Electricity Power Needs Evaluation in Kulonprogo Post Developing the Yogyakarta International Airport

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\textbf{Abstract.} The planned construction of the Kulonprogo district's strategic zone, which began in 2013, this Regency will certainly experience a large development, so for that, it needs to be accompanied by adequate electricity preparation. Based on the real conditions, the speed of construction is experiencing some obstacles, so there is only phase 1 of NYIA airport has been completed by 2020, while for the Steel Industry Center construction, Iron Sand Processing, Adikarto Port, there are also have many obstacles. This also affected the domestic and non-domestic residents' activities, especially in terms of economic progress in the district. This study intended to evaluate the preparation of electricity power so its preparation is expected to be more efficient. From the results of this study at the end of 2032, at least 626 MVA of electricity power needs to be prepared to support an estimated peak load of 438 MVA. This research was conducted quantitatively and aimed for giving some references to be used by PT PLN (Persero) in reviewing Electricity Supply Business Plan (RUPTL).

1. \textbf{Introduction}

1.1 \textit{Background}

Kulonprogo Regency is an underprivileged area in the Special Region of Yogyakarta (DIY) compared to Sleman, Bantul, and Yogyakarta Regencies. The condition of the district's infrastructure is very minimalized, while the potential of the region is quite large and has a great opportunity to be developed. (1)

There is some awareness to be concerned. The Regional Government of Kulon Progo Regency through its policies mentioned in Kulonprogo Regional Regulation No: 1 of 2012 regarding the Spatial Planning of the Kulon Progo Region for 2012 - 2032, has established a strategic area. In its Regional Regulation (PERDA) it is defined that: "Regency Strategic Area is defined as an area which has spatial planning should be prioritized because it has a very important influence within the district scope in terms of economy, social, culture, and/or environment". (1)

There are Strategic plans planned by the government as below:

a. Construction of Southern Cross Roads (Jalur Jalan Lingkar Selatan/JJLS),

b. International Airport Development,
c. Ocean and Fisheries Port Development  
d. Special Economic Zone Plan,  
e. Development of the Glagah-Congot Tourism Area,  
f. Iron sand mining with its processing industry  

From the above data that really needs attention is the construction of the New Yogyakarta International Airport, Special Economic Zone consisting of the Development Plan for the Processing of the Iron Sand Industry, Steel Industry, and Large Industries in the Lendah and Sentolo areas. Because of this development, it will greatly impact economic improvement, besides that, in terms of electricity, its capacity is quite large. To support these developmental needs, which is very important to note is the availability of electric power and its distribution network. For this reason, an in-depth study is needed (1) 

To support these developmental needs, the availability of electric power and its network distribution are very important concerns. Based on those reasons, an in-depth study is needed to be conducted.

1.2 Literature Review  

The role of electrical energy is very important for increasing economic activity and national resilience, so that energy management which including the supply, utilization, and exploitation must be carried out fairly, sustainably, rationally, optimally, and in an integrated manner as it stated in the Law of the Republic of Indonesia Number 30 Year 2007, concerning Energy.(2)  

Refer to the appendix B.5 on 2015-2024 PLN RUPTL, it stated that the electricity system development of PT PLN (Persero) in the Special Region of Yogyakarta is intended to serve the load growth, a new substation will be built at 660 MW.(3)  

| Table 1. Development of 150/20 KV substation in DI Yogyakarta |
|---------------------------------------------------------------|
| No | Sub Station          | Voltage (v) | Information | Capacity (MV/LB) | COD (year) |
|----|----------------------|-------------|-------------|------------------|------------|
| 1  | Wirobrajan           | 150/20 kV   | Ext         | 60               | 2015       |
| 2  | Kentungan            | 150/20 kV   | Ext         | 60               | 2015       |
| 3  | Wates                | 150/20 kV   | Uprate      | 60               | 2015       |
| 4  | Godean               | 150/20 kV   | Ext         | 60               | 2016       |
| 5  | Kentungan            | 150/20 kV   | Ext         | 60               | 2018       |
| 6  | Wates                | 150/20 kV   | Ext         | 2 LB             | 2019       |
| 7  | Kentungan Baru/ Kalasan | 150/20 kV   | New        | 60               | 2019       |
| 8  | Wates                | 150/20 kV   | Ext         | 60               | 2019       |
| 9  | Bantul Baru          | 150/20 kV   | New        | 60               | 2021       |
| 10 | Kentungan Baru/ Kalasan | 150/20 kV   | Ext        | 60               | 2024       |
|    | Sum                  |             |             | 660              |            |

Source: 2015-2024 PLN RUPTL(4)  

From the data above, it is clear that the electric power that will be prepared by PLN until 2019 is 240 MVA. This seems to have not been realized, and also many large projects such as the Processing of Iron Sand, Steel Mills have not yet been realized either.  

The development of the Kulonprogo Airport Area is included in the PPP Project Book BAPPIENAS Program, 2010-2014. It means that it provided an opportunity for private and foreign investors interested in managing the airport under the Technical Implementation Unit (UPT) of the Directorate General of Civil Aviation. The Kulonprogo Airport Masterplan has located about 30 km on the west of Yogyakarta city and has 3,600 meters’ runway. The runway is very adequate for large
size aircraft and international standards. On the east-west side runway, plus two perimeters of 900 meters each for a total of 4,400 meters. The runway is the first thing to be done, then following with the perimeter and lighting. The area of the airport covered around 350 hectares, equipped with 7 taxiways with 4 interconnecting taxiways. There are required airport facilities that should be provided such as apron, terminal building, commercial building, technical building, and flight operations support with Air Traffic Control (ATC) and parking facilities for visitors. The airport is capable of serving 61 million passengers every year. (4)

Tanjung Adikarto Pelabuan area is located in Karangwuni Village, Wates District. The total area for infrastructure development is 83 Ha. Its location has good accessibility and easy to reach, connected to cities in southern Java by the south Java regional transportation routes. It is located 2 km south of the South Java National road and is lined by the Southern Cross Road Development Plan (JJLS). Planned to be able to land ships with weights up to 150 GT. It has 6 hectares parking area and can be expanded up to 15 hectares.

Mining Allocation Area according to Kulon Progo Regency Regulation Number 1 Year 2012 (abbreviated as KPP) is an area that has the potential for solid, liquid, or gas mining material resources based on maps / geological data and is the place where all stages of mining activities include research, general investigations, exploration, production/exploitation, and post-mining operations, both inland and water areas, and not limited by land use, both cultivation and protected areas.

The area around the iron sand mining is planned to be developed into 2,000 Ha National Steel Industrial Zone (Sentolo, Lendah, and Galur Districts) initiated by the Ministry of Industry of the Republic of Indonesia.

1.3 Basic Theory
1.3.1 Arithmetic Method

Arithmetic method is a method used to calculate the projected population in Kulon Progo Regency from 2019 to 2032 with a tendency to follow the data set by BPS Kulonprogo Regency, while from 2010 to 2018 using data taken from BPS reports. This method is used assuming that the population in the future will increase by the same amount every year. The following is the formulation of the arithmetic method.

\[ P_n = P_0 (1 + rm) \]

(2.1)

with,

- \( P_n \) : total population in year n
- \( P_0 \) : total population in the initial year (base)
- \( r \) : average population growth in 2020 - 2032
- \( n \) : time period between the base year and year n (in years)

To determine the amount of electricity needed in Kulon Progo Regency, it is needed an estimate of the population (projected population) until 2032 and basic assumptions for domestic and non-domestic electricity demand.

1.3.2 Domestic, Non-Domestic and Industrial Estate Electricity

The electricity consumption in 2010 to 2019 is based on the data from the Central Bureau of Statistics (6-10) and from 2020 to 2032 which is analyzed based on assumptions by the Regional /
City Spatial Detailed Plan Guidelines and also based on the National Technical Shutter Reference that is in force today, namely:

a. Domestic Categories

Domestic (initial/standard) needs will be divided according to the type of house, as follows:

i. 10% luxury home section type (assumed 2200 VA);
ii. Type of medium housing 30% part (assumed 1300 VA);
iii. Type of simple house 60% of the part and settlement that already exists 1 part (assumed 900 VA and 450 VA).
iv. For each type of house above will be multiplied by the Electrification Ratio (RE) of 85%, for 2018 and 100% for 2032

b. Non-Domestic Categories

The needs are defined as government/office needs, commercial, social and public facilities, and street lighting with the assumption of need that is 30% of domestic needs.

c. Industrial Estate Category

Referring to the Decree of the Minister of Industry No: 35 / M-IND / PER / 2010, Table 4, Regarding General Service Technical Standards, Page 31, stated that the electricity demand for industrial estates is 0.15 to 0.2 MVA per Ha.

d. International Airport

The international Airport Passenger Capacity about 61 million passengers per year, Electricity Power is around 75 MPA.

e. The estimated reduction in transmission of electric power is assumed to be 4% from domestic and non-domestic demand. The 4% power loss consists of 2.5% technical losses and 1.5% non-technical losses (electricity theft).

Domestic electricity needs were calculated using arithmetic method, while projected electricity needs for industrial areas and airport electricity needs were calculated using a comparison method, which is to compare with similar objects that already exist.

1.4 Problem Identification

Based on PERDA no 1, regarding strategic areas. What has been realized is Airport Development phase 1, while others have not been realized as desired, as an example of the construction of the Iron Sand factory and the existence of the Tanjung Adikerto Port development. So this affects the effectiveness of electricity supply in Kulonprogo Regency

1.5 Research Objectives and Benefits

The purpose of this study is intended to obtain macro data on the need for electricity infrastructure in Kulonprogo Regency to support the development of the Kulonprogo Regency strategic area. The benefits of this research can be used as one of the basic considerations for executives in determining their policies.

2. Research methods

2.1. Research Methods

This study used qualitative and quantitative methods for collecting the data. The qualitative methods applied a questionnaire for interviewing the targeted respondents among the parties and also site survey to complete the qualitative data. The calculation from survey data considered as quantitative data.

2.2. Research Steps
The study was conducted in the following stages:

a. Phase 1, reviewing secondary data
b. Phase 2, interviewing with Kulonprogo Regency BAPPEDA office, PT PLN UPJ WATES, Kulonprogo Regency's Department of Industry and ESDM to obtain more details information on the development plan profile which can be derived from the secondary data
c. Phase 3, conducts a study and identification of primary data obtained from:
   i. Regional Planning and Development Agency, Kulonprogo Regency
   ii. PT PLN UPJ Wates
   iii. Department of Industry and Trade and ESDM Kulonprogo
d. Phase 4, carrying out surveys and measurements
e. Phase 5, carries out analysis and calculation of measurement data

The research stages as described below:

![Research Stages Diagram](image)

**Figure 1.** Research Stages

3. Analysis

The following are research data including analysis of domestic, non-domestic electricity power needs, industrial electric demand, air sport electricity needs, and substation requirements as well as transmission and distribution networks.
To determine the amount of electricity needed in Kulon Progo Regency, it is needed an estimate of the population (projected population) until 2032 and basic assumptions for domestic and non-domestic electric demand and energy losses.

3.1. Projected population

To calculate domestic and non-domestic electricity power requirements, up to 2032 data on the number of households is needed. Data from 2010 to 2018 can be obtained from BPS data, while 2019 to 2032 is calculated based on projections. As for the data on the addition of the population is calculated based on the population increase in previous years. The results of the projections are shown in table 02.

Table 02: Total Population Projection Result by 2032

| Sub District | Average Growth Rate for 2020-2022 | Basic Year | Total Population Projection Result |
|--------------|-----------------------------------|------------|-----------------------------------|
|              | 2010 | 2018 | 2022 | 2026 | 2030 | 2031 | 2032 |
| Temben       | 1.24% | 24,741 | 27,310 | 30,646 | 32,322 | 34,039 | 34,546 | 35,069 |
| Wates        | 1.34% | 44,123 | 49,090 | 51,287 | 54,091 | 57,049 | 57,814 | 58,559 |
| Pangsitua    | 1.24% | 33,492 | 36,946 | 40,691 | 42,916 | 45,283 | 45,870 | 46,468 |
| Galuyu       | 1.04% | 29,259 | 33,715 | 36,420 | 39,302 | 42,388 | 45,701 | 48,898 |
| Lendah       | 1.20% | 36,547 | 40,212 | 43,224 | 46,588 | 49,081 | 48,725 | 49,378 |
| Sentoal      | 1.21% | 44,655 | 49,353 | 52,552 | 55,426 | 58,457 | 59,241 | 60,034 |
| Pengasih     | 1.34% | 45,308 | 50,412 | 54,536 | 57,520 | 60,666 | 61,478 | 62,303 |
| Kedung       | 0.54% | 31,193 | 32,553 | 33,885 | 34,873 | 35,045 | 35,045 | 35,045 |
| Gumalrejo    | 1.01% | 21,944 | 23,018 | 24,126 | 25,769 | 29,067 | 29,457 | 29,861 |
| Naosentulan  | 1.77% | 27,136 | 30,076 | 32,253 | 34,016 | 35,877 | 36,357 | 36,845 |
| Kalibungam   | 0.63% | 26,665 | 28,242 | 31,873 | 34,616 | 35,454 | 35,929 | 36,411 |
| Senggapeh    | 0.64% | 24,744 | 26,649 | 30,036 | 31,679 | 33,411 | 33,859 | 34,313 |

Kulon Progo: 0,48 389,852 425,376 465,835 491,310 518,179 525,122 532,159

Source: Analysis 2020

3.2. Projected population, domestic and non-domestic power requirements

From the above data we can calculate the domestic and non-domestic electricity power requirements as shown in table 03 and table 04, as below:

Tabel 03: Domestic and Non-Domestic Electricity Needs by 2020

| Sub District | Projected Result | Number of Family Head | 900 VA (60%) | 1200 VA (90%) | 1800 VA (99%) | Non Domestic (59%) | Number of ER (97%) | Total Domestic & Non Domestic | Trans. & Distrib. Shrinkage (4%) | Total Electricity Power Needs (MVA) |
|--------------|------------------|-----------------------|--------------|---------------|---------------|-------------------|-------------------|-----------------------------|----------------------------------|---------------------------------|
| Temben       | 39,841           | 7,490                 | 4,028,478    | 2,990,496     | 1,614,332     | 6,863,333        | 2,009,009        | 8,922,332                  | 356,939                          | 10,279,269                      |
| Wates        | 49,939           | 12,483                | 6,741,811    | 4,869,036     | 2,746,644     | 11,486,048       | 3,458,814        | 14,951,862                 | 597,374                          | 15,549,236                      |
| Pangsitua    | 39,622           | 9,903                 | 3,349,938    | 2,863,137     | 2,179,203     | 9,113,040        | 1,822,608        | 10,935,648                 | 437,468                          | 11,373,116                      |
| Galuyu       | 33,516           | 8,179                 | 4,234,684    | 3,267,837     | 1,843,390     | 7,708,721        | 1,541,744        | 9,250,465                  | 370,019                          | 9,620,484                      |
| Lendah       | 42,089           | 10,327                | 5,681,951    | 4,103,637     | 2,314,859     | 9,660,362        | 1,938,072        | 11,646,434                 | 464,657                          | 12,111,092                     |
| Sentoal      | 51,172           | 12,790                | 6,908,170    | 4,989,234     | 2,914,440     | 11,769,476       | 2,530,845        | 13,300,321                 | 612,013                          | 13,912,334                     |
| Pengasih     | 33,853           | 12,379                | 7,160,263    | 5,173,017     | 2,930,786     | 12,244,196       | 2,442,839        | 14,682,025                 | 586,381                          | 15,268,406                     |
| Kedung       | 37,165           | 9,395                 | 5,039,522    | 3,486,807     | 1,902,495     | 6,707,060        | 1,200,118        | 7,907,177                  | 251,887                          | 8,158,064                     |
| Gumalrejo    | 35,444           | 6,361                 | 3,433,000    | 2,653,895     | 997,723       | 4,630,889        | 1,389,287        | 5,519,176                  | 240,808                          | 5,759,984                     |
| Naosentulan  | 31,405           | 7,831                 | 4,239,711    | 3,041,342     | 1,563,738     | 5,715,738        | 1,714,728        | 7,430,466                  | 287,219                          | 7,717,685                     |
| Kalibungam   | 31,033           | 7,759                 | 4,189,716    | 2,917,399     | 1,533,473     | 5,668,438        | 1,694,331        | 7,362,769                  | 293,719                          | 7,656,488                     |
| Senggapeh    | 29,347           | 7,112                 | 3,948,393    | 1,901,078     | 804,406       | 5,323,018        | 1,596,055        | 6,919,073                  | 276,797                          | 7,195,870                     |

Source: Analysis 2020

Tabel 04. Domestic and Domestic Electricity Needs in 2032
3.3. Projected electricity power requirements at the end of the 2032 year

The following are the results from the calculation of electrical power requirements in Kulonprogo Regency according to the data from table 01 to table 04 and also power requirements for large and small industrial zones, maritime industry, and electric power needs at NYIA Airport.

Tabel 05 Electricity Power Needs of Domestic and non Domestic, Industrial Zone and Airports

| Location                        | Land Area (Ha) | Coefficient of Land Use (%) | Electricity per Ha (MVA) | Installed Power (MVA) | Demand Factor |
|---------------------------------|----------------|------------------------------|--------------------------|-----------------------|---------------|
| Desa Tukuono, Sentolo           | 200            | 65%                          | 0,14                     | 18                    | 70%           |
| Galur, Lendah, Sentolo          | 2000           | 65%                          | 0,14                     | 182                   | 60%           |
| Sentolo, Lendah                 | 4796           | 65%                          | 0,14                     | 436                   | 60%           |
| Naggulan                       | 700            | 65%                          | 0,14                     | 64                    | 60%           |
| Temen                          | 500            | 65%                          | 0,14                     | 46                    | 50%           |
| Airport Electricity Power       |                |                              |                          | 75                    | 90%           |
| Kulonprogo Domestic and Non-Domestic Electricity Power | 207 | 50% |

From table 05 the results of this analysis can be evaluated more deeply. By calculating the demand load, demand factor, and simultaneous factor, it is obtained:

- Projected Instaled Electricity Load = 1.028 MVA
- Projected Demand Load = 626 MVA
- Projected Demand Factor = 61 %
- Projected Simultaneous Factor = 70 %
- Projected Peakload estimation = 438 MVA

4. Conclusion

This study concluded some points as below:

a. The electricity demand in Kulonprogo Regency at the end of 2032 can be predicted as follows:

i. Projected Instaled Electricity Load = 1.028 MVA
ii. Projected Demand Load = 626 MVA
iii. Projected Demand Factor = 61 %
iv. Projected Simultaneous Factor = 70 %
v. Projected Peakload estimation = 438 MVA
b. The power capacity of the 46 MVA substation, which has been upgraded on November 2014 to 90 MVA, will not be able to supply electricity needs in Kulonprogo Regency after the enactment of the Kulonprogo Regency Regulation No. 1 of 2012 concerning the Kulonprogo Regency Spatial Planning Year 2012 – 2032

c. Industrial area power supply and NYIA airports should be separated from other power supplies to maintain stability and continuity of power distribution.

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