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Overview of Electrical Energy Planning in West Sumatera

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Abstract— The need for the availability of electrical energy over time continues to increase from year to year. Population, Economic and Industrial Growth are factors in the increasing consumption of electrical energy in West Sumatra. In order to avoid an energy deficit, an estimate of long-term electricity consumption is carried out until 2028 in West Sumatra. The first step that needs to be done is to forecast the future demand for electrical energy with data based on historical data on electric energy sales and economic parameters, population growth from the previous several years. In this overview, the future energy demand and supply projection in West Sumatera from National Electricity Supply Business Plan (RUPTL) 2019-2028 are analyzed and compared. The realization of the sale of electricity in 2018 was around 3,485 GWh increased around 5.93 % in average. The need for electrical energy tends to increase from year to year. In 2019 the need for electrical energy is 3,705 GWh with peak load 641 MW, while in 2028 to be 6,980 GWh with peak load 1,151 MW. The average growth in energy sales and peak load are 7.29 % and 6.73% respectively. Based on the projection, it is necessary to build a power plant of 2,368.4 MW to meet the demand growth.

Keywords: Power system planning, Electrical energy consumption, Generation planning and Electrification ratio.

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1. Introduction

Electricity has become a basic necessity for modern society today, almost all human activities utilize electrical energy. On the other hand, the need for electrical energy continues to increase, along with the increase in population, customers, industry, gross domestic product and so on. At this time, the availability of electrical energy has not been able to serve the needs of all levels of society in West Sumatra Province. The electrification ratio of West Sumatra, it is stated that the Electrification Ratio (ER) of West Sumatra has reached 96.56% in October, 2019 which consists of 95.30% (1,165,201 household) which is PLN utilities and 1.26% (14,954 household) is private electricity. So that from the data there is still 3.44% or 98,829 residential not electrified. Meanwhile, the ratio of villages with electricity has reached 99.91% where this value represents 1,157 villages/Nagari in West Sumatra that have electrification, and the remaining 0.09% represents 1 village in the Mentawai Islands Regency that is not electrified [1].

The provision of electricity to meet the needs of the province of West Sumatra is currently being undertaken by PT. PLN. The West Sumatra region is one part of the Southern PLN interconnection system area. With the existence of this interconnection system, it is possible to meet the demand for electricity in each region (province) in the interconnection area to be supplied from other surplus regions. In the short term, electricity needs in West Sumatra can be met from existing generators in this area and the shortfall is supplied from other regions through the interconnection network. The delivery of power to load centers in West Sumatra from outside the province is not without risk, the transmission of power far away causes large line losses, this makes the price of electricity even more expensive. In addition, regional power plants are needed for a counterweight or regional balance in

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order to anticipate the possibility of disruption to the interconnection network to West Sumatra.

The need for electrical energy is increasing from time to time, so to be able to continue serving the electrical energy needs of customers, it is necessary to develop an electrical energy system that is in tune with the increasing demand for electrical energy.

2. Electric Power System Planning

Electric power structures or energy systems are very large and complex. Electric power cannot be stored in large quantities and the demand is still increasing; Electric power must be generated in the right amount and time when it is needed. To build a power supply facility requires a long lead-time. Therefore, planning is needed in its construction. Power system planning is a process in which the aim is to decide on new as well as upgrading existing system elements, to adequately satisfy the loads for a foreseen future [2].

The power system components can be divided into five (5) main levels or subsystems as shown in Figure 1 below:

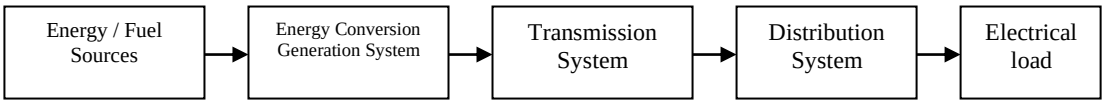


Figure 1. Power System Components

The first component is a source of energy or fuel to be used for conversion which can be coal, gas, oil and others depending on the availability of fuel and conversion technology. Energy sources in West Sumatra [3][4] include water sources, geothermal sources, bioenergy, wind energy, solar energy and micro hydro as shown in Figure 2.

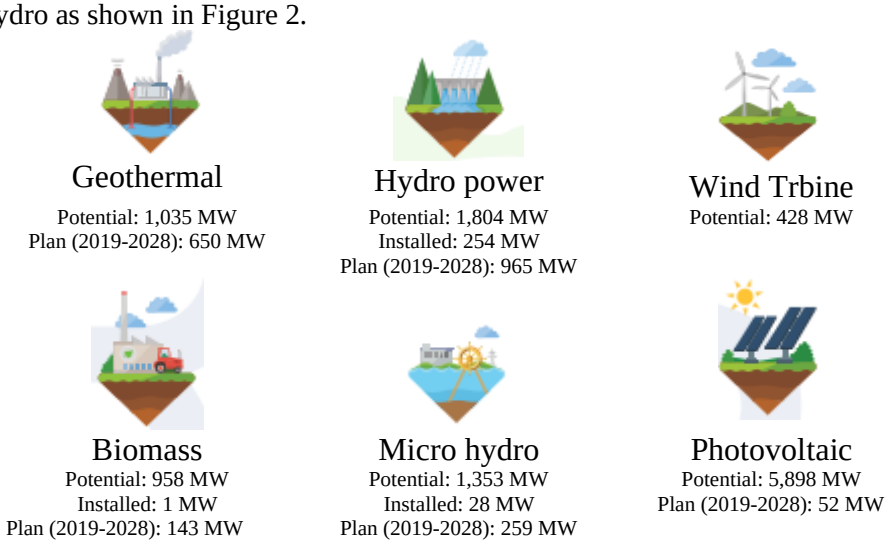


Figure 2. Renewable energy potential in West Sumatra [3].

Electricity development aims to ensure the availability of electricity in sufficient quantity, good quality, and at a reasonable price in order to improve the welfare and prosperity of the people in a just and equitable manner and to realize sustainable development [5]. Therefore, the purpose of an electric power supply system is to provide electricity to the end of the consumer with the following conditions:

- Affordable electricity prices
- Reliability secure N-1
- A suitable power quality such as voltage should be within a certain limit (± 5% of nominal voltage), less harmonics and low losses.

3. Overview of Electrical Energy Planning in West Sumatera

3.1 Analysis of electrical demand, generation planning and power balance based on RUPTL 2019-2028

In 2019 the need for electrical energy in West Sumatra is 3,705 GWh, while in 2028 it is 6,980 GWh with an average sales energy growth of 7.29 percent. The household sector has the highest demand for electrical energy in 2028, amounting to 3,769 GWh with an average percentage increase per year of 6.6 percent and 26.425% when calculated based on the average number of sales of electrical energy each year.

Table 1. Projection of Electric Power Demand [6]

Year	Economic growth (%)	Sales (GWh)	Production (GWh)	Peak Load (MW)	Customer
2019	5,22	3.750	4.021	641	1.401.051
2020	5,40	3.938	4.261	677	1.470.575
2021	5,34	4.224	4.556	722	1.493.012
2022	5,26	4.528	4.877	771	1.514.137
2023	5,17	4.855	5.220	823	1.535.114
2024	5,09	5.214	5.596	879	1.555.952
2025	4,98	5.589	5.978	937	1.576.573
2026	4,88	6.018	6.417	1.003	1.597.430
2027	4,77	6.482	6.889	1.074	1.618.267
2028	4,67	6.980	7.407	1.151	1.639.089
Growth (%)	5,14	7,29%	7,02%	6,73%	1,77%

The peak load in West Sumatra in 2019 was recorded at 591.2 MW. From the peak load, the power that can be generated is 677.7 MW, which West Sumatra will automatically have a surplus as reserves of 86.5 MW. This capable power comes from existing power plants in West Sumatra, including Hydro Power Plants (PLTA), Steam Power Plants (PLTU) and Micro Hydro Power Plants (PLTMH). The generator data are as follows: PLTA Maninjau (DMN: 67.80 MW), PLTA Singkarak (DMN: 74.64 MW), PLTU Ombilin (DMN: 170 MW), PLTU Teluk Sirih (DMN: 180 MW), PLTG PauhLimo (DMN: 49.02 MW) Standby, and MHP (DMN: 21 MW) [7][8]

Regarding the problem of the West Sumatra electrification ratio, it is stated that the Electrification Ratio (RE) of West Sumatra has reached 96.56% (October, 2019) which consists of 95.30% (1,165,201 RT) which is PLN electricity and 1.26% (14,954 RT) is non-PLN electricity . So that from the data there is still 3.44% (98,829 RT) not electrified. Meanwhile, the ratio of villages with electricity (RD) has reached 99.91%, where this value represents that 1,157 villages / nagari in West Sumatra have electrified, and the remaining 0.09% represents 1 village in the Mentawai Islands Regency not yet electrified [7][8]. Then for the data on Simple Households (RTS) without electrification, it was noted that West Sumatra contributed 1.78% of RTS who were not electrified from a total of 100% of RTS who were not electrified throughout Indonesia, of which 1.78% represented 39,256 RTS for the West Sumatra region.

3.2 Comparison with Previous Planning

The comparison between the 2019-2028 RUPTL and the 2018-2027 RUPTL is as follows [6][9][10]:

1. Rescheduling of electricity projects in accordance with projected demand and supply. Other reasons for changes in project scope and capacity, such as:

Adjusted to the results of the technical evaluation of the generator

Make use of new found locations and energies

Adjusted to the readiness and needs of the system

Adjusted to changes in system base load

Replacement of generator models

Not continued based on technical evaluation

2. Addition of new projects in the electricity sector that will be completed before 2028, with the following information:

Utilizing the land that is already available and strengthening the electricity generation sub-system. Optimizing the potential of New Renewable Energy

3. Change in Projection of Electricity Needs in West Sumatra from what was originally in RUPTL 2018-2017 with an average growth of energy sales for 10 years of around 6.99%, an increase in RUPTL 2019-2028 with an average growth of energy sales for 10 years. about 7.29% year.

4. Changes to the Recapitulation of the Transmission Network Development Plan in West Sumatra in 2027 for the 150 kV and 275 kV systems, from the original 740 kms to 727 kms.

5. Changes to the Recapitulation of the 150 Kv and 275 kV Substation Development Plans until 2027 in West Sumatra, from the original 2,390 MVA to 1,630 MVA.

6. Changes to the Physical Needs Distribution Development Plan in West Sumatra from what was originally in RUPTL 2018-2017 as follows:

- Total JTM (kms) = 8,504
- Total JTR (kms) = 9,077
- Total number of transformers (MVA) = 548
- Total Number of Additional Customers = 303,769

Based on the 2019-2028 RUPTL changes to:

- Total JTM (kms) = 52,986.5
- Total JTR (kms) = 13,160.8
- Total number of transformers (MVA) = 782.7
- Total number of additional subscribers = 300,417

7. Electricity Supply Business Plan (RUPTL) for the period 2019-2028. The government determines that new and renewable energy in the energy mix is at least 23 percent by 2025, so the government has decided that NRE generation initiatives under 10 MW need not be included in the RUPTL The goal is to pursue an energy mix that comes from EBT.

8. The government directs PLN to keep the energy mix from gas to a minimum of 22 percent in 2025 and beyond. The gas energy mix is needed to support intermittent renewable energy plants (cannot provide power 24 hours a day), such as wind power and solar power.

9. Power plants with fossil fuels, starting in 2025, the operation will be limited to a maximum of 0.4 percent. In 2025, diesel-based electricity can only be used for rural areas and the 3T (frontier,

disadvantaged, and outermost) areas of Indonesia. This means that urban areas must be prepared to switch to renewable energy electricity from now on.

Summary of RUPTL 2019-2028 and comparison with RUPTL 2018-2027 of West Sumatera as shown in Table 2 as follows [6][9]:

Table 2. Comparison with Previous Planning

No		RUPTL 2018-2027	2019-2028 RUPTL
1	Electricity Growth	6.99 %	7,29 %
2	Peak load	8,58% (1,189 MW in 2027)	6,73% (1,151 MW in 2028)
3	Additional Generating Capacity	401 MW	2,363.4 MW
4	Energy Mix in 2025 (National)	New and Renewable Energy: 23.0% Gas: 22.2% Coal: 54.4% Fuel Oil: 0.4%	New and Renewable Energy: 23.0% Gas: 22.0% Coal: 54.6% Fuel Oil: 0.4%
5	Additional Transmission Network	740 kms	727 kms
6	Additional Substation Capacity	2,390 MVA	1,630 MVA
7	Additional Distribution Networks	8,504 kms	52,986 kms
8	Number of customers	303.769 (548 MVA Dist Trafo)	300,417 (782.7 MVA of Dist Trafo)

From the comparison, the final energy demand projection in 2019 shows smaller disparity than the final energy demand projection in 2018. However, the estimated additional generating capacity requirements are quite different. This is because several private generation projects have not been recorded in RUPTL 2018-2027.

4. Conclusion

The need for electrical energy tends to increase from year to year. In 2019 the demand for electrical energy in West Sumatra is 3,705 GWh, while in 2028 it is 6,980 GWh with an average sales growth of 7.29 %. The household sector has the highest demand for electrical energy in 2028, amounting to 3,769 GWh with an average percentage increase per year of 6.6 % and 26.425% when calculated based on the average number of sales of electrical energy each year. The electrification ratio of West Sumatra, it is stated that the ER of West Sumatra has reached 96.56% on October, 2019. Tthere is still 3.44% or 98,829 household not electrified. Meanwhile, the ratio of villages with electricity has reached 99.91%, where this value represents that 1,157 villages / nagari in West Sumatra have electrified, and the remaining 0.09% represents 1 village in the Mentawai Islands Regency not yet electrified.

The peak load in West Sumatra in 2020, based on electricity statistics, is recorded at 53.05 MW. From the peak load, the power that can be generated is 72.70 MW, which West Sumatra will automatically have a surplus as a reserve of 19.65 MW. So far, there have been no significant obstacles related to electricity in West Sumatra Province. The change in projection of electricity needs in West Sumatra from what was originally in RUPTL 2018-2017 with an average growth of energy sales for 10 years of around 6.99%, an increase in RUPTL 2019-2028 with an average growth of energy sales for around 10 years 7.29%. Perform routine maintenance and maintenance of the reliability of the generating system both on the facilities and infrastructure, which aims to anticipate

damage to the power plant system that is currently operating, thereby reducing the system repair process that causes the plant to malfunction.

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