Forecasting the electrical energy needs in Bangka Island

R Mahendra¹, R F Gusa¹2, W Sunanda¹2, Asmar¹ and F Arkan¹

¹Department of Electrical Engineering, Universitas Bangka Belitung, Indonesia
²Research Centre for Energy and Information Technology, Universitas Bangka Belitung, Indonesia

E-mail: rikafavoriagusa@gmail.com

Abstract. Bangka Island is one of the two largest islands in Bangka Belitung Islands Province. The total population in Bangka Island in 2018 was 1146654 persons. The growth of the population every year is accompanied by an increase in electricity demand. The increase in electricity demand is also caused by economic factors, namely GDP growth and regional development factor. By using LEAP software, forecasting of electricity needs for the year 2019-2028 are obtained. The number of electricity customers grows by an average of 1.83%/year while average growth of electricity consumption is 11.697%/year. The total electricity production in 2028 is estimated to reach 2.47GWh with peak load of 394.07 MW. The average peak load growth during 2019-2028 is 10.48%/year. Fulfillment of electricity demand will be met by the construction of 4 new types of power plants and the addition of submarine cables from Substation Tanjung Api to Substation Mentok in 2020.

1. Introduction

Bangka Island is one of the big islands in Bangka Belitung Island Province that consists of 1 capital city and four districts. Electricity consumption in the Province of Bangka Belitung Islands in the period 2011 to 2018 showed growth of 24.11% with the sale of electricity in 2018 amounted to 1.044 GWh. The largest group of customers that use electricity is households, with average electricity usage in 2011 to 2018 of 551.4GWh/year. Even in 2018, household customers consumed 627 GWh of electricity[1].

The Bangka electricity system is part of the Bangka Belitung electricity system. The total capacity of power for Bangka Island is 188.79 MW with peak load of 150.7 MW that supplied by steam power plants, diesel power plants and biomass power plants [1]. The number of customers is 349778, with consumption of electrical energy 824 MWh. As a new province, of course, there will always be population growth every year. The total population of Bangka Island in 2018 was 1.146.654 persons [2].

By using the energy planning estimation method, it is forecasted the growth of electrical energy needs in Bangka Island until 2028. Some research forecast electricity needs [3-5], electricity price [6], the gas sector in Bangladesh until 2020 with data 1993-2000 [7], annual peak load for long term reflect on the demand-side program in Belgrade [8]. Other research use LEAP to make a model for energy demand and environmental emission in Beijing until 2025 [9], forecast power sector up to 2030 in Pakistan with considering some factors; electric consumers growth, level of activities, final energy intensity, and forecasted growth [10]. Also, there is some research using LEAP to forecast electricity demand in Indonesia until 2025[11], electricity demand in Sumatera until 2035 [12], future needs of Kuwaiti electric network [13] and Morocco [14].
2. Methodology
In this study, electrical energy needs in Bangka island is forecasted for 2019-2028 based on data in 2009-2018 using the energy planning forecast method. Demand forecasted for five sectors, that are household, business, social, government and industry sector. For the household sector, the number of customers in the future is forecasted based on population number, electrification ratio and population growth rate. For other sectors, the number of customers projected based on customer capacity factor and gross regional domestic product (GDP) growth. The customer capacity factor is obtained by dividing the customers number growth rate by GDP growth rate.

The projection of electrical energy consumption for the household sector is calculated based on energy consumption elasticity, number of customers, energy intensity and GDP growth rate. For non-household sectors, electrical energy consumption is estimated based only on energy consumption elasticity and GDP growth rate. The elasticity of energy consumption is obtained by dividing the growth rate of electricity consumption by GDP growth rate and energy intensity can be obtained by dividing the total electricity consumption by the number of customers.

3. Results and discussion
The projection of electrical energy customers number in Bangka Island electricity system in 2019-2028 using LEAP software is shown in Figure 1.

![Figure 1. Total number of customers projection](image)

The total number of electricity customers in Bangka electricity system continues to increase from 2019 to 2028 with an average growth of 1.83% per year or increase from 370625 in 2018 to 436,214 in 2028. Household sector customers are forecasted to grow by an average of 1.942% per year so that in 2028 it will reach 410432 customers while the forecast of business sector customers growth is 0.134% per year so that in 2028 it will reach 16976 customers, the industrial sector amounted to 0.41% per year so that by 2028 it will reach 332 customers, the social sector amounted to 0.173% per year so that in 2028 it will reach 5621 customers and the government sector by 0.185% per year so that in 2028 it will reach 2853 customers. The household sector dominates customer forecast growth in the Bangka electricity system. It is because the number of customers in the household sector is greater than other sectors and also the household sector gets more attention from the PLN.

Electrical energy consumption levels according to the modeling in this study are influenced by the growth of GDP and the level of energy elasticity. The growth of these two factors is the basis for
calculation by 2018 as the base year. Electricity energy consumption in Bangka electricity system for 2019-2028 is projected using LEAP software. Electricity consumption forecast in Bangka electricity system shows an increase from 2019 with the total consumption of 921 MWh to 2.473 GWh in 2028 as illustrated in Figure 2. In other words, the average growth in total electricity consumption from 2019 until 2028 is 11.697% per year.

![Electricity consumption projection](image)

**Figure 2.** Electricity consumption projection

The household energy consumption level is prominent compared to other sectors. The household sector energy consumption is estimated to grow by an average of 14.873% per year so that in 2028 it will reach 2.1 GWh while the forecast of business electricity consumption growth is 1.065% per year so in 2028 it will reach 153 MWh, the industrial sector amounted to 3.403% per year so that in 2028 it will reach 152.6 MWh, the social sector amounted to 1.476% per year so that in 2028 it will reach 33.3 MWh and the government sector grows 2.867% per year so that in 2028 it will reach 44.6 MWh. Total of energy consumption in 2028 is 2.47 GWh.

The total electricity consumption is 921MWh in 2019 with losses in transmission and distribution of 6.04%, so the electrical energy that must be provided at the side of the plant is 922 MWh as shown in Figure 3. Likewise, for the year 2028, the electrical energy that must be produced at the side of the generator is 2.47 GWh to meet the total electricity consumption needs of 2.47 GWh with losses in transmission and distribution of 5.15%. From 2019 until 2028, the total electricity production grows by an average of 10.34% per year.

The increasing demand for electricity in Bangka Island electricity system leads to an increase in the energy produced by PLN to meet the needs so that the peak load is also getting higher. By knowing the total production of electricity, the peak load can be calculated. Peak load in the Bangka Island electrical system is forecast using LEAP software.
Fig. 3. Projection of Electrical Energy Production

Based on the forecasting results, the electrical energy needs in Bangka Island electricity system are increasing every year with the peak load of electrical energy demand in 2019 amounted to 151.45 MW and increasing in 2028 to 349.07 MW. It can be said that during the period from 2019 to 2028, the amount of the peak load of electrical energy demand in Bangka Island electricity system grows by an average of 10.48% per year.

Bangka Belitung Province has the potential for renewable energy, namely biomass of 217.7 MW, biogas of 5.4 MW, solar of 2.810 MW. To meet the needs of electrical energy in the Bangka Island electrical system until 2028, it will be built several renewable energy power plants (biomass, biogas and solar power plants). It also will be built submarine cables from substation Tanjung Api-Api (South Sumatera) to substation Mentok (West Bangka) to fulfill the electricity demand for all sectors in the future.

4. Conclusion
1. The electricity customers number in Bangka electricity system from 2019 to 2028 continues to increase from 370625 to 436214 customers or grows by an average of 1.83% per year.
2. The amount of electrical energy consumption in 2028 is forecasted at 2.47 GWh or the average growth of electricity consumption during 2019-2028 is 11.697% per year.
3. The total electricity production in 2028 is estimated to reach 2.47GWh with peak load of 394.07 MW.
4. Fulfillment of electricity demand for all sectors will be met by the construction of new plants and the addition of submarine cables from substation Tanjung Api-Api to substation Mentok.

References
[1] PT PLN (Persero) Wilayah Bangka Belitung 2019 Rencana Usaha Penyediaan Tenaga Listrik Tahun 2019 – 2028 Kepulauan Bangka Belitung
[2] Badan Pusat Statistik 2018 Laju Pertumbuhan Penduduk Provinsi Kepulauan Bangka Belitung Menurut Kabupaten/Kota 2007-2017 Kepulauan Bangka Belitung
[3] Esteves G R T, Bastos B Q, Cyrino F L, Callili R F and Souza R C 2015 Long Term Electricity Forecast : A Systematic Review Procedia Computer Science Elsevier Masson SAS 55 549–558 doi: 10.1016/j.procs.2015.07.041
[4] Yudianto T, Sunanda W and Asmar 2017 Prakiraan Kebutuhan Beban dan Energi Listrik Provinsi Kepulauan Bangka Belitung Tahun 2017-2026 Prosiding Seminar Nasional Penelitian dan Pengabdian Kepada Masyarakat 198-207
[5] Srivastava A K, Pandey A S and Singh D 2016 Short-Term Load Forecasting Methods : A Review Int. Conf. on Emerging Trends in Electrical Electronics & Sustainable Energy Systems (ICETEES) IEEE pp 130–138 doi: 10.1109/ICETEES.2016.7581373

[6] Karabiber O A and Xydis G 2019 Electricity Price Forecasting in the Danish Day-Ahead Market Using the TBATS, ANN and ARIMA Methods. Energies 12 928 doi: 10.3390/en12050928

[7] Khan S I, Islam A and Khan A H 2011 Energy Forecasting of Bangladesh in Gas Sector Using LEAP Software Global J. of Researches in Engineering 11 15

[8] Rajakovic N L and Shiljkut V M 2017 Long-term forecasting of annual peak load considering effects of demand-side programs J. of Modern Power Systems and Clean Energy 6 145 doi: 10.1007/s40565-017-0328-6

[9] Guo F 2016 Energy Demand and Environment Integration Model and Application: the Case of Beijing MATEC Web of Conf. 65 02005 doi: 10.1051/matecconf/20166502005

[10] Perwez U and Sohail A 2014 Forecasting of Pakistan’s net electricity energy consumption on the basis of energy pathway scenarios Energy Procedia 61 2403

[11] Windarta J Purwanggono B and Hidayanto F 2018 Application of LEAP model on long-term electricity demand forecasting in Indonesia, period 2010-2025 SHS Web of Conf. 49 02007 doi: 10.1051/shsconf/20184902007

[12] Suhonono and Sarjiya 2015 Long-term electricity demand forecasting of Sumatera system based on electricity consumption intensity and Indonesia population projection 2010-2035 Energy Procedia 68 455 doi: 10.1016/j.egypro.2015.03.277

[13] Almeshaiei E and Soltan H 2011 A methodology for Electric Power Load Forecasting Alexandria Engineering J. 50 137 doi: 10.1016/j.aej.2011.01.015

[14] Raouz K 2015 Morocco ´s Energy System Forecasted Using LEAP (Stockholm: Royal Institute Of Technology)

[15] Stockholm Environment Institute 2006 Long-range Energy Alternative Planning System, User Guide (Boston: Stockholm Environment Institute)

Acknowledgement
We gratefully acknowledge the funding from USAID through the SHERA program – Centre for Development of Sustainable Region (CDSR). In the year 2017-2021 CDSR is lead by Centre for Energy Studies – UGM.