conductor Line to grid-connect Entawau



7.4.5 Katibas Grid Connection

7.4.5.1 33kV Covered Conductor Lines from Song to Katibas

This line is proposed as the main long-term source of electricity supply to Ulu Katibas. It is constructed from Song EHV Substation – along Jalan Takan and the newly approved road from Nanga Banjor, Song to Rumah Peter, Nanga Lian which will be undertaken by RECODA with the road name "Proposed Construction of Nanga Banjor/Nanga Makut Road, Katibas and Proposed Construction of Nanga Makut/Nanga Engkuah Road, Katibas". The new road is expected to complete in two to three years. Double circuit 33kV Covered Conductor lines will be constructed, and the estimated distance is approximately 70km.

This proposed line will enable villages along the route that currently rely on SARES or solar hybrid schemes to be connected to the grid and enjoy unlimited and reliable electricity supply. A 33/11kV substation is also being proposed for inclusion.

7.4.5.2 Katibas 33/11kV Substation

The proposed Katibas 33/11kV Substation will provide for future load growth and enhance reliability of supply to Katibas and its surrounding areas.

Presently, Katibas' longhouses and schools are relying on SARES as their electricity source. With the incoming lines and substation at Katibas, their electricity source can be transitioned to the grid, which will become the long-term solution and their reliable electricity source.

Figure 26: (a) 33kV Covered Conductor Lines from Song to Katibas with respect to (b) Katibas 33/11kV Substation

7.4.6 Last Miles Renewal and Expansion in Kapit

The rural electricity systems in Kapit are relatively new with many projects commissioned in 2020. However, with load growth, it is necessary to replace the older systems and upgrade portions of the distribution lines and equipment. We propose an allocation of RM10 million for the implementation of renewal and expansion projects.

7.4.7 Renewal or Grid Transition of SARES and Hybrids Systems in Song

A total of 73 villages with 1,384 households in Song are utilising the SARES systems implemented between 2016 and 2022. In SK Nanga Janan, four villages with 103 households receive supplies from the SK Nanga Janan Solar Hybrid Station. Only one village in Katibas has been identified as grid connectible with road extension works reaching the village.

Enabling grid connection for the other villages will depend on road extension works along the Katibas river. At Tekalit, only two villages have been identified for possible grid connection as they are located near the existing RES lines. Connecting these villages and households to the grid is estimated to cost RM5.1 million.

In addition, a solar hybrid station is being planned for Nanga Engkuah to benefit three villages, schools, a clinic and an agriculture station. This new solar hybrid station is estimated to cost RM20.5 million.

Based on the number of households, presence of government facilities and potential growth in the area, a few of the existing SARES villages have also been identified as potential candidates to be upgraded with solar hybrid stations under the KPLB programme. The proposed upgrade is for:

- five villages with 92 households in Katibas Tengah, costing RM20 million,
- three villages with 75 households in Ulu Katibas, costing RM16.5 million
- four villages with 61 households further upstream of Katibas, costing RM13.4 million

While most of the identified villages are in Katibas, three longhouses with 45 households at Sungai Iran has also been identified for the solar hybrid system upgrade, which is estimated to cost RM 10 million. Sungai Iran is on the northern side of Song, opposite Batang Rejang.

Figure 27: SARES Villages in the Central Region

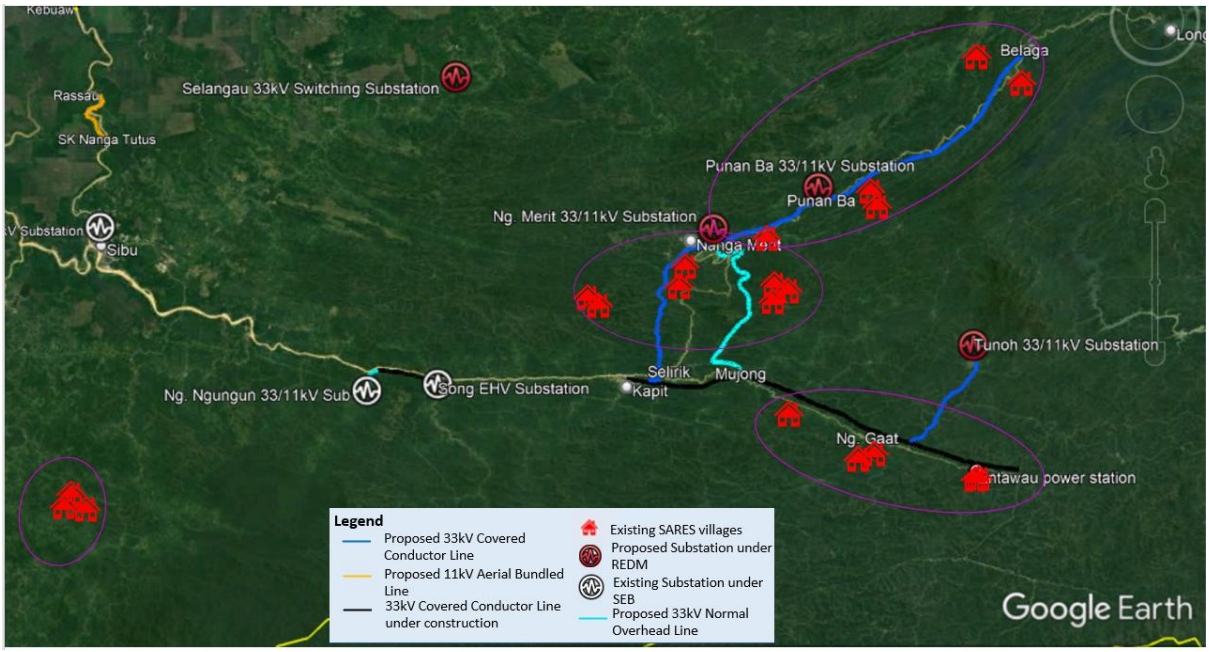


Figure 28: Location of Solar Hybrid Stations in the Central Region

The remaining 70 villages with 1,333 households will continue to rely on SARES or hybrid schemes for long-term electricity supply. These villages either have no access roads or are not feasible for grid connection. Battery replacements for the 73 villages under the SARES scheme will be required in stages and is estimated to cost RM28 million while costs for SK Nanga Janan Solar Hybrid will be RM 1.5 million.

7.4.8 Renewal or Grid Transition of SARES and Hybrids Systems in Ulu Rejang (Selirik-Merit)

There are 65 villages with 1,486 households in Ulu Rejang, including Selirik and Merit, with SARES systems implemented between 2016 and 2022. In addition, there are three solar hybrid stations providing electricity to 11 villages with 160 households.

Table 31: Solar hybrid stations at Ulu Rejang

No.	Station Name	Location	Villages & Households	Government Facilities
1	Nanga Metah	Merit	3 villages, 53 households	Sekolah Kebangsaan Nanga Metah
2	Nanga Merit	Merit	7 villages, 87 households	Sekolah Kebangsaan Nanga Merit Klinik Kesihatan Nanga Merit
3	Nanga Peraran	Merit	1 village, 17 households	Sekolah Kebangsaan Nanga Peraran

The new SK Nanga Ibun Solar Hybrid Station has been commissioned but has not been handed over yet for operation due to completion issues. The schools in this area will also be connected to SK Nanga Ibun Solar Hybrid Station in the near future.

There are two grid proposals that will affect the plan for villages with SARES schemes at Ulu Rejang, namely the 33kV covered conductor line along a proposed RECODA road from Kapit (Selirik) to Merit, as well as a grid line from Mujong to Merit. Once these grids are constructed, it is possible to grid-connect villages along these two-line routes, benefitting a total of 43 villages and 904 households along Batang Rejang. In addition, the three aforementioned solar hybrid stations can also be connected to the grid. The new grid line connecting Punan Bah to Belaga will enable the grid connection for seven villages with 234 households that currently use the SARES systems, including the Punan Bah village, which is currently supplied by an existing solar hybrid station. The total cost to interconnect these villages at Ulu Rejang to the new lines is estimated at RM107 million.

The remaining 15 villages with 348 households will rely on SARES for their long-term electricity supply. These villages have no access roads and are not feasible for grid connection yet. In addition, grid interconnections are expected to take time to implement. As such, all the batteries in SARES and Solar Hybrid schemes will need to be replaced. The estimated cost of battery replacement for the 65 villages in Ulu Rejang is estimated at RM30 million, while costs for the solar hybrid stations are estimated at RM6.6 million. Lastly, there is one village in Sungai Ibun with 20 households that is currently under construction and will eventually be connected to SK Nanga Ibun solar hybrid station once completed.

7.4.9 Renewal or Grid Transition of SARES and Hybrids Systems in Baleh

In Baleh, there are 87 villages with 2,221 households utilising the SARES systems, that were implemented between 2016 and 2023. In addition, there are six solar hybrid stations providing electricity to 12 villages with 415 households. The schools in Baleh are expected to be connected to the solar hybrid stations in future. The diesel power station at Nanga Entawau, Baleh has an installed capacity of 292kW, and it currently supplies for 207 households.

No.	Station Name	Location	Villages & Households	Government Facilities
1	Sungai Tunoh	Melinau	1 village, 165 households	Mabong District office (Future) Agriculture office Bukit Mabong airport (Future) Sekolah Kebangsaan Sungai Tunoh Klinik Kesihatan Tunoh
2	Nanga Entuloh	Merirai	1 village, 55 households	Sekolah Kebangsaan Nanga Entuloh
3	Nanga Kain	Gaat	2 villages, 44 households	Sekolah Kebangsaan Nanga Kain
4	Nanga Balang	Gaat	1 village, 38 households	Sekolah Kebangsaan Nanga Balang
5	Nanga Meluan	Melinau	1 village, 66 households	Sekolah Kebangsaan Nanga Meluan
6	Nanga Bebangan	Melinau	1 village, 49 households	Sekolah Kebangsaan Nanga Bebangan

Under *Projek Rakyat*, a RES Last Miles project will be implemented near Gaat. Once this project is completed, it will be possible to grid-connect two villages with 36 households that are currently supplied by the SK Nanga Kain Solar Hybrid Station.

The proposed Mujong – Merit 33kV Normal Overhead Line will connect eight villages with 110 households to the grid. The Gaat – Tunoh 33kV Covered Conductor Line is also planned for implementation soon and with this, it is feasible to grid-connect six villages with 117 households which are currently using SARES schemes and another 168 households which are depending on the Sungai Tunoh Solar Hybrid Station. Besides the villages in Tunoh, another eight villages and 239 households currently with SARES schemes along the Baleh river will also be connected to the grid for unlimited and more reliable electricity supply.

At Baleh HEP, a 500/33kV supply is proposed to provide a local reliable source for the Tunoh area. When the Baleh HEP is commissioned, it will be possible to connect 12 villages with 190 households that are relying on SARES schemes to the grid. In addition, four villages with 207 households which are currently supplied by the Entawau Diesel Power Station will also be connected to the grid. In the long term, the implementation of these grid projects will help another 31 villages with 803 households to be connected to the grid. The total cost of grid-connecting the villages in Baleh that are currently under the SARES or Hybrid schemes is estimated to be RM116.7 million. Three solar hybrid stations at Bukit Mabong namely, Nanga Entuloh, Nanga Meluan and Nanga Bebangan with 180 households will also be connected to the grid at an estimated cost of RM 18 million.

The remaining 22 villages with 762 households will rely on the SARES or Hybrid schemes for their long-term electricity supply. These villages either have no access roads or are not feasible for grid connection. Battery replacement for 87 villages in Baleh with the SARES scheme is estimated at RM45.3 million, while battery replacement at the solar hybrid stations is estimated to cost RM16.9 million.

There are four villages with longhouses under construction in the Baleh zone, with 118 households to be proposed for a standalone solar scheme at the total cost of RM6.5 million.

Lastly, a mini-hydro project is planned for Long Busang, which was recently electrified under the SARES solar scheme. This mini-hydro generation will be combined with existing the SARES solar system to create an off-grid microgrid, which will provide reliable electricity to Long Busang and other future developments in the area.

7.4.10 Renewal or Grid Transition of SARES and Hybrid Systems in Kapit

Close to Kapit town, 19 villages with 315 households are scheduled to be supplied through SARES schemes between 2022 and 2023. Several grid projects are also being planned in conjunction with the construction of roads by RECODA and JKR.

- All eight villages with 128 households at Sungai Belawai that are currently using the SARES scheme will be able to connect to the grid once the RECODA road is completed.
- For the Sungai Semujan area, four villages with 61 households that are currently using the SARES scheme will be able to connect to the grid through the construction of an overhead line along an existing logging road.

The remaining seven villages with 126 households will continue to rely on the SARES schemes for their long-term electricity supply. These villages have no access roads or are not feasible for grid connection. The total cost to interconnect the accessible villages at Kapit is estimated to be RM15 million.

There are two villages with longhouses under construction in the Kapit Zone as well as 19households that have been proposed for a standalone solar scheme at a total cost of RM1 million.

Battery replacements for the SARES scheme in Kapit is estimated to cost RM6.4 million and will be implemented in batches, depending on the design life expectancy and the actual health conditions of the battery banks.

8 NORTHERN REGION

This section explains the status of electricity grid infrastructure in the Northern Region, including ongoing system expansion and reinforcement projects. The impacts or benefits of these developments on the electricity systems in the surrounding rural areas will be elaborated on before the proposal and explanation of further grid expansion and reinforcement projects. The Northern Region is divided into six zones, namely Bintulu, Bakun, Miri, Marudi, Telang Usan and Limbang.

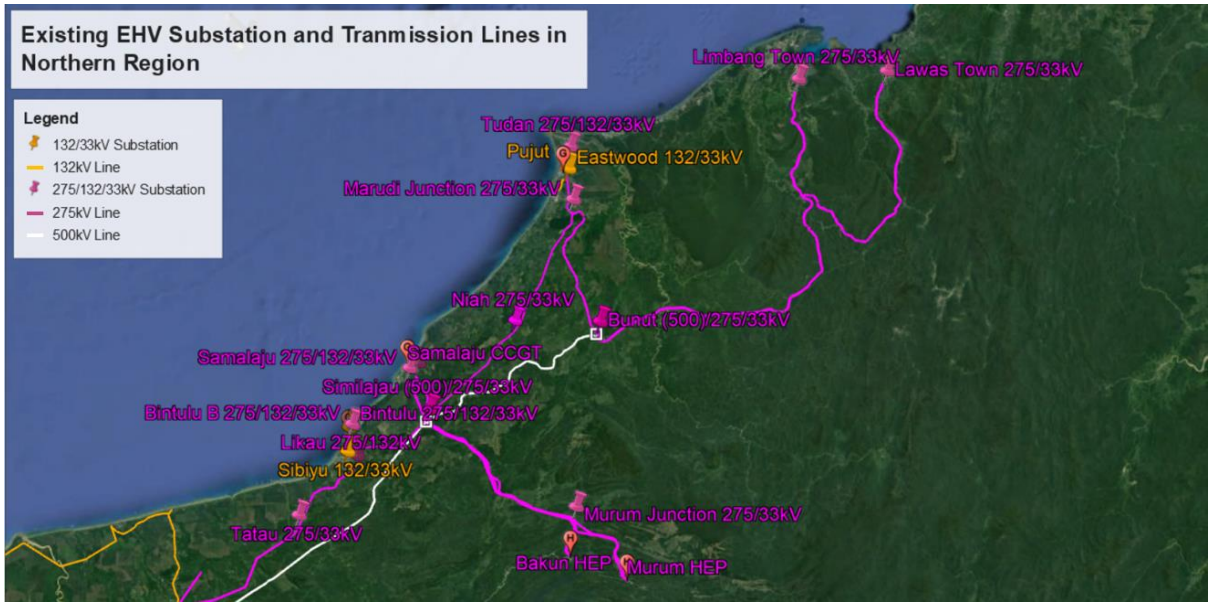
Currently, the Northern Region comprises major generation plants in Sarawak, with the main sources being Bakun HEP and Murum HEP, both of which are supported by open and combined cycle gas power plants at Tanjung Kidurong, Bintulu and Pujut, Miri.

For the Bintulu network, the supply source is injected via six EHV substations, namely Kemena 275/33kV, Bintulu 275/132/33kV, Bintulu B 275kV, Similajau 275/33kV, Murum Junction 275/33kV and Tanjung Kidurong 132/33kV. EHV substations at Kemena, Bintulu and Tanjung Kidurong and local generation from Bintulu Power Station also supply Bintulu City. The rapid demand growth in Bintulu has resulted in the 33kV distribution network losing contingency criteria on power transformers at several substations as well as overhead lines and underground cables. Several transmission and distribution projects were undertaken to resolve these limitations for Bintulu city.

For Miri, the supply source is injected via three EHV substations - Tudan 275/132/33kV, Marudi Junction 275/132/33kV and Eastwood 132/33kV. Miri city is supplied via 33kV distribution network lines sourced from these EHV substations in addition to Pujut Power Station. Currently, the sub-urban areas are supplied from Marudi Junction EHV Substation and Luak Bay 33kV Zone Substation. System reliability can be improved through additional source injections from Niah 275/33kV EHV Substation and Bunut 275/11 kV Substation.

The Limbang and Lawas networks are currently operated as a non-grid isolated system supplied by local diesel generations. Both stations will be grid-connected via 275kV transmission lines under the Northern Agenda which is currently in progress, linking Bunut 275kV substation to the Limbang and Lawas EHV substations.

Figure 29: Existing EHV substations and transmission lines in Northern Region



With dynamic expansion to rural areas, Sarawak Energy has initiated several projects to ensure the electrical system reliability is not compromised.

Zones	Recently commissioned Sarawak Energy projects that benefit rural customers		Ongoing/future Sarawak Energy projects that benefit rural customers		Proposed rural electricity system projects for REDM	
	Quantity	Value (RM 'mil)	Quantity	Value (RM 'mil)	Quantity	Value (RM 'mil)
Bintulu	2	3.70	1	0.04	6	381.90
Bakun	3	31.40	1	14.00	3	129.00
Miri	3	20.40	1	172.30	1	10.00
Marudi	4	162.50	5	151.10	7	262.00
Telang Usan	-	-	-	-	10	895.40
Limbang	1	1.00	1	135.70	7	580.00
Total	**13**	**219.00**	**9**	**473.14**	**34**	**2,258.30**

In recent years, 13 rural related projects amounting to about RM219 million were commissioned by Sarawak Energy across the Northern Region's six zones. In addition, nine more projects at an estimated total cost of about RM473 million are being planned by Sarawak Energy to further expand the transmission and distribution networks into the interior.

For the REDM, a total of 34 grid expansion and reinforcement projects are proposed for the Northern Region as illustrated in Figure 30. These projects are necessary in line with the development needs of the rural electricity infrastructure in the respective zones of Bintulu, Bakun, Miri, Marudi, Telang Usan and Limbang.

Figure 30: Locations of Proposed Projects under Northern Region

8.1 Bintulu Zone

The Bintulu distribution network is supported by seven bulk power injection points via Bintulu 275/132/33kV, Kidurong 132/33kV, Kemena 275/33kV, Similajau 275/33kV, Samalaju 275/33kV, Samalaju B 275/33kV and Murum Junction 275/33kV EHV substations. It is expected to have continual load growth at an average rate of 2.39% per annum. The actual recorded peak load for Bintulu Station in 2022 is 245.7MV. Bintulu Station is forecasted to reach a peak load of 253.4MV in 2023.

The load growth in the rural areas of Bintulu has been supported by the development of a few substations - Tatau 275kV Substation, Sebauh 33/11kV Substation, and Sangan 33/11kV Substation. The development of Tatau 275/33kV Substation will strengthen the reliability of electricity supply to Bintulu Airport, Zedtee Plantation, Selangau, and the wider Tatau area, which includes Samarakan, Sangan, Sungai Anap and Muput. Sebauh 33/11kV Substation, which was developed under *Projek Rakyat,* will cater for load growth in the Sebauh area. This substation, which is sourced from Similajau EHV Substation, will also provide a strong source of supply to rural communities along Sungai Pandan.

The Sangan 33/11kV Substation which is sourced from Tatau EHV Substation via a double circuit MVCC lines was also developed under *Projek Rakyat* to provide reliable source of supply to rural villages and longhouses in Sangan. The substation will enable the expansion of the distribution system to connect the more remote villages in Sangan which are currently supplied by SARES. Ultimately, the distribution system will be expanded to provide an alternative reliable source for Nanga Merit.

Table 32: Recently completed rsystem reinforcement projects in Bintulu

No.	Projects	Completed	Cost (RM 'mil.)
1.	Installation of 200A 33kV voltage regulator on Tatau Line	2018	0.7
2.	Sebauh & Ulu Sebauh link via 33kV Overhead Line	2020	3.0

	Total		**3.7**

Due to the low voltage issues at Tatau line, a voltage regulator was installed at the line in 2018. To further reinforce and reorganise the distribution system in Tatau, Tatau 275/132/33kV Substation was constructed under *Projek Rakyat* in 2020. The distribution system in Sebauh has also been strengthened with the completion of the 33kV link between Sebauh and Ulu Sebauh, providing contingencies and reliable supply to both areas.

Table 33 List of projects to be constructed by Sarawak Energy in Bintulu

No.	Name	Implementation Year	Cost (RM 'mil.)
1.	Installation of 2nos 1.5MVAR Capacitor bank at Jepak 33/11kV	2023	0.04
	Total		**0.04**

For Jepak, Sarawak Energy has proposed the installation of capacitor banks at Jepak 33/11kV Substation in 2023 to improve the system voltage and cater for increased power demand at the location and surrounding areas.

Table 34: List of rural electricity projects proposed under REDM for Bintulu

No.	Name	Implementation Year	Cost (RM 'mil.)
1	New Jepak 33/11kV Substation	2024	26.80
2	Kuala Tatau 33/11kV Substation, 33kV Covered Conductor Line from Tatau to Kuala Tatau	2026	51.60
3	33kV Covered Conductor Line from Sangan to Nanga Merit	Beyond 2030	68.00
4	Last Miles Renewal & Expansion	By 2030	10.00
5	Upgrading of SARES schemes to Hybrid Stations	By 2030	130.00
6	Renewal or grid transition of SARES/Hybrid	By 2030	95.50
	Total		**381.90**

8.1.1 New Jepak 33/11kV Substation

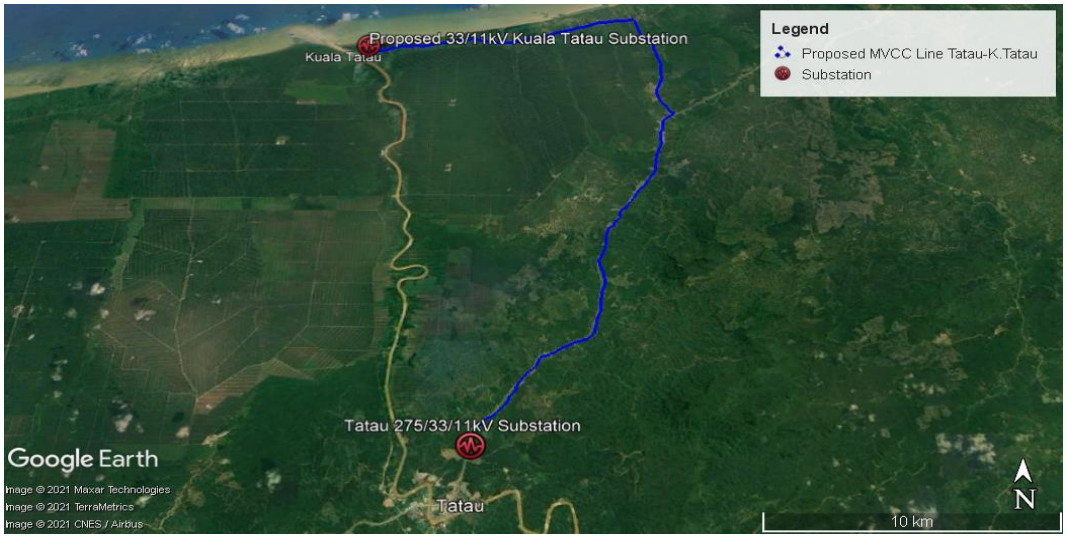
In the medium term, it is anticipated that the existing Jepak 33/11kV Substation will not be able to support the increasing load demand in Jepak and its surrounding areas. A new 33/11kV substation is proposed along Jalan Jepak – Kuala Tatau with an additional 33kV line to supply new customers along the road.

Figure 31: Location of New Jepak 33/11kV Substation

8.1.2 Kuala Tatau 33/11kV Substation and 33kV Covered Conductor Lines from Tatau to Kuala Tatau

The Kuala Tatau 33/11kV Substation is proposed to serve the load growth in the Kuala Tatau area alongside the construction of estimated 39km 33kV double-circuit covered conductor lines from the Tatau 275/132/33kV Substation. The proposed Kuala Tatau 33/11kV Substation will serve as the main source of power injection to electrify growing customers along Kuala Tatau Coastal Road.

Figure 32: Map Showing Kuala Tatau 33/11kV Substation with the Extension of 33kV Covered Conductor Lines from Tatau EHV to Proposed Kuala Tatau 33/11kV Substation

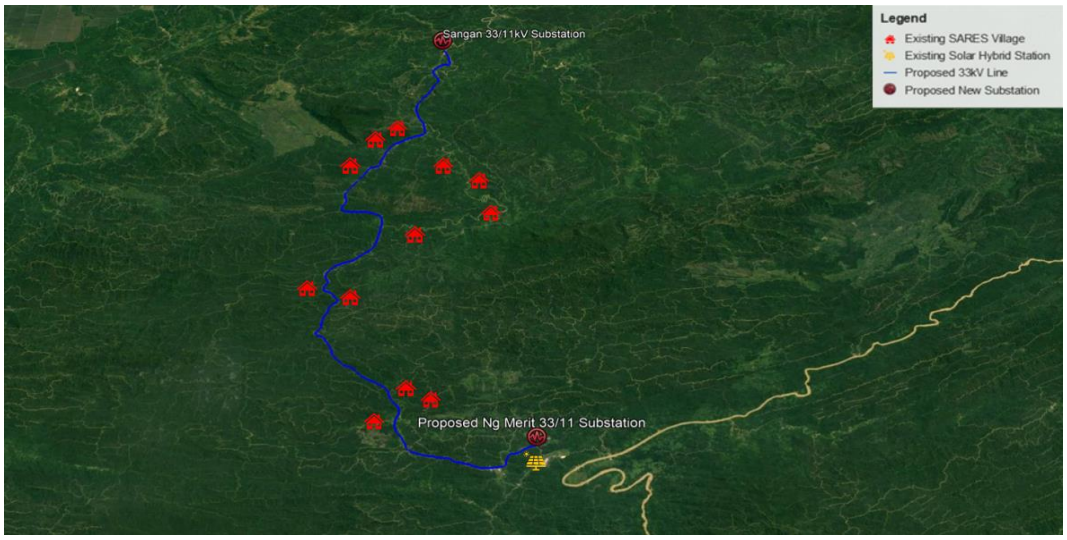


8.1.3 33kV Covered Conductor Lines from Sangan to Nanga Merit

With the Nanga Merit 33/11kV Substation proposed under the Central Region and the solar hybrid station there to be connected to the grid in the future, this proposed project will potentially link link the Nanga Merit 33/11kV substation to the Sangan 33/11kV substation to create a 33kV loop. An estimated 85km of 33kV double circuit covered conductor lines is proposed to link these two

substations to provide system contingencies to both areas. This line will also provide reliable supply and grid connection to a total of 25 villages with 336 households currently relying on the SARES scheme along the Sangan – Nanga Merit route.

Figure 33: 33kV Covered Conductor Lines from Sangan to Nanga Merit



8.1.4 Last Miles Renewal and Expansion in Bintulu

While many rural electrification projects have been implemented in Bintulu, major grid extensions to the interior were only carried out under *Projek Rakyat* in recent years. Hence, there are rural lines and equipment in Bintulu that may require replacement or upgrading due to aging facilities and load growth. Therefore, an allocation of RM10 million for the implementation of renewal and expansion projects is proposed.

8.1.5 Renewal or Grid Transition of SARES and Hybrid Systems in Tatau and Sebauh

In Tatau, there are 69 villages with 1,150 households which are currently utilising the SARES scheme while in Sebauh there are 21 villages with 340 households using SARES since 2016. In addition, the Data Kakus Solar Hybrid Station is supplying electricity to 182 households in the area.

With extensive road construction or upgrading works currently taking place, 28 villages with 446 households at these areas using the SARES scheme have been identified as grid-connectable in the near future. Similarly, the Data Kakus Solar Hybrid Station can also be connected to the grid soon. The total cost to interconnect villages currently supplied by the SARES scheme at Tatau and Sebauh is estimated to be RM35.7 million, while the total cost to connect Data Kakus is RM18.5 million.

In Tatau, 12 villages with 229 households in Ulu Anap, which are currently supplied by SARES, have been proposed for solar system upgrade to solar hybrid with an estimated cost of RM50 million. Another seven villages located in Penyarai, Tatau with 134 households are also being proposed for upgrading from the SARES system to solar hybrid at an estimated cost of RM30 million. In Sebauh, seven villages with 224 households are also going for similar upgrading works, which will cost an estimated RM50 million.

There remain 36 villages with 457 households which will need to continue relying on the SARES scheme for electricity supply in the long-term. These remote villages have no road access for the foreseeable future and are too far from the grid system. For these villages, solar battery replacement for the SARES systems in Tatau and Sebauh will be carried out at an estimated cost of RM30.4 million. These batteries will be replaced in batches depending on their life expectancy and health. A battery replacement project, which is due in 2023, is also in place for the Data Kakus Solar Hybrid Station and is estimated to cost RM4.4 million.

To make sure that no village in Sarawak is left unlit, the State Government will continue to provide new villages with electricity supply via the grid or the SARES scheme. For instance, there are two new villages in this area, namely Long Beyak near Data Kakus, with 59 households, and Rh. Mawang at Nanga Merit, with 30 households, which are currently under construction and will be electrified via SARES once completed. The estimated cost to supply these two villages is RM4.8 million and RM1.7 million respectively.

8.2 Bakun Zone

At Bakun, the distribution network is supported by two bulk power injection points at Similajau 275/33kV Substation and Murum Junction 275/33kV Substation. There are plans to extend the grids to Metalun, Belaga, Punan Bah, Merit and eventually link to Kapit. The completion of the 57km 33kV double-circuit covered conductor lines from Murum Junction EHV Substation to Belaga in 2021 has enabled the Belaga area to be connected to the grid. With construction of Belaga 33/11kV substation progressing and expected to be completed by 2023, Belaga will be connected to the grid. Subsequently, the diesel power station which currently provides supply to Belaga and its surrounding area can be decommissioned.

Table 35: Recently completed system reinforcement projects in Bakun

No.	Projects	Completed	Cost (RM 'mil.)
1	Construction of double circuit covered conductor lines from Murum Junction EHV to Belaga	2021	23.70
2	Construction of 33kV ABC from Murum Junction EHV to Sungai Asap	2021	7.10
3	Installation of 2nd 2.5MVA transformer at Sungai Asap	2019	0.60
	Total		**31.40**

The Sungai Asap Township is currently supplied from Murum Junction 275/33kV Substation with a backup source from Similajau 275/132/33kV Substation via an 80km single circuit 33kV OAK 7/4.65 overhead line. With the installation of a second 2.5MVA transformer, the grid system can cater for the growing load in Sungai Asap.

Table 36: List of projects to be constructed by Sarawak Energy in Bakun

No.	Name	Year	Cost (RM 'mil.)
1	Metalun Micro-Hydro Project	2023	14.00
	Total		**14.00**

The Metalun Resettlement, which consists of Long Singu, Long Tangau, Long Luar and Long Menapa, is currently supplied by local diesel generators. Currently, the resettlement does not have proper road access and extending the grid to the area remains unfeasible. To strengthen the source of supply for this area, two units of micro-hydro generators are to be installed under the RM14 million Metalun Micro-Hydro Project in 2023.

Table 37 List of rural electricity projects proposed under REDM for Bakun

No.	Name	Year	Cost (RM 'mil.)
1	33kV Normal Overhead Line from Jalan Murum Hydro - Long Jeik	2025	8.50
2	Last Miles Renewal and Expansion	By 2030	10.00
3	Renewal or grid transition of SARES	By 2030	110.50
	Total		**129.00**

8.2.1 33kV Normal Overhead Line from Jalan Bintulu-Bakun to Long Jeik

Currently, customers along Jalan Murum Hydro to Long Jeik, Belaga are supplied via a single circuit 33kV overhead line. To provide more reliable supply to consumers in that area, an N-1 contingency circuit is proposed via the construction of another 40km 33kV overhead line from Jalan Bintulu-Bakun to Long Jeik.

Figure 34: 33kV Overhead Line from Junction of Bintulu-Bakun towards Murum and Location of Metalun Hydro

8.2.2 Last Miles Renewal and Expansion in Bakun

The rural electricity systems in Bakun are among the newest in the State, with many of their rural projects being completed and commissioned in recent years. However, with increased load growth, it has become necessary to replace or upgrade some portions of the lines and equipment. An allocation of RM10 million is proposed for the implementation of renewal and expansion projects.

8.2.3 Renewal or Grid Transition of SARES and Hybrid Systems in Belaga and Bakun

In Belaga and Bakun, there are 23 villages with 748 households that have utilised SARES systems since 2019. Furthermore, there are four hybrid stations providing electricity to 490 households. The Belaga Diesel Power station has a power capacity of 2.7MW and currently supplies 696 households. It will be decommissioned when Belaga is connected to the grid upon the completion of the Belaga 33/11kV Substation in 2023.

Table 38: List of Solar Hybrid Stations under Belaga/Bakun

No.	Station Name	Location	Households	Government Facilities
1	Kampung Punan Bah	Belaga	163	Sekolah Kebangsaan Punan Bah
2	SK Long Urun	Sungai Asap, Belaga	229	Sekolah Kebangsaan Long Urun
3	Lusong Laku	Bakun, Belaga	59	Sekolah Kebangsaan Lusong Laku Klinik Kesihatan Lusong Laku
4	Long Kajang	Bakun Belaga	26	No Government Facilities

With the proposal to link the grid from Belaga to Punan Bah, seven villages with 229 households that are currently using SARES systems along the Batang Rejang river downstream of Belaga towards Punan Bah have been identified for grid-connection. In addition, further grid extension surrounding Belaga town will also enable grid connection to another six villages with 272 households currently supplied under the SARES scheme. The total cost to interconnect these villages is estimated at RM40 million.

With the grid reaching Punan Bah, the existing Punan Bah Hybrid Station, which supplies 159 households, could potentially be integrated to the grid as a part of distributed generation (DG).

Long Urun Hybrid Station, which is supplying 235 households will, also be able to be integrated to the grid in the coming years, with an estimated interconnection cost of RM39.4 million.

The remaining 10 villages with 247 households in these areas will continue to rely on SARES schemes. Another 96 households will continue to be supplied by the Lusong Laku and Long Kajang Solar Hybrid Stations for their long-term electricity supply, as these villages do not have any road access and are not grid connectible.

The cost of battery replacement for all SARES systems in Belaga is estimated at RM15.3 million. Battery replacement exercises have been planned for the next several years to replace aging batteries at an estimated cost of RM14.6 million. This includes SARES systems that are pending connection the grid.

A new village, Uma Lesung Batu Keling with 23 households, that is still under construction will also be provided with the SARES system at an estimated cost of RM1.2 million.

8.3 Miri Zone

There are five bulk power injection points at Miri, which are:

- Tudan 275/33kV Substation,
- New Tudan 275/132/33kV Substation,
- Pujut Power Station 33kV Substation,
- Eastwood 132/33kV Substation and
- Marudi Junction 275/33kV Substation.

Tudan 275/33/11kV Substation and New Tudan 275/132/33kV Substation are supporting load demand in the northern area of Miri. Load demand at central Miri is supplied by Eastwood 132/33kV Substation and Pujut Power Station 33kV Substation. The power station is also supported by Tudan 275/33kV Substation via a double circuit 33kV lattice tower line. Meanwhile, Marudi Junction 275/33kV Substation is supplying load demand in the southern area of Miri.

The Niah town and Bekenu areas are currently supplied from Marudi Junction 275/33kV Substation and Luak Bay 33/11kV Substation. The total combined peak load for Miri's outstation areas reached 18.6MW in 2021. The system is now operating at System Reliability Level 2 with an alternative backup source from the Similajau 275/33/11kV Substation. Therefore, a new bulk power injection at Niah is planned to resolve the long outstanding reliability and power quality issues there. Niah 275/33kV Substation project are expected to be awarded in Q3 2023 and will be commissioned by end of 2026 therefore will strengthen the power supply at Niah and its surrounding areas.

Table 39: Recently completed system reinforcement projects at Miri

No.	Projects	Completed	Cost (RM 'mil.)
1.	To divert Airport 33/11kV to Marudi Junction 275/33kV by joining the existing double circuit of Airport-Lambir with portion of Lambir-Marudi monopole lines	2019	5.20
2.	Construction of Niah 33/11kV Substation	2020	14.50
3.	Installation of 33kV VR at Similajau - Niah (H7L5) feeder	2020	0.70
	Total		**20.40**

Diversion of sub-urban area load from Airport 33/11kV to Marudi Junction 275/33kV Substation has been completed and is able to strengthen the system reliability supply to Miri suburban areas which cover Lambir, Marudi, Bekenu and Niah. The development of Niah 33/11kV, which is sourced from Similajau 275/33kV Substation has been completed, with the load around the Niah areas being diverted to the Niah 33/11kV Substation. The installation of the 33kV VR at Similajau – Niah has also been completed, solving low voltage issues and frequent tripping along the long 33kV line.

Table 40: List of projects to be constructed by Sarawak Energy in Miri

No.	Name	Implementation Year	Cost (RM 'mil.)
1.	Niah 275/33kV Substation (2 x 30MVA)	2016	172.30

	Niah Double Circuit Loop-in-and-out of Marudi Junction-Similajau Transmission Lines (2 x 600MVA, 4kM)		
	Total		**172.30**

Although there are already three existing 33kV 7/4.65 overhead lines from the Marudi Junction 275/33kV, Luak Bay 33/11kV and Similajau 275/33kV substations as well as ongoing line extension from Samalaju B 275/132/33kV Substation, the Niah area is still facing frequent power outages due to the long overhead line and low voltage issue as load demand increases. The development of Niah 275/33kV Substation will serve as the bulk power injection to Niah and as a new power injection for Niah 33/11kV Substation.

Table 41: List of projects to be proposed under REDM in Miri

No.	Name	Implementation Year	Cost (RM 'mil.)
1	Last Miles Renewal and Expansion	By 2030	10.00
	Total		**10.00**

8.3.1 Last Miles Renewal and Expansion in Miri

There is a mixture of old and new rural electricity systems in villages around Miri. With load growth and aging electrical infrastructure, it is necessary to replace older systems or upgrade certain lines and equipment. A significant amount of replacement and upgrading works were piggy-backed on recently completed RES Last Miles projects under *Projek Rakyat.* An allocation of RM10 million is proposed for the implementation of additional renewal and expansion projects.

8.4 Marudi Zone

The Marudi area, which covers Bakong, Tinjar and Lapok, is currently supplied from the Marudi Junction 275/33kV Substation via the existing Marudi Junction-Niah conventional 33kV overhead lines. Upon the Bunut 275/132/33kV substation's completion in Q3 2022, the supply for the whole Bakong area has been shifted to this new EHV substation. It significantly improved the reliability and voltage performance for these areas and reduced the loading on the Marudi Junction-Niah line.

The Bunut 275/132/33kV is located approximately 4km away from Pekan Lapok. A 5MVA 33/11kV transformer is proposed following to the completion of the Bunut EHV substation to take up about 2MW of loads at Bakong, Tinjar and Lapok areas. The transformer installation was completed in Q3 2022.

Table 42: Recently completed system reinforcement projects at Marudi

No.	Projects	Completed	Cost (RM 'mil.)
1	Construction of Marudi Junction 275/33kV	2018	131.00
2	Construction of Marudi Junction 33kV (incorporated with EHV)	2018	7.20

3	To lay double circuit of 33kV 630mm2/CU/1C/XLPE from Marudi Junction 275/33kV to Lambir 33/11kV	2018	22.00
4	To divert Marudi 33kV monopole lines to be supplied from Marudi Junction 275/33kV	2018	2.30
	Total		**162.50**

The recently completed Marudi Junction 275/132/33kV Substation is now the source of supply for Marudi, Niah, Bekenu, Lambir and Bakong.

Table 43: List of projects to be constructed by Sarawak Energy in Marudi

No.	Projects	Implementation Year	Cost (RM 'mil.)
1	Installation of 5MVA 33/11kV transformer at Bunut 275/132/33kV	2018	1.00
2	Construction of Bunut 275/132/33kV	2015	140.20
3	Installation of 5MVA 33/11kV transformer at Marudi Junction 275/33kV	2021	0.80
4	Construction of Bunut 33kV (incorporated with EHV)	2017	8.30
5	11kV load reorganization for Bakam 33/11kV	2019	0.80
	Total		**151.10**

The development of Bunut 275/132/33kV Substation will not only benefit the Bakong to Long Lama area, but also strengthen the reliability of Miri power system. Miri will no longer solely depend on the existing double circuit Similajau – Marudi Junction 275kV lines. The city will have alternative sources of supply from Bunut 275/132/33kV via the Similajau – Bunut 275kV line and Bunut – Marudi Junction 275kV line. The installation of the 5MVA 33/11kV transformer at Bunut 33kV Substation will be able to cater for the load at Bakong, Tinjar and Lapok and reduce the stress on the 33/11kV Marudi Junction-Niah feeder. The installation of the 5MVA 33/11kV transformer at Marudi Junction 275/33kV will be able to improve system reliability towards Microwave and Bukit Song Booster Pump.

Table 44: List of projects to be proposed under REDM in Marudi

No.	Name	Implementation Year	Cost (RM 'mil.)
1	Marudi Town 33kV Substation	2024	15.80
2	33kV Covered Conductor Lines from Eastwood to Marudi Town	Beyond 2030	36.80
3	33kV Covered Conductor Lines from Marudi Town to Mulu	2026	60.50
4	Mulu 33kV Substation	2026	19.50
5	Last Miles Renewal and Expansion	By 2030	10.00
6	Upgrading of SARES schemes to Hybrid Stations	By 2030	83.00
7	Renewal or grid transition of SARES	By 2030	36.40
	Total		**262.00**

8.4.1 Marudi Town 33kV Substation

Supply to Marudi Town is currently sourced from the Marudi Junction 275/33kV Substation via a double circuit 33kV Ash, a mixture of monopoles and lattice towers with a line length of 44km. The proposal is to construct a new 33kV full-fledge zone substation at Marudi to cater for the existing 33kV line sourced from Marudi Junction 275/33kV Substation. This will provide a reliable source of supply to the proposed additional 33kV double-circuit covered conductor lines sourced from Eastwood 132kV Substation. This new substation will also provide supply to two outgoing 33kV covered conductor lines to the proposed Long Panai Junction 33kV Switching Substation. With the additional source from Eastwood 132kV Substation, system reliability for Marudi Town is expected to improve significantly.

Figure 35: Proposed Marudi Town 33kV Substation Location and 33kV Double Circuit Covered Conductor Lines from Eastwood EHV Substation

8.4.2 33kV Covered Conductor Lines from Eastwood to Marudi Town

The approximately 45km double circuit 33kV covered conductor lines from the Eastwood EHV 132/33kV Substation to the proposed Marudi Town 33/11kV Substation will provide an additional energy source to Marudi, improving system reliability. The proposed line route will follow the new RECODA road and pass-through multiple plantation estates, providing opportunities to supply electricity to these plantation premises as well as villages along the route in the future.

8.4.3 33kV Covered Conductor Lines from Marudi Town to Mulu

With the road linking Marudi to Mulu being planned by RECODA, construction of 33kV double-circuit covered conductor lines, with an estimated length of 75km, along the road is proposed. Besides connecting Mulu town and its surrounding villages, the line will also provide reliable supply to the Marriot Resort, Mulu National Park and other common facilities. With the completion of this line, villages currently supplied by SARES will be able to be connected to the grid. This line will also be the backbone to support the development of RECODA's Mulu Development Master Plan.

8.4.4 Mulu 33/11kV Substation

With the objective of bringing the grid to Mulu via the aforementioned 33kV covered conductor line, it is also proposed to construct a full-fledged 33/11kV substation for the distribution of electricity supply to the whole of Mulu.

Figure 36: Proposed Long Panai 33kV Substation, Mulu 33/11kV Substation Location and 33kV Double Circuit Covered Conductor Lines from Marudi Town Substation

8.4.5 Last Miles Renewal and Expansion in Marudi

The rural electricity systems in Marudi are relatively new with many projects being undertaken and commissioned under *Projek Rakyat* around 2020. However, with increased load growth, it may be necessary to replace older systems or to upgrade portions of distribution lines and equipment. It An allocation of RM10 million for implementation of renewal and expansion projects is proposed.

8.4.6 Renewal or Grid Transition of SARES and Hybrid Systems in Marudi

In Marudi, there are 13 villages with 666 households utilising SARES systems that have been implemented since 2018. The Mulu Diesel Power Station has a power capacity of 1.4MW and currently supplies the Marriott Hotel. It will soon supply two villages in Mulu.

With the proposed Long Panai 33kV Switching Substation, Mulu 33kV Substation and 33kV double circuit covered conductor lines from Marudi Town Substation, it is possible to connect seven villages with 285 households situated along Marudi-Mulu, all of which are currently utilising the SARES scheme. The two larger villages, Long Panai and Long Terawan, will also be connected to the grid upon completion of the 33kV line. However, the transition to grid for these villages is expected to be implemented beyond 2030 at a cost of RM22.8 million due to the time required to complete road access construction between Marudi-Mulu. Due to this, a SARES system battery replacement exercise, which costs an estimated RM13.6 million, is proposed to replace the aging batteries, considering that the grid infrastructure will not be ready in the near future.

SARES systems at Long Panai, which has 135 households, and Long Terawan, with 97 households, will be upgraded to solar hybrid by 2026 at an estimated cost of RM55 million. Meanwhile, there are another two villages with 128 households which are currently supplied via SARES that have been proposed for upgrading to solar hybrid at a total estimated cost of RM28 million.

Meanwhile, Logan Tasong, which has with six households, will rely on the SARES system for their long-term electricity supply as the village has no road access and is not grid connectible.

8.5 Telang Usan Zone

There is currently no transmission or distribution grid in Telang Usan. The Northern Agenda aims to connect Limbang and Lawas to the State Grid by 2024. The new 275kV transmission line, starting from Marudi Junction Substation, shall transverse Telang Usan and create opportunities to connect the villages to the grid.

Table 45: List of projects to be proposed under REDM in Telang Usan

No.	Name	Implementation Year	Cost (RM 'mil.)
1	Upgrading of SARES schemes to Hybrid Stations	By 2030	345.00
2	Renewal or Grid Transition of SARES and Hybrids systems in Telang Usan	By 2030	142.20
3	Long Bedian 275/33kV Substation	2026	261.60
4	Long Kevok 33kV Substation	2026	8.30
5	33kV Covered Conductor Lines from Long Lama to Long Panai	2028	29.70
6	Long Panai Junction 33kV Substation	2028	8.30
7	33kV Covered Conductor Lines from Long Bedian to Long Lama Junction	Beyond 2030	15.40
8	33kV Covered Conductor Lines from Long Bedian to Long Kevok	Beyond 2030	23.10
9	Bario 33kV Substation	Beyond 2030	18.80
10	33kV Covered Conductor Lines from Ba'kelalan to Bario	Beyond 2030	43.00
	Total		**895.40**

8.5.1 Renewal or Grid Transition of SARES and Hybrids systems in Telang Usan

There are currently 96 villages with 5,214 households utilising the SARES systems that have been implemented since 2017. Furthermore, there are 14 solar hybrid stations and one micro-hydro hybrid station providing electricity to 22 villages with 1,531 households.

Table 46 List of Solar Hybrid Stations under Telang Usan Zone

No.	Station Name	Location	Households	Government Facilities
1	Long Peluan	Telang Usan	13	SACOFA tower

2	Pa Remudu	Bario	21	No Government Facilities
3	Pa Lungan	Bario	28	No Government Facilities
4	Pa Dalih	Bario	52	SK Pa Dalih Klinik SACOFA tower
5	Pa Mada	Bario	22	No Government Facilities
6	Bario Central	Bario	416	SK Bario, SMK Bario Klinik Bario Bario District Office Sarawak Forestry Immigration Office Bario Airport
7	Long Lellang	Bario	57	SK Long Lellang Klinik Long Lellang SACOFA tower
1	SK Long Wat	Long Bemang, Marudi	138	SK Long Wat
2	SK Long Atip	Long Bemang, Marudi	153	SK Long Atip
3	SK Long Bedian	Long Bemang, Marudi	291	SK & SMK Long Bedian Pejabat Daerah Kecil Long Bedian Klinik Long Bedian JBALB water treatment SACOFA tower
4	Kampung Long Tujang	Long Bemang, Marudi	56	Tadika Kemas
5	Kampung Long Buang	Long Bemang, Marudi	36	No Government Facilities
6	Kampung Long Bemang	Long Bemang, Marudi	300	SK Long Bemang Klinik Long Bemang Tadika Kemas SACOFA tower
7	Long Seridan Buyo	Marudi	63	SK Long Seridan Klinik Long Seridan JBALB water treatment SACOFA tower

There are also two diesel power stations in Telang Usan - Long Lama Diesel Power Station, which has an installed capacity of 1.4MW and supplies 569 households, and Long San Diesel Power Station, which has an installed capacity of 375kW and supplies 97 households. The Long San Solar Hybrid Station, which is currently under construction, is due for completion by end of 2022 and will replace the diesel power station as the source of electricity supply for Long San.

At Long Banga, the Long Banga Micro Hydro Hybrid Station Phase 1 is supplying 137 households. The Long Banga Micro Hydro Hybrid Station Phase 2 is pending completion and will supply an additional two villages with 108 households, the Integrated Highland Agriculture Station as well as new households upon commissioning.

In Telang Usan they are seven villages with 972 households that are currently under planning for an upgrade from the SARES system to solar hybrid. The cost for this upgrade is estimated at RM214 million. The villages are Long Miri, Long Pillah, Long Naah, Long Jeeh, Long Moh, Long Selaan and Long Apu.

Furthermore, an additional eight large villages with 594 households in Telang Usan will be proposed for similar upgrades to solar hybrid at the cost of RM131 million

Due to the limitation of road access and grid availability, there are only two villages, with a total of 102 households, bound for transition to the grid with total households. This will cost an estimated RM8.1 million.

The remaining 79 villages, with 3,546 households, will continue to rely on SARES for their long-term electricity supply while all 14 existing solar hybrid stations and one micro-hydro station will continue serving 1,531 households as these villages have no road access and are not grid connectible. Battery replacement for the SARES systems in Telang Usan is estimated at RM106.3 million. The battery replacement cost for Solar Hybrid Stations in Telang Usan is estimated at RM26.2 million.

There are three villages that have yet to be electrified in Telang Usan zone, namely Ba Bareh, Ba Ubong and Ba Taha, all three of which have a total of 29 households. The proposal is to supply these villages via the SARES scheme at a total cost of RM1.6 million.

8.5.2 Long Bedian 275/33kV Substation

The existing grid connection is mainly situated along the western coast of the Northern Region. The rural households in the central and eastern portion are mostly supplied via Sarawak Energy's diesel power stations as well as SARES or hybrid systems. Extending the existing distribution grid lines is not possible due to major issues such as low voltage and poor reliability. Therefore, it is essential to construct the Long Bedian 275/33kV Substation as a new injection point for the central part of the region.

This substation will be situated near Long Bedian and is proposed source from the Bunut-Medamit 275kV transmission line. Its construction will provide an additional source of supply to both Long Lama 33kV Substation and the newly proposed Long Panai Junction 33kV Substation. It will also eventually connect to the proposed Mulu 33kV Substation.

8.5.3 Long Kevok 33kV Substation

The Long Kevok 33kV Switching Substation is proposed to be constructed near to the junction towards Long Kevok, constructing three 33kV outgoing feeders to the surrounding areas with villages that are

currently supplied via SARES or solar hybrid stations. This will enable these villages to be connected to the grid once the grid infrastructure is ready.

8.5.4 33kV Covered Conductor Lines from Long Lama to Long Panai Junction

Based on the RECODA road plan for Long Lama, a new road connecting Long Lama and Long Panai will be constructed in the near future. Hence, the implementation of double circuit 33kV covered conductor lines is proposed along the planned road with an estimated length of 30km. The proposed line can also connect three hybrid stations to the grid, namely Long Bemang, Long Tujang and Long Buang.

Figure 37: The 33kV Covered Conductor Lines Connection between Proposed Long Bedian EHV Substation, Proposed Long Panai 33kV Substation and Long Lama 33kV Substation

8.5.5 Long Panai Junction 33kV Substation

With the Marudi Town-Mulu 33kV Covered Conductor Line crossing the Long Lama-Long Panai Junction 33kV Covered Conductor Line near Long Panai Junction, a 33kV switching substation at Long Panai junction is proposed for ease of switching and system operation in the future. With this grid expansion in place, villages currently supplied via SARES schemes and solar hybrid in the Tutoh Cluster will be able to be connected to the grid in the near future.

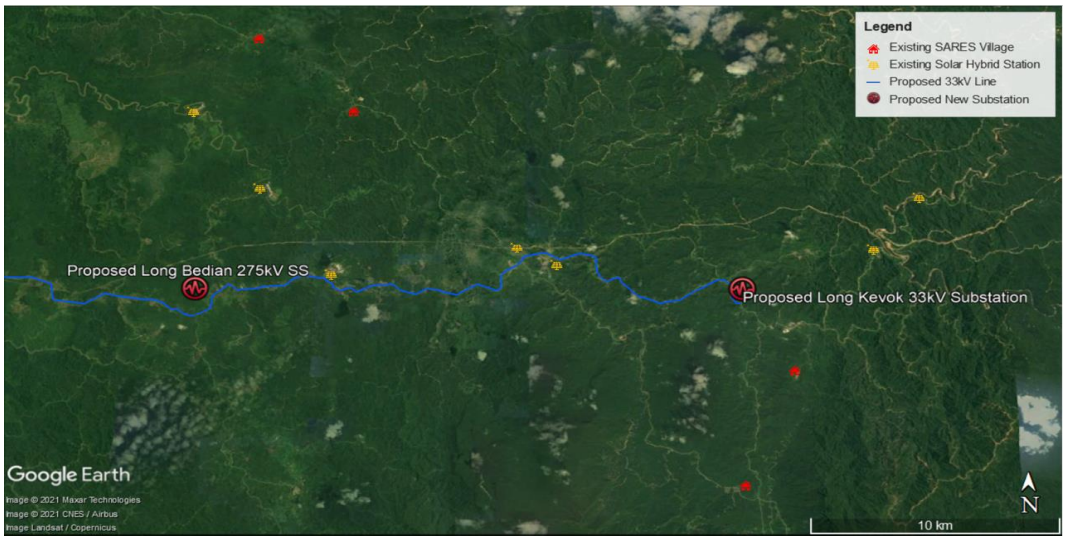
8.5.6 33kV Covered Conductor Lines from Long Bedian to Long Lama Junction

With new road access from Long Lama Town to Long Bedian Town, construction of approximately 20km double circuit 33kV covered conductor lines from Long Bedian 275/33kV EHV Substation is proposed to link the Long Lama-Long Panai Junction 33kV Covered Conductor Lines at Long Lama Junction. With the connection from Long Bedian EHV Substation, both Long Lama 33kV Substation and Long Panai Junction Substation will have additional sources of supply, thus improving the system reliability in that area.

8.5.7 33kV Covered Conductor Lines from Long Bedian to Long Kevok

The proposal is to construct double circuit 33kV covered conductor lines from Long Bedian 275/33kV Substation to Long Kevok 33kV substation. These 30km MVCC lines will supply the proposed Long Kevok 33kV Substation and enable grid connection to villages currently supplied by SARES schemes and solar hybrid stations in the vicinity.

Figure 38: Proposed Long Kevok 33kV Substation Location and 33kV Double Circuit Covered Conductor Lines from Proposed Long Bedian EHV Substation



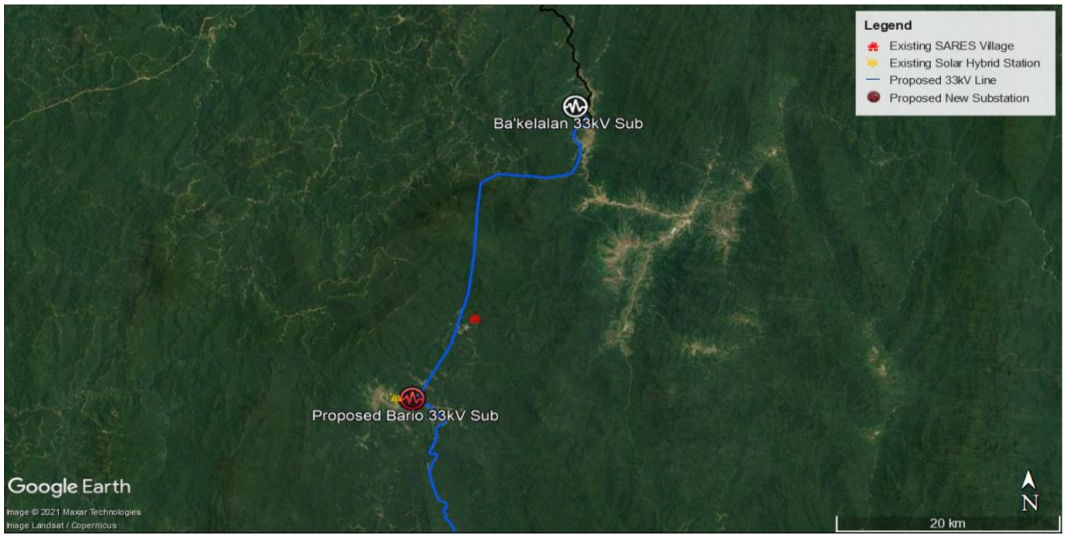
8.5.8 Bario 33kV Substation

Bario is located 56km from Ba'kelalan and close to the Sarawak-Kalimantan border. Households in this area are currently supplied by the 998kW Bario Central Solar Hybrid Station which is equipped with three units of diesel generators. With a population of more than 400 households, it is proposed to construct a 33kV zone substation to be supplied via 33kV covered conductor lines from Ba'kelalan 33kV Substation. The grid connection is proposed to further extend grid infrastructure to enable the interconnection of Bario Central Solar Hybrid Station to the grid while simultaneously providing a grid source to villages currently supplied via SARES and solar hybrid systems.

8.5.9 33kV Covered Conductor Lines from Ba'kelalan to Bario

Another 33kV double circuit covered conductor lines is proposed to connect Bario from Ba'kelalan 33kV Substation via the existing Jiwa Murni Roadm which is approximately 60km long. This line shall be the source of supply for the proposed Bario 33kV Substation.

Figure 39: Proposed Ba'kelalan - Bario 33kV Covered Conductor Lines



8.6 Limbang Zone

Under the Limbang zone, both Limbang and Lawas towns are currently supplied by their own respective diesel generating stations. As part of the Northern Agenda, 275kV transmission lines are under construction from the Marudi Junction 275/132/33kV EHV substation to connect both towns to the State Grid, allowing for the decommissioning of their respective diesel power stations. At the distribution level, a reinforcement project was completed recently to convert a 33kV ABC to a conventional overhead line from Tedungan/Medamit Junction to Mekasing, improving line reliability.

Table 47: Recently completed system reinforcement projects in Limbang

No.	Projects	Completed	Cost (RM 'mil.)
1	Convert 33kV ABC to 33kV Overhead Line from 33kV OH Line from Tedungan/Medamit Junction to Mekasing	2020	1.0
	Total		**1.0**

Table 48: List of projects to be constructed by Sarawak Energy in Limbang

No.	Projects	Implementation Year	Cost (RM 'mil.)
1	Lawas 275/33kV Substation	2019	135.7
	Total		135.7

The development of the ongoing Lawas 275/33kV substation and 275kV transmission lines from Marudi Junction will enable grid connection to Lawas, which will benefit the rural consumers in the Lawas, Long Luping and Ba'kelalan areas, with grid penetration via a 33kV covered conductor lines from Lawas to Ba'kelalan.

Table 49: List of projects to be proposed under REDM in Limbang

No.	Name	Implementation Year	Cost (RM 'mil.)
1	Trusan Junction 275/33kV Substation	Beyond 2030	224.80
2	Medamit 275/33kV Substation	Beyond 2030	147.40
3	33kV Covered Conductor Lines from Medamit to Trusan	Beyond 2030	60.80
4	33kV Covered Conductor Lines from Medamit to Mulu	Beyond 2030	102.40
5	Last Miles Renewal and Expansion	By 2030	10.00
6	Upgrading of SARES schemes to Hybrid Stations	By 2030	18.50
7	Renewal or grid transition of SARES	By 2030	16.10
	Total		**580.00**

8.6.1 Trusan Junction 275/33kV Substation

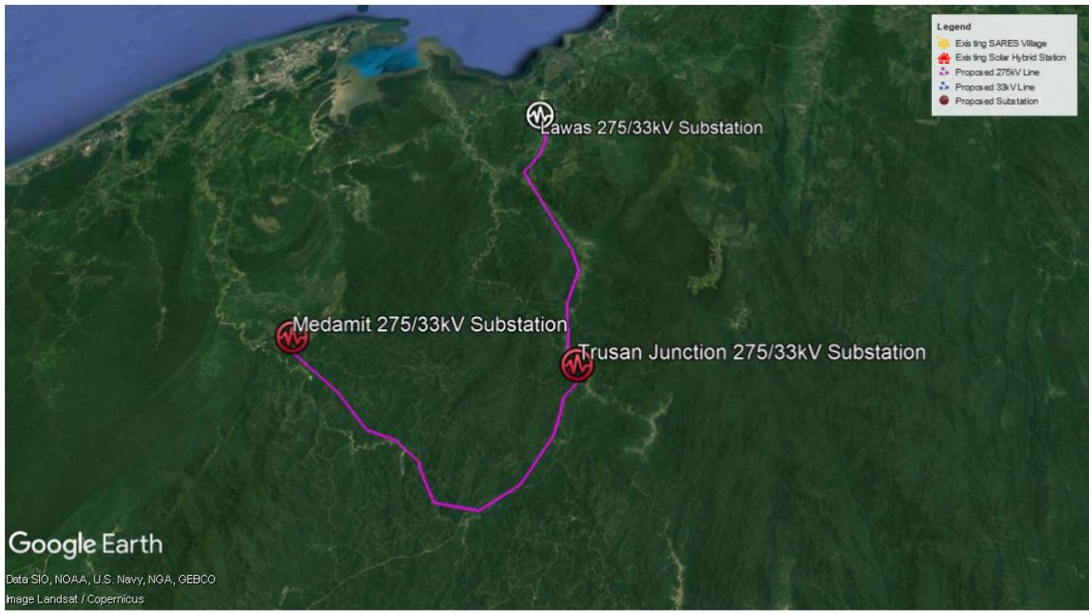
Trusan HEP located in the Northern Region has been identified as a potential small hydroelectric plant in the future. The development of Trusan Junction 275/33kV will serve as a connection point for the integration of Trusan HEP. Rural communities scattered inland at the border of North Kalimantan will be able to benefit from grid connection and power reliability from this 275/33kV substation. Further extension into Northern Kalimantan becomes viable for power export opportunities to neighbouring rural communities at the border.

For rural electricity systems, this substation shall enable the Lawas-Ba'kelalan MVCC lines to be extended all the way to Bario (subject to the readiness of road connectivity) to connect the villages and surrounding areas to the State grid. By switching its source to this substation, villages and other customers connected to this MVCC line will experience improved supply capacity and reliability too.

8.6.2 Medamit 275/33kV Substation

The construction of the Medamit 275/33kV substation enables grid integration for potential future hydroelectric plants located in the Northern Region, such as Limbang HEP 1 & 2. In addition, the development of the Medamit 275/33kV will improve supply reliability for domestic loads in the region.

Figure 40: Proposed Trusan 275/33kV and Medamit 275/33kV Substation Location

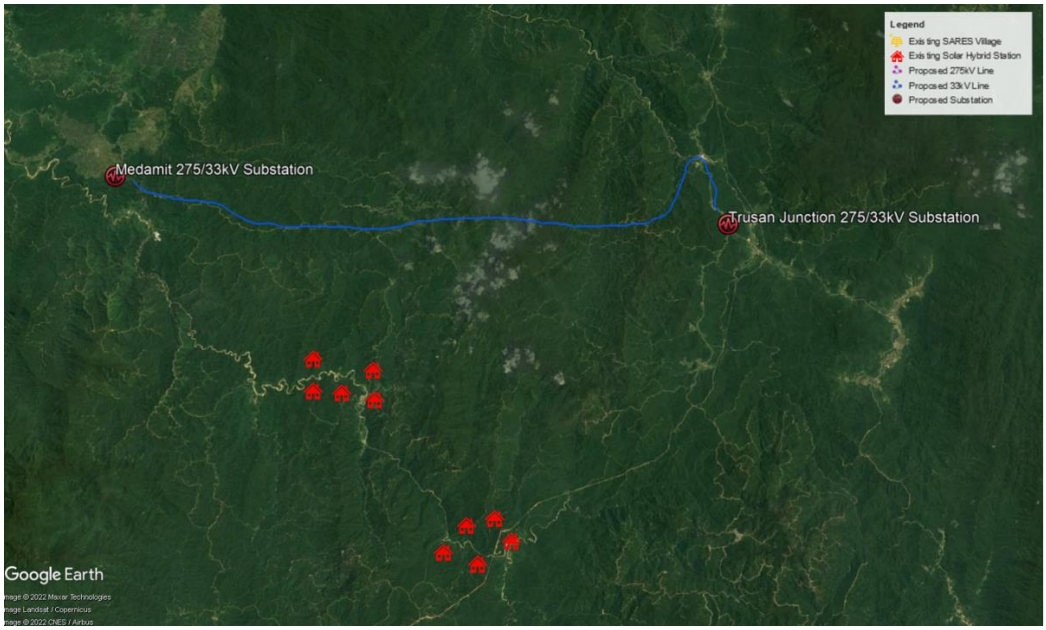


8.6.3 Mulu – Medamit – Trusan Interconnecting Loop

8.6.3.1 33kV Covered Conductor Lines from Medamit to Trusan

The construction of 33kV Covered Conductor lines between Medamit 275/33kV substation and Trusan Junction 275/33kV Substation is being proposed following the planned Sarawak-Sabah Link Road (SSLR) Phase 2 project, which is estimated to be 76 km long. This proposed line will serve as the reliable source to connect villages that are currently supplied via SARES schemes at Ulu Medamit and Long Merarap to the grid.

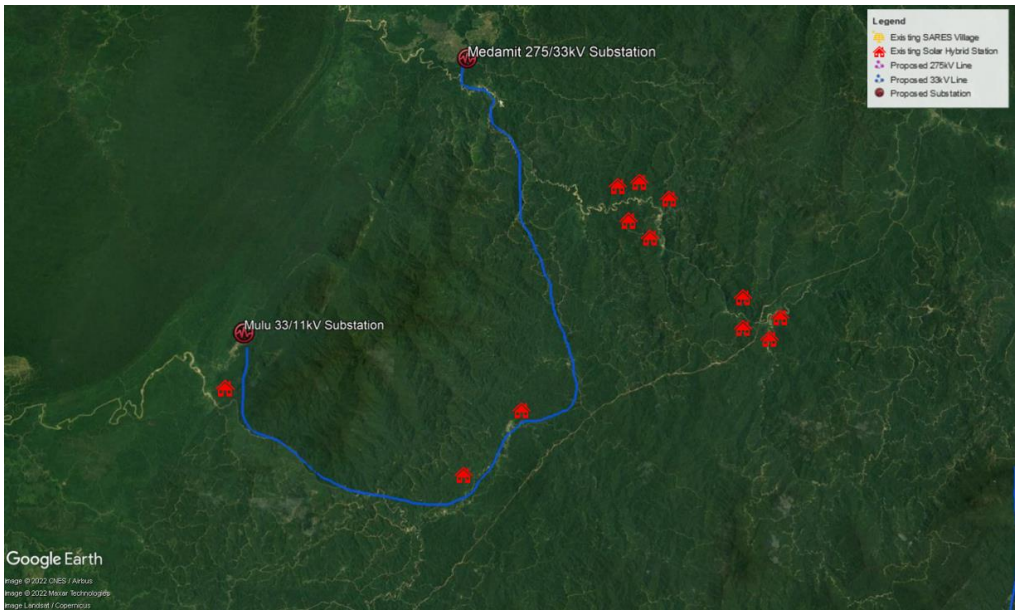
Figure 41: Proposed Medamit – Trusan 33kV Covered Conductor Route



8.6.3.2 33kV Covered Conductor Lines from Medamit to Mulu

The proposed Medamit-Mulu 33kV Covered Conductor Lines is intended to provide an additional source to Mulu 33kV Substation from Medamit EHV Substation. Hence, improving the reliability of supply for Mulu town. The line length is estimated at 128km and it will be constructed following the completion of Sarawak-Sabah Link Road (SSLR) Phase 2. In addition, this line will provide necessary grid connection to villages that are currently supplied via SARES schemes or solar hybrid stations along the new road from Medamit to Mulu.

Figure 42: Proposed Medamit – Trusan 33kV Covered Conductor Route



8.6.4 Last Miles Renewal and Expansion in Limbang

The rural electricity systems in Limbang are relatively new with many projects implemented and commissioned under *Projek Rakyat* around 2020. However, with increased load growth, it may be necessary to replace the older systems or to upgrade portions of distribution lines and equipment. An allocation of RM10 million for the implementation of renewal and expansion projects is proposed.

8.6.5 Renewal or Grid Transition of SARES systems in Limbang

In the Limbang and Lawas Zones, there are 14 villages with 257 households that are utilising SARES schemes, which have been implemented since 2017. There are two solar hybrid stations, namely Long Sukang Solar Hybrid Station and Long Semadoh Solar Hybrid Station in Lawas, providing electricity to 97 households. These stations will be integrated to the grid once the Lawas-Ba'kelalan MVCC line is completed. The estimated cost for the integration is estimated at RM9.7 million. A battery replacement exercise estimated at RM1.2 million shall be carried out as the aging batteries are bound for replacement before integration to the grid a few years later.

All of the villages supplied via SARES will continue to rely on the off-grid system for their long-term electricity supply as these villages have no road access and are not feasible for grid connection for the foreseeable future. Battery replacements for these SARES stations is estimated to cost RM5.2 million.

For better system reliability, the possibility to upgrade the SARES systems to solar hybrid will also be explored. Long Napir (49 households) and Kampung Bahagia (35 households) have been proposed for system upgrade to solar hybrid at a total estimated cost of RM18.5 million.

9 EMERGING TECHNOLOGIES

9.1 Embracing Emerging Technologies in Rural Electrification

As we move toward achieving full electricity coverage in rural Sarawak, it is imperative that we continue to improve the services we provide to rural communities and businesses. The Sarawak Government and Sarawak Energy have continued exploring emerging technologies and finding ways to incorporate them into rural electricity development. Some of the new initiatives currently taking place are listed below.

1. Advanced energy storage technologies
2. Emerging hydroelectric technologies
3. Distributed Energy Resources

9.2 Advanced Energy Storage Technologies

In 2023, Sarawak Energy commissioned a pilot containerised solar-hydrogen power station at Rumah Bangau, Katibas. Currently, it is at the research and data collection stage. This system was designed equivalent to SARES solar system specifications, with the aim of studying the potential of the containerised hydrogen system to store excess renewable energy and improve overall power plant efficiency, ultimately serving as an alternative energy solution for rural electrification. This hydrogen application has the potential to be incorporated into other off-grid solar hybrid and hydro power generation in rural Sarawak.

Besides Hydrogen, there are other promising energy storage solutions such as Lithium-ion battery, flow battery, sodium battery and super capacitor that can be used to replace the older Lead Acid battery technology. Further study is needed to determine their suitability as sustainable and cost-effective energy solutions in rural electrification application.

9.3 Emerging hydroelectric technologies

With many rivers and tributaries in rural Sarawak, there are many sites that have the potential for energy generation using emerging hydroelectric technologies such as Low Head Hydro (LHH) and Hydrokinetic technologies. These types of technologies can be deployed at rural areas to support rural community energy needs. Sarawak Energy has initiated a LHH Masterplan to explore LHH technology and identify suitable locations where it can be adopted. The masterplan will explore concepts and best practices with a strong focus on strategies for economically integrating these new hydroelectric technologies to complement the existing off-grid rural electrification scheme, which mostly relies on solar technology.

9.4 Distributed Energy Resources

In the coming years, it is anticipated that more and more off-grid villages which currently rely on SARES and solar hybrid systems will be connected to the main grid as the Government continues to strengthen and expand grid infrastructure into Sarawak's rural areas. With the arrival of the grid, many of these SARES and solar hybrid stations can be grid-connected and serve as DG.

The integration of DG will enable utilities to transition from a centralised system towards a decentralised one. This requires advanced energy management, monitoring and control systems as well as the digitalisation of power stations and improved cybersecurity.

Sarawak Energy is working on two initiatives to support distributed energy resources (DER). The first is the pilot microgrid system at Semadang, Borneo Highland. This microgrid includes DG sources like solar, mini hydro, and battery. The pilot microgrid system aims to demonstrate the effectiveness of integrating multiple DG sources and operating them in conjunction with the main grid. The system can operate in both on-grid and off-grid scenarios, enhancing the flexibility and reliability of the grid system.

The second initiative is the proposed Community Solar scheme, which involves converting off-grid SARES stations to grid-connected solar systems. The electricity generated from the solar system will be exported to the grid through a Net-Energy Metering scheme and this allow the community to become prosumers while also gaining savings on their electricity bill.

In summary, through these initiatives, Sarawak Energy aims to foster a more inclusive and sustainable energy future for rural communities. This approach emphasises the importance of collaboration among stakeholders, including local communities, government agencies, and the private sector. Ultimately, it serves to drive rural electrification and support sustainable economic growth.

10 CONCLUSION

REDM 2030 is a blueprint jointly developed by Sarawak's Ministry of Utility and Telecommunication and Sarawak Energy with the primary aim of maintaining continuous development of electrical infrastructure and enhancing the prosperity of Sarawak's rural areas by ensuring no village is left in the dark. It is a continuation of the successful implementation of the Rural Electrification Master Plan (REMP) 2018, which is currently on track to achieve full state-wide electrification by 2025.

Apart from providing a basic necessity to rural communities, the availability of reliable electricity infrastructure is the backbone for achieving sustainable growth and prosperity for Sarawak by meeting the need for sustainable, reliable, and affordable energy. This will enable Sarawak to achieve developed status by 2030. This masterplan lays out what has been achieved by Sarawak Energy through government funding, further commitments to invest in electricity infrastructure across the state, necessary projects for maintaining accessibility, improving capacity and reliability, and achieving a sustainable ecosystem in rural Sarawak for the long term.

The masterplan does not concern itself with the operation and maintenance of the rural electricity systems once it is commissioned. An annual grant shall be sought separately from the government to cover the increasing costs of operating and maintaining rural electricity systems.

11 APPENDIX

Table 50: List of Standard Rates for Project Cost Estimates

No.	Description	Qty	Unit Price (RM)
1	33kV Normal Overhead Line	1km	400,000
2	33kV Covered Conductor Single Circuit	1km	700,000
3	33kV Covered Conductor Double Circuit	1km	800,000
4	33kV Aerial Bundled Cable	1km	600,000
5	11kV Normal Overhead Line	1km	350,000
6	11kV Aerial Bundled Cable	1km	500,000
7	Normal 33kV Substation	1 ls	7.5 million
8	Full-fledged/ Switching/ Zone Substation	1 ls	18 million
9	132kV Substation	1 ls	80 million
10	275kV Substation	1 ls	150 million
11	132kV Transmission Line Double Circuit	1km	6.5 million
12	275kV Transmission Line Double Circuit	1km	8.5 million
13	SARES (Off-grid)	1hh	55,000
14	Hybrids (Off-grid)	1hh	250,000
15	SARES to Hybrids upgrading	1hh	220,000
16	Off-grid Transition to Grid	1hh	80,000

Table 51: Voltage Levels

Voltage Level	Voltage
Transmission: Extra High Voltage (EHV)	275kV
	132kV
Distribution: Medium Voltage (MV)	33kV
	11kV
Distribution: Low Voltage (LV)	415V