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ANALYSIS AND PREDICTION OF ELECTRICAL ENERGY CONSUMPTION IN THE URBAN COMMUNE OF MAMOU (REPUBLIC OF GUINEA)

Jean Ouèrè Toupouvogui[1]*, Mohamed Ansoumane Camara[2] Ansoumane Sakouvogui[3], And Mamby Keita[4]

[1]Department of Instrumentation and Physical Measurements, Higher Institute of Technology of Mamou, Guinea.

[2]Electrical Engineering Department, Polytechnic Institute, Gamal Abdel Nasser University of Conakry, Guinea.

[3]Energy Department, Higher Institute of Technology of Mamou, Guinea.

[4]Department of Physics, Faculty of Sciences, Gamal Abdel Nasser University of Conakry, Guinea.

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***Corresponding Author**
Jean Ouèrè Toupouvogui
Department of Instrumentation and Physical Measurements, Higher Institute of Technology of Mamou, Guinea.

ABSTRACT

In recent decades, contemporary lifestyle, as well as technological development, have increased household electricity consumption. Excessive electricity use has a negative impact on the environment, increasing the carbon footprint and contributing to climate change. Governments are increasingly concerned about how our societies use energy and are committed to reducing greenhouse gas emissions. The data for this analysis are collected from the annual statistics of peak loads, energy consumption of the arteries of Electricity Of Guinea for the years 2018, 2019, 2020 and 2021. The purpose of this study is to analyze the electricity consumption of the urban municipality of Mamou to understand, evaluate and predict the electrical energy demand of the urban municipality of Mamou in order to highlight the capacity of the substation in relation to the demand of the municipality in the future.

KEYWORDS: Energy, Consumption, Prediction, Load peaks, Electricity of Guinea.

1. INTRODUCTION

The consumption of electrical energy is a continuous temporal process which depends on many contextual variables: weather variables (temperature, cloud cover, wind), calendar variables (type of day, position in the year) and variables due to the properties of temporal (consumption of the day before).[1,2,3]

Over the past few decades, due to increased demand and improved lifestyle of the people, the demand for energy in the residential sector has increased rapidly, which has caused concern among policy makers. The international climate negotiation is an opportunity for decision-makers to promote the improvement of energy efficiency and the reduction of greenhouse gas emissions and to make commitments in terms of renewable energy consumption. The recent Energy Strategy 2030 and the Paris Climate Conference (COP21) focus on previous targets to keep a global temperature increase this century below 2°C.[4]

In Guinea, the rate of access to channeled energy is only 7%, one of the lowest in the sub-region, and nearly 70% of the population does not have access to electricity. . Guinea plans to increase access to electricity to 100% by 2030, as well as increasing the share of renewable energy, access to cooking technologies and clean fuels, and better energy efficiency.[5]

The rate of access to electricity, which is progressing very slowly in Guinea, was 18.1% in 2011 (Figure 2), with very significant differences between urban (47.8%) and rural (2%) areas. on average.[6] In 2019, this rate is 87.7% in urban areas and 16.4% in rural areas.[7] The urban commune of Mamou had an electrification rate of 5.2% in 2003, 6.1% in 2007 and 6.8% in 2012.[8,9]

In Guinea, the demand for energy has increased, mainly due to electrification projects and the development of mining industries. In 2015, electricity demand increased by 13% and is expected to continue to grow at a rate of around 10% per year over the next five years. This growth is due to the satisfaction of demand thanks to the implementation of electrification projects aimed at achieving the objective of 35% electrification by 2025, but also to the likely development of industrial activities, particularly in the mining industry. The forecasts of the National Master Plan for Electricity Production and Transmission are counting on a growth in electricity demand from 1,666 GWh in 2016 to approximately 16,000 GWh in 2035.

Total energy consumption and the electricity mix have evolved, with significant development of hydroelectricity. Guinea's current electricity mix is dominated by hydroelectricity and fossil fuel-based energy sources. Guinea is recognized as having the greatest hydroelectric potential in West Africa, with an estimated potential of over 6000 MW.[10,11]

During low water periods, most of the production was provided by the thermal power stations. During the rainy season, most of the energy production (63%) is ensured by hydropower plants due to the abundance of natural water supplies, which have thus allowed the optimal exploitation of hydropower plants.[12]

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During the rainy season, most of the energy production is by hydraulic power stations due to the abundance of natural water supplies, which thus allowed the optimal exploitation of hydropower stations.

In 2021, the interconnected network was marked by gross production of 2995 GWhs against 2414 GWhs in 2020, i.e. an annual growth rate of 19%. The actual production level (3097 GWhs) reached 97% of the forecast production (3186.2 GWhs).[13]

2. MATERIAL AND METHOD

2.1 Presentation of the study area

The prefecture of Mamou, capital of the administrative region of Mamou is between 9^{o}54' and 11^{o}10' North latitude and 11^{o}25' and 12^{o}26' West longitude with an average altitude of 700 m. It covers an area of 8,000 km2 with a population of 318,981 inhabitants, i.e. an average density of 30 inhabitants per km^2.[14] It is limited: to the North by the Prefectures of Dalaba and Tougué; to the south by the Republic of Sierra Leone; to the east by the prefectures of Dabola and Faranah; to the west by the Prefecture of Kindia. Its climate is of the Foutanian type, characterized by the alternation of two (2) seasons of equal duration: a dry season from November to April and a rainy season from May to October; The rainy season is dominated by scattered rains of short duration and gales. Its area is divided between an urban municipality which has 28 neighborhoods and 13 rural communities, namely: Bouliwel, Dounet, Gongoré, Kégnéko, Konkouré, Niagara, Ourékaba, Porédaca, Saramoussaya, Soya, Téguéréya, Timbo and Tolo. The population is predominantly rural, 79% of Mamou's population is found in rural areas. Its density is 30 inhabitants/km² and its climate is tropical.

The Urban Commune of Mamou is located 266km from Conakry. It is limited to the North by the Rural Development Commune of Boulliwel and Tolo, to the North-East by that of Dounet, to the South-East by that of Soyah, to the West by that of Konkouré. The Urban Commune of Mamou, a city located in the heart of Guinea on the National (International) Conakry-Kindia-Kankan-Faranah and Labé, hence its name as the most characteristic crossroads city of the physiognomic summary of all ethnic groups from Guinea. It has 28 districts. The highest temperatures are observed in March-April (37°C and 38°C), while the lowest are noted in December (11°C).[15]

2.2 Work equipment

As part of this work, we used Microsoft Excel software, a database of peak load statistics from the Mamou substation for the years 2018, 2019, 2020 and 2021, the production of electrical energy from the power stations of the Electricity of Guinea for the years 2017, 2018, 2019, 2020 and 2021.

3.3 Method

The method used focused on the regression method. Thus, we selected a model that allowed us to understand, evaluate and predict the demand for electrical energy in the urban municipality of Mamou. This model allows us to calculate the forecast energy consumption.

For data collection (energy consumption), we extracted peak load statistics from the artery of the Mamou substation through the annual peak load statistics, energy consumption of the arteries of the Electricity of Guinea. Subsequently, determine the total consumption of the urban municipality of Mamou.[16] Thus, the regression equation allowed us to determine the value of the annual consumption of the urban municipality of Mamou. The regression equation used is given by formula 1.

$$Y=AX+B \qquad (1)$$

Where A and B are constants to be determined (2, 3).

$$A = \frac{\sum(X_i - X_b)(Y_i - Y_b)}{\sum(X_i - X_b)^2} \qquad (2)$$

$$B = Y_b - A * X_b \qquad (3)$$

Where X_i, Y_i are series of months and monthly consumption in kWh.

$$X_b = \frac{\sum X_i}{n} \quad \text{et} \quad Y_b = \frac{\sum Y_i}{n} \qquad (4)$$

With: X_b and Y_b, the means of the series X_i and Y_i; n = 12 , is the number of elements in the series 12 months.

3. RESULTS AND DISCUSSSION

3.1 Annual consumption trends

This study shows that in recent years, the urban municipality of Mamou has experienced an increase in its energy consumption due to the increase in its population and standard of living through the purchase of electronic devices, household appliances, thus causing a exorbitant current draw in the network (Figure 1).

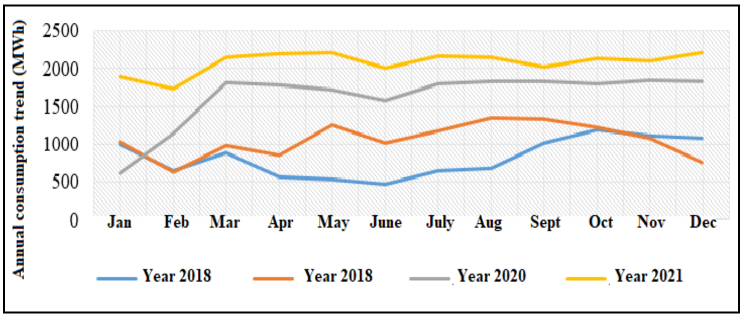

Figure 1: Annual consumption trend in the urban municipality of Mamou.

This trend for these different years shows a fluctuation in the electricity consumption of the urban municipality of Mamou. A decrease in electricity consumption is observed from March until the end of May, this is due to the decrease in electricity production by hydroelectric plants by the drop in water level in these hydroelectric dams.

3.2 Electro-energy balance of the different feeders

The electro-energy balance of the various departures supplying the urban municipality of Mamou (Figures 2, 3 and 4).

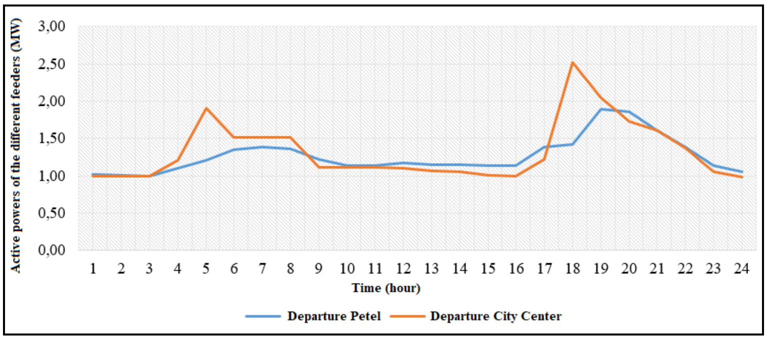

Figure 2: Active powers of the different departures from the municipality of Mamou.

Figure 2 illustrates a power peak around 6 p.m. to 7 p.m. through the massive use of high-power appliances for cooking, goods and services production activities.

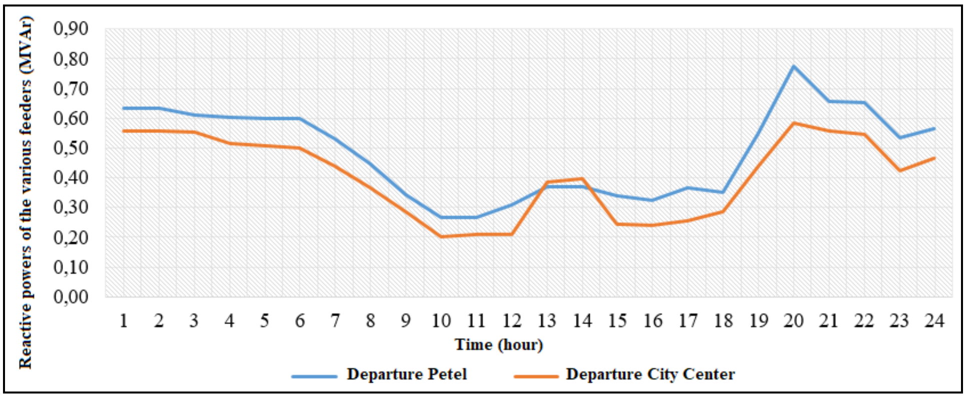

Figure 3: Reactive powers of the different feeders in the municipality of Mamou.

The results of the electro-energy balance (active power, reactive power and apparent power, current and power factor) of the various outgoing feeders supplying the urban municipality of Mamou, show that: A load peak around 7 p.m. to 8 p.m. due to the use massive electrical energy in households as shown in figure 2 and 3.

A large variation in the reactive energy demand of the various substation feeders. This leads us to propose the use of compensated fluorescent lamps, household appliances with a good power factor.

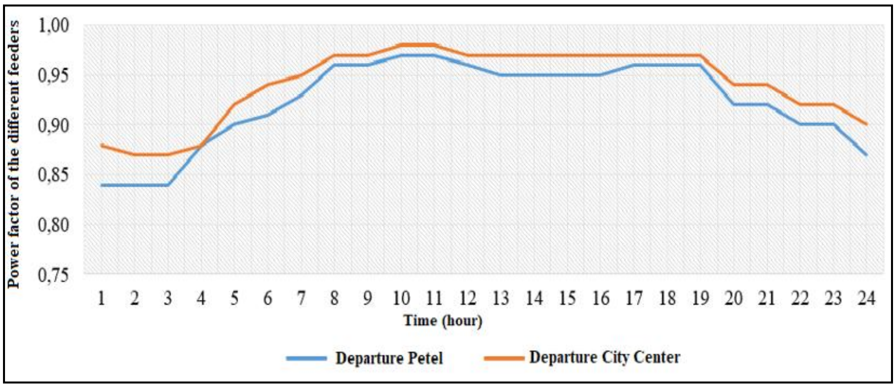

Figure 4: Variation of the power factor of the different departures from the commune of Mamou.

We note a bad power factor of the various departures during the night hours, this is due to the use for lighting of fluorescent lamps which have a bad power factor (0.48), Uncompensated discharge lamps (0.4 to 0.6); the use of induction furnaces with integrated compensation (0.85), resistance welding machines (0.3 to 0.8), static single-phase arc welding stations (0.5).

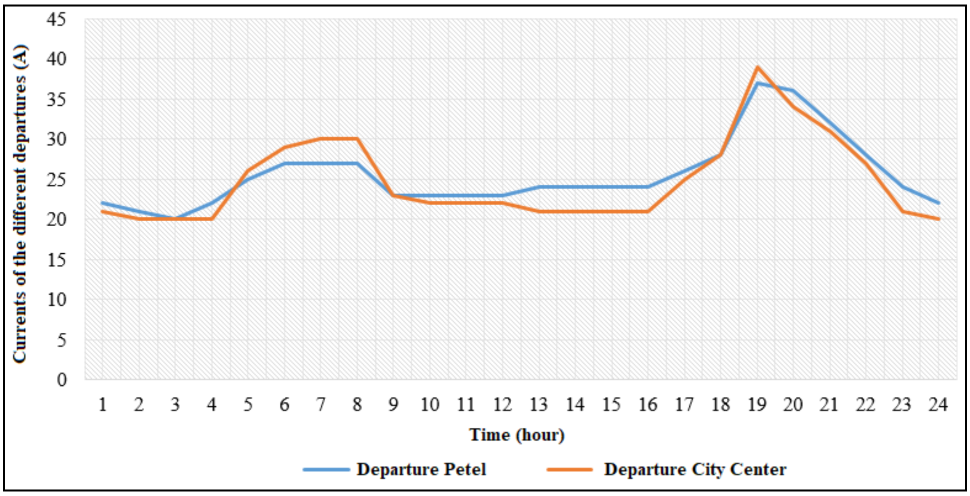

Figure 5: Currents from the different departures from the commune of Mamou.

This figure shows a load peak on the various departures from 5 p.m. The maximum load is observed around 7-8 p.m., this is due to the massive use of household appliances for cooking, lighting, air conditioning and other activities. We see at these peak hours an increase in consumption of about 98%.

3.3 Energy consumption regression equation

The peak load statistics, energy consumption of the urban municipality of Mamou for the year 2020, give us the following regression equation: Y=AX+B.

After the calculations, we have: A= 72.1517483 and B= 1164.16364. The regression equation will then be: Y = 72.1517483 X+1164.16364

This equation allows us to calculate the forecast energy consumption of the urban municipality of Mamou at all times, starting from X=1 in January 2020 (1236.3153883 MWh). In January 2030, (X=120), the energy consumption of the urban municipality of Mamou would theoretically be equal to 9822. 373436 MWh, which far exceeds the doubling of consumption in ten (10) years.

4. CONCLUSION

Electrical load prediction is an important process that can increase the efficiency and revenue of power generation and distribution companies. It helps them plan their capacity and operations to reliably supply all consumers with the required energy.

This study made it possible to have, in the present and in the future, an idea of the energy consumption of the Urban Commune of Mamou and to propose solutions applicable to real situations such as: the planning of the maintenance of electrical systems with minimal impact on consumers; the size of the electrical equipment that can support this consumption without risk of overloading the electrical network of the municipality of Mamou.

Electricity demand during peak hours is approximately 95% of demand during normal hours. By analyzing the electricity consumption per capita, we noticed that there is a positive relationship between the level of economic income and the amount of electricity consumption.

Energy efficiency should be the main determinant of long-term electricity consumption, partly offsetting the effect of economic growth, demographics, as well as market share gains and new uses.

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