Impact of Relocating the National Capital on the Projection of Electrical Energy Consumption: a Case Study in East Kalimantan Province, Indonesia

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Abstract—**The availability of electrical energy is one of the crucial parameters in the growth and development of a region. To accelerate Indonesia's economic transformation and change the orientation of development to become Indonesia-centric, the government will move the current capital city to the province of East Kalimantan. Various policies have been drawn up, including the plan to relocate civil servants. The increase in population and economic mobility will have an impact on the demand for electrical energy. This research uses LEAP software, where the approach method used to calculate the projected electrical energy demand is the end-use method. There are three scenarios for projecting electricity demand, that is business as usual (BAU), moderate scenario (MOD), and optimistic scenario (OPT). MOD and OPT are scenarios with the impact of moving the national capital. The projection results for the 2022-2035 period show that the consumption of electrical energy in each scenario increases every year. The BAU scenario grew by 8.11%, the MOD scenario by 9.09%, and the OPT scenario by 9.64%. Cumulative energy consumption for all customer sectors in 2035 in the BAU scenario will reach 13,760 GWh. The MOD scenario is 15,899 GWh, and the highest energy consumption in 2035 is in the OPT scenario which reaches 17,171 GWh.**

Keywords— **energy consumption, electrical energy, LEAP, new capital city, East Kalimantan Province**

I. INTRODUCTION

Indonesia has been declared by the United States government as a developing country and categorized as a developed country. Currently, Indonesia continues to grow with a sizable population, which also impacts a fast-growing economy with a growth rate of 6% since 2010, with several emerging classes in the energy sector relying on fossil fuels. As a result, domestic energy demand has also increased massively by an average of almost 8% [1]. Indonesia is a country with the highest level of energy consumption among Southeast Asian countries, accounting for more than 36% of energy demand and 66% of its consumption.

This value is even higher than the country in the second rank, namely Thailand [2]. Indonesia's electricity demand is proliferating, driven by strong economic growth. Total electricity demand increased from 134.5 TWh in 2008 to 203 TWh in 2015, an average growth rate of 6% per year [3].

Recently, it has been in the spotlight after the reform era, namely regarding a breakthrough by the President of the Republic of Indonesia to move the country's capital city from Jakarta to East Kalimantan [4]. This plan has been on the agenda since 2019. Mapping and land design have also been determined, where the IKN area will be built in the administrative area, namely Penajam Paser Utara Regency and Kutai Kartanegara Regency [5].

This study uses LEAP (Low Emission Analysis Platform) software for electricity energy planning. LEAP is a modelling tool with various quite comprehensive scenarios based on environment and energy. [6], [7]. In that energy system Various assumptions can be used, such as population, technology, including price. So that the use of this modelling tool is more supple [8]. The data needed in this study for the LEAP simulation are population growth, economic growth, energy consumption, and supporting data regarding the IKN mega project. The final result of the LEAP simulation is a pattern of energy allocation that will be needed so that these results will be used to analyze the demand and supply of electrical energy in the new state capital area in East Kalimantan.

Planning is made to assist in selecting the best and most efficient alternative. Electricity planning in Indonesia is carried out on a national and regional level. As stated in Law No. 30 of 2009, electricity planning is an obligation for government administrators, namely the central government and local governments. The policy plan for the electricity sector is set out in the National Electricity General Plan and the Regional Electricity General Plan [9].

II. METHODS AND ASSUMPTIONS

This projection is carried out over 25 years, where 2019 is used as the base year, 2020 as the first projection year and 2035 as the final projection year. The modelling structure in this study only considers the demand for electrical energy. There are three scenarios of energy consumption projections, namely the BaU (Business as Usual) scenario, the Moderate IKN scenario (MOD) and the Optimist IKN scenario (OPT). Each scenario has differentiating factors that affect population growth and economic growth. Meanwhile, customer growth and energy intensity follow from the existing economic growth.
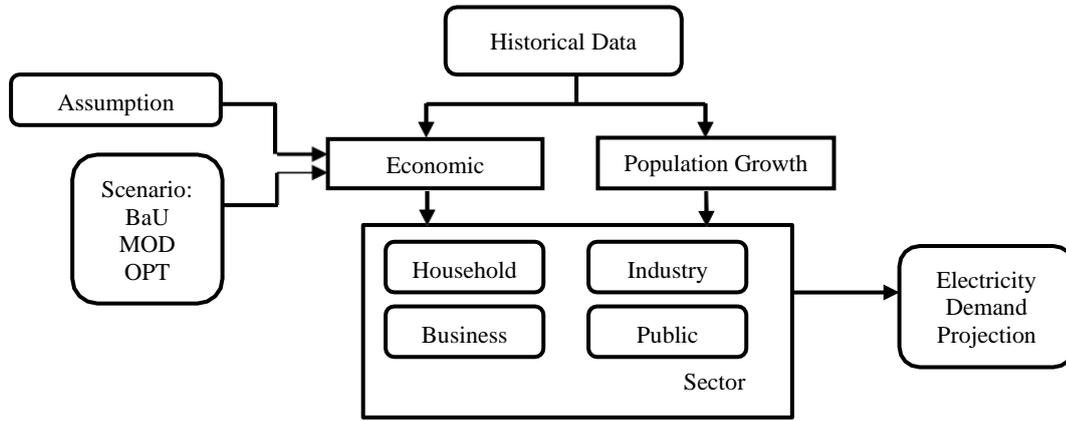
Fig. 1 Model of Demand Projection

A. Assumption of Population Growth

The assumptions related to population growth are used for the average population growth rate from 2014 to 2019 for the BaU scenario. The other two scenarios, namely MOD and OPT, are based on the Ministry of Administrative Reform and Bureaucratic Reform regarding the transfer of ASN to a prospective new capital city. There are two planned scenarios, namely displacement based on the age group up to 45 years with 118,506 ASN. The second scenario does not consider the age group, which is 188,092 People [10]. By considering the age group, the scenario is assumed to be a moderate scenario (MOD), while for the other scenarios, it is assumed to be an optimistic scenario (OPT). Concerning government planning, every single Civil Servant counts as many as five people. The OPT scenario, there are 940,460 people, and for MOD, it is 592,530 people. The transfer was carried out in stages for five years, starting from 2023 to 2027.

TABLE I
CIVIL SERVANTS TRANSFER SCENARIO

	Number of Civil Servants (People)				
Year	2023	2024	2025	2026	2027
OPT	13,156	23,472	120,133	2,341	28,990
MOD	7,218	10,571	79,343	1,494	19,880

B. Assumptions of customers and the Energy Intensity.

The customer assumptions and the intensity of the MOD and OPT scenarios are based on the economic targets achieved, namely, by moving IKN will increase Gross Regional Domestic Porduct (GRDP) by 7.6%. Meanwhile, BaU uses historical data from 2014 to 2019 [11],[12]. The growth percentages for both are taken from the government's assumptions from 2023 to 2027. Based on the extrapolation results, energy intensity of household sector will increase by 0.134 % for the optimistic scenario and 0.086 % for moderate scenario during these five years. The Business Sector is targeted to increase by 0.073% for the optimistic scenario and 0.468% for the moderate scenario. The industrial and public sectors have the same growth rate, namely 0.61% for the optimistic scenario and 0.390% for the moderate scenario.

III. RESULT AND DISCUSSION

A. Population Growth

The population of East Kalimantan Province every year continues has increased every year with an average population growth of 2.12%. In this projection, several assumptions are used regarding the government scenario regarding relocating the nation's capital city. The transfer of ASN has an impact on population growth. The average population growth resulting from the optimistic scenario is 3.14% and 2.78% for the moderate scenario. Based on the processing of the LEAP software, the results of the population projections for 2020-2035 are shown in Table II.

TABLE II
POPULATION PROJECTION of ALL SCENARIOS EVERY FIVE YEARS

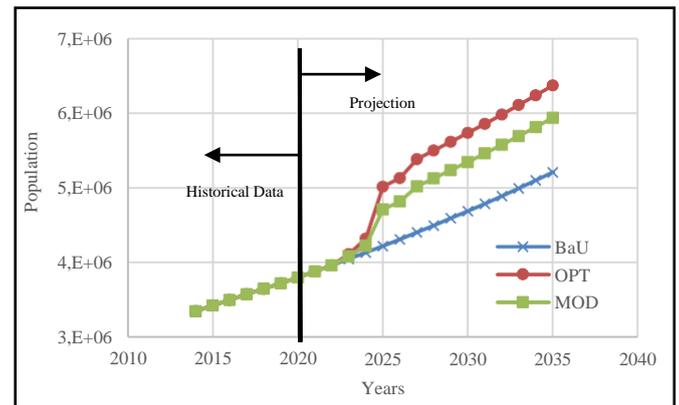| Year	Population		
	BaU	OPT	MOD
2020	3,800,282	3,800,282	3,800,282
2025	4,220,558	5,009,670	4,708,885
2030	4,687,313	5,739,788	5,343,045
2035	5,205,686	6,364,560	5,932,863

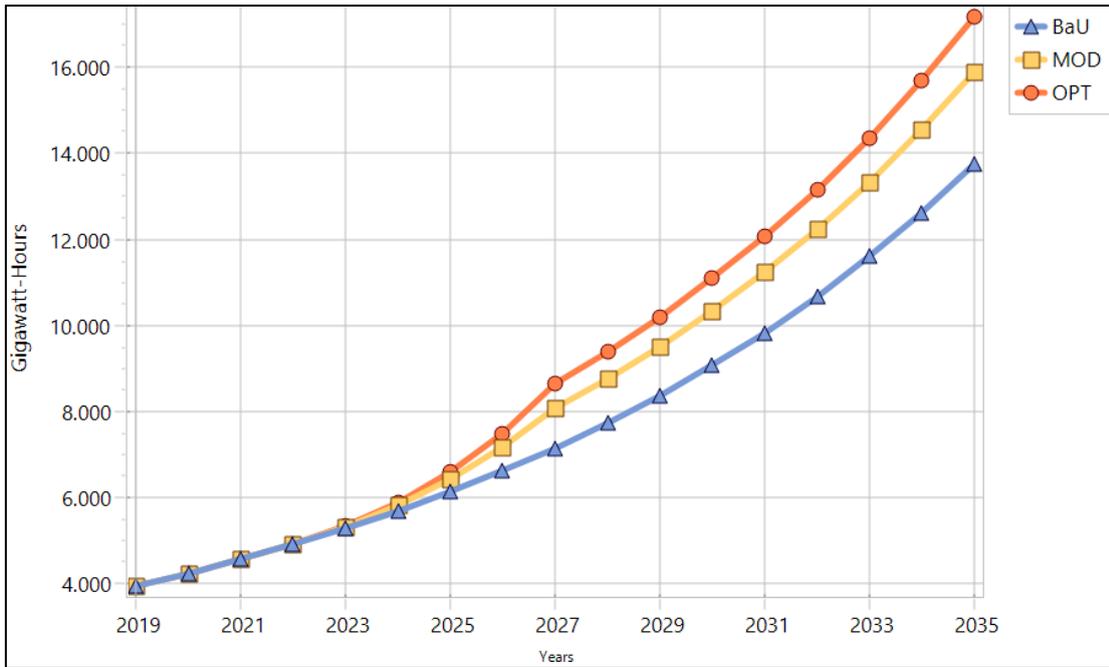Fig. 2 Graph of Population Projection in BaU, OPT and MOD Scenarios

Fig. 3 LEAP graph of Electrical Energy Demand Projection in all Scenarios

Based on the graph shown in Figure 2. The scenario with the highest average growth is the optimistic scenario. IKN relocation will impact increasing the population to reach 1 million people from the normal scenario.

B. Electrical Eneergy Costumers

Customer projections using historical data for the BaU scenario, while the IKN relocation scenario, both optimistic and moderate scenarios, uses the government's assumption data regarding electricity customers with the impact of moving the country's capital city. The highest percentage is in the business sector. According to the Ministry of National Development Planning explanation, the transfer of IKN will encourage the improvement and development of non-traditional sectors, especially the service sector, increase inter-provincial trade, and increase employment opportunities by up to 6%. Then followed by the industrial and public sectors with the same magnitude, while for the household sector, it will increase by no more than 0.7% until 2027. In 2028, there will be the same increase following the BaU projection for all scenarios. Based on the assumption of government projections, the average percentage increase during 2023-2037, as shown in Table III.

TABLE III
PERCENTAGE INCREASE RATE EACH YEAR OPT and MOD
SCENARIOS in PERIOD 2023 to 2027

Sector	Scenaio	
	OPT	MOD
Household	0,13%	0,09%
Industry	0,61%	0,39%
Business	0,73%	0,47%
Public	0,61%	0,39%

A. Electrical Energy Demand (BaU Scenario)

This scenario is based on historical or actual data from 2014 to 2019. The average growth of electricity customers and the intensity of electrical energy is shown in Table IV. The processed data will be simulated in the LEAP software poured as current account data into the BaU scenario. This scenario is based on the projected growth of electrical energy running normally in all sectors. The data used in the BaU scenario is historical data from the period 2014-2019, where 2019 is the base year of the projection and 2035 is the final year of the projection. In addition, the assumptions in this scenario are also at a constant value for population and household growth or do not experience substantial changes. The population growth rate data obtained from the East Kalimantan statistic center is 2.12%, with a total population in 2019 of 3,721,389 people. The BaU scenario is a scenario with the assumption that there is no transfer of IKN to East Kalimantan Province.

TABLE IV
ELECTRICAL ENERGY DEMAND PROJECTION (BAU SCENARIO)

Years	Electrical Energy Demand (GWh)			
	Household	Industry	Business	Public
2019	2,213.45	312.89	1,020.30	406.24
2020	2,327.60	361.02	1,114.23	441.67
2025	2,992.96	738.28	1,730.66	670.96
2030	3,848.53	1,509.79	2,688.11	1,019.28
2035	4,948.66	3,087.52	4,175.25	1,548.43

The results of the projected calculation of electrical energy consumption in the BaU scenario show an average growth in the 2019-2035 period for the household sector of 5.16%; the industrial sector has the highest average of 15.38%, the business sector is 9.21% and public sector by 8.72%. During the 2019-2035 period, the average electrical energy

consumption in the household sector is around 170.95 GWh per year. The industrial sector is 173.41 GWh, the business sector is 197.18 GWh, and the public sector is 71.39 GWh.
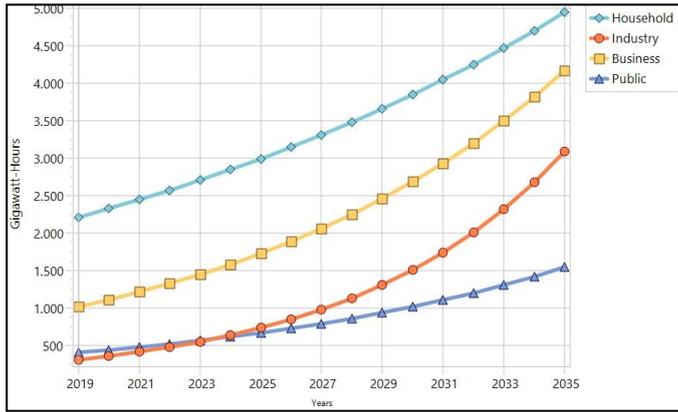

Fig. 4 Projection of Electrical Energy Demand in the BaU Scenario with LEAP

B. Electrical Energy Demand (MOD Scenario)

The moderate scenario is the scenario with the influence of the relocation of the national capital and various government policies related to the planning of the new capital city. This scenario is based on government policy assumptions regarding the transfer of civil servants to IKN areas. The transfer used uses a scenario with an civil servants age limit of up to 45 years of 118,506. Based on the planning from the Ministry of State Apparatus Utilization and Bureaucratic Reform, each civil servant is assumed to consist of five people, namely 1 civil servant, one wife/husband, two children and one housemaid. So the total displacement from the moderate scenario is 592,530 souls that have been planned annually for a period of five years (2023-2027). The year 2023 is the initial year of migration until 2027, where the primary data as a reference is used data from the BaU scenario.

TABLE V
ELECTRICAL ENERGY DEMAND PROJECTION (MOD SCENARIO)

Years	Electrical Energy Demand (GWh)			
	Household	Industry	Business	Public
2019	2,213.45	312.89	1,020.30	406.24
2020	2,327.60	361.02	1,114.23	441.67
2025	3,064.21	823.48	1,855.23	686.66
2030	4,080.88	1,979.36	3,195.84	1,079.82
2035	5,247.44	4,047.79	4,963.88	1,640.40

Based on the calculation results of the IKN MOD projection, the average growth for the 2019-2035 period is 5.55% in the household sector, with an average growth in demand of 189.61 GWh. The industrial sector increased by 2.02% from the BaU scenario, with average consumption growth of 233.43 GWh per year. The average business sector increased to 10.41%, with an average growth in electricity consumption of 246.67 GWh. Meanwhile, the public sector

also increased its consumption growth by 9.12%, with an average growth in energy consumption of 77.13 GWh.
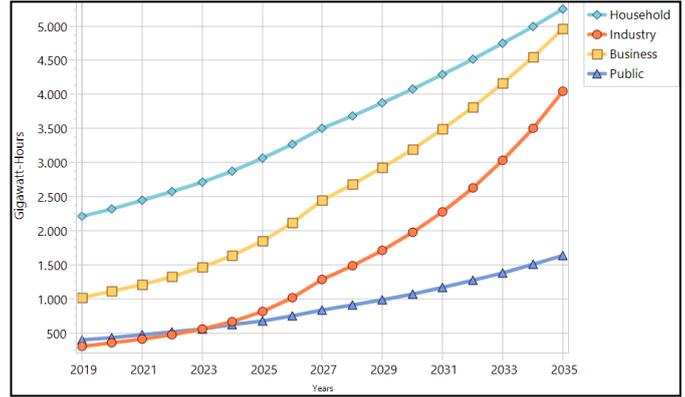

Fig. 5 Projection of Electrical Energy Demand in the MOD Scenario with LEAP

C. Electrical Energy Demand (OPT Scenario)

Unlike the MOD scenario, this scenario uses the government's assumptions regarding the transfer of ASN with projected displacement regardless of age limit or all transfers. The number of ASN transferred was 188,092 people, so the additional population for five years in the IKN area was 940,460 people. The baseline data used in the projection are customer growth data and also the intensity of electrical energy from the BaU scenario, which is then added with government targets regarding customers and also electrical energy sold.

TABLE VI
ELECTRICAL ENERGY DEMAND PROJECTION (OPT SCENARIO)

Years	Electrical Energy Demand (GWh)			
	Household	Industry	Business	Public
2019	2,213.45	312.89	1,020.30	406.24
2020	2,327.60	361.02	1,114.23	441.67
2025	3,104.58	866.91	1,928.47	695.65
2030	4,216.75	2,245.13	3,517.51	1,115.22
2035	5,422.14	4,591.29	5,463.51	1,694.18

Fig. 6 Projection of Electrical Energy Demand in the OPT Scenario with LEAP

Based on the projection results of the projected pest scenario shown in Fig. 6, there is an increase in each sector compared to the other two scenarios. In the household sector, the average energy consumption increased by 5.77%, increasing the average consumption of around 200.55 GWh. The industrial scenario increases to 18.39% or almost 3% more than the scenario without IKN transfer, with average consumption growth of 267.41 GWh. The increasing business scenario is 11.10%, with average consumption growth of 277.70 GWh. Meanwhile, in the public sector, the consumption growth rate increased to 9.34%, increasing total consumption approaching 3.4 GWh from the MOD scenario.

IV. CONCLUSIONS

The projected demand for electrical energy in East Kalimantan in the BaU scenario increases every year in the 2019-2035 projection period. The final consumption value in 2035 is 13,759.85 GWh, with an average projected growth of 8.11%. The sector with the highest energy demand is the industrial sector with 15.38%. In the household sector, demand growth was 5.16%, the business sector was 9.21%, and the public sector was 8.72%. The transfer of IKN will increase the value of energy consumption. This is due to an increase in population and various sustainable developments. The projected demand for electrical energy in the moderate scenario (MOD) also increases every year. in 2035, its electrical energy consumption will reach 15,899.50 GWh with an average projected growth rate of 9.09%. In the household sector, demand growth was 5.55%, the industrial sector was 17.40%, the business sector was 10.41%, and the public sector was 9.12%.

Meanwhile, the OPT scenario has the most significant consumption value at the end of the projection year compared to all scenarios, 17,171.11 GWh, with an average projected growth rate of 9.64%. For all customer sectors. In the household sector, demand growth was 5.77%, the industrial sector was 18.39%, the business sector was 11.10%, and the public sector was 9.34%.

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