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Assessment Of The Energy Parameters Of The Kalako Site In Dabola In The Republic Of Guinea For The Installation Of A Small Hydroelectric Power Station

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ABSTRACT : This article focuses on the evaluation of the energy parameters of the Kalako site on the Tinkisso river in Dabola in the Republic of Guinea from the rainfall data reconstructed from the Dabola meteorological station. To this end, we used the method of evaluating energy parameters from the missing pluviometric data reconstructed from the Dabola meteorological station. These missing data in the number of 82 months out of 42 years of observations were reconstituted by the method of «Generation of long series of inputs from rains" or method of "Filling in missing data». The energy parameters thus determined are as follows: the average fall height (H_{moy}) is equal to 61.65m, the gross power (P_b^{CH}) is 8.3MW, the calculated flow (Q_{cal}^{CH}) is equal to 16.10m^3/s, the volume of water that the dam can hold full time is 119.44.106m3. The combined use of the method of reconstructing rainfall data and the relationships that determine the energy parameters of a site, offers an efficient method for the evaluation of the energy potential, with an acceptable precision from a research point of view (10 % difference with the German study from the same site). The method can be used for the valuation of many similar sites in Guinea and elsewhere. The realization of a project to build a dam on this site could improve the supply of electricity in the localities (Dinguiraye, Dabola, Faranah, Bissikirima and Kouroussa), through an interconnection with the existing power plant in Dabola with installed power. of 1.65MW.

Keywords: Evaluation, energy parameters, hydroelectric power station, Guinea.

1. INTRODUCTION

The problem of electric power is acute in the Republic of Guinea, however, the hydro-energy potential is enormous and the hydrographic network is very dense (1165 rivers) covering the whole country. From these resources, we can develop a hydroelectric potential estimated at more than 6000 MW.

The use of unconventional and renewable energy sources, the energy efficiency of hydrocarbon fuels and the stabilization of the ecological balance in energy practice are areas of scientific research of great importance in the world. In this regard, long-term national energy programs in developed countries have set themselves the goal of achieving the share of renewable energy sources of at least 20% [1, 2]. In world practice, micro hydropower plants are intensively put into operation for energy supply, which are among the priority representatives of renewable energy sources, and special attention is paid to the development of this research area [3].

All over the world, special attention is paid to the application of reliable and environmentally friendly technologies in the production of electricity. In this industry, in particular, a main priority over others is given to the modeling of micro-hydroelectric power plants exploiting the operating and design parameters in low pressure rivers, improving the structures in general and in developing efficient technologies used in low pressure stream systems [4, 5, 6]. Despite significant progress in this direction, the problem of improving energy and resource efficient micro hydroelectric power stations for low pressure water courses and the development of simple structures of this device has not been sufficiently studied. [7-13]. This article deals with the problems of determining the main energy parameters of a given site with a view to the installation of mini-hydroelectric power stations for the improvement of the productivity of the locality in question.

Hydropower is one of the most promising types of renewable energy source. It is probably the most mature technology used to convert natural water into electrical energy compared to other renewable energy sources. The hydroelectric resource is a sustainable energy source, which can be exploited as runoff or storage hydroelectric projects [14-18]. It has been used around the world for many years and is one of the most popular and important sources of energy [19-22].

Hydropower is currently an important source of electrical energy around the world [23]. It contributes a fifth of the total energy in the world and is the only domestic source of electricity production in many countries [24,25]. In addition, from an environmental point of view, hydropower is more sustainable than other systems of electric power generation [26]. The use of small hydroelectric plants with an installed capacity of less than 10 MW is also an optimal solution for rural electrification, it is a simple technology and at low installation and management costs [27-31].

2. MATERIAL AND METHOD

2.1.1. PRESENTATION OF THE STUDY AREA

The city of Dabola is the capital of the Prefecture. It is located in the central part of the Republic of Guinea, 430 km from Conakry. The Prefecture is between 11 ° 30 ’and 11 ° 35’ West longitude and 10 ° 20 ’and 11 ° 00’ North latitude. Its area is 6,350 km^2 with a total population of 150,658 inhabitants, i.e. a density of 24 inhabitants / km^2 today.

Fig 1: Hydrographic map of the Republic of Guinea [32]

2.1.2. MATERIAL

During this research, we used the empirical formulas for calculating the energy parameters, the results of the coastline measurement campaign carried out in 1984 by the Germans and the Autocad software which was used as a tool to draw the curve.

2.1.2. METHOD

For the evaluation of the energy potential of the Kalako site, we used the method of evaluating the energy parameters from the rainfall data reconstructed from the Dabola weather station. These missing data in the number of 82 months out of 42 years of observations were reconstituted by the method of «Generation of long series of inputs from the rains» or method of «Filling in missing data» [33].

The energy parameters (average height of the head, gross power of the power plant, calculated flow rate of the site and useful volume of the reservoir) determined were calculated by the relationships below.

2.2.1. AVERAGE FALL HEIGHT

The average height of fall is determined by relation (1) [34] :

$$H_{moy} = \frac{H_{\max} + H_{\min}}{2} \qquad (1)$$

Or :

$H_{\max}$: maximum drop height (m)

$H_{\min}$: minimum drop height (m)

The maximum and minimum fall heights are determined by relations (2) and (3) :

$$H_{\max} = \nabla NN - \nabla N^{aval} \qquad (2)$$

$$H_{\min} = \nabla N_{\min}^{excepl} - \nabla N^{aval} \qquad (3)$$

Or :

∇NN : designates the slope of the normal level, equal to 463.30 m

∇N^{aval} : designates the coast of the downstream water level, equal to 399.0 m

$\nabla N_{\min}^{excepl}$: designates the coast of the exceptional minimum level, equal to 458.0 m

2.2.2 GROSS POWER OF THE PLANT

The gross power of a hydroelectric power station is determined by the relation (4) :

$$P_b^{CH} = P_{gar}^{Tr} + 0{,}1 P_{gar}^{Tr} \qquad (4)$$

Or

P_{gar}^{Tr} : guaranteed working power in kW, defined by the following relation :

$$P_{gar}^{Tr} = 9{,}81 Q_{orég(t)} H_{moy} \eta_{éq.éner} \qquad (5)$$

With $$Q_{orég(t)} = \frac{\sum Q_{men}^{éc}}{12} \qquad (6)$$

$\sum Q_{men}^{éc}$: is the sum of the monthly flow rates, calculated from the data in Table 1

$Q_{orég(t)}$: average flow rate regulated in m^3/s, as a function of time t

$\eta_{eq.éner} = \eta_{alt}\eta_t$: efficiency of energy equipment

η_{alt} =0,95 à 0,98 : alternator efficiency

η_t =0,90 : turbine efficiency

2.2.3. SITE CALCULATED FLOW

2.2.4. THE USEFUL VOLUME OF THE DAM RETENTION

The useful volume (Vut) of the dam reservoir is determined from the calculated hydrological data (Table I). For this, we proceed by the following method :

- ✓ Construct the so-called integral curve by considering as the abscissa axes, the months starting with the month of October and that of the ordinates, the flow volumes, for the year 1989 which was chosen as the year of calculation for the determination site rainfall data;
- ✓ Draw the line that connects the beginning and the end of the integral curve;
- ✓ Draw two tangents parallel to the line from two points of the integral curve so that they do not cross the integral curve;
- ✓ Make the projections from the tangent points on the line;
- ✓ Project these crossing points on the y-axis (flow volume), we note these projections V_1 and V_2, which are the coasts;
- ✓ The useful volume is thus calculated by the relation $V_{ut} = V_1 + V_2$.

The water flow Q_{cal}^{CH} of the hydroelectric power station is determined by the relation (7) [35] :

$$Q_{cal}^{CH} = \frac{P_b^{CH}}{9{,}81 H_{moy}\eta_{éq.éner}} \qquad (7)$$

3. RESULTS AND DISCUSSION

3.1. AVERAGE FALL HEIGHT

he values of the coasts were determined during the hydrological data measurement campaign in 1984 by the German company Energieplan that we adapted to our research.
Thus, the maximum, minimum and average fall heights are respectively : **H_{max}=64,3m**, **H_{min}=59m** and **61,65m**.

3.2. GROSS POWER OF THE PLANT

From formula (5) we find that: the guaranteed working power is 7613.26kW and relation (4) gives the calculated gross power of the site, which is 8.375MW.
The German study which was carried out in 1984 gave an estimated gross power of 7.2MW, as long as that of our studies gave an estimated power of 8.375MW. A comparison of our results with those of the Germans reveals a difference of 1.175MW, or 10%. This denotes a fairly good coincidence and shows that the determination of the energy parameters from the method of reconstituting the rainfall data can be used for the estimation of the energy potential of many sites whose hydrological and meteorological data series contain breaks.

3.3 SITE CALCULATED RATE

The flow calculated from relation (7) using Table I, is : **Q_{cal} = 16,10m^3/s**

Table I: Precipitation levels, flow volume and monthly flow rate

Month	Jan	Feb	Mar	Apr	Mai	Ju	Jul	Aug	Sep	Oct	Nov	Dec
W_{men} $W.10^6[m^3]$	0	2,72	0	9,89	50,04	62,83	68,34	83,02	113,42	62,22	3,02	0
Q [m^3/s]	0	1,04	0	3,81	19,30	24,23	26,36	32,02	43,75	24,00	1,16	0

3.4. USEFUL VOLUME OF DAM RETENTION

To determine the useful volume of the dam, we used the monthly volumes given in the table above, in order to construct the integral curve using the Autocad software. This curve is shown in Figure 2. It is also called the cumulative flow rate curve. The calculation of the different volumes gives : **V_1=57,22.10^6 m^3** and **V_2 =62,22.10^6 m^3.**
Thus, the useful volume of the dam that will be built on this site must store a quantity of water equal to : **119,44.10^6 m^3**.

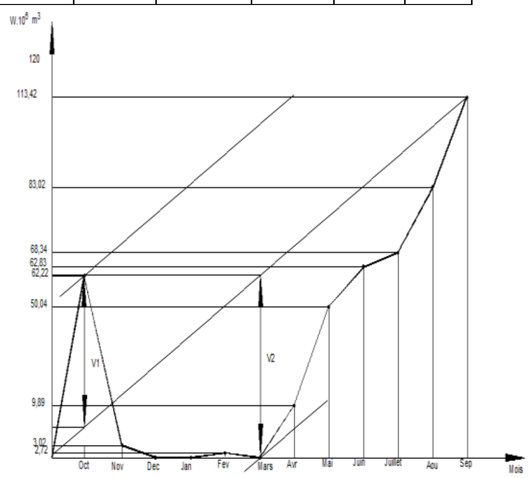

Fig 2: Integral curve

4. CONCLUSION

This research made it possible to determine the energy parameters (average height of the fall, gross power of the plant, calculated flow of the site and useful volume of the reservoir) of the Kalako site on the Tinkisso river.

The gross power calculated by the method we used is 8.375MW. In view of the German study which gives 7.2MW, a difference of 10% with our obtained result, which represents a fairly good coincidence.

It emerges from our results that the combined use of the method of reconstituting rainfall data and the relationships which determine the energy parameters of a site, offers an efficient method of evaluating the hydroenergetic potential, with an acceptable precision from the point of view. of research. The method can be used for the valuation of many similar sites in Guinea and elsewhere.

Also, the Tinkisso dam in Dabola, on the same river, has a useful power of 1.65MW, it is therefore desirable, in order to improve the supply of electricity in the area (Dinguiraye, Dabola, Faranah, Bissikirima and Kouroussa), to consider the energy use of this site by interconnecting this existing power plant and the one that would be built on this Kalako site.

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