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Electricity Demand Planning For Dki Jakarta Province In 2023-2033: Modeling Using Leap

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Abstract— This research focuses on planning DKI Jakarta's electrical energy demand from 2023 to 2033 using Long-range Energy Alternatives Planning (LEAP) software. The aim is to develop strategies to ensure adequate electrical energy supply, considering population growth, GRDP, and energy consumption patterns in sectors such as household, industrial, commercial, and public. This research method uses a quantitative approach with LEAP to model Jakarta's energy system, including analysis of final energy consumption and energy intensity in various sectors. The projection results show significant growth in energy demand from the industrial sector, stable demand from the household sector, and a decline in energy consumption in the public sector. This research is important to support sustainable energy infrastructure planning amidst the dynamics of economic growth and rapid urbanization in Jakarta.

Keywords— Electrical Energy Planning, LEAP, Population Growth, Energy Consumption, Energy Infrastructure

I. INTRODUCTION

Electrical energy is a basic necessity for modern life in DKI Jakarta Province that plays a vital role in maintaining the comfort and safety of the community [1]. With rapid economic growth and continued urbanisation, the demand for electricity in Jakarta continues to increase year after year. [2]. Therefore, careful and planned planning in anticipating the need for electrical energy is an urgent need [3].

Electricity demand planning is a crucial step in ensuring adequate, efficient and sustainable energy availability in DKI Jakarta Province. In this context, this research aims to develop an appropriate planning strategy to fulfil the electricity demand in Jakarta in the future period [4].

DKI Jakarta Province, as the centre of Indonesia's economic, political, and social activities, has significant electrical energy needs. Rapid population growth, high urbanisation, and industrial development have led to increased electrical energy consumption in the region in recent decades [5]. However, in the face of the challenges of climate change and energy sustainability, careful planning to meet electricity demand is becoming increasingly important [6].

LEAP is used as a tool in planning electrical energy demand in DKI Jakarta Province. LEAP allows the analysis of electrical energy demand for a long period of time, namely the next 10 years. By using LEAP, electrical energy demand planning can be done by considering factors such as population, GRDP, the number of electrical energy customers from various sectors, namely household, industry, commercial, and public, final energy consumption which also comes from various sectors, and also electrical energy intensity which consists of various sectors similar to the previous two factors [7]. Data obtained from the BPS and PLN websites, so that from this data, it can later be processed and can be visualised so that it can facilitate researchers in conducting analyses.

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II. RESEARCH METHODOLOGY

This research uses a quantitative approach with modelling using LEAP (Long-range Energy Alternatives Planning System) software. This approach aims to analyse and project the demand for electrical energy in DKI Jakarta Province during the period 2023-2033. With this approach, the projections produced will be more accurate and relevant, so that they can support effective and sustainable energy planning.

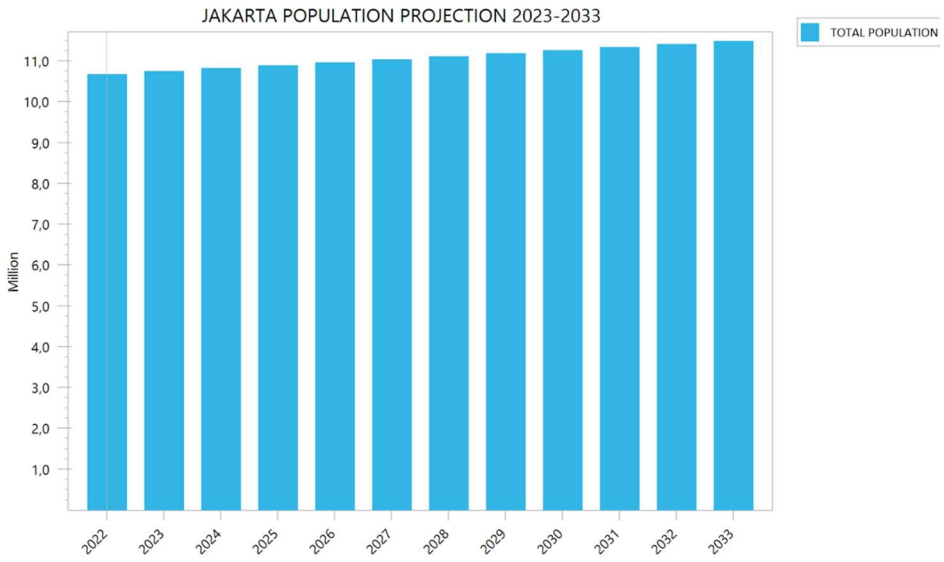
III. RESULT AND DISCUSSION

MODELLING ELECTRICAL ENERGY USE PLANNING IN 2023-2033

LEAP (Long-range Energy Alternatives Planning) is software used for long-term energy planning. The software enables policy makers, researchers and energy practitioners to develop comprehensive models of a region's or country's energy system. LEAP allows users to analyse various policy scenarios, technologies and assumptions to understand their impact on future energy choices [8].

LEAP has a feature called "key assumptions", Key assumptions in LEAP are key assumptions used as the basis for energy modelling. The following are the key assumptions used to visualise the demand for electrical energy in DKI Jakarta in 2023-2033, namely population, GRDP (Gross Ratio Domestic Revenue), number of electricity customers by tariff class and sector in DKI Jakarta province, Final Energy Consumption and intensity of the household, industrial, commercial and public sectors [9]. The following are the projection results of key assumptions in the planning of electricity demand in DKI Jakarta in 2023-2033.

1. Total Population



Branch	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Total Population	10,7	10,8	10,8	10,9	11,0	11,0	11,1	11,2	11,3	11,3	11,4	11,5
Total	10,7	10,8	10,8	10,9	11,0	11,0	11,1	11,2	11,3	11,3	11,4	11,5

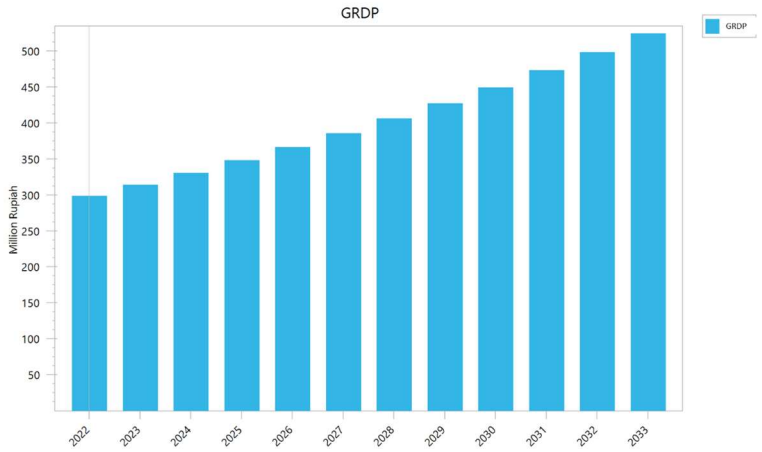
Population has a significant influence on the demand for electrical energy. From the graph, it shows that the more years increase, the greater the population of an area, so the higher the need for electrical energy to meet daily needs, such as lighting, cooling, heating, and the use of electronic devices [10].

2. GRDP

Gross Regional Domestic Revenue (GRDP) has a significant influence on electrical energy demand. GRDP is a measure of the total value of goods and services produced by a region in a certain period of time, and can be used as an indicator for the level of

economic activity of a region [10]. From the graph and table above, it shows that GRDP in DKI Jakarta Province has increased every year, causing the amount of electrical energy demand to tend to increase as well. An increase in GRDP often indicates the economic growth of a region, which directly or indirectly affects the need for electrical energy [11].

3. Number of Electricity Customers

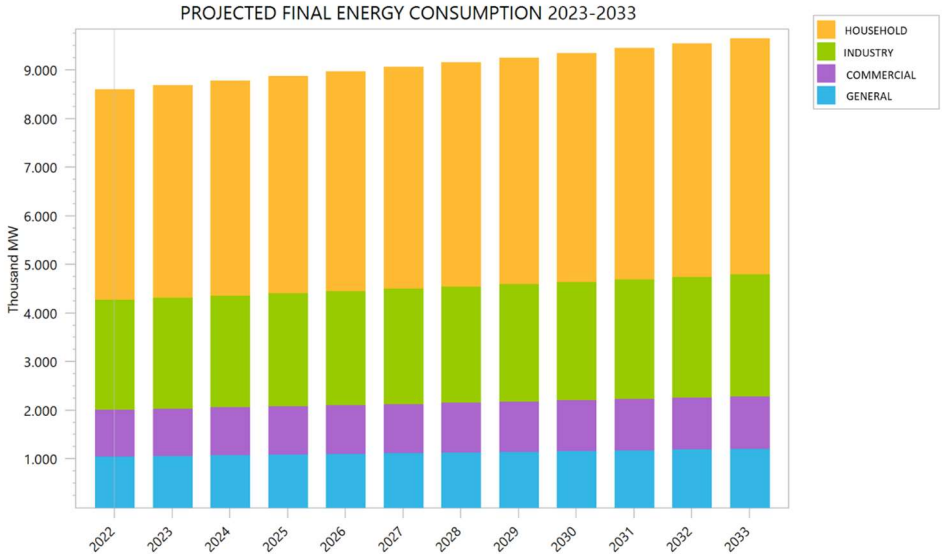


Branch	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
GRDP	298,6	314,3	330,8	348,2	366,5	385,7	405,9	427,3	449,7	473,3	498,1	524,3
Total	298,6	314,3	330,8	348,2	366,5	385,7	405,9	427,3	449,7	473,3	498,1	524,3

The number of electricity customers has a significant influence on the demand for electrical energy. The more the number of electricity customers, the higher the demand for electrical energy. This is due to daily needs in households, such as lighting, cooling, heating, and the use of electronic equipment, the use of technology and electrical equipment, and changes in people's consumption patterns [12].

From the graph and table, it can be seen that the number of electricity customers in households tends to be more dominant than the industrial, commercial, and public sectors due to the larger population, different consumption characteristics, and the nature of demand that tends to be constant throughout the day due to basic needs such as lighting and cooling. However, it is important to note that although the number of electricity customers in the household sector is more dominant, the contribution of the industrial, commercial, and public sectors to total electrical energy consumption is usually significant due to the more intensive use of electrical energy in operations [13].

4. Final Energy Consumption

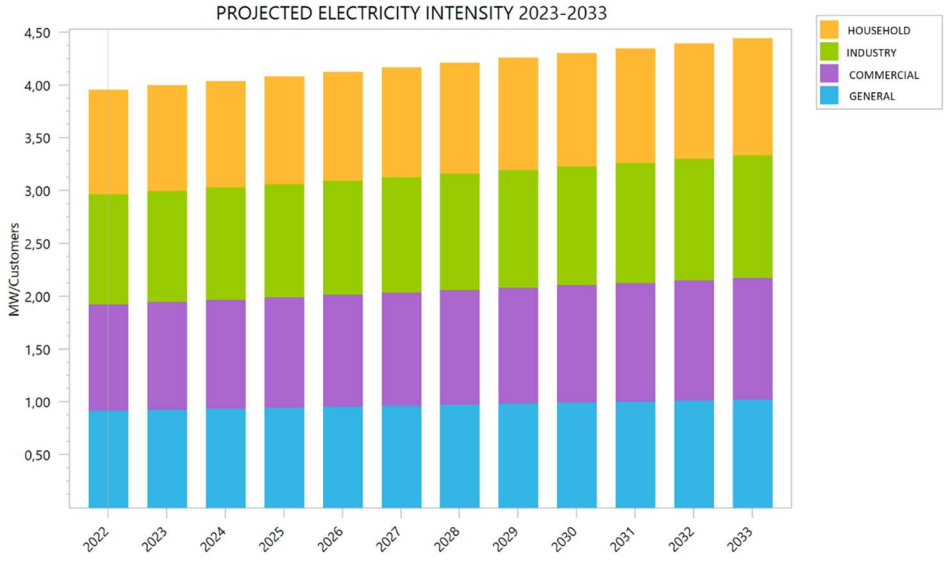


Branch	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Household	4.322,1	4.367,2	4.412,8	4.458,9	4.505,4	4.552,5	4.600,0	4.648,0	4.696,6	4.745,6	4.795,1	4.845,2
Industry	2.257,9	2.279,6	2.301,5	2.323,5	2.345,9	2.368,4	2.391,1	2.414,1	2.437,2	2.460,6	2.484,3	2.508,1
Commercial	964,3	974,1	984,0	994,1	1.004,2	1.014,4	1.024,8	1.035,2	1.045,7	1.056,4	1.067,2	1.078,0
General	1.057,0	1.070,4	1.084,0	1.097,8	1.111,7	1.125,8	1.140,1	1.154,6	1.169,3	1.184,1	1.199,2	1.214,4
Total	8.601,3	8.691,3	8.782,3	8.874,3	8.967,2	9.061,1	9.156,0	9.251,9	9.348,8	9.446,8	9.545,7	9.645,8

Final energy consumption has a direct influence on the demand for electrical energy. This is because electrical energy is often used as the final energy source in various human activities. Therefore, changes in the final energy consumption pattern will directly affect the demand for electrical energy [14]. The greater the final energy consumption, the greater the energy demand. This is due to the close relationship between final energy consumption and overall energy demand. Growth in final energy consumption needs to be considered in the planning and management of energy infrastructure to ensure adequate and sustainable energy supply [15].

From the graph and table above, it can be seen that the final energy consumption is dominated by the household sector compared to the industrial, commercial, and public sectors due to the larger number of customers, different consumption characteristics, and the basic needs of households that tend to be stable and constant over time. Although dominant in terms of quantity, the contribution of energy by the industrial, commercial and public sectors is often greater in total energy consumption due to their higher energy use intensity.

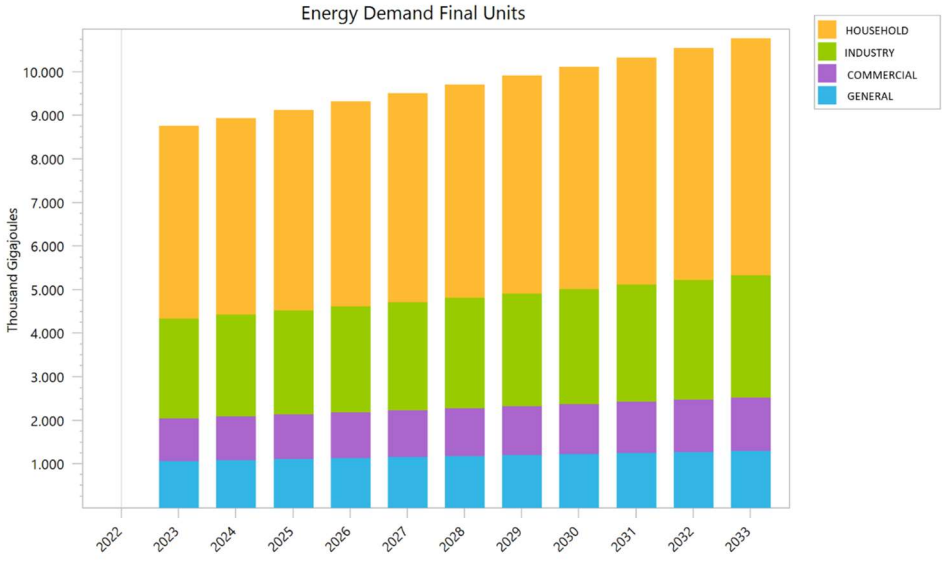
5. Intensity



Branch	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Household	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,1	1,1	1,1	1,1	1,1
Industry	1,0	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,2
Commercial	1,0	1,0	1,0	1,0	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,2
General	0,9	0,9	0,9	0,9	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0
Total	4,0	4,0	4,0	4,1	4,1	4,2	4,2	4,3	4,3	4,3	4,4	4,4

Intensity in the energy context refers to the amount of energy used per unit of output or activity. The greater the electrical intensity of an activity or process, the greater the demand for electrical energy because greater electrical energy use is required to meet the needs of the more intensive activity [16]. From the graph and data, the household, industrial and commercial sectors have similar values, because most activities in the public sector, such as government offices, educational institutions, and other public facilities, generally do not require large-scale or intensive energy use. These activities tend to be lighter in energy use when compared to industrial production processes or the daily energy needs of households [17].

6.Energy Demand Final



Branch	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Household	-	4.412,0	4.503,8	4.597,6	4.693,2	4.790,9	4.890,6	4.992,3	5.096,2	5.202,2	5.310,5	5.421,0
Industry	-	2.285,0	2.332,1	2.380,1	2.429,2	2.479,2	2.530,3	2.582,5	2.635,7	2.690,0	2.745,4	2.802,0
Commercial	-	982,1	1.004,2	1.026,8	1.049,9	1.073,6	1.097,8	1.122,5	1.147,8	1.173,6	1.200,1	1.227,1
General	-	1.078,0	1.099,4	1.121,3	1.143,6	1.166,4	1.189,6	1.213,3	1.237,4	1.262,0	1.287,1	1.312,8
Total	-	8.757,1	8.939,6	9.125,8	9.316,0	9.510,1	9.708,2	9.910,5	10.117,0	10.327,8	10.543,1	10.762,8

The graph and table above show the projected final energy demand from 2023 to 2033 for four main sectors: household, industrial, commercial and public. Below is the interpretation of the data from the graphs:

1. Households

Final energy demand from the household sector (shown in orange) is likely to be stable or increase slightly from 2022 to 2033. The data shows the amount of final energy demand from the household sector for each year from 2023 to 2033. This is the total energy consumed by households in the timeframe indicating that household energy consumption is expected to remain relatively stable in the timeframe.

2. Industry

Final energy demand from the industrial sector (shown in green) shows a consistent upward trend from 2022 to 2033. The data in the table displays the amount of final energy demand from the industrial sector for each year from 2022 to 2033. This reflects the total energy used by industry in that timeframe for production and operational processes. This indicates that the industrial sector is expected to experience growth in energy use over the period.

3. Commercial

The final energy demand from the commercial sector (shown in purple) shows relatively stable fluctuations from 2022 to 2033, with slight increases in some years. This indicates that energy consumption within the commercial sector is expected to remain relatively stable with little variation.

4. General

The final energy demand of the public sector (shown in blue) shows a consistent downward trend from 2022 to 2033, indicating that the public sector is expected to reduce energy use within this timeframe.

From the data interpretation of the graph, it can be concluded that the industrial sector shows significant growth in final energy demand, while the household sector tends to stabilise, and the commercial sector shows relatively stable fluctuations. Meanwhile, the public sector shows a downward trend in final energy demand.

IV. CONCLUSION

This research shows that LEAP (Long-range Energy Alternatives Planning) software is effective in modelling and projecting electrical energy demand in DKI Jakarta Province for the period 2023-2033. Some of the key assumptions used include population, GRDP, number of electricity customers, final energy consumption, and energy intensity. The analysis shows that an increase in population and GRDP drives an increase in demand for electrical energy. The number of electricity customers, especially in the household sector, also has a significant effect on energy demand. High final energy consumption, especially in the household and industrial sectors, contributes significantly to total energy demand.

The industrial sector is projected to experience significant growth in energy demand, while the household sector is likely to stabilise and the general sector shows a decline in energy demand. The commercial sector is expected to remain stable with minimal fluctuations. This research is important for the planning and management of sustainable energy infrastructure in DKI Jakarta.

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