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Implementation of Biomass Boiler Aimed at Reducing Negative Impacts in an Industry

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***Abstract*—** *Non-renewable energy sources have organic plant or animal origin, and it takes millions of years to form in nature. This high consumption harms society and the environment, because of the high volume of carbon dioxide (CO_2), which its burning releases into the atmosphere. Renewable energy in Brazil has a significant participation, portraying 43.5% of the country's entire energy matrix. This presence is even greater if we consider only electricity, which totals 81.7%, while the world index is approximately 20%. This case study aims to present a technological solution for the supply of steam produced through a biomass boiler in a domestic feed industry. From a diagnosis and implementation, with objectives aimed at the implementation of technology through commodities capital. We opted for biomass through eucalyptus wood with high replanting control, there are nine stages of implementation of the project, aligned with the concept of the Deming improvement cycle. The integrated and dynamic process of the Biomass Boiler makes all its product and its waste have the best use from the environmental point of view. Working with the burning of biomass, the renewable fuel in the new Boiler unit managed to reduce greenhouse gas emissions more than 70%.*

I. INTRODUCTION

According to Bezerra (2016), the Brazilian Energy Matrix experienced transformations, especially in the insertion of renewable sources. On the other hand, there was a reduction in the production of firewood, which in 1970 represented 64.2% of renewable sources, while in 2014 it had a share of only 9.1% of the renewable matrix. For non-renewable sources, oil and natural gas stood out, which despite incentives for the reduction of fossil sources, showed a growth trend from 1970 to 2014. It was found that, for 25 years (1970-1995) and, in 24 years (1970-1994), Brazil did not present a satisfactory performance in production and per capita energy supply, respectively, presenting high instability over the period. However, even with the increase in energy supply, external dependence showed an upward trend, with a Geometric Growth Rate of 8.35% per year, noting that even with all investments allocated to achieve energy self-sufficiency, the need for imports remained in ascendancy to meet the internal energy demand.

The high consumption of natural gas used by thermal power plants at the time of the drought impacts smaller systems that also use natural gas, as prices rise to alarming levels and are difficult to predict, not to mention the greater negative environmental impact in terms of greenhouse gas emissions. Due to the scarcity in some

periodos in the year, the natural gas supplied to the unit is reduced by the supplier or there are significant increases in the values per consumption in m³. Because of this, the plant saw its electricity costs increase. As energy and gas price curves are highly volatile, it becomes increasingly difficult to build a cost forecast and operation planning of the company's manufacturing units worldwide, then the GIS program considered it advisable to reduce plant exposure to fossil fuel use, reducing risk to the production process.

According to Koeller and Miranda (2022), The discussion on the importance of technology for sustainable development dates to the 1980s. Also in the author's view, the imposition of environmental standards can induce companies to innovation, aiming at reducing mitigation costs and fines related to the negative environmental impact caused, or increasing the value of their products, increasing competitiveness. This would therefore be one of the main factors inducing environmental innovations.

The company's principles and sustainability plans seek improvements in systems that bring benefits to the company, mainly related to the care of the planet. To this end, the industry has implemented a steam generation system, through a biomass boiler, to reduce costs and operational risks, reduce investment to adapt the steam production plant, increase reliability in the supply of steam and sustainable appeal to the brand.

Noting that biomass estimation is a way to evaluate the amount of biological material of a forest for its energy conversion and nutrient cycling, as well as studies on plant biomass and the nutritional composition of plants can make up an important database for the development of conservation programs, and be a comparative reference for the recovery of degraded areas and for the administration of forest remnants, combating the indiscriminate use of the forest (SILVA, 2019)

The approaches of this study, consider the application of biomass technology, management, controls, and monitoring that will be implemented with the maximum governmental responsibility and with the use of a third-party operation model with defined time for total acquisition of the operation, this is a contractual model, little explored In Brazil, which resembles a commodity process.

Commodities or Commodity (singular) is an expression of English that has spread in economic language to refer to a particular good or product of primary origin marketed on commodity and stock exchanges around the world, and which has a great commercial and strategic value. Generally, these are mineral, vegetable, or agricultural resources, such as oil, coal, soybeans, sugarcane, and others (BRIDGES, 2017).

The project planning was the main step to define the objectives and goals, current legal service, economic viability through industry budgets, predictions of future scenarios, such as expansion, for example. In this phase there is measurement of current consistent data under the required production volume versus the demand provided by the boiler. Therefore, it is necessary to carry out technical studies that ensure a subsequent, safe and sustainable execution.

This case study aims to apply biomass boiler technology to the generation of thermal energy to produce steam for cooking and processing of domestic feed, aiming at reducing consumption of finite natural resources.nk.

II. METHODOLOGY

Study Area

The pet food industry is in São Paulo, Brazil, and its products are marketed in the country and other Latin American countries (Figure 1).

Fig.1. The industry of pet food. Source: Google Maps, 2022.

The unit has about 700 employees and about 300 contractors. The products are of agricultural origin and proteins of white and red meats and for their process there are types of dry products with various types of brands for dogs and cats, and moist that are produced in sachets and cans being 70% of the production volume for dogs and 30% for cats, both processes, have thermal energy consumption needs for the preparation and finalization to the consumer.

Methodological Procedure

This project is based on the case study of biomass boiler implementation. According to Marconi and Lakatos (2010) the case study is a research method that generally uses qualitative data collected from real events, with the

objective of explaining, exploring, or describing current phenomena inserted in their own context.

The classification method is descriptive of quantitative character with results obtained through elements of the basic statistics. Quantitative research is a method of social research that uses quantification in the modalities of information collection and its treatment, through statistical techniques, such as; percentage, mean, standard deviation, correlation coefficient, regression analysis, among others (MICHEL, 2007).

Considering the steps of the PDCA, according to De Matos (2010), the PDCA tool applied to environmental management presents the steps and elements of the implementation process. Therefore, the use of the PDCA tool also helps to ensure success in the implementation of environmental management models.

Considering the pdca steps, the study was developed in nine stages distributed within the improvement cycle, as follows:

Planning

STEP 1: Survey of consumption data and demands of the current thermal boiler versus production volumes.

STEP 2: Study of the Brazilian energy matrix, considering the supply of the company's area of activity.

STEP 3: Analysis of the organization's global strategy to reduce environmental impacts through eco-innovations and technologies.

STEP 4: Scope and analysis of suppliers.

Carrying out or executing

STEP 5: Project execution.

STEP 6: Definition of the business model and pricing.

STEP 7: Hiring a company specialized in environmental licensing

Verification and control

STEP 8: Quantitative and qualitative analysis of investments.

Evaluation and correction

STEP 9: Environmental controls and monitoring.

Detailing the nine stages of the case study

Each stage of this case study aims to present the development of the project, from the planning, execution, controls, and monitoring phase. Thus, it can be observed the company's direction in following with biomass technology for the purpose of producing thermal energy in its manufacturing process.

STEP 1: Survey of consumption data and demands of the current thermal boiler versus production volumes.

Initially, data analysis was fundamental to measure the demands of thermal energy consumption that the industry currently uses, considering production volumes, to make some decisions about which types of technologies and innovations could be considered and what capacities of the demands would not be sufficient to support the production process for dry and wet product lines. Data from the last 6 years and the proportional volume estimate for 2 years after implementation were analyzed, considering an increase in production volume.

STEP 2: Study of the Brazilian energy matrix, considering the supply of the company's area of activity.

This analysis considered the Brazilian energy matrix, in the aspects of consumption and supply of sources of electricity (hydroelectric), natural gas and biomass using wood, for this it was necessary to understand the processes and their impacts, to consider what would be more sustainable and could meet the company's objectives.

STEP 3: Analysis of the organization's global strategy to reduce environmental impacts through eco-innovations and technologies.

Bringing an investment like this to the company's business unit to Brazil would be as important for competitiveness as for business sustainability, which brings more stability in manufacturing processes. The new boiler optimizes production costs, increasing competitiveness, and brings a great environmental advantage with the use of renewable fuel.

Another point of extreme importance, for the unit in Brazil, this case study is based on the development and implementation of a biomass boiler, which makes the unit more economically competitive in terms of energy, besides a positive environmental impact, because the plant's energy matrix starts to use a renewable fuel, significantly reducing greenhouse gas (GHG) emissions compared to the previous process, taking into account the objects of the organization as to the reduction of CO_2 emissions.

STEP 4: Scope and analysis of suppliers.

The definitions of the scope and analysis of suppliers applicable to competition, after the technical evaluation of engineering, used the main financial parameters for final validation of the supplier, such as prices, developer experience, customer references, financial evaluation made by third-party supplier and legal conditions of contract.

To consider a supplier analysis, some validation criteria were necessary at this stage, however, each criterion has a weight in the evaluation, because it was considered that not always the best price could be enough to ensure an excellent quality in project delivery. Therefore, the experience of the developer and its references in the

market where similar projects already exist, made the big difference at this point.

The strategy of the engineering group involved in this stage, sought to analyze through criteria of suppliers researched via internet and by external recommendation, with a limit of up to 04 (four) options of companies with expertise in biomass design. The criteria for convening the selection were distributed via the internal purchasing system through e-mail contacts and with the active call considering an internet search of suppliers working with this type of project.

STEP 5: Project execution.

The project comprises supply of the equipment (biomass boiler) under conditions contracted by suppliers who make the investment of the equipment, operate and maintain in exchange for a long-term contract in which the steam unit will be sold to us in m³. The capacity of the equipment will cover 100% of consumption and the supplier will also be responsible for maintaining the natural gas boiler in case of emergencies and maintenance in the biomass boiler. The area for the installation of the biomass steam production system is located next to the existing natural gas boiler (Figure 2). This area, considers:

1. Biomass Storage Yard (3 days);

2. Steam Boiler. According to the preliminary layout indicated next to it, an area of approximately 750 m² will be required.

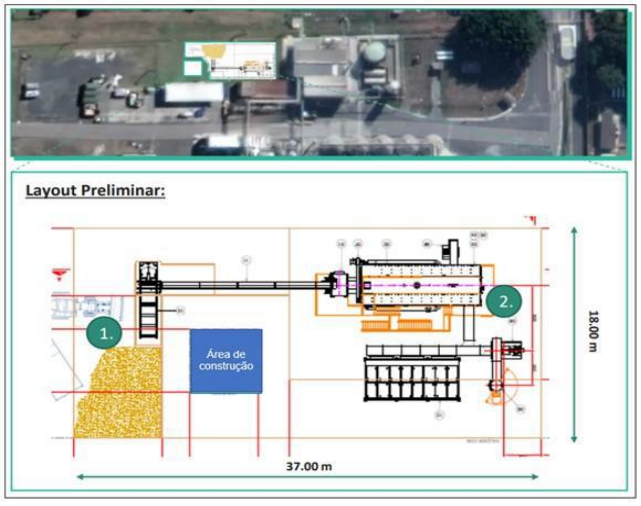

Fig.2. Location of the biomass boiler installation. Source: The Authors (2022).

STEP 6: Definition of business model and pricing

In this stage, the process of defining the business model and preficiency is understood, where the conception of the solution is demonized until the moment of the execution and operation of the boiler system.

SOLUTION DESIGN: Development of conceptual solution for the generation of steam with biomass.

INVESTMENT IN THE PROJECT: The financial solution includes the total investment in the installation and equipment, and the remuneration is carried out during the period of 10 years.

INSTALLATION, COMMISSIONING AND APPROVALS: Outsourcing of management and installation risks.

FUEL: Outsourcing the risk of fuel supply and exposure to the biomass market.

OPERATION: Local operation through specialized team and remote monitoring with data storage, in addition to commitment to the performance and availability of equipment.

SYSTEM MAINTENANCE: Predictability in steam costs.

STEP 7: Hiring a company specialized in environmental licensing.

The hiring of a specialized company to develop the licensing processes, required in Brazil and the State of São Paulo, where the project is carried out, was fundamental to ensure all environmental and company premises. In order to ensure that the project implementation planning was obtained the desired success, a previous alignment with the execution schedule of the biomass boiler was fundamental

STEP 8: Quantitative and qualitative analysis of investments.

At this stage, the results values of current consumption with the natural gas boiler versus the consumption destined to the use and consumption of the biomass source are calculated, considering that one of the premises consists of the basis calculation that the application of the project is financially feasible. Therefore, in addition to all the analyses of positive environmental impacts, the result of investments in the maintenance of the operation is a fundamental part of the decision-making analysis of the implementation of the project. Considering, therefore, that the calculations of initial investments and maintenance of the operation are quantitative data, however, based on the qualitative study of social analyses (PEREIRA, 2020), the Internal (investments within the company), External (investments in society) and environmental indicators are key factors in the analysis of results for decision making.

STEP 9: Environmental controls and monitoring.

Environmental controls and monitoring are part of the evaluation and correction phase, because, through the data achieved and the measurements of the results, it will be possible to evaluate the deviations and correct the process,

aiming at continuous improvement. According to Feil (2013), sustainability indicators have the purpose of identifying whether a company is in the right or opposite direction of the interrelation of economic, social and environmental dimensions.

Considering the structure of the operation that requires operating efficiently that ensures the production of steam that meets the demands of production, this will be one of the monitoring factors in volume of steam produced from steam by product volume. In addition, atmospheric analyses will undoubtedly be one of the units for monitoring efficiency and ensuring legal compliance.

III. RESULTS AND DISCUSSION

Social Results

The execution of the project has the performance of multidisciplinary professionals and the involvement and hiring of specialized labor. More than 1 million and 200,000 hours worked are necessary to perform the services related to the project, from the planning, assembly and the start of the operation of the Boiler. This demand for labor provided professional development in training and greater job offer for professionals in the region. The concern for the safety of the workers involved was also a very relevant issue and prevention actions contributed to the services being carried out safely respecting all operational procedures.

With the start of the biomass boiler operation, the demand for wood had an important growth, the organization established a contract with rural producers in the region around the unit. In the mode of promotion, the supplier offers the necessary conditions for the producer to cultivate eucalyptus.

Economic Results

Due to the growing challenge to maintain operating costs and competitiveness in the business, it was necessary to develop a project that would also contribute to cost reduction. With the implementation of the new Boiler, the plant became 90% self-sufficient in energy reducing the purchase of electricity externally. The cost reduction with the project was significant due to the difference in natural gas cost compared to wood, more electricity and oil reduction.

Environmental Results

The integrated and dynamic process of the Biomass Boiler makes all its product and its waste have the best use from the environmental point of view. Working with the burning of biomass, the renewable fuel in the new Boiler unit managed to reduce greenhouse gas (GHG) emissions more than 70%.

SUSTAINABILITY. Reduction of CO2 emissions to ZERO using reforestation wood, i.e., average emission reduction for steam production of 5,870 T-CO_2/year. This reduction in the emission level is equivalent to the planting of 375,000 trees considering the average CO_2 of a native tree of the Atlantic Forest.

Table 1 shows the comparison of the emission reduction of polluting gases, comparing the natural gas (NG) and biomass boilers of waste wood.

Table 1 - Comparison of the emission reduction of polluting gases.

PARAMETER mg/Nm³	BOILER A GN	BIOMASS BOILER
Particulate Matter (PM)	10 (3% oxygen)	350 (8% oxygen)
NOx (Nitrogen Oxides)	320 (3% oxygen)	81 (8% oxygen)
SOX (Sulphur oxides)	3 (3% oxygen)	Immune

Source: The Authors (2022).

Thus, it can be affirmed that replacing the boiler with GN with one with biomass will reduce the number of Pollutants of NOx (Nitrogen Oxides) and SOx (Sulfur Oxides). The amount emitted from Particulate Material (PM) by a biomass boiler is greater than that of the natural gas boiler, however it complies with the Legislation CONAMA 382, of December 26, 2006, (limit of 520 mg/Nm³ for PM), where it establishes the maximum emission limits of air pollutants for fixed sources and provides other measures.

Also when performing a comparison, based on CO_2, one of the main items in the calculation base for obtaining carbon credits and one of the main responsible for the greenhouse effect, it can be affirmed that with the replacement of the boiler the GN, to reduce approximately 1558 tons of CO_2 emitted per month by the chimney, in addition to, in case of certification, can generate monthly 1558 credits (carbon) to be marketed.

IV. CONCLUSION

The Global Renewable Energy Strategy, guided by the SiG (Sustainable in a Generation) goal of using 100% renewable energy in the future, provides the comprehensive framework for this approach.

The category's global strategy focuses on long-term bilateral contracts to ensure the coverage of fincanceiros resources, achieve economic savings, and provide a degree

of cost security for the business. In addition, but by identifying and structuring customized solutions, we can optimize our energy purchase and eliminate inefficiencies in production.

According to initial results, there is a tendencyto r educe 83% of the use of natural gas on site, and thereby reduce 5400 tons of CO2 generation, generating savings that positively support the value of the final product when consuming, making them more competitive in the market.

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