FINANCING AND INTEGRATING RENEWABLE ENERGY IN THE CITY OF BUTUAN

BIOMASS PILOT PROJECT FOR BUTUAN CITY

PRE-FEASIBILITY STUDY REPORT

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PREFERRED ENERGY, INC.

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ABBREVIATIONS

AGRAC	Agusan Greenfield Resources and Agrotec Corporation
ANECO	Agusan del Norte Electric Cooperative, Inc.
BCEDP	Butuan City Energy Development Plan 2023-2050
BPP	Biomass Pilot Project
BXU	Butuan City
CGB	City Government of Butuan
FinRE-BXU	Financing Integration of the Renewable Energy Projects in Butuan City
LGU	Local Government Unit
MPSUID	Master Plan for the Sustainable Urban Infrastructure Development in Butuan City December 2020
MW	Megawatt
PEI	Preferred Energy, Inc.
PEP	Philippine Energy Plan 2020-2040
PSPP	Power Supply Procurement Plan 2024-2033
Pre-FS	Pre-Feasibility Study
RE	Renewable Energy
TJ	TeraJoules
WWF Philippines	Kabang Kalikasan ng Pilipinas Foundation, Inc.

1. INTRODUCTION

The Philippines is geographically located with an abundant supply of these RE sources. The Philippine government has enacted R.A. No. 9513 or the Renewable Energy Act of 2008 to promote the exploration, development, utilization, integration of RE power generating facilities in the country. The Philippine government, through its Philippine Energy Plan 2020-2040 (PEP), has also implemented energy roadmaps[1] to track its clean energy goals through a larger RE share in the country's energy generation mix and reducing the dependence on imported fossil fuels. The country's goal is to increase its RE share by 35% by 2030 and 50% by 2040[2]. This will be the Philippine's conducive action to the United Nation's Sustainable Development Goals once achieved.

The City Government of Butuan (CGB) has successfully conducted its RE resource assessment within its political boundaries. The results of these assessment are cited in its Butuan City Energy Development Plan 2023-2050 (BCEDP). Preliminary findings indicate the city can potentially develop solar and biomass power projects as well as the application of electric vehicles within the city. The CGB opted for the partnership offered by Kabang Kalikasan ng Pilipinas Foundation, Inc. (WWF-Philippines) for the implementation of the Financing Integration of the Renewable Energy Projects in Butuan City (FinRE-BXU) upon identifying RE sources as stated in the BCEDP.

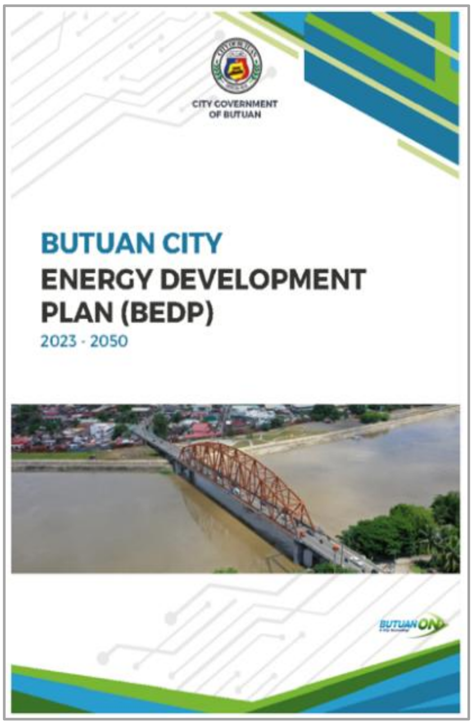

Figure 1. The Butuan City Energy Development Plan 2023-2050

The CGB will spearhead innovative economic development solutions for the Province of Agusan del Norte and the entire Caraga Administrative Region or Region XIII. It also aims to be the leading local government unit (LGU) in energy efficiency and waste management whilst upholding the environment in accordance with the Local Government Code of 1991, the Ecological Solid Waste Management Act of 2000, the Renewable Energy Act of 2008, the Energy Efficiency and Conservation Act of 2019, and other relevant laws and regulations in the country. Toward this end, the CGB will lead to the approval and development of several RE pilot projects within their jurisdiction to meet the growing city's energy demands.

WWF-Philippines sought the expertise of Preferred Energy, Inc. (PEI) as its renewable energy consulting firm for the identification, preparation and provision of applicable financial solutions for the FinRE-BXU Project. PEI is a non-stock, non-profit organization registered with the Securities and Exchange Commission on 19 April 1996 that promotes the development of renewable energy, other clean development mechanisms as well as energy efficiency and demand-side management in the Philippines. PEI is one of the pioneer firms engaged in RE market analysis, financial and technical feasibility studies in the country. It pioneered several outstanding initiatives and projects which led to commercial implementation of RE projects in the Philippines. Among these are the Philippine Wind Energy Atlas (2001) by the National

[1] p. 3, Energy Roadmaps and Sustainable Development Goals, Philippine Energy Plan 2020-2040
[2] p. 2, Clean Energy Scenario, Philippine Energy Plan 2020-2040

Renewable Energy Laboratory of the United States (US NREL), the first 1MW solar farm, the largest in the developing world in 2007 and operated in conjunctive use with hydropower in Cagayan de Oro City, the first 1MW rice husk-fired biomass power plant (2005) in Isabela, Cagayan, and the first biogas power project to qualify for carbon credits under the Clean Development Mechanism, among others.

As per engagement, PEI has been tasked to conduct a pre-feasibility for the implementation of a biomass power project, one of the potential projects identified in the BCEDP. The proposed biomass pilot project is viewed as the CGB's initiative on utilizing city's agricultural waste as potential feedstock for efficient and sustainable energy generation. This project will be implemented in accordance with the country's national and regional plans and policies for accessible, clean and reliable energy sources.

2. BUTUAN CITY ENERGY DEVELOPMENT PLAN BIOMASS FINDINGS

The project team of Preferred Energy, Inc. (PEI) initiated the pre-feasibility study of a biomass project within Butuan City based on the findings of the Butuan City Energy Development Plan (BCEDP). Here are the key findings of the BCEDP.

1. The following agricultural crops were identified as potential sources of agricultural residues: (a) rice, (b) coconut, (c) corn and (d) palm oil.
2. For each crop, the BCEDP identified the specific agricultural residues: i.e., (a) straw and husks from rice; (b) husks and shells from coconut; (c) stalks, cobs and husks from corn; and (d) shells, fiber and empty fruit bunches from palm oil trees.
3. For each agricultural residue, the BCEDP estimated the feedstock amounts using what may have been the residue to product ratios[3]. The total feedstock amount was aggregated and using 2019 data, the total biomass feedstock quantity was estimated at 216,536.2 MT.
4. The theoretical energy potential was calculated per crop residue and reported as TeraJoules (TJ) per year. The total biomass feedstock theoretical energy potential was reported as 3,278 TJ per year. The theoretical equivalent in MW-hour per year is 910,665. The table below shows these agricultural residues and their equivalent energy potentials as reported in the BCEDP.

Table 1. BCEDP Biomass Resource Assessment[4]

Crops	Agricultural Residues	Total Production in 2019 (MT)	Feedstock (MT/yr)	Theoretical Potential (TJ/yr)	Theoretical Potential (MWh/yr)
Rice	Straw	60,371	106,072	2,011	558,570
	Husks		16,119		
Coconut	Husks	94,808	39,725	945	262,634
	Shells		11,377		
Corn	Stalks	17,037	34,074	310	86,133
	Cobs		4,651		
	Husks		3,407		
Palm Oil	Shell	2,555	166	12	3,328
	Fiber		358		
	Empty Fruit Bunches		588		
Total				3,278	910,665

5. The BCEDP assumed a biomass power plant thermal efficiency at 25% and a capacity factor of 80%. Thus, 910,665 x 25% = 227,666.25 MW-hour per year. At 80% capacity factor, 227,666.25 MW-hours per year ÷ 8,760 hours in a year ÷ 80% = **32.487 MW.**

Given the findings of the BCEDP, PEI's task is to validate the conclusion made that about 32.487MW of power can be installed in Butuan City as part of its pre-feasibility study.

[3] This article illustrates the use of residue to product ratios in estimating agricultural residues: https://www.researchgate.net/publication/223062794_Assessment_of_sustainable_energy_potential_of_non-plantation_biomass_resources_in_the_Philippines.

[4] p. 59, Table 15. Theoretical Potential of Agricultural Residue, Butuan City Energy Development Plan 2023-2050

3. BIOMASS PROJECT IDENTIFICATION

The first step in the pre-feasibility study is to identify a specific biomass project starting with its feedstock and location. Table 1 shows that *rice is the dominant agricultural resource*, accounting for more than half of the theoretical energy potential. Thus, the use of rice residues of feedstock is the proper starting point for project identification.

3.1. Rice Residues

There are two rice residues identified: straw and husks. In the field, both residues are found in different locations. Rice straw is a byproduct of rice production. Rice straw is removed from the rice grains during harvest and it ends up being piled or spread out in the field depending if it was harvested manually or using mechanical harvesters. These residues mostly end up being burned in open fields when farmers clean up the fields in preparation for the next planting activity. According to the International Rice Research Institute (IRRI), open-field straw burning has increased dramatically over the last decade[5].

In Butuan City, rice harvesting is still primarily done manually, making the collection of rice straw a tedious and costly labor-intensive process. *There is no known application of rice straw for energy applications in the Philippines*, although PEI staff are aware of the ongoing project development[6] of a power plant in Isabela Province where rice straw will be one of its potential biomass feedstocks. This is possible in Isabela because rice harvesting is more mechanized and the larger volumes of available rice straw can make mechanized collection of straws more cost effective.

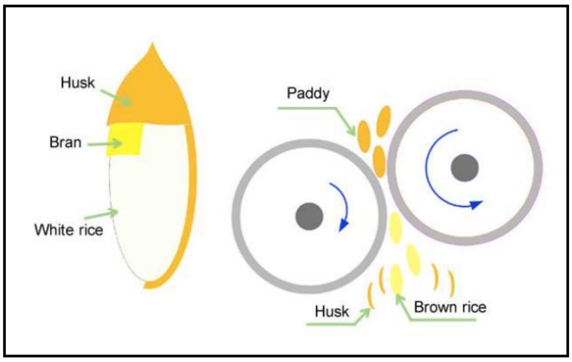

Figure 2. Rice Paddy Composition and Milling Process

On the other hand, rice husks can be found in the rice mills after milling of the paddy. Each kg of milled white rice results in roughly 0.28 kg of rice husk as a by-product of rice production during milling[7].

In Butuan City, the PEI project team has been able to get information on 37 rice mills within the city. Most of these rice mills are described as “compact” rice mills with capacities ranging from 5 to 20 MT per day over an 8-hour operation.

The rest are “conventional” and “modern” rice mills, some of which are large enough to support a rice husk power plant by themselves. The largest of these rice mills is the *Agusan Greenfield Resources and Agrotec Corporation (AGRAC)* with a daily production of 500 MT of rice.

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[5] https://www.irri.org/rice-straw-management

[6] PEI’s information comes from its previous work in Isabela where it initiated and completed the feasibility study of the first rice husk-fired power plant in one of the large rice mills. The implementation of the project started the development of rice husk-fired power plants in the country. Today, the biggest developers of biomass power projects are in the rice industry, supplanting those in the sugar industry.

[7] http://www.knowledgebank.irri.org/step-by-step-production/postharvest/rice-by-products/rice-husk

Applying the rice husk to milled rice ratio of 0.28, the daily amount of rice husk is 500 MT x 28% = 140 MT rice husk per day. At a conservative rice husk feedstock consumption of 2 MT per hour per MW, the potential capacity is 140 MT rice husk per day ÷ 24 hours per day ÷ 2 MT per hour per MW = 2.9 MW. At this capacity, the typical biomass technology applicable is the gasifier. At 5 MW and above, the steam power plant using a boiler and steam turbine will typically be more applicable. Since all other rice mills are significantly smaller than AGRAC, the gasifier technology will be the applicable technology for them as well.

The next largest rice mill is *DL Rice and Corn Mill* with an aggregate daily rice production of 203 MT. Thus, 203 MT x 28% = 56.8 MT rice husk per day. The potential capacity is 56.8 MT rice husk per day ÷ 24 hours per day ÷ 2 MT per hour per MW = 1.2 MW.

AGRAC is located in Barangay Taguibo while DL Rice and Corn Mill is located in the adjacent Barangay Ampayon. Thus, it is possible for a single power plant to source rice husk feedstock from both rice mills. To assure long-term feedstock supply, the rice husk power plant must have a capacity of no more than 1.2 MW in order to have 2 competing rice mill suppliers.

However, based on information from Butuan City staff, “Rice husks are no longer feasible for a biomass facility in BXU since all of these waste are being utilized for industrial heating and drying (rice millers use their own waste for heating and drying during rainy season) as well as for domestic cooking.”

3.2. Coconut Residues

Coconut residues account for about half of the theoretical potential of rice residues. The BCEDP has identified two coconut residues: husks and shells.

The first step in coconut farming is the harvesting of mature coconuts. Coconuts are ready for harvest when they are fully ripe and have turned brown. The process involves climbing the coconut tree and cutting the fruit from the tree. Once harvested, the husk or outer shell of the coconut must be removed. This is done by hand or with the use of a mechanical dehusking machine. The next step is to process the coconut meat into copra. In copra processing the coconut flesh is dried to produce copra. This can be done by exposing the flesh to sunlight, or by using a kiln or dryer. The coconut shell needs to be taken off when the flesh has cured. The shell is broken either manually or mechanically. After being extracted from the shell, the copra is gathered in bags or other containers.

Thus, the husks and shells may be found at the farmers’ premises and at different times during copra processing. Like rice straw, these coconut husks and shells need a supply chain that will handle their collection and logistics. Sadly, that supply chain remains to be developed in Butuan City. Similar to rice husks, coconut husks are also used as feedstock for kilns in copra processing, while the shells are mainly processed into charcoal for cooking.

3.3. Corn and Palm Oil Residues

Corn and palm oil residues account for less than 10 percent of the theoretical potential identified by the BCEDP. The various residues can also to be found in different locations, making their collection and logistics as problematic as explained for rice straw and coconut residues.

3.4. Wood Industry Residues

During the meeting of technical working group with the PEI project team, there was a suggestion from the Agusan del Norte Electric Cooperative, Inc. (ANECO) participants to look at the potential of the unused sawdust and woodwaste in several wood-working companies within Butuan City. Following this suggestion, PEI formulated a survey instrument that the Butuan City government can use to investigate the potential for woodwaste as feedstock for a biomass power plant. The survey was conducted during the last quarter of 2024. The consolidated data is summarized and presented in Table 2. This information was used as the basis to determine the volume of wood residues within the city that can be used as feedstock for the proposed biomass facility.

Table 2. Summary of Wood Waste Data Survey

Monthly Volumes	Monthly Volume in MT	Used by company, MT	Not used, MT
Wood clips	55.60	35.55	20.05
Wood clippings	770.80	751.20	19.60
Wood shavings	0	0	0
Sawdust	208.72	176.00	32.72
Wood trimmings	15.00	15.00	0
Others	13.50	13.50	0
Total	**1,063.62**	**991.25**	**72.37**

Data Source: City Environment and Natural Resources Department, survey conducted last quarter of 2024

From the survey, it was found out that over 93 percent of the wood residues were used by the companies themselves, primarily as feedstock in their process heating applications. Only 72 MT of wood residues were not used and thus available for biomass feedstock. This volume of feedstock, assuming all of it is used can only support a 100 kW biomass power plant which is too small to justify setting up a biomass supply chain.

The Butuan City staff suggests that it is much more practical to use wood branches or trimmings from falcata plantations as feedstock. Further, they have a view that a biomass facility in BXU can only be considered if there are dedicated feedstock plantations.

4. BIOMASS STUDY CONCLUSION

Based on the above review of the biomass feedstock supplies in Butuan City we can conclude that there is no sufficient feedstock that can be collected to sustainably support at least a 1 MW biomass power plant in Butuan City. The agricultural residues, such as rice straw and coconut husks identified in the BEDP report are deemed too spread out for feasible collection. To set up a biomass supply chain for this purpose would be too burdensome and expensive. Even if we consider the residues that is available from both the rice and wood processing industries, still there is not enough feedstock to justify the viability of even just a 1MW biomass plant.

Wood branches and trimmings from falcata plantation may be a possibility but this will require further study and discussion with plantation owners, as collection of wood branches and trimmings in plantations is not a normal practice. PEI agrees with the Butuan City staff's opinion that to ensure the viable operation of a biomass power plant in Butuan, there should be a dedicated biomass supply source, such as a plantation, that can provide biomass feedstock supply year-round.

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