The study commenced with an assessment of feedstock and supply chain, a critical step to achieve several objectives: (1) mapping the potential of sugar palm waste, (2) evaluating the sustainability of raw materials, (3) understanding the geographical conditions for biomass transportation, and (4) assessing the feasibility of biomass supply to nearby coal-fired power plants (CFPPs) for co-firing. A site survey conducted in Sarayuda, Cijeungjing District, Ciamis Regency, revealed substantial potential in sugar palm powder and fiber waste (Figure 1).



Figure 1. Sugar palm waste as by-products from sugar palm factories in Ciamis

The area is home to 13 sugar palm flour factories within a maximum distance of 1 kilometer, all of which have been operating for approximately 15 years without any by-product treatment during this period. As a result, the accumulated sugar palm waste is estimated at 1–2 million tons, with an additional production of approximately 100 tons per day from ongoing operations. These findings highlight Ciamis Regency as a key region with the potential to sustain a robust biomass supply ecosystem.



Figure 2. (a) Sugar Palm Powder and (b) Sugar Palm Fiber

The supply chain assessment also aimed to evaluate the accessibility and co-firing capabilities of nearby CFPPs as potential off-takers for sugar palm waste. Several CFPPs in West Java, such as CFPP Suralaya, CFPP Indramayu, CFPP Lontar, CFPP Pelabuhan Ratu, and CFPP Labuan Banten, were considered. Among them, CFPP Indramayu is the closest, located 183 kilometers from the site, while CFPP Suralaya and CFPP Pelabuhan Ratu are situated 406 kilometers and 371 kilometers away, respectively. However, as of April 2024, these CFPPs still face biomass supply shortages.

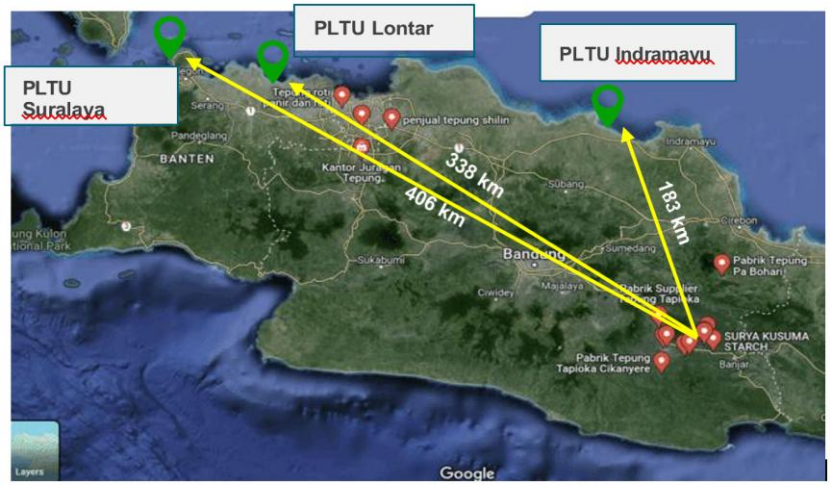


Figure 3. CFPP nearby the sugar palm factories in Ciamis

2.2 Technology Selection for Biomass Processing

From the laboratory analysis as depicted in Table 1, sugar palm waste has gross calorific value which makes it possible as a raw material for biomass cofiring. However, the sugar palm waste have not fully meet the specifications for CFPP biomass cofiring requirements as it has relatively high total moisture (55.6% for fibers and 83.6% for powders).

Requirements for biomass cofiring follows Indonesia National Standards (*Standar Nasional Indonesia*/ SNI) for each type of biomass. As the sugar palm waste is in the form of powder and similar to sawdust, the SNI for sawdust can be used as reference (Figure 9). For utility quality that been used in CFPP, the maximum total moisture for sawdust is 35% with the minimum gross calorific value (GCV) is 3,009 kcal/kg.

Table 1. Laboratory analysis of sugar palm waste from Ciamis factories

Parameter	**Unit**	**Results**		**Method**
		Fiber	Powder	
Total Moisture	%, ar	55.6	83.6	ASTM D 3302 – 17
Proximate Analysis:				
- Moisture in Analysis	%, adb	6.7	3.8	SNI 8951 – 2020
- Ash Content	%, adb	2.0	2.8	SNI 8951 – 2020
- Volatile Matter	%, adb	79.3	81.0	SNI 8951 – 2020
- Fixed Carbon	%, adb	12.0	12.4	SNI 8951 – 2020
Total Sulfur	%, adb	0.05	0.07	PO MIN BT-03
Gross Calorific Value	Kcal/kg, adb	2118	2076	PO MIN BT-04

All results have been obtained in Mineral Laboratory of PT. Sucofindo Cibitung

To meet the co-firing specification, the high moisture content of sugar palm waste must be reduced before transport and combustion. Drying and mechanical dewatering are established physical conversion routes for removing moisture from biomass and other wet organic materials [4]. Drying can achieve a lower final moisture content, but it requires thermal energy. Comparative inventory data from sludge treatment show that thermal drying is substantially more energy-intensive than mechanical dewatering, although the absolute values depend on feedstock and process conditions [7]. Because sewage sludge and sugar palm waste have different structures, this evidence is used here only as a process-energy comparison; the achievable performance for sugar palm waste must be verified by site-specific testing.

Mechanical dewatering removes free water without the heat input required by thermal drying and is

therefore attractive for very wet feedstocks [4, 7]. Screw-press systems have also been developed for high-moisture organic slurries, demonstrating the practical applicability of continuous mechanical solid-liquid separation [5]. Based on the measured moisture characteristics of the Ciamis feedstock and the lower energy intensity of mechanical water removal, dewatering was selected as the primary upgrading step in this study. The achievable final moisture content, maintenance needs, and operating stability should nevertheless be validated under full-scale operation rather than assumed from other feedstocks.

3. Result and Analysis

3.1 Dewatering Specification

As dewatering process has been chosen as the main technology to reduce water content in the sugar palm waste, the machine specification that compatible with the sugar palm waste characteristics is needed.

The projection of production capacity from the dewatering process can be shown in table below.

Table 2. Production capacity projection for the biomass processing facility

No	Description	Unit
1	Machine capacity	10 ton/ hour
2	Machine capacity factor	70%
3	Machine operation	10 hour/ day
4	Yearly production	300 days
5	Project lifetime	8 years
6	Production output	70% yield; 30% water

As dewatering machine fabrication in Indonesia is currently limited, it is needed to do survey from local and overseas companies.

Table 3. Sugar palm dust screw dewatering machine specifications

No	Specifications	Value
1	Machine Capacity	10 T/Hr
2	Voltage	380 V
3	Power	30 kW
4	Dimensions	4445x1000x2003 mm
5	Processing Capacity	10-15m3/h
6	Critical Materia	Stainless Steel 304