

## **In Search of a Viable Hydropower Development in Nigeria: A Case of River Benue**

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### *Abstract*

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*The study has the major objectives of examining the potential of hydropower generation of River Benue. The study was based on 30-year monthly and annual discharge records, and the hydroelectric power potential was determined using the concept of energy and power flow. The results of the analysis show that both the monthly and annual power potentials are very high and viable. This paper argues that this could be harnessed to generate electricity to compliment the present power supply.*

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**Key words:** Hydropower, Power flow, Discharge, Power Supply, River

### **1.0 Introduction**

The electrical energy produced by the world's Hydroelectric Projects (HEP) has supplanted the combustion of vast quantities of oil and coal. HEP is widely adopted by leading industrialized and technically advanced countries. It was observed that only 3% of the world's hydroelectric installed capacity is located in Africa by 1991 and about 64% capacity in Europe and North America [1].

The distribution of HEP in Africa according to Abubakar shows that Ghana and Nigeria have the lowest installed capacity. It should be noted that in Nigeria, Kainji Dam has the highest installed capacity with eight generating machines (turbines) each with a capacity of 95MW. This is followed by Jebba Dam located downstream of Kainji Dam with six generating machines each with a capacity of 90MW, and finally, the Shiroro hydroelectric power station with a power output of 600MW from four generating machines. On the whole, Abubakar observes that Shiroro produces 14% of the total electricity supply while Kainji and Jebba produce 11% each. The remaining 64% comes from thermal generation [2].

In spite of the high availability factor of HEP in Nigeria, energy production is as low as 20% in 1985 [3]. This pattern of low energy production has not changed. In fact, the recent power failure is a typical scenario. Abdul-aziz [4] studied the current status of three hydro stations in Nigeria and the conclusion from his study is that they are all due for overhaul and repairs.

The problem of how to meet the energy demand for over 180 million Nigerians has been the central concern of successive governments in Nigeria. The question has always been asked "where would additional plants to provide the energy demand for the increasing population come from"? Attempts at providing an answer to this question form the basis of this paper. The objective of this paper is to consider the possibility of developing hydroelectric power station in Nigeria using River Benue, the second largest river in the country. The aim is to compliment the hydropower supply from Power Holding Company of Nigeria (PHCN) and also help in meeting the power demand of rural communities which are not linked to the national grid and, therefore have no reliable power supply.

### **2.0 Methodology**

The major data used in this study is river discharge of River Benue, the second largest River in Nigeria located in the middle belt of the country. Data collected covered a 30-year period (1960-1989). The locational characteristics are summarized in Table 1. The mean annual runoff of the River Benue at Makurdi is shown in Figure 1. Figure 2 shows the mean monthly runoff of River Benue, while Figure 3 shows the mean minimum and maximum flow of River Benue on monthly basis for the 30-year period under study.

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The power generation potential of the River on annual and monthly basis is shown in Figures 4 and 5 respectively. The power generation potential of River Benue on annual and monthly basis was calculated based on the concept of energy and power of water flow [5]. This concept has been successfully applied for micro hydropower study of some Rivers in Nigeria [6,7]. For detail of this concept of energy and power flow, the reader is referred to these papers.

Table 1: Elevation and Data Duration

River Basin	Station	Latitude	Longitude	Altitude (AMSL) (metres)	Period of Observation
Lower Benue	Makurdi	07° 44'	08° 32'	250	1960-1989

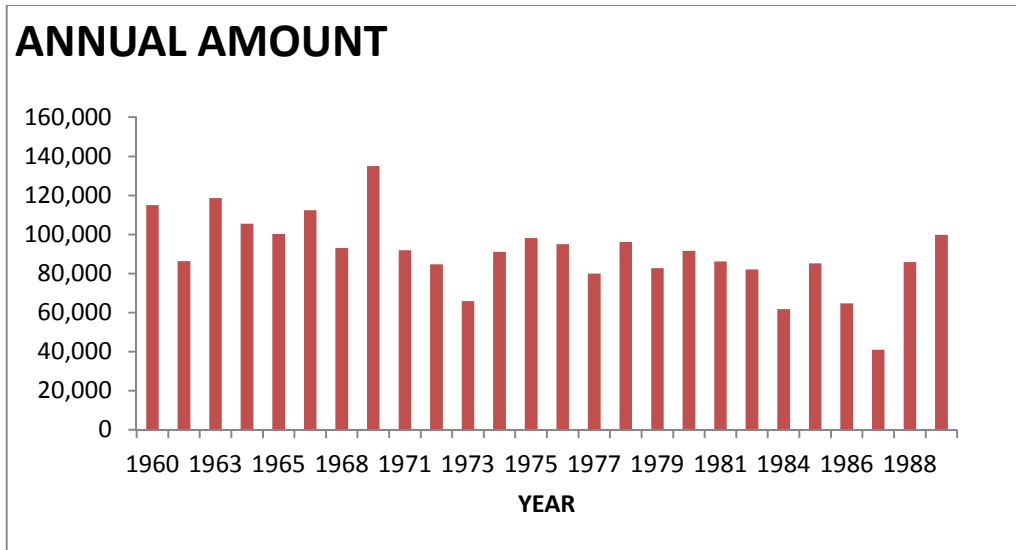


Figure 1: Mean Annual Runoff of River Benue (1960-1989)[8]

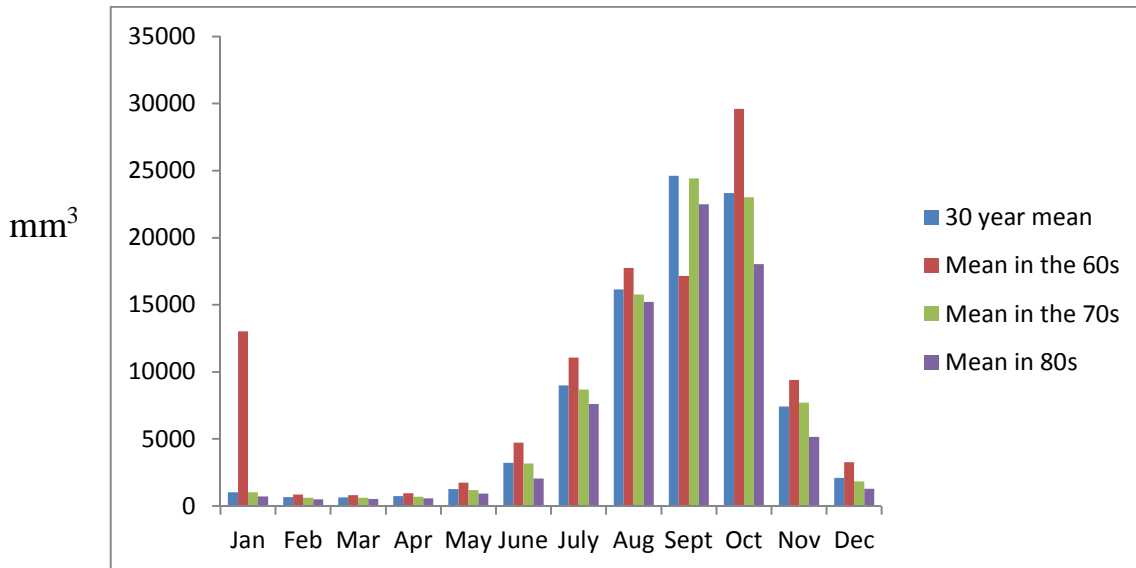


Figure 2: Mean Monthly Runoff of River Benue (1960-1989)

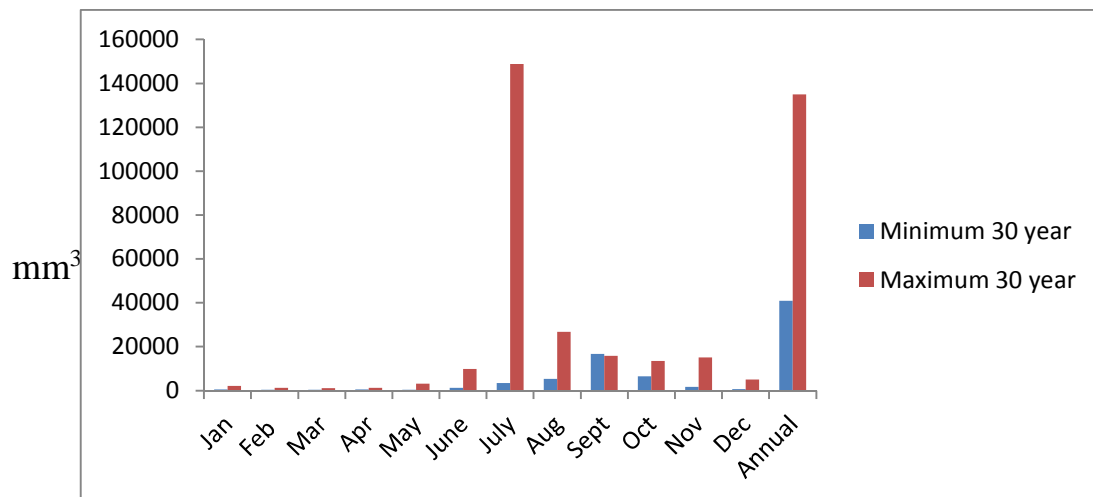


Figure 3: Minimum and Maximum Flow of River Benue (1960-1989)

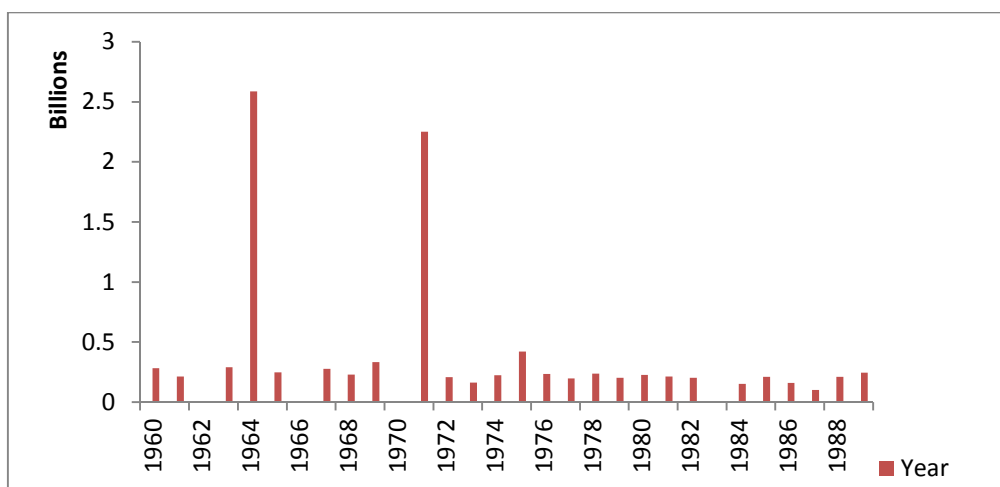


Figure 4: Annual Power Generation Potential (kW) of River Benue (1960-1989)

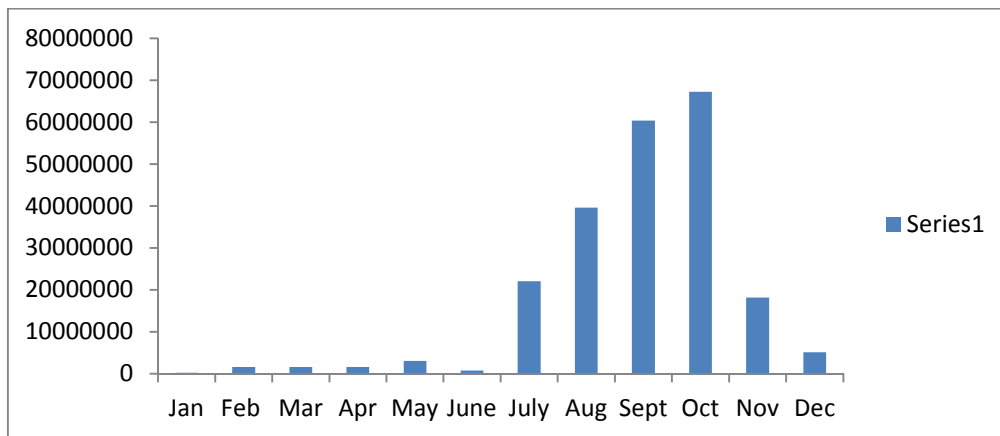


Figure 5: Monthly Power Generation Potential (kW) of River Benue with Height 250m

### 3.0 Results and Discussion

The mean monthly discharge for the 30-year period (Fig. 2) for River Benue shows that the discharge is high throughout the years. The mean value for 30 years from 1960 to 1989 shows that March has the lowest runoff value of  $656\text{mm}^3$  while the month of September recorded the highest value of  $24,941\text{mm}^3$ . The annual runoff values (Fig. 1) are relatively high in the 1960s but suffered decline in early 70's and middle 80's. Annual runoff values vary from 15,727 in 1960 to 99,727 in 1989. Figure 4 shows that the annual generation potential of River Benue at Makurdi. It can be interred from the figure that annual power generation (kW) fluctuates from 100,214,055 to 331,013,925. On the other hand, Figure 5 shows the monthly power generation potential of Benue River. The figure shows the power generation potential is high throughout the year with an exceptionally high value during the month of June (787,9882.5) to October (57236445). Fig 5 also shows the power generation potential is high during the month of July (2203087) to October (672336445). From these assertions it is of the view that River Benue has a very high hydroelectric power potential that could be developed to compliment the available source of power supply from the present generation companies and supply electricity to many villages and settlements in Nigeria that are not linked to the national grid.

### 4.0 Conclusion

In this paper, the use of the concept of energy and power has been used to demonstrate that the hydroelectric power potential of River Benue at Markurdi is very high. This is because the River shows high economic viability and potential for hydroelectric power generation throughout the months of January to December. The annual power generation (kW) fluctuates from 100,214,055 to 331,013,925 for the period of study. This paper concludes that this energy could be harnessed to generate electricity to compliment the present power supply in Nigeria.

### 5.0 References

- [1] Abubakar A. S. (2000) Environmental Impact Assessment and Hydro-trains Construction in Nigeria, Paper presented at the First National Training Workshop on Climate and Natural Disasters in Nigeria held at the Federal University of Technology, Minna from April 2<sup>nd</sup> to 15<sup>th</sup> April, 2000.
- [2] Adeleye E. A (1997) The Problem of Power Supply in Nigeria Proc. of Quarterly Lectures on the Nigeria Society of Engineers (Minna Branch), Part 1: 49-71.
- [3] Sule, B. F (1992). Some Aspects of Water Management in Hydro Electric Power Generation: A Case Study from Selected River Systems in Northeastern Nigeria AMSCE Journal, Vol. 74, No.7, pp. 1-18.
- [4] Abdul-Aziz D. (1997) The Nigerian Power System in the 2<sup>nd</sup> Century Proc. Of Quarterly Lectures on the Nigerian Society of Engineers (Minna Branch)
- [5] Cristescu D., Pantelimon , L. and Darie S. (1982) Power Station and Electric Network. Editura Didactica and Pedagogical, Baucharest, pp. 71-74.
- [6] Uhunmwangho, R. and Ologunorisa, E. T (2001). The Potential of Micro HydroPower Generation: A case Study from Selected River Systems in Northeastern Nigeria AMSCE Journal, Vol. 74, No. 7, pp. 1-18.
- [7] Uhunmwangho R., and Okedu K.E. (2010) Macro and Micro Hydropower: An Option for Socioeconomic Development, Case Study-Agbokim Waterfalls, Cross River State, Nigeria, Pacific Journal of Science and Technology PJST, vol. 10, no. 2, pp. 529-534.
- [8] JICA-NWRMP (1995)The Study on the National Water Resources Master Plan. Water Resources Inventory Survey, Vol. 2&3 Part 2, pp.1-450.