DESIGN AND IMPLEMENTATION OF A 10.5 MW BIOMASS POWER PLANT IN FRENCH GUINEA: TECHNOLOGICAL SOLUTION AND ENERGY IMPACT

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ABSTRACT: The paper describes the design, supply, and commissioning of a 10.5 MW biomass power plant located near the Petit-Saut Dam, French Guiana, using wood chips from submerged logs, to sustainably contribute 5% of the region's energy needs and demonstrate the effectiveness of renewable technological solutions, as well as an analysis of the pros and cons of this project.

KEY WORDS: Biomass, Water tube boiler, Vibrating grid, Renewable energy, Sustainability.

1. INTRODUCTION

As climate change accelerates and fossil fuel resources continue to deplete, the transition to sustainable energy sources becomes a global priority. In this context, biomass stands out as a viable solution due to its unique characteristics. Being a renewable resource available in significant quantities, biomass can be obtained from various sources, including agricultural waste, forest residues, energy crops, and recyclable biological materials. This diversity makes it a flexible and adaptable alternative in energy production.

The project aims to design, construct, and operate a 10.5 MW biomass power plant located near the Petit-Saut Dam in French Guiana, using wood chips from submerged logs as the raw material. The plant's advanced technology, based on a water tube boiler and a vibrating grate, allows for efficient combustion, emission reduction, and the simultaneous generation of both electrical and thermal energy. [1]

By promoting sustainability, reducing environmental impact, and supporting the local economy, the power plant serves as an example of sustainable energy transition and integrated regional development. At the same time, there will always be pros and cons to the production of renewable energy.

2. CONTEXT

The project analyzes the design, construction, and operation of an innovative biomass power plant with an installed electrical capacity of 10.5 MW, strategically located near the Petit-Saut Dam in Sinnamary, French Guiana. This location provides access to a unique biomass resource: wood chips from submerged logs, resulting from forestry activities upstream.

By utilizing this raw material, the power plant not only contributes to the sustainable use of local resources but also helps reduce the environmental impact of these waste products. The technology used includes a modern water tube boiler and a vibrating grate for combustion, allowing for efficient burning and strict control of harmful emissions.

The system's technical parameters, such as the pressure of 79 bar and temperature of 525°C, ensure optimal performance, simultaneously generating 10.5 MW of electrical power and 40 MW of thermal energy. This makes it

possible not only to cover 5% of the region's energy demand but also to promote a virtuous environmental cycle by reducing particulate emissions and reusing the ash as an agricultural soil amendment[3].

The project also highlights significant economic benefits, including the creation of jobs in mechanical assembly and forestry operations, as well as reducing dependence on energy imports. Additionally, it contributes to achieving the region's sustainability goals, providing a concrete example of an energy transition based on renewable resources. Therefore, this biomass power plant represents a model of integrated regional development, demonstrating both technological viability and the potential of the wood energy sector to support sustainable economic growth.

3. MAIN EQUIPMENT OF THE PRESSURE BOILER

The equipment used for the implementation of the project consists of a system made up of the following components:

- Boiler,
- Boiler drum,
- Vibrating grate with water cooling (WCVG),
- Economizer.

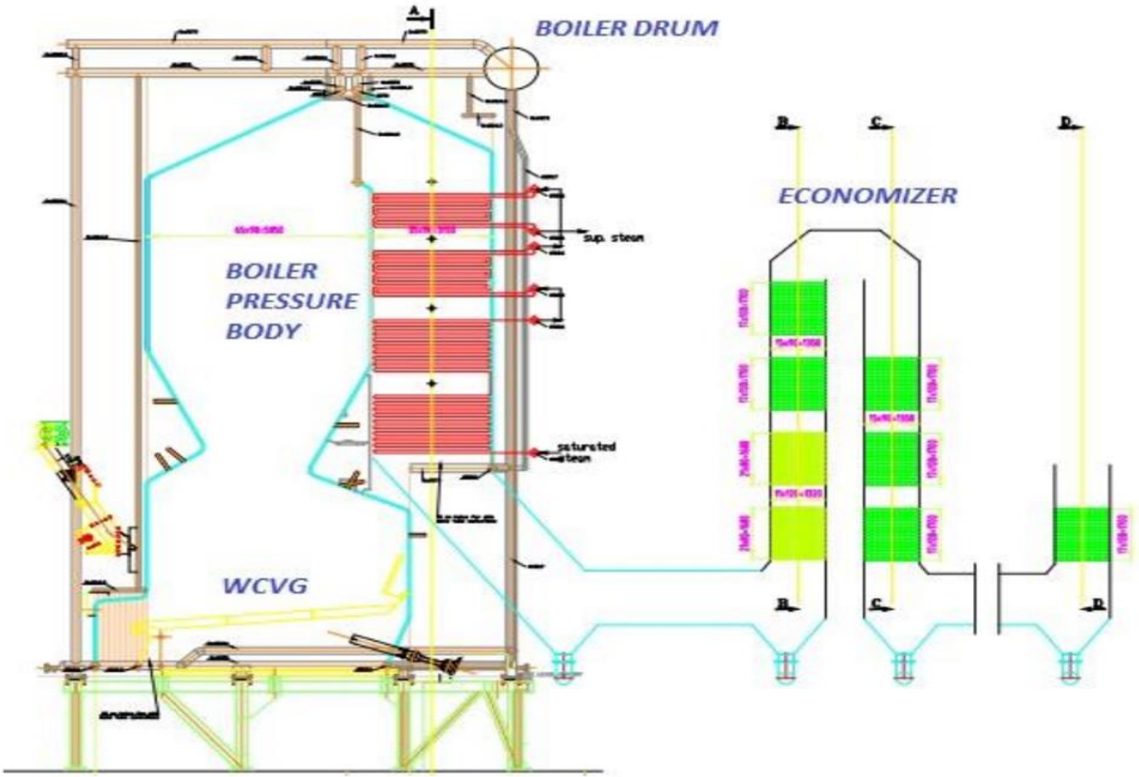

Figure 1. The equipment of the biomass energy production project

This innovative concept meets market demands through the development, design, construction, and commissioning of biomass-based boilers optimized for high efficiency in electricity generation. With over 30 years of experience in the biomass sector, these boilers integrate the most advanced available technology (BAT), including patented designs for the boiler, grate, and fuel feeding system, as well as solid expertise in managing technologies for flue gases.

The water-cooled vibrating grate (WCVG) is an essential element of the combustion system in the biomass boiler, designed to enhance combustion efficiency and reduce pollutant emissions. This type of grate can be manufactured in a wide range of sizes, from 30 MWt to 150 MWt, to meet the various capacity requirements of the plant.

The operating principle of the vibrating grate involves the use of controlled vibrations to ensure uniform distribution of the fuel and

efficient combustion, preventing ash buildup and ensuring complete combustion of the raw material.

The water-cooling system of the vibrating grate is a crucial aspect, as it helps maintain optimal operating temperatures, preventing damage to components and maximizing their lifespan. Additionally, water cooling contributes to the overall energy efficiency of the system by helping dissipate heat and reducing energy consumption for cooling other parts of the plant.

Regarding fuel supply, the systems are adapted based on the type of fuel used. Low-density fuels, such as certain types of agricultural waste or forest residues, require a double-screw feeder that ensures a constant and uniform flow of material to the grate.

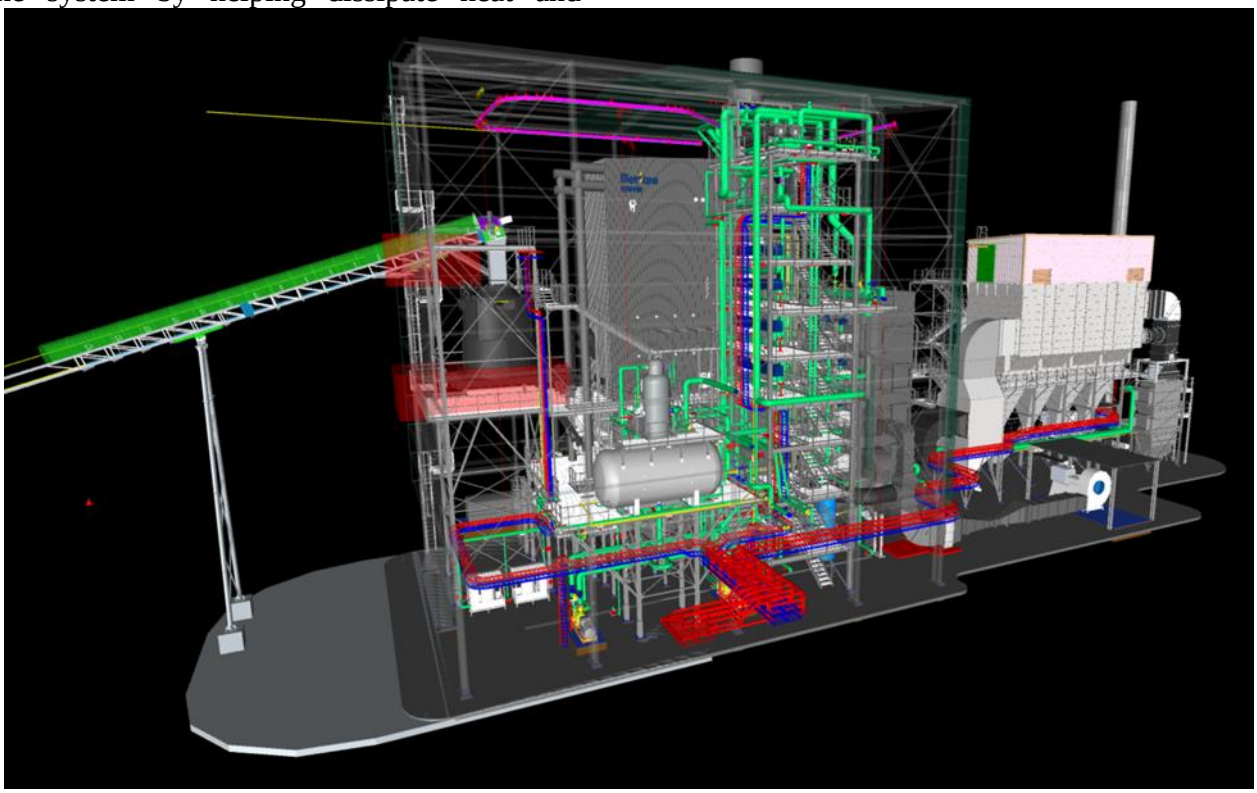

Figure 2. Biomass production facility

On the other hand, high-density fuels, such as cut logs or more solid materials, require a specialized distributor capable of handling larger volumes of fuel, ensuring proper and efficient supply to the combustion system. These adaptations guarantee optimal performance of the boiler, depending on the type of biomass used, while also ensuring better control of emissions and the overall efficiency of the energy production process.

4. PROS AND CONS OF THE BIOMASS POWER PLANT PROJECT IN SINNAMARY, FRENCH GUIANA

4.1. Pros:

a) Sustainable Use of Local Resources: The project utilizes a locally available resource—wood chips from submerged logs—raw material that would otherwise be considered waste. This contributes to the efficient management of resources and reduces the negative environmental impact caused by forest waste.

b) Reduction of Dependence on External Energy: The power plant helps reduce the region's reliance on energy imports, providing a local and renewable energy source. This increases the energy security of the region, which is essential for sustainable economic development.

c) Positive Environmental Impact: The project promotes a virtuous environmental cycle by reducing particulate emissions and reusing the

ash as an agricultural soil amendment. This aspect helps improve soil quality and enhances the sustainability of local agriculture[4].

d) Job Creation and Stimulation of the Local Economy: The project generates jobs in mechanical assembly and forestry operations, thus supporting local economic development. Job creation is crucial for the communities in Sinnamary and the surrounding region.

e) Optimal Technological Performance: The advanced technology, including the modern water-tube boiler and vibrating grate for combustion, ensures efficient burning and strict control of harmful emissions. Optimal technical parameters (79 bar and 525°C) contribute to high-performance energy generation while minimizing environmental impact.

f) Contribution to Sustainability Goals: The project is a concrete example of the energy transition to renewable sources, helping to achieve the region's sustainability goals. It supports the development of a circular economy, where resources are used efficiently and responsibly.

4.2. Cons:

a) Potential Impact on the Aquatic Ecosystem: The collection of wood chips from submerged logs may have an impact on the aquatic ecosystems around the Petit-Saut Dam. Harvesting and transporting biomass could affect the local aquatic flora and fauna if not carefully managed.

b) Initial Investment Costs: While the project provides long-term economic benefits, the design, construction, and installation costs for the 10.5 MW power plant can be significant, and the investment payback period could be relatively long. This could pose a barrier to attracting investors.

c) Dependence on Available Biomass: The power plant relies on a continuous supply of biomass (wood chips) from forestry activities. This creates a vulnerability in case biomass resources become insufficient or inaccessible due to ecological or economic reasons. Additionally, any fluctuations in biomass availability could affect the performance of the plant.

Global Forest Watch is an entity concerned with analyzing deforestation data worldwide, and it has raised many alarms regarding French Guiana, as shown in the figure below. [5]

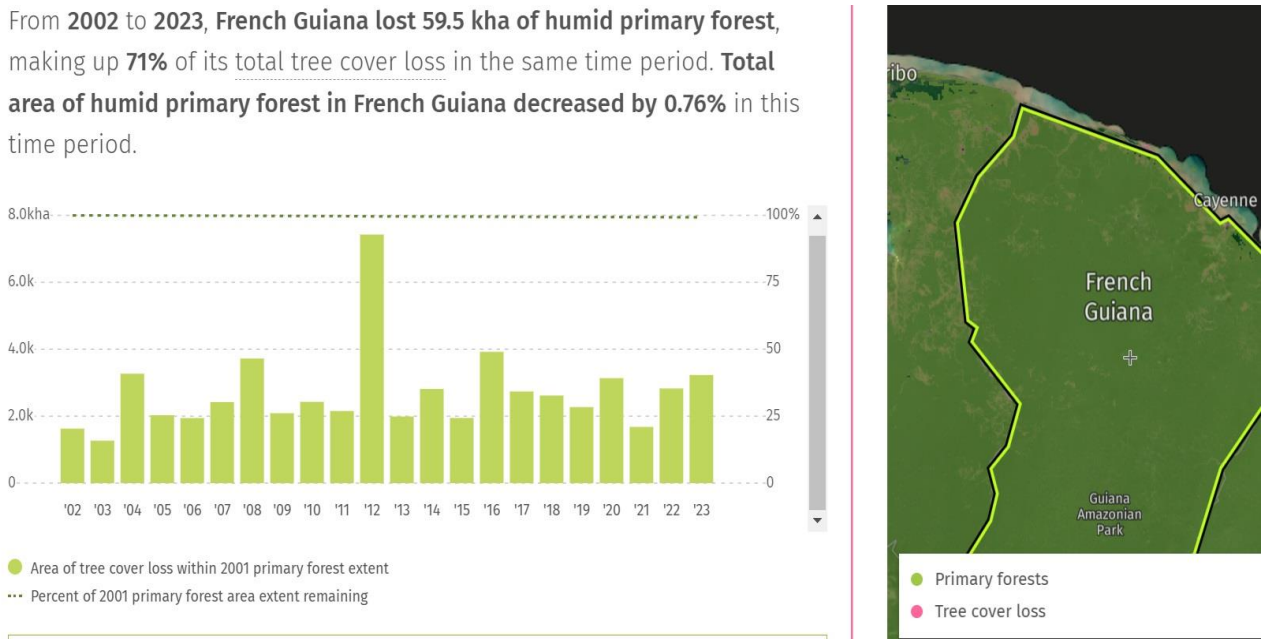

Figure 3. Analysis of deforestation in French Guinea

d) Harmful Emissions and Air Quality:

Although the technology used allows for strict emission control, biomass combustion can still produce CO2 emissions and other pollutants, such as nitrogen dioxide and fine particles, which can affect air quality in

neighboring regions. Additionally, incomplete combustion may lead to short-term pollution.

e) Biomass Transport Costs and Logistics:

The transportation and handling of biomass (wood chips) can add additional costs and logistical challenges, especially given the location of the power plant near the Petit-Saut Dam. The infrastructure required for collecting and transporting biomass may be costly and complex.

f) Competition with Other Regional Development Priorities:

Regional resources may be limited, and economic and ecological priorities could include other projects, such as environmental protection or tourism development. Therefore, an overemphasis on a biomass energy project could lead to the neglect of other areas of regional development.

5. CONCLUSION

The biomass power plant project in Sinnamary represents a significant opportunity for sustainable energy development, with a positive impact on the local economy and environment, particularly through the use of renewable resources and carbon emission reduction. However, its success depends on the careful management of local biomass resources, ecological impact, and associated costs. If effective emission control measures and sustainable resource management are implemented, the plant could become an example of sustainable energy development for the entire region.

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