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# Analysis of the environmental and social impact of electricity production in Guinea: The case of the Kaloum (100MW) and Kipe (50MW) power plants

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## Abstract

The objective of this research is to assess the environmental and social impacts of electricity production in Guinea based on tangible and demonstrated elements. To achieve this, we first conducted an inventory of the production plants and then proceeded to analyze the environmental and social impacts.

The analysis of environmental impacts (air pollution, greenhouse gas emissions, waste management, etc.) was carried out on the thermal power plants of Kaloum (100MW) and Kipe (50MW).

This analysis revealed that these thermal power plants in Guinea, particularly those in Kaloum and Kipé, have significant environmental impacts similar to those of thermal power plants using fossil fuels. The particularity is that these power plants are close to homes and emit a lot of smoke and noise, so the risk of contamination is very high.

Although these plants contribute to the increase in electricity production in Guinea, this research has shown that this comes at a significant environmental cost.

According to the results of the inventory of electricity production (table 1) acquired from this study, we note that the production capacity presents two sources of energy, including hydroelectricity which occupies a share of 78% and thermal 22%.

**Keywords:** Analysis; Environment; Thermal power plants; Electricity production; Greenhouse gas emissions

## 1. Introduction

These days, it's hard to imagine a world without electricity. Energy is an essential factor in the socioeconomic development of any country; it drives industrial growth and improves people's living conditions. Electrical energy has become an essential commodity in people's daily lives. Past choices have left us dependent on three non-renewable energy sources: oil, gas, and coal. This dependence is particularly strong for the most developed countries with energy-intensive lifestyles, such as China and the United States.

In a world where energy demand is continuously increasing, humanity is today facing three major challenges: energy security, climate change and sustainable development [1].

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These challenges are interdependent and linked together by the common problem of energy.

However, the consumption of fossil fuels poses serious environmental problems: disruption of the greenhouse effect, atmospheric pollution, maritime degradation and deforestation. This general problem is acute and requires a responsible approach. This is why we deemed it necessary and judicious to address the theme entitled:

### 1.1. Analysis of the environmental and social impact of electricity production in Guinea: the case of the Kaloum and Kipé power plants

In Guinea, energy consumption has been and still remains largely dominated by biomass (around 75% on average over the observed period 2011-2017), with a share nevertheless tending to decrease, in favor of the increase in the consumption of petroleum products which represented 21% [2].

This reflects an energy situation in Guinea which remains to this day massively dependent on plant resources, with the threat that this induces on the country's vegetation cover. The excessive consumption of wood to meet domestic cooking needs causes deforestation.

The share of electricity in total consumption remained relatively low, not exceeding 10% over the observed period. This reflects the weak development of the electricity system in Guinea, which is only able to very poorly meet the energy needs of the entire country.

Since independence in 1958, no Guinean government has been able to implement an energy development program that takes into account rigorous environmental assessments, in order to sustainably resolve the problems of electricity supply. However, Guinea's potential is such that it would be able to supply the sub-region with electricity. The installation of thermal power plants such as Kaloum 2, 3, 4 or Kipé in Conakry can only represent a temporary solution and are not without impact on the environment.

Over the past thirty years, only the Garafiri dam has been built, which is simply incapable of meeting the needs of the city of Conakry alone. The rest of the country is logically plunged into darkness. This phenomenon of "load shedding" is the cause of social tensions. The Guinean population continues to complain about cohabitation with these thermal power plants because of the various pollutions they generate. A complaint that it expresses through demonstrations, some of which are very violent, where the police are forced to intervene to limit the damage.

The electrification rate increased from 6.4% in 1990 to 33.5% in 2016. Electricity consumption is concentrated in urban areas, and electricity is almost unavailable for rural households. In 2014, production from thermal power plants had become predominant, accounting for between 60% and 70%. Since the commissioning of Kaléta in 2015, the situation has improved significantly, with hydroelectric production increasing to 72% in the Conakry Interconnected Network (RIC).

Guinea's hydroelectric and solar potential is immense, estimated at 6,000 MW and 40,343 MW respectively [3], but the electricity production capacity is still insufficient to cover national needs and meet growth acceleration objectives.

The Guinean Government, aware of the country's energy deficit, has for nearly a decade initiated a vast program to develop environmentally friendly (hydraulic) energy resources in order to promote economic growth and reduce the poverty rate while reducing the share of fossil fuels in favor of hydroelectric potential [3].

## 2. Material and methods

The methodological approach we adopted mainly involves two aspects: data collection and the methods used for their processing. It is based on a qualitative approach.

**Qualitative approach:** is a research method that we used by conducting interviews and observations to understand the impact of electricity production on the environment, the population, businesses, etc. Our methodological approach specifies the types of data collected, the techniques adopted, the collection tools used, and the organization and structure of the work carried out. It required the acquisition of data from documentary, demographic, climatic, and socioeconomic sources. To facilitate a better understanding, the data and the methods used for their collection and processing have been presented by specific objective.

### 2.1. Status of electricity production in Guinea

This part of the study focuses on the summary of the electricity production plants in Guinea. For this purpose, the study was carried out by technical visit of each plant. As part of our work, the Kaloum and Kipé plants were taken as a sample. The results of this stage allowed us to understand the different types of plants used by the Guinean electricity company (EDG) in order to offer the most environmentally friendly and economically efficient ones.

**Table 1** Presentation of the production park - August 2024 of EDG. SA

| Production type | Power centrals | Installed power | Availability rate% | Guaranteed power | Observations |
|---|---|---|---|---|---|
| EDG HYDRAULIC | Garafiri | 75 | 100 | 25 | |
| | Great Falls | 27 | 0 | 0 | Under renovation |
| | Donkeah | 15 | 0 | 0 | Under renovation |
| | Banéah | 5 | 0 | 0 | Under renovation |
| | Kinkon | 3.4 | 75 | 2.25 | Seasonal |
| | Tinkisso | 1.65 | 71 | 1.25 | Seasonal |
| Total Hydraulic EDG | | 127.05 | | 27.25 | |
| IPP HYDRAULIC | Souapiti | 450 | 74 | 184 | Konkoure Water Management Plan |
| | Kaleta | 240 | 72 | 94 | |
| Total Hydraulic IPP | | 690 | 73% | 278 | |
| THERMAL EDG | Kaloum 5 | 32 | 28 | 9 | Under review |
| | Kaloum 1 | 24 | 50 | 12 | Under review |
| | Kaloum 2 | 26 | 69 | 18 | Under review |
| | Kipe | 50 | 64 | 32 | Under review |
| | Interior of the country | 104.9 | 50 | 52.45 | |
| Total Thermal EDG | | 236.9 | | 123.45 | |
| THERMAL IPP | Te - Power | 50 | 100 | 50 | Planned maintenance |
| | Kaloum 3 | 44 | 0 | 0 | |
| Total thermal IPP | | 94 | 100% | 52 | |
| TOTAL | | 1 147.95 | | 480.7 | |

### 2.2. Analysis of the environmental and social impact of thermal power plants

Environmental assessment is a very broad field, which is not only limited to the determination of negative and positive impacts, but also extends to the optimization of the different stages of the environmental and social management plan.

Electricity production poses more and more environmental problems with a lack of management characterized by inadequacies at all levels, and an increase in the production of greenhouse gases under the economic, demographic and socio-cultural effect [4]. To this end, we set out to find the best optimization of the management of environmental impacts in the invested power plants in order to have the elements of assessment and economic evaluation for any electricity production strategy.

*2.2.1. Characterization of impacts:*

The aim of this study is to describe the impacts in such a way as to facilitate the determination of their significance. Seven criteria were used to characterize the impacts, namely: type, interaction, intensity or magnitude, extent or scope, duration, reversibility, probability or occurrence.

Also, the criteria are defined as follows:

- The nature of the impact indicates whether the impact is negative or positive;
- The interaction specifies the relationship between the project and the impact will be said to be direct when it is linked to the works (or to the operation) by a cause-and-effect relationship;
- The intensity or magnitude expresses the degree of disturbance of the environment, depending on the vulnerability of the component studied; three classes are considered: high, medium and low [5];
- The extent gives an idea of the spatial coverage of the impact. Here, too, three classes have been distinguished: specific, local, regional [6];
- The duration of the impact indicates the manifestation of the impact over time; we will speak of short term to designate an impact that manifests itself during the implementation of the project and less than one year after; long term when it manifests itself more than one year after the implementation of the project; and continuous to qualify the impacts that manifest themselves since the implementation of the project and which continue during the operational phase for more than one year [7];
- The occurrence or probability of occurrence indicates the chances of an impact occurring. There are three classes: certain to qualify impacts with a greater than 90% chance of occurring, probable for those with a 25 to 75% chance of occurring, and unlikely for those with a less than 25% chance of occurring [5].
- Reversibility describes the extent to which an impact is more or less reversible, either naturally or through mitigation measures. An impact is said to be reversible when it has a greater than 50% chance of being reversible; less reversible when impacts have a less than 50% chance of being reversible [4].

## 3. Results and discussion

In this section, we present the results of our work, followed by their discussions

### 3.1. Socio-economic impacts

Electricity production in Guinea has been experiencing a crisis, characterized by untimely power cuts and load shedding, which has worsened after the fire of December 18, 2023, which ravaged the country's main fuel depot located in Kaloum, which supplied the thermal power plants of the EDG company. It has had profound socio-economic impacts that affect various aspects of citizens' lives and the functioning of the country's economy.

**Impact on households.** Due to the crisis, many households are facing frequent power outages or limited access to electricity, which directly impacts their quality of life. Power outages reduce households' ability to use essential appliances, and this can affect health, education, and domestic activities.

In addition, faced with the instability of electricity supply, households must resort to more expensive and polluting alternative sources of electricity, limiting their purchasing power.

Moreover, the lack of electricity also affects the safety of neighborhoods at night and significantly reduces domestic comfort.

**Impact on businesses.** Frequent power outages disrupt business operations, particularly in the industrial and manufacturing sectors, leading to productivity losses, production delays, and, in some cases, the deterioration of products or raw materials.

To address this instability, companies are forced to invest in generators or other expensive energy solutions to maintain their operations. This strategy increases their production costs, making their products less competitive in the national and international markets.

The instability of the electricity sector therefore leads to a reduction in investments since it makes the business climate less attractive, discouraging national and foreign investments, as investors perceive the energy crisis in Guinea as a major risk to the profitability and sustainability of their investments.

**Impact on employment.** The economic difficulties resulting from the crisis in the electricity sector are leading companies to lay off workers and reduce job opportunities, exacerbating the unemployment rate, particularly among young people.

Furthermore, small and medium-sized enterprises (SMEs), which are often less resilient than large companies, are particularly vulnerable to power outages. Some are forced to close temporarily or permanently, resulting in job losses and reduced income for family's dependent on these activities.

**Impact on basic social services.** The electricity crisis is causing major disruptions to healthcare services, as hospitals and health centers rely heavily on electricity to power medical equipment, vaccine refrigerators, incubators, and other vital devices. Power outages compromise the quality of care and can lead to loss of life.

The impact on education is also significant, as schools and universities use electricity for lighting, computer equipment, and sometimes air conditioning. Power outages therefore limit access to quality learning, particularly in educational institutions.

Higher where modern laboratories and technologies require a constant supply of energy.

Access to safe drinking water is compromised when water pumping and treatment systems are affected by power outages, endangering public health and increasing the risk of waterborne diseases.

**A brake on economic development.** The energy crisis is a major obstacle to economic growth. It limits the country's ability to develop its industrial sector and diversify its economy, which relies heavily on mining.

It therefore constitutes an obstacle to the industrialization of the country since it delays industrialization efforts, by slowing down the creation of local added value chains and the exploitation of natural resources in a more efficient manner.

**Exacerbation of social inequalities.** The electricity crisis is exacerbating socioeconomic inequalities and contributing to widening wealth gaps between regions, with rural populations having limited access to services and development opportunities.

Indeed, only companies and households with significant financial resources can afford expensive energy alternatives, while others remain in a situation of energy vulnerability.

**Social and political tensions.** Recurring power outages fuel frustration and social discontent. Demonstrations and strikes related to the energy crisis are frequent and violent, and can lead to increased social tensions and political instability.

The failure of the government and relevant institutions to resolve the energy crisis is leading to a loss of public confidence in public authorities, which can exacerbate social tensions.

In short, the electricity crisis in Guinea affects almost every aspect of Guinean society and economy, contributing to slowing the country's development and exacerbating social and regional inequalities. Hence the relevance of this study of the electricity sector in Guinea.

### 3.2. Impact on atmospheric conditions (air quality and noise)

Guinea's thermal power plants, particularly those in Kaloum, Kankan, and Kipé, have significant environmental impacts similar to those of fossil fuel-fired power plants. The particularity is that these power plants are located close to homes and emit a significant amount of smoke and noise, so the risk of pollution is very high.

Although these plants contribute to increasing electricity production in Guinea, it has been found that this comes at a significant environmental cost. Here are some key negative impacts noted by the study:

**Greenhouse gas emissions:** The combustion of fossil fuels such as fuel oil in these thermal power plants produces carbon dioxide and methane which contribute to global warming.

**Air pollution:** It has been found that in addition to $CO_2$, these power plants emit air pollutants such as Sulphur dioxide and nitrogen oxides which can cause respiratory and cardiovascular diseases in local populations and operators.

The operation of these power plants has a negative, minor, certain, temporary and immediate impact on air quality. The impact on air quality is negative, medium, certain, temporary and immediate.

### 3.3. Impact on the ground

During the construction phase, site development can have a destabilizing effect on the soil structure and can lead to soil loss through erosion. However, this negative impact remains minor, temporary and will be felt in the long term. Construction waste: sheet metal, rubble, iron, pieces of wood, etc. can accumulate or be scattered around the site. In this case, the inconvenience caused is linked to the clutter of the space and can lead to accidents. The degradation of soil quality during construction work has damaging, medium, certain, permanent and immediate impacts.

**Waste Management:** It has been found that the effluent treatment mechanism is faulty in these power plants, which suggests that the effluent is being dumped on the ground. (See Figure1)

This discharge from these power plants can contaminate the soil and groundwater, so the risk of contamination of drilling water is high for human health.

To mitigate these impacts, measures such as $CO_2$ capture and storage and the transition to renewable sources are recommended.

**Figure 1 T**he defective condition of equipment at Kaloum 2 due to lack of maintenance and spare parts

**Figure 2** The discharge of effluent from the Kipe power plant

### 3.4. Impact of human activities on hydroelectric dams

This study found that the banks of the Konkoure River (river on which the Garafiri, Kaleta and Souapiti dams are built) are denuded due to human activities. Cases of excessive cutting of trees, bush fires (very often recurring) on these banks for commercial purposes (charcoal, sale of wood etc.) and the proliferation of crops have been observed. These activities can cause the dams in question to silt up in the long term and make the banks deforested (uncovered).

To illustrate these findings, we present the two recent cases of bush fires near the Kaleta factory (Figure 1&2) and the Souapiti base camp.

**Figure 3** Effect of bushfires near the Kaléta factory

**Figure 4** Bushfires just behind the Souapiti base camp near the Konkoure River basin (04/21/2024 at 1 p.m.)

## 4. Conclusion

This study highlights a persistent inability to provide reliable and sustainable electricity, the result of a tangle of structural, financial, and operational challenges. These shortcomings impact economic growth, the environment, and the population's quality of life, and pose a significant obstacle to the country's long-term development ambitions. Short-term efforts to mitigate the crisis, while necessary, are proving costly. As such, long-term solutions must be prioritized, particularly through structural and legal reforms, strategic investments, and the optimization of operational processes.

Looking ahead, energy demand by 2035, according to the April 2019 "Master Plan Report," estimated at over 16 GWh in a context of cautious growth, requires a substantial expansion of production and distribution capacity. To meet growing needs and ensure Guinea's energy security, it is becoming crucial to consider diversified, less polluting and environmentally friendly energy sources, such as solar, wind, and hydroelectricity. The inclusion of these potentially cost-effective energy sources, provided they are strictly regulated, could play a major role in Guinea's future energy mix, reducing dependence on fossil fuels and contributing to the reduction of greenhouse gas emissions.

The study also recommends that EDG's General Management consider in-depth environmental analyses of the company's various electricity generation operations. These analyses provide leverage for developing a solid strategic plan aimed at strengthening the company's strengths, addressing its shortcomings, exploiting opportunities, and mitigating identified threats. Finally, this research has demonstrated the impacts of electricity production in Guinea and also the impact of human activities on hydroelectric dams. It is therefore imperative that the State, in partnership with stakeholders in the sector, undertake far-reaching reforms and sustained investments to ensure a reliable and sustainable energy supply by 2035, thus meeting the country's economic and social aspirations

## Compliance with ethical standards

### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

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