International Journal of Recent Engineering Research and Development (IJRERD)
ISSN: 2455-8761
www.ijrerd.com || Volume 05 – Issue 05 || May 2020 || PP. 27-35

Projection of Electricity Energy Demand in Central Java Province, 2019 - 2025 with Dkl Method and Business as Usual (Bau) using Leap Software

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Abstract: In the process of planning the development of electric power systems in the Central Java province, a projection of electricity needs in the future is needed. The projection results obtained can be used as material for policy makers to formulate actions that will be taken for the future. This aims to achieve optimization in the process of providing electricity in the Central Java province. In making the planning of electricity energy projections in Central Java in 2019-2025 the author uses 2 planning methods, namely DKL is a model compiled by the electricity demand department by combining several methods such as econometrics, trends and analytical with sectoral approaches, and BAU methods (Base As Usual) is a method where the tendency of electric energy usage patterns is still the same in the base year. The projection results in Central Java province using the DKL 3.2 method show that the number of total electricity customers has increased on average every year by 6.43% and for the BAU method an average increase of 4.5% each year, while for the projected needs Total electricity using the DKL 3.2 method has an average increase of 12.46% annually and for the BAU method an average increase of 8.6% annually.

Keywords: electricity demand forecasting, DKL, BAU

1. Introduction

The availability of electrical energy is an essential aspect and even becomes a parameter to support the success of regional development. Proper and directed management of electrical energy resources will make the potential of an area develop and be utilized optimally. Therefore, energy planning and management in general, including electrical energy, needs to get serious attention from local governments. This is certainly also in line with the increasing role of local governments in managing energy resources [1].

Based on considerations for fulfilling electrical energy, the need for electric power in the coming year is estimated to be the amount of electrical power needed by consumers. Therefore forecasting electrical energy needs is required to help take policies to increase electricity in the short, medium and long term. By knowing the amount of electricity demand in a certain period, it will be able to project electrical energy needs for the next period. So forecasting electrical energy needs is an anticipatory step to see the growth in electrical energy needs which is expected to develop rapidly in the following years. Besides, the estimated electricity consumption load also affects the planning and operation of the electrical system because forecasting results can be used as a reference in the construction of new power plants to reduce the electricity crisis [2].

Forecasting electricity needs in national and regional scope using various methods. In this project, two methods will be discussed, namely the DKL method and the Business As Usual (BAU) method for projecting electrical energy needs in Central Java Province until 2020. By comparing the results of forecasting the electrical energy requirements of the two approaches, it is expected to obtain results the best electric energy projections to meet the needs of electrical energy in the province of Central Java.

2. Methods

The model prepared by the Electricity Demand Research Office or DKL 3.2 is a model developed by combining several methods such as econometrics, trends and analytics with a sectoral approach [3].The BAU model, or Business As Usual, is considered that the final year the projected electricity usage pattern is still the same in the base year. This is because there is no change in the determination of development policies in estimating modelling. Estimates are constant without influential policies [4]. The preparation of this Project can be illustrated through the Flow Chart below

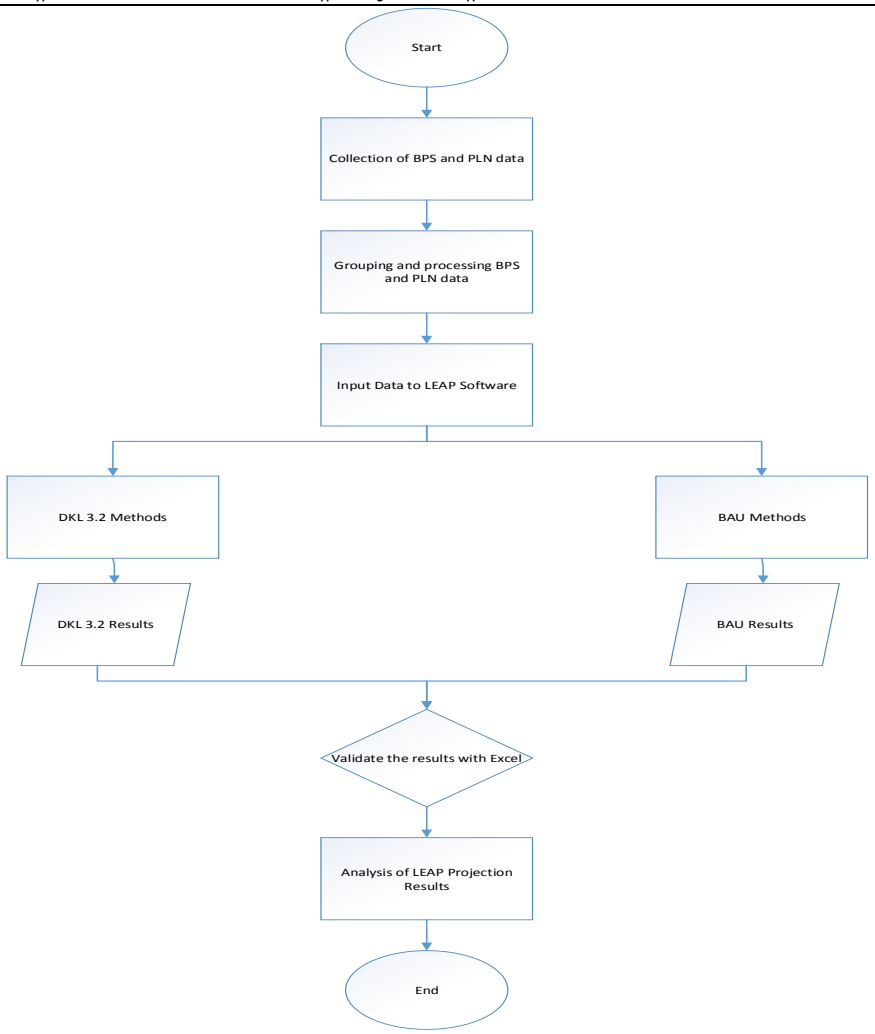

Figure 1: Flowchart Methods

2.1 Data Collection and Data Processing

The data used in this study were obtained from survey data at institutions or institutions that provided the necessary data such as BPS (Statistics Indonesia) and PLN (State Electricity Company) as well as other textbook sources, internet, journals, final project papers, technical reports, the law on energy policy and government supporting documents in this study.This statistical data was obtained from BPS (Statistics Indonesia). Statistics here include the GRDP of Central Java province. The GRDP data used is a constant 2000 GDP price data where the economy is considered stable, so the GDP calculation does not depend on the effect of inflation.

Table 1: Central Java GRDP 2014-2017

Central Java Province GRDP (Billion Rp)				
Year	**2014**	**2015**	**2016**	**2017**
AGRICULTURE	107.793,3	113.826,3	116.421	118.125,6
MINING AND EXCAVATION	15.566,65	16.278,16	19.367,6	20.373,3
PROCESSING INDUSTRY	271.526,7	284.306,5	295.960	308.820,9
ELECTRICITY, GAS AND DRINKING WATER	1.434,47	1.464,84	1.517,92	1.604,76
BUILDING	76.681,88	81.286,11	86.589	92.726,02
TRADE, HOTEL AND RESTAURANT	110.899,1	115.430,1	121.904	129.342,1

TRANSPORT AND COMMUNICATION	78.470,08	84.846,47	90.508,3	98.778,63
FINANCE, RENTAL & COMPANY SERVICES	36.410,3	39.200,07	42.469,5	45.031,5
SERVICES	36.410,3	70.126,42	74.573,9	79.211,3
T O T A L	764.959,15	806.765,09	849.313,2	894.050,47

Electrical data were obtained from PT. PLN (Persero) Cirebon City from Cirebon in the form of raw data. The raw data collected here is electrical energy business data consisting of the number of customers, electricity consumption, and connected power.

2.2 LEAP Input Data

Input data for the demand module are electricity exploitation data that has been processed based on the Central Statistics Agency (BPS) Method Approach, and intensity processing data.

Table 2: Activity level input data

Activity Level	
Household	8.910.045
Commercial	383.671
Public	300.992
Industry	9179

Table 3: Energy Intensity input data

Energy Final Intensity (MWh/consumers)	
Household	1,17
Commercial	6,86
Public	5,22
Industry	857,34

Based on the existing scenario, it is necessary to add a new variable to the key assumptions section. The following additional variables are shown in the key assumptions module.

Table 4: Key Assumptions

VARIABLE	VALUE
GRDP Total Growth	5,33%
Industrial GRDP Growth	4,65%
Commercial GRDP Growth	6,55%
Public GRDP Growth	6,17%
Household Customer Growth	3,99%
Industrial Customer Growth	12,31%
Commercial Customer Growth	11,84%
Public Customer Growth	5,86%
Household Elasticity	0,73
Industrial Elasticity	0,77
Commercial Elasticity	1.31
Public Elasticity	1,34
Household Customer Factors	1,00
Industrial Customer Factors	3,08
Commercial Customer Factors	2,96
Public Customer Factors	1,46
Delta Household Customers	0,0339%
Consumption unit	1,17
Household Connected Power Average	0,,72
Industrial Connected Power Average	325,335
Commercial Connected Power Average	4,76
Public Connected Power Average	2,9475

Growth of Household Connected Power	5,71%
Growth of Industrial Connected Power	7,92%
Growth of Commercial Connected Power	10,60%
Growth of Public Connected Power	10,28

3. Result and Analysis

3.1 DKL Methods

The following are the results of the projected number of customers, electrical energy needs, connected power, in the province of Central Java using the DKL method

Table 5: Projection of the number of electric customers DKL scenario

Projection of Number of Customers				
Year	**Household**	**Commercial**	**Public**	**Industrial**
2019	9.885.168	546.865	357.662	11.997
2020	10.412.048	652.891	389.881	13.715
2021	10.967.010	779.474	425.003	15.679
2022	11.551.551	930.599	463.288	17.924
2023	12.167.249	1.111.023	505.022	20.492
2024	12.815.764	1.326.428	550.515	23.426
2025	13.498.844	1.583.596	600.106	26.781

Based on table 5 above, the average total customer growth of 6.43% per year with an average growth of each user sector namely Households by 5.53%, Commercial by 19.38%, Publicby 9%, and Industry by 14.32%. The following diagram shows the number of DKL scenario customers.

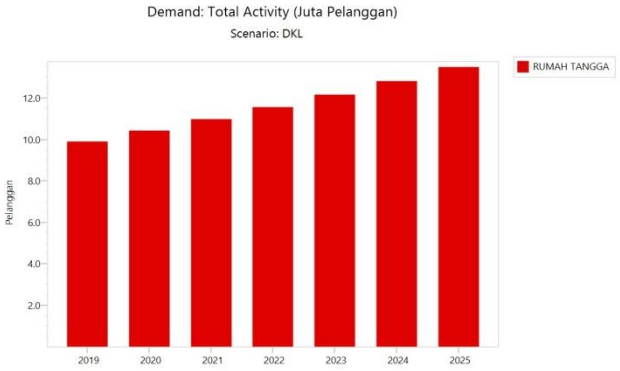

Figure 2: Projected number of electricity customers in the household sector.

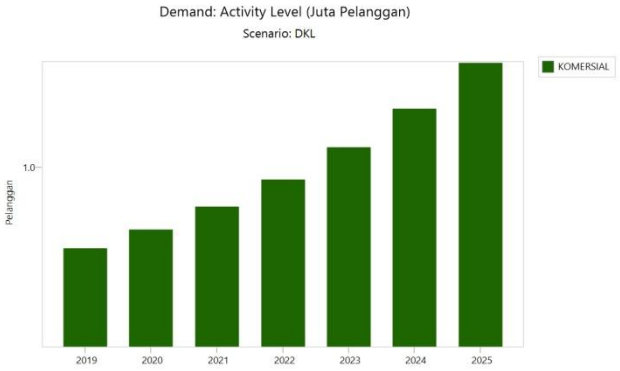

Figure 3: Projected number of electricity customers in the commercial sector.

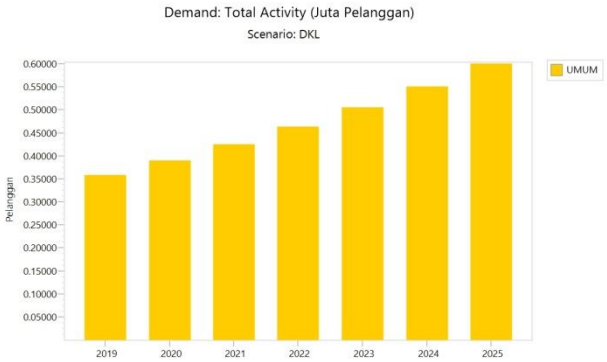

Figure 4: Projected number of electricity customers in the public sector.

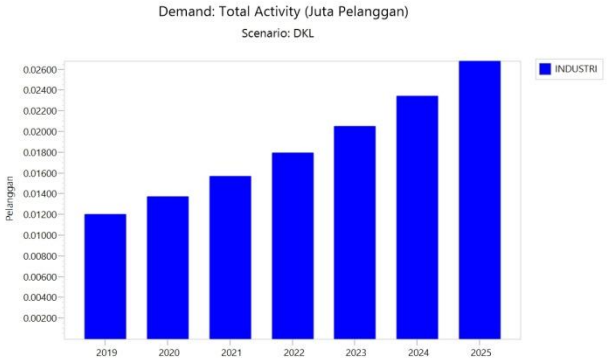

Figure 5: Projected number of electricity customers in the industrial sector.

Table 6: Projected electrical energy needs in the DKL scenario

Electric Energy Consumption Projection (MWh)				
Year	**Household**	**Commercial**	**Public**	**Industrial**
2019	12.358.952	3.757.936	1.870.086	10.172.405
2020	13.4357.22	4.490.375	2.040.233	11.633.461
2021	14.592.337	5.365.568	2.225.860	13.304.367
2022	15.834.258	6.411.341	2.428.376	15.215.264
2023	17.167303	7.660.940	2.649.317	17.400.622
2024	18.597667	9.154.091	2.890.361	19.899.862
2025	20.131950	10.938.264	3.153.335	22.758.066

Based on table 6 above, the average total energy growth is 12.46% per year with an average growth of each user sector namely Households at 8.4%, Commercial at 19.5%, General at 9%, and Industry by 14.36%. The following diagram shows the output of electricity demand for the DKL scenario.

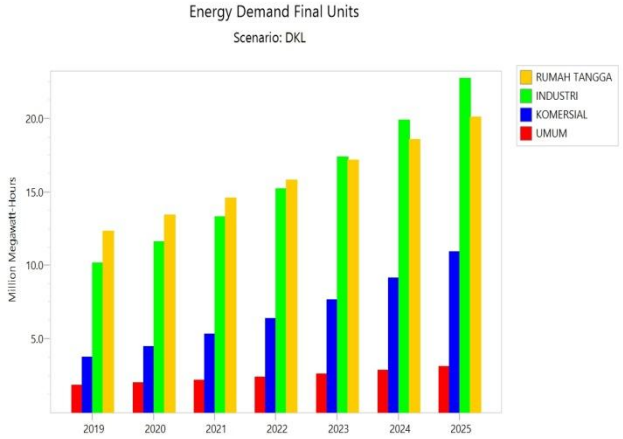

Figure 6: Projected electrical energy needs in the DKL scenario

Table 7: Power projection connected with DKL scenario

Connected Power Projection (KVA)				
Year	**Household**	**Commercial**	**Public**	**Industrial**
2019	7.326.742	2.581.778	1.113.081	3.669.144
2020	7.706.095	3.086.462	1.208.046	4.228.116
2021	8.105.668	3.688.996	1.311.566	4.867.143
2022	8.526.538	4.408.348	1.424.412	5.597.691
2023	8.969.840	5.267.168	1.547.422	6.432.869
2024	9.436.770	6.292.497	1.681.514	7.387.661
2025	9.928.588	7.516.616	1.827.685	8.479.198

Based on table 7 above, the total average annual growth of connected power is 11.18% with an average growth of each user sector namely Households by 5.2%, Commercial by 19.5%, General by 8.62% and Industry 15%.

3.2 BAU (Business As Usual) Methods

The following are the results of the projected number of customers, electrical energy needs, connected power, in the province of Central Java using the BAU method.

Table 8: Projection of the number of electric customers BAU scenario

Projection of Number of Customers				
Year	**Household**	**Commercial**	**Public**	**Industrial**
2019	9.635.251	479.902	337.301	11.577
2020	10.019.698	536.723	357.067	13.003
2021	10.419.483	600.271	377.991	14.603
2022	10.835.221	671.343	400.142	16.401
2023	11.267.546	750.831	423.590	18.420
2024	11.717.121	839.728	448.412	20.688
2025	12.184.634	939.152	474.689	23.235

Based on table 8 above, the average total customer growth of 4.5% per year with an average growth of each user sector namely Households by 4%, Commercial by 11.84%, General by 5.86%, and Industry at 12.31%. The following diagram outputs the number of BAU scenario customers.

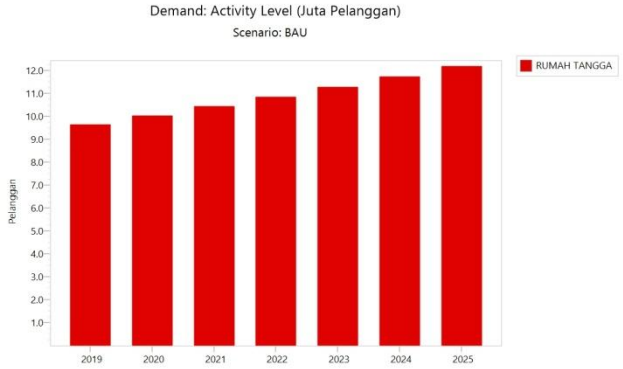

Figure 7: Projected number of electricity customers in the household sector.

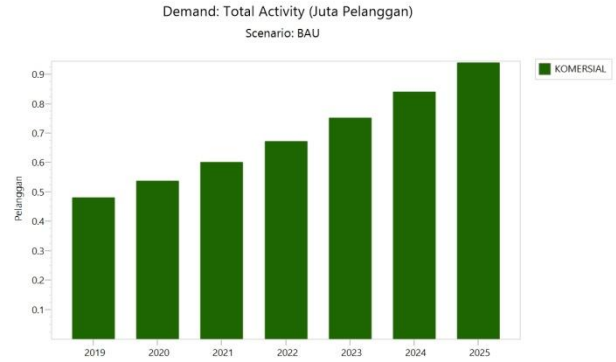

Figure 8: Projected number of electricity customers in the commercial sector.

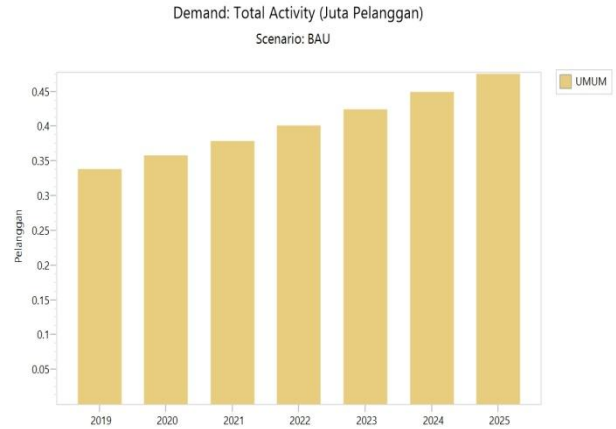

Figure 9: Projected number of electricity customers in the public sector.

Figure 10: Projected number of electricity customers in the industrial sector.

Table 9: Projected electrical energy needs in the BAU scenario

Electric Energy Consumption Projection (MWh)				
Year	**Household**	**Commercial**	**Public**	**Industrial**
2019	11.273.244	3.292.133	1.760.716	9.810.472
2020	11.723.046	3.681.922	1.863.894	11.018.142
2021	12.190.796	4.117.861	1.973.118	12.374.475
2022	12.677.209	4.605.416	2.088.742	13.897.773
2023	13.183.029	5.150.697	2.211.143	15.608.589
2024	13.709.032	5.760.540	2.340.716	17.530.006
2025	14.256.023	6.442.588	2.477.882	19.687.949

Based on table 9 above, the average total energy growth is 8.6% per year with an average growth of each user sector namely Households by 3.99%, Commercials by 11.84%, General by 5.86%, and Industry 12.31%. The following diagram shows the BAU scenario's electrical energy output needs.

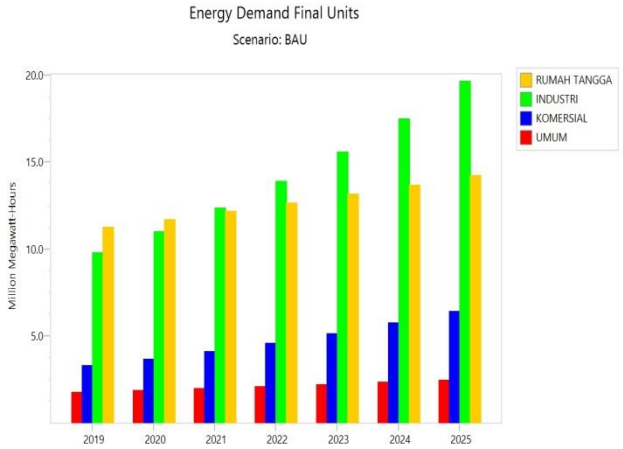

Figure 11: Projected electrical energy needs in the BAU scenario

Table 10: Power projection connected with BAU scenario

Connected Power Projection (KVA)				
Year	**Household**	**Commercial**	**Public**	**Industrial**
2019	7.402.787	2.207.908	1.150.550	3.205.772
2020	7.825.487	2.441.946	1.268.826	3.459.669
2021	8.272.322	2.700.792	1.399.261	3.733.675
2022	8.744.671	2.987.076	1.543.105	4.029.382
2023	9.243.992	3.303.707	1.701.737	4.348.509
2024	9.771.824	3.653.900	1.876.675	4.692.911
2025	10.329.795	4.041.213	2.069.597	5.064.589

Based on table 10 above, the average total annual growth of connected power is 7.45% with an average growth of each user sector namely Households at 5.71%, Commercials at 10.60%, General at 10.28% and Industry 7.92%.

3.3 Comparison of Projected Results of Electrical Energy Demand with RUPTL 2019 – 2025

The results of the projected electrical energy requirements obtained are then compared with the 2019-2025 RUPTL projections. A complete comparison of the projected results with the 2019-2025 RUPTL projection data for Central Java Province is as follows.

Table 11: Comparison of projection results with actual PLN data (2015)

COMPARISON OF TOTAL PROJECTION RESULTS OF ELECTRICITY ENERGY (MWh)			
Year	**RUPTL**	**DKL Methods**	**BAU Methods**
2019	24.616.000	28.159.379	26.136.565
2020	25.867.000	31.599.790	28.287.003
2021	27.374.000	35.488.132	30.656.250
2022	28.974.000	39.889.239	33.269.140
2023	30.622.000	44.878.182	36.153.458
2024	32.368.000	50.541.981	39.340.294
2025	34.226.000	56.981.614	42.864.442

Based on Table 11, it can be seen that the total projection result of electricity customers in the province of Central Java for 2019-2025 both with the DKL and BAU methods compared with the RUPTL in 2019-2025 there are significant differences. This is caused by factors that affect each estimation method. RUPTL projects customer forecasting by considering economic growth from 2019-2025, while for the DKL project customers forecast by taking into historical account data such as electricity exploitation and GRDP per customer sector. For the BAU method, projecting customer estimates by not taking into account economic growth, or GRDP only considers the historical data of the previous year.

4. Conclusion

The results of projected electricity needs in the province of Central Java in 2019 to 2025 using the DKL 3.2 method for the household sector experienced an average annual growth of 5.33% for the number of customers, 8.4% for electricity consumption needs, and 5.5.2% for power is connected. The commercial sector experienced an average annual growth of 19.38% for the number of customers, 19.5% for electricity consumption, and 19.5% for connected power. The Industrial Sector experienced an average annual growth of 14.32% for the number of customers, 14.36% for electricity consumption, and 15% for connected power. The General Sector experienced an average growth of 9% each year for the number of customers, 9% for electricity consumption, and 8.62% for connected power. The results of the projected electricity demand in the province of Central Java in 2019 to 2025 using the BAU method for the household sector experienced an average growth of 4% per year for the number of customers, 3.99% for electricity consumption needs, and 5.71% for connected power. The commercial sector experienced an average annual growth of 11.84% for the number of customers, 11.84% for electricity consumption, and 10.6% for connected power. The Industrial Sector experienced an average annual growth of 12.31% for the number of customers, 12.31% for electricity consumption, and 7.92% for connected power. The General Sector experienced an average annual growth of 5.86% for the number of customers, 5.86% for electricity consumption, and 10.28% for connected power.

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