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Renewable Bioresources for Energy & Raw materials -Sustainable Transformation of SPB Erode Unit

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Abstract: *Seshasayee Paper and Boards Ltd. (SPB), through its Erode unit, represent a paradigm shift in the traditionally resource-intensive pulp and paper industry by fully integrating circular bio economy principles. The mill is transitioning from fossil fuel and natural forest dependence to a resilient, bio-based industrial model.*

Central to this transformation is a dual-track strategy focusing on renewable bio resources and circular resource management. SPB utilizes a diversified fiber mix of responsibly sourced plantation wood and agricultural residues, such as sugarcane bagasse, supported by FSC-certified farm forestry initiatives that bolster rural livelihoods.

A defining feature of SPB's operational excellence is its energy self-sufficiency. The unit meets approximately 60% of its total energy requirements by utilizing renewable biomass. This is achieved primarily through an advanced chemical recovery system that processes 'black liquor' to generate carbon-neutral thermal and electrical energy, alongside the combustion of solid biomass such as pith, bark, and sawdust in its Captive Power Plant (CPP).

With a chemical recovery efficiency of 96% and extensive water recycling, SPB Erode significantly minimizes its environmental footprint while aligning with national climate goals. This model positions SPB as a benchmark for the Indian paper sector, proving that high-yield industrial growth can be decoupled from carbon-intensive resource consumption.

Keywords: *Circular Bio economy, Biomass-Based Energy, Energy Self-Sufficiency, Agro-Residue Utilization*

Introduction: The Strategic Context

The Indian paper industry faces a dual challenge: a scarcity of wood fiber and the volatility of fossil fuel prices (coal). SPB, established in 1960 in Erode, Tamil Nadu, has addressed these challenges by engineering a closed-loop system where the output of one process becomes the input of another.

Unlike standalone mills that rely solely on market-purchased wood and grid power, SPB operates a complex ecosystem involving local farmers, an associate sugar mill (Ponni Sugars), and urban recycling centers. This integration allows the mill to source three distinct streams of renewable raw material:

1. Forest-based: Clonal wood (Eucalyptus/Casuarina).
2. Agro-based: Bagasse (Sugarcane residue).
3. Urban-based: Recycled fibre (Waste paper).

Furthermore, the "waste" generated from processing these materials—specifically Black Liquor and Bagasse Pith—are recovered to fuel the mill, significantly reducing the carbon footprint per ton of paper produced.

2. Renewable Bio resources for Raw Material

SPB's raw material strategy is built on de-risking the supply chain through diversification and community engagement.

2.1. Forest-Based Resources: The Farm Forestry Model SPB does not own captive forests; instead, it relies on a robust Farm Forestry Program that covers a radius of approximately 300 km around the Erode mill.

- Clonal Technology: To ensure high yields and farmer profitability, SPB operates a Clonal Multiplication Centre (CMC). This facility produces millions of high-yielding clonal seedlings annually (specifically Casuarina and Eucalyptus). These clones are developed to thrive in the semi-arid conditions of Tamil Nadu.
- Reduced Harvest Cycles: Through Tree Improvement Research, SPB has successfully reduced the harvest cycle of pulpwood. Traditionally taking 6–7 years, these genetically improved clones can be harvested in 3–4 years, providing faster returns for farmers and a quicker renewable cycle for the mill.
- The "Wood Positive" Status: By distributing seedlings and bringing approximately 20,000 acres of land under plantation annually, SPB ensures that the biomass it regenerates exceeds the biomass it consumes for pulping.

2.2. Agro-Based Resources: The Bagasse Symbiosis A defining feature of SPB's sustainability is its relationship with Ponni Sugars (Erode) Limited, a sugar mill located adjacent to the paper mill. This relationship is governed by a long-term tripartite agreement that secures a steady flow of bio-material.

- The Exchange Mechanism: Ponni Sugars crushes sugarcane to produce sugar. The fibrous residue, Bagasse, usually burnt by sugar mills for low-efficiency heating, is instead diverted to SPB via a conveyor belt system.
- Pulp Production: SPB processes this bagasse to produce high-quality agro-pulp. This reduces the pressure on forest wood, as bagasse acts as an excellent substitute for hardwood pulp in printing and writing paper grades.
- Coal-for-Bagasse Swap: In return for the bagasse, SPB historically supplied coal or steam to Ponni Sugars to run their boilers. This arrangement ensures that the high-value fiber (bagasse) is used for paper (a higher economic use) rather than just being burnt.

2.3. Urban-Based Resources - Recycled Fiber: To further reduce reliance on virgin bioresources, SPB's unit in Tirunelveli and the upgraded facility in Erode utilize significant quantities of De-inked Pulp (DIP). By treating waste paper as an "urban forest," the company processes nearly 35,000–40,000 TPA (Tonnes Per Annum) of recycled fiber, effectively closing the loop on paper consumption.

3. Renewable Bioresources for Energy Generation

Paper manufacturing involves digesting wood chips/bagasse in chemicals to separate cellulose fibers from lignin. The resulting liquid waste and solid residues are chemically rich bio-fuels. SPB leverages these to offset its thermal and electrical energy requirements.

3.1. Black Liquor Solids (Chemical Recovery) The single largest source of renewable energy at SPB is Black Liquor, a by-product of the pulping process.

- The Process: When wood or bagasse is "cooked" in digestors, the lignin (the natural glue holding wood fibers together) dissolves into the cooking chemicals, creating a viscous dark liquid called Black Liquor.
- Energy Recovery: This liquor is concentrated in multiple-effect evaporators to increase its solid content from 15% to over 70%. It is then sprayed into a Chemical Recovery Boiler.
- Thermal Valorization: The organic component (lignin) burns, generating high-pressure steam. This steam drives turbines to generate electricity) and is subsequently used as low-pressure steam for drying paper.
- Chemical Recycling: The inorganic chemicals (sodium salts) are recovered as molten smelt at the bottom of the boiler and reused in the pulping process, ensuring that neither chemicals nor biomass energy is wasted.

3.2. Biomass Power (Bagasse Pith & Agro-Waste): Before bagasse can be pulped, the soft, non-fibrous core (pith) must be removed, as it degrades paper quality. This Bagasse Pith accounts for roughly 30% of the bagasse weight.

SPB has successfully reduced its reliance on imported coal by integrating locally sourced renewable bio-wastes into its multi-fuel fluidized bed boilers. This initiative not only reduces fossil fuel consumption but also creates a secondary income stream for the local farming community by utilizing agricultural waste.

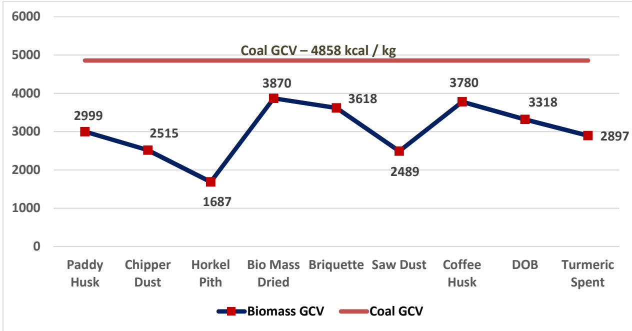

Figure 1. Fuel GCV comparison

Coffee husk GCV – 3780 kcal/kg is better than the Paddy Husk - 2999 kcal/kg and Saw Dust 2489 kcal/kg. From Februay'22 onwards we have started consuming Coffee Husk mixed with coal&other bio fuels and feeding through underfeeding (Fig. 1). Since ash softening temperature is low around 800oC, its use is restricted to around 30 TPD.

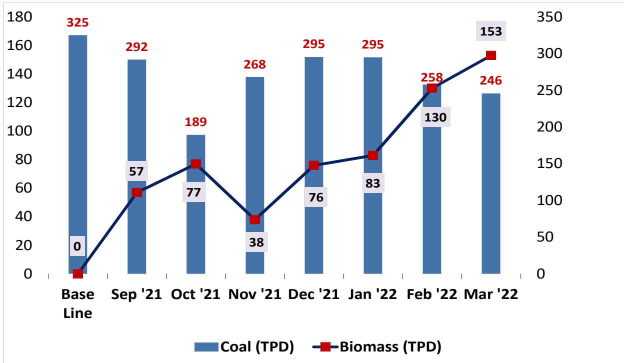

Figure 2.Consumption of Bio fuels and coal, TPD

Table1. Before and after project

Description	Fuel Pattern
Before project	100% Imported coal
After project	65% Imported coal & 35% Bio fuels

As summarized in Table 1, the fuel consumption details are.

Bio fuel consumption	Base Line	0 TPD
	Present Level	153 TPD
Coal consumption	Base Line	325 TPD
	Present Level	246 TPD
		(After Biofuels consumption)
	Coal Savings	**79 TPD**

The breakup of these 153 TPD Biofuels is as follows:

	Coal Savings	**79 TPD**
1)	Chipper dust	40 TPD
2)	Paddy husk	66 TPD
3)	Saw dust	4 TPD
4)	Horkel pith	5 TPD
5)	Coffee husk	36 TPD
6)	Turmeric spent	2 TPD
	Total	**153 TPD**

The integration was achieved with high operational efficiency:

- Method: Bio-fuels are mixed with coal and fed through underfeeding.
- Efficiency: The switch was managed without any modification to the boiler furnace, fuel handling, or ash conveying systems.
- Seasonality: The specific fuel usage pattern fluctuates based on the seasonal availability of biomass resources.

3.3. Bio-Methanation (Biogas): SPB treats its high-BOD (Biological Oxygen Demand) liquid effluent in anaerobic lagoons.

- Methane Capture: The anaerobic digestion process releases methane-rich biogas.
- Application: This biogas is captured and piped to the Lime Kiln, where it is used as a fuel to reburn lime sludge into lime (calcium oxide). This directly replaces fossil fuels like furnace oil or pulverized coal that would otherwise be required to fire the kilns.

4. The Water-Food-Energy Nexus: The Lift Irrigation Scheme

No discussion of SPB's bioresources is complete without the Lift Irrigation Scheme, which physically links the water discharge of the mill to the raw material intake.

1. Water: SPB treats its mill wastewater to meet irrigation standards.
2. Agriculture: Through a tripartite agreement, this treated water is pumped to irrigate over 2,000 acres of dry land in the vicinity of the mill.
3. Raw Material: Farmers use this water to grow sugarcane.
4. Loop Closure: The sugarcane is sold to Ponni Sugars. Ponni Sugars processes the cane and sends the bagasse back to SPB for paper making.

This "Bio-Loop" transforms a potential environmental liability (waste water) into a critical asset that secures the mill's raw material supply (bagasse).

5. Out of box concepts

SPB continues to refine its biorefinery model with targeted innovations aimed at specific waste streams.

5.1Foul Condensate Biogas System: Foul condensate, a high-BOD effluent stream containing methanol and turpentine, was typically a source of odor nuisance and ETP load. The alternative to a high-cost steam stripping column was the retrofitting of an existing anaerobic lagoon. The method involved installing a specialized balloon cover system to capture generated biogas and a piping network to feed this gas directly to the rotary lime kiln as supplemental fuel. Lab testing confirmed the biogas contained approximately 65% methane content.The process to produce biogas from foul condensate and bagasse pith filtrate is shown in Figure 3.

The foul condensate management project provided dual benefits: environmental compliance and energy savings. By capturing and utilizing the biogas, the mill achieved a significant 20% reduction in the effluent treatment plant (ETP) organic load. The biogas offset 3-3.5 kL/day of furnace oil in the lime kiln, resulting in annualized savings of roughly Rs. 3.6 crores. This innovative approach effectively eliminated the odor nuisance associated with the open lagoon.

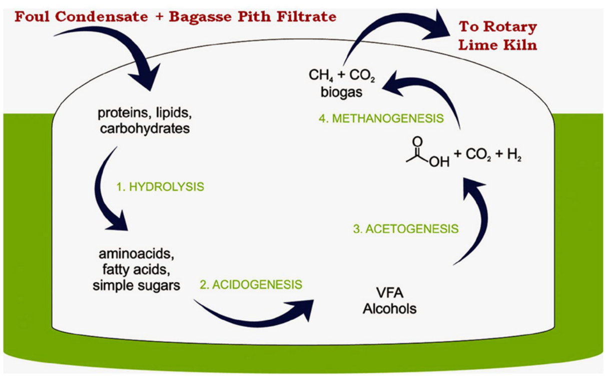

Figure 3. Foul condensate to bio gas process flow diagram

5.2 MLSS Solar Drying Chambers: Managing secondary clarifier sludge (Mixed Liquor Suspended Solids - MLSS) is a challenge for paper mills. To address this, SPB installed a solar sludge drying system (Figs 4 and 5).

Operational Data:

- Capacity: The system covers 2000 square feet and operates at temperatures between 34°C and 50°C.
- Efficiency: In a standard cycle, six tonnes of MLSS are dried over six days, reducing moisture content from roughly 85% to 30% (increasing solids from 15% to 70%).
- Volume Reduction: During the initial period, the system processed 123.92 tonnes of sludge down to just 21.5 tonnes of dried material.

Utilization:

The dried MLSS is a free-flowing granulate with a calorific value of 3260 to 3460 kJ/kg. It is subsequently used as biomass fuel in the power boiler. While the current system handles 20% of the requirement, capacity augmentation via additional solar dryers or flue gas drying is planned.

Figure 4. Solar sludge drying system

Figure 5. Solar sludge drying system

6. Conclusions

Seshasayee Paper and Boards Ltd. demonstrate that "renewable energy" in manufacturing is not limited to installing solar panels or wind turbines. By conceptually treating the paper mill as a biorefinery, SPB extracts value from every stage of the organic lifecycle. These models prove that with strategic foresight, the Indian paper sector can effectively decouple industrial growth from carbon-intensive resource consumption. Our endless efforts will continue for the years to come.