



# Sustainable renewable energy solutions in Integrated Pulp & Paper Industry (Big Concern)



**Anuj Kumar Tayal\***  
 President, (Technical)



**S.S. Hiremath\***  
 G.M ( Power Plant)



**B.N. Patil\***  
 Asst. General manager(Power Plant)



**Sham Patil \***  
 Asst. General Manager.( Energy Cell)

\*West Coast Paper Mill Limited  
 Dandeli

**Abstract:** This paper addresses sustainability of Renewable Energy source in paper industries, through maximizing/enhancing usage of in house available renewable energy sources like Black liquor solids, chipper dust, wood bark & ETP sludge etc.

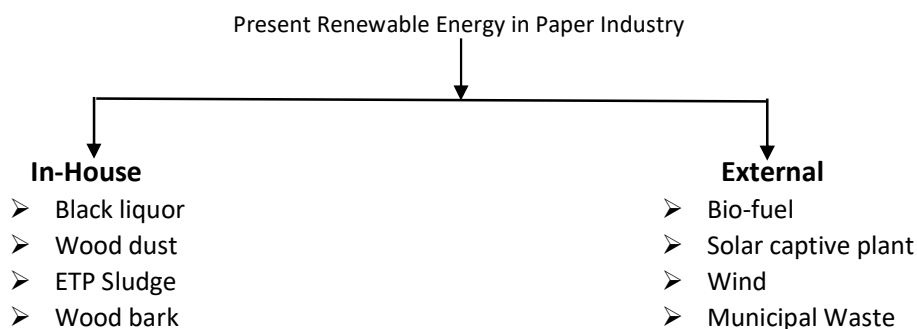
Reducing fossil fuel for generating electricity produced through condensing mode by complementary adoption of Solar and Wind energy, coupled with Advanced Cogeneration Systems, strengthens Energy diversification and resilience.

Integrated Pulp & Paper Industries is having  $58 \pm 2\%$  renewable energy with raw materials as Mixed Hard Wood and now requirement of hour is for "Better utilization of these Renewable energy"

**Keywords:** Sustainability, Optimization, Better utilization, Renewable energy

## Maximizing Renewable Energy in Pulp and Paper Industry.

The pulp and paper industry is undergoing a critical transformation as it seeks sustainable solutions to meet rising energy demands and reduce environmental impacts. Bioenergy, derived from renewable bio-resources offers a viable pathway to achieve both energy security and carbon reduction



This paper explores key bioenergy pathways relevant to the paper sector, including biomass combustion, waste heat utilisation from renewable sources, wood dust utilisation, bio-fuel and solar captive plant.

## D) Black Liquor Utilisation.

### 1. Increasing Cycle efficiency.

In present scenario most of Integrated Pulp and Paper industries are using around  $58\% \pm 2\%$  renewable energy generated in Chemical recovery boiler by burning black liquor solid.

Thermal efficiency of these boilers on lower side, say about 65 %.Most of Chemical recovery boilers are operating at 40 kg/cm<sup>2</sup> or at most 65 kg/cm<sup>2</sup>. There is potential to increase utilization of this renewable energy by replacing boilers with High pressure steam boilers. With this there will be increase in power generation by about 10 to 12 % (Refer table 1) with same quantity of renewable source of energy.

Table 1 Enhancement of boiler working pressure benefits

Sl. No.	Description	Up gradation	Increase in power generation
1	Increasing Boiler pressure	From 40kg/cm <sup>2</sup> to 63 kg/cm <sup>2</sup>	10 %
2	Increasing Boiler pressure	From 40 kg/cm <sup>2</sup> to 83 kg/cm <sup>2</sup>	35 %
3	Increasing Boiler pressure	From 63 kg/cm <sup>2</sup> to 83 kg/cm <sup>2</sup>	27 %

In West Coast Paper, One recovery Boiler is operating at 40 kg/cm<sup>2</sup> and other at 63 kg/cm<sup>2</sup>

West coast Paper Mill is also planning to go for high pressure recovery boiler in near future.

## 2. Increasing Boiler Efficiency [2]

In chemical recovery Boilers Black liquor needs to be preheated for better combustion. In some chemical recovery boilers direct heating of black liquor is being used. In this case there are two types of losses.

- Steam condensate mixed with black liquor increasing moisture in fuel. This will lead to efficiency loss.
- Condensate recovery is lost.

In order to increase boiler efficiency and also recover condensate recovery it is advisable to go for indirect black liquor heater (fig 1).

At WCPM at ENMAS chemical recovery boiler direct heating of Black liquor is replaced by indirect heater in 2025.

There is increase in steam generation by about 10 Tons' per day and increase in condensate recovery by about 25 MT /day (Fig. 2)

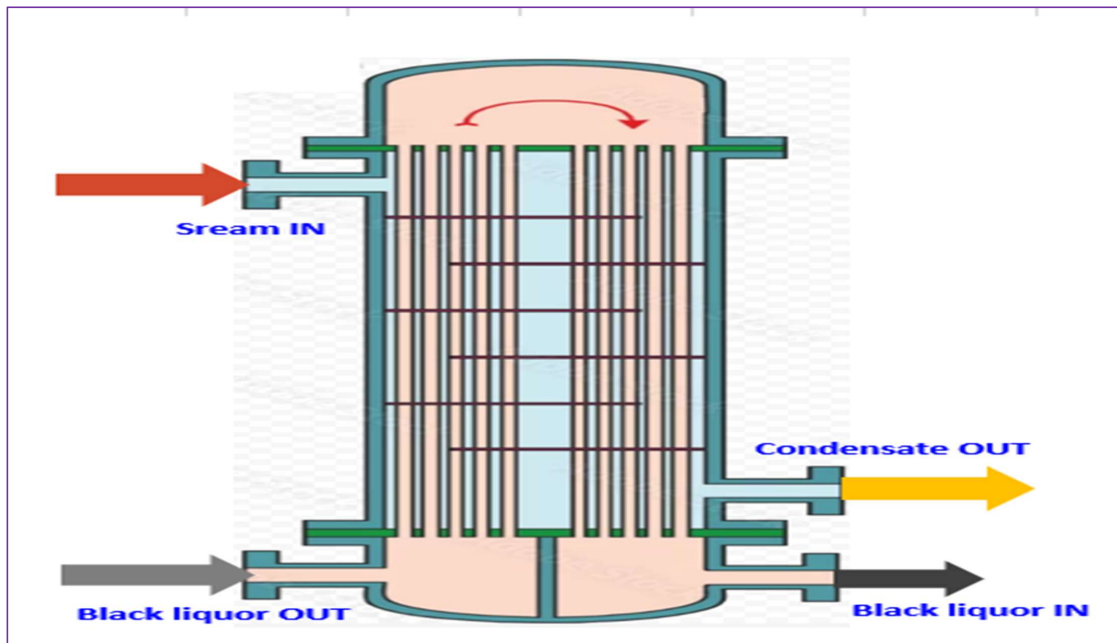


Fig. 1 Indirect heat exchanger

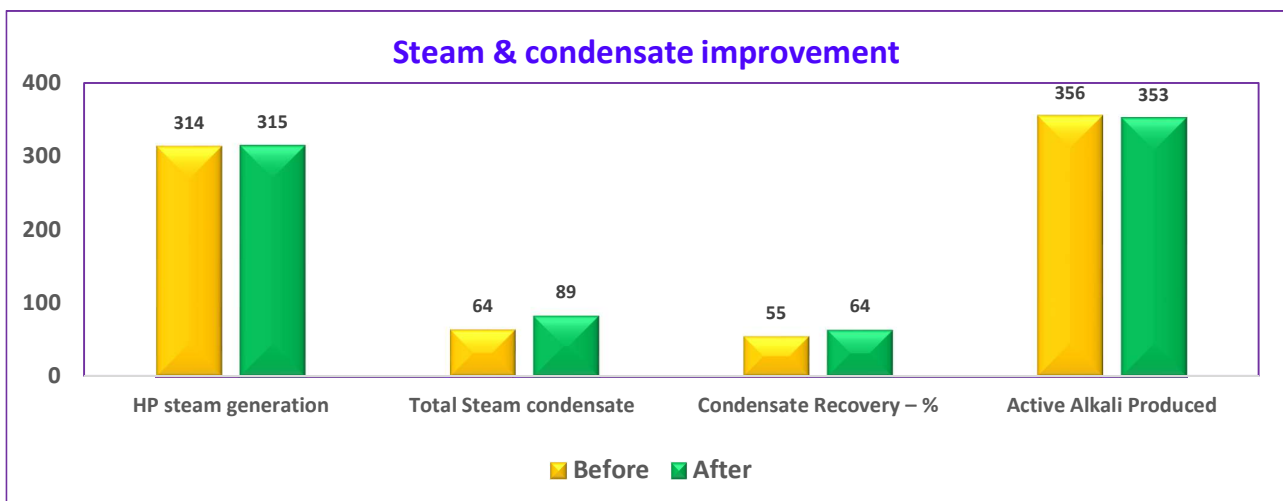


Fig. 2 Steam & condensate

## 3 Recovery of waste heat from Renewable source of energy.

In Chemical recovery Boilers black liquor is fired in boiler and Hot Chemical liquid so generated for recovery of caustic is collected in dissolving tank for further process of recovery of caustic. In Main Dissolving tank hot fumes along with some part of hot vapors are vented out at about more than 100°C. There is potential to recover this waste heat (fig 3).

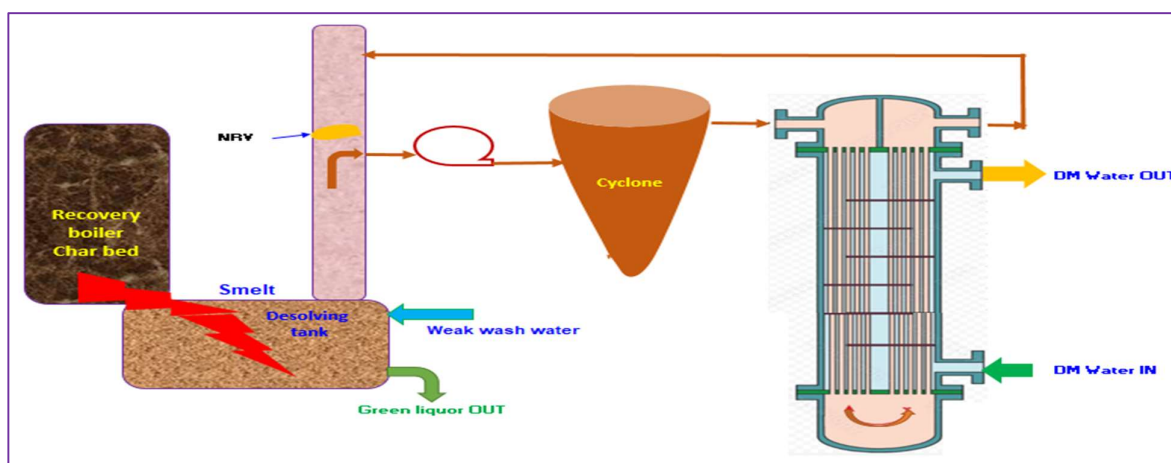


Fig. 3 Waste heat recovery

In WCPM Heat exchange installed in ENMAS Boiler Chemical Recovery Boiler for heating D.M water. About 100 MT ton of L.P steam is saved in de-aeration tank. DM water temperature is raised from 30°C to 62°C and 90 to 120 MT of D.M water is being heated up.

Steam Savings Based on heat recovered from MDT vent to DM Water (table 2)

Table 2 MDT vent heat exchanger parameters

Sl. No	Description	Quantity & Unit
1	Average quantity of DM water passed through Heat exchanger	2200 M <sup>3</sup> /Day
2	Average DM Water inlet Temperature	30 °C
3	Average DM Water inlet Temperature	62 °C
4	Heat gained by DM water	70.40 Mkcal / Day
5	Equivalent L.P steam reduced in De-aerator	103 MT / day

Table 3 MDT vent heat exchanger performance

Sl. No.	Description	UOM	Before	After
1	Total H.P Steam	MT/Day	8057	7823
2	Boiler Feed water Flow	MT/Day	8135	7936
3	DM water Flow	MT/Day	2897	3003
4	Condensate return from Process	MT/Day	4861	4709
5	L.P steam to De-aerator	MT/Day	801	680
6	% of H.P Steam	%	9.94	8.69

Net equivalent L.P. Steam Saving = 96 MT

#### 4 Optimising Fuel Quality (Black liquor) in Recovery Boilers [1] (Fig. 4)

Quality of Black liquor especially, solids % plays vital role is deriving boiler performance.

In olden boilers, black liquor firing was being done in the range of 60 %– 65 %. Due to this low solids the following problems were faced.

- ★ High water content → poor combustion stability.
- ★ Flame temperature drops, leading to incomplete burning.
- ★ Higher carryover of unburnt carbon and more fouling.
- ★ Reduced steam generation efficiency.

The benefits of increasing the dry solid content of black liquor fired in a recovery boiler up to 70- 75 % are obvious. The lower water content of fuel increase thermal efficiency and improved, more stable combustion conditions can be expected to lead to better burn out, less plugging of the heat transfer surfaces, higher reduction and reduced emissions.

In order to avoid the above problems and to improve boiler efficiency solids in black is to be increased and min 70 to 72 % solid firing is advantage in present designed boilers.

Advantages of Black liquor firing at higher % Solid firing.

- ★ Preferred range in modern recovery boilers.
- ★ Higher calorific value → better combustion and higher steam output. For every 5 % rise in Solids, there will increase in 1% increase in steam generation.
- ★ Reduced flue gas volume → lower load on air systems and ESP.
- ★ Improves reduction efficiency of sodium sulphate to sodium sulphide.
- ★ Less carryover and deposition.

Steam generation of 3.2±2 MT per MT of Black liquor is expected in such Boilers depending on steam pressure of pressure.

In WCPM, both Chemical recovery boiler black liquor firing is carried out with 70% -72% solid concentration.

For further increasing in solid firing beyond 75% requires technology up gradation. It may be possible in near future. The expected concerns such as over the potential for increased evaporator fouling , difficulties in handling the high dry solids liquor , more fuming and carry over and perceived risk of increased furnace NOX generation may be faced, if increased beyond 75% and are to be addressed for going beyond 75% solid firing.

Residual alkali in black liquor also plays significant role. In pulping process, mixed raw material is used & hence white liquor used in process changes, which in return affect the performance of Boiler

Higher the residual alkali, less steam generation. Hence in order to get higher steam consumption, raw material mix is also required to be optimized and coordination is required.

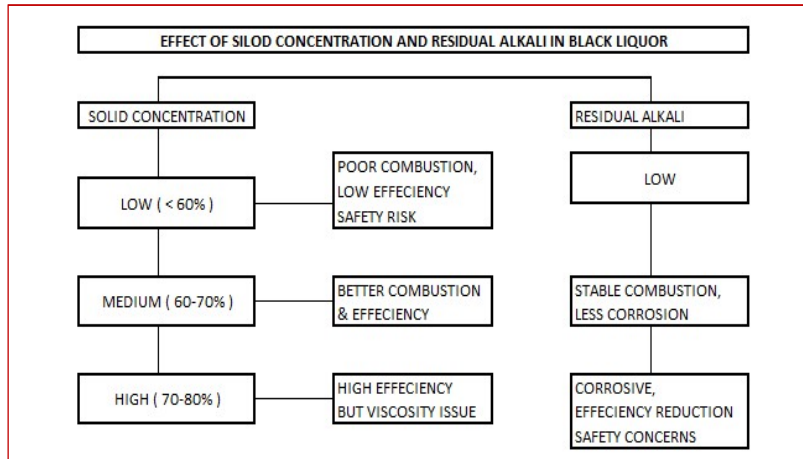


Fig. 4 Effect of slid concentration & residual alkali

**II) Maximizing energy generation form Renewable steam extracted from Steam turbine for process use.**

In cogeneration plants normally steam at lower pressure are extracted from Turbine for process use. Different process in plants requires different pressure and temperature, whereas, normally process steam is extracted from turbine at max two set pressures.

When this extracted steam from turbine is used in process with lower than extracted pressure then there is potential to generate electrical energy using Micro steam turbine.

In WCPM process steam is extracted at two stages one at 11 kg/cm2 and other at 3.8 kg/cm2.

In de-aerators for raising feed water temperature to 1350 C, Steam pressure required is only 2.2 kg/cm2 maximum. For this L.P steam at 3.8 kg/cm2 extracted from 34.5 MW turbine is used.

WCPM recognized this area for installing micro steam turbine and installed 350 kW micro steam turbine (Fig. 5) from NCON Turbo Tech Pvt. Ltd Bengaluru.

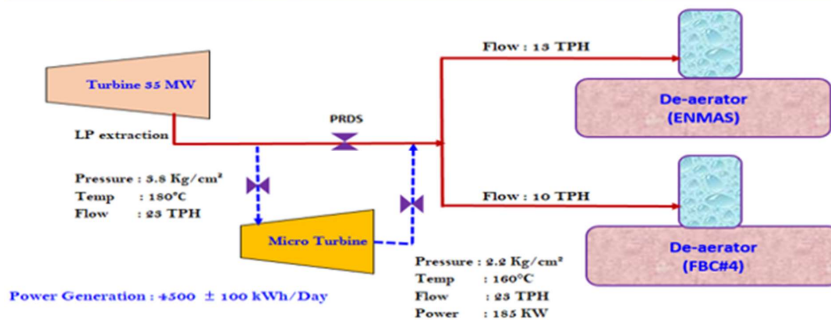


Fig. 5 Micro turbine

Increase in Power generation about 4250 kWh/day (table 4) from same quantity of Renewable source there by Reduction in fossil fuel consumption.

**Table 4** Micro turbine generation report

Date	Power Generation (kWh)				Steam consumption (MT)			
	A	B	C	Total	A	B	C	Total
13.01.26	1427	1492	1414	4333	172	164	168	504
14.01.26	1435	1460	1370	4265	168	168	168	504
15.01.26	1493	1369	1400	4262	176	160	168	504

Accordingly equivalent fossil fuel (Coal) consumption reduced by 2450 MT/Year

**III) Wood dust**

Why to use wood dust? (fig. 6)

**Utilization of Wood Dust: [3]**

In most of Pulp and paper Industries Wood dust of about 3 to 4 % of wood is generated in wood chippers, along with minor quantity of Wood bark

This wood dust can be used in Coal fired AFBC and CFBC boilers.

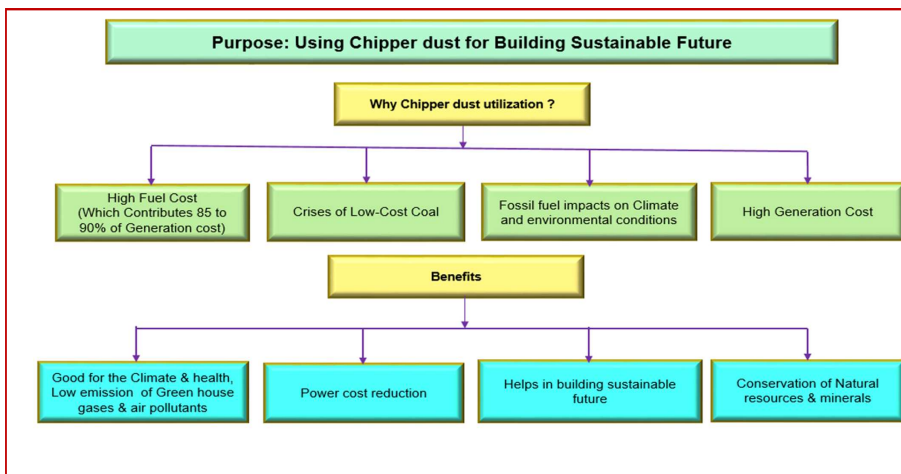
Moisture associated with Wood dust plays vital role & it is necessary to control moisture in wood dust before feed to boiler. Up to 12 % to 15 % wood dust can be mixed with coal without major changes in present AFBC coal fired boilers.

In WCPM, about 90 to 100 MT wood dust is mixed with coal at inlet of coal crushing plant itself for better mixing and Wood dust is pre exposed to sunlight so as to reduce moisture in

wood dust with naturally. WCPM observed that, wood dust moisture reduced from 40% to 20% with this natural exposure to sun light during winter and summer season.

WCPM is on also exploring ways to reduce moisture from Wood dust in monsoon season. Wood dust is stored in covered sheds during Monsoon to avoid exposure to rain.

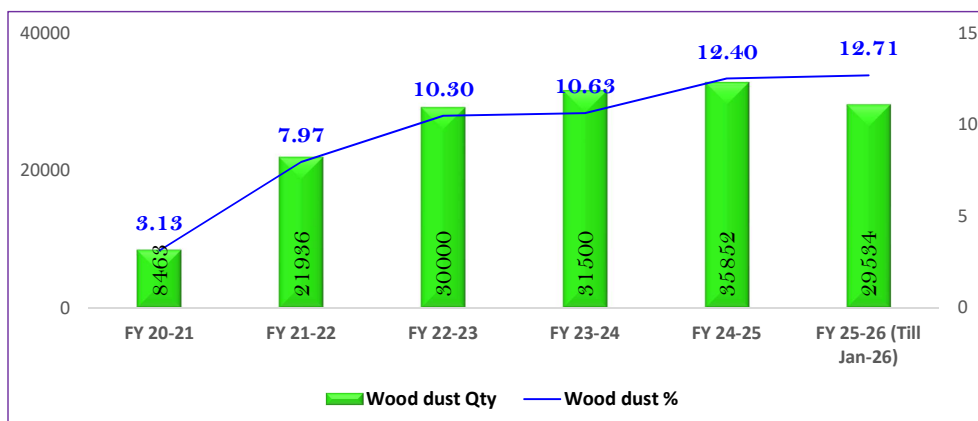
WCPM is on the way to increase % of Wood dust firing to possible extent and is maintained consistence from last 3 years. (table 5 & Fig. 7)



**Fig. 6** Glance on wood dust utilization

**Table 5** Wood dust consumption report [3]

Sl. No.	Year	Wood Dust quantity ( MT )	% of Total fuel	Reduction of fossil fuel (MT)
1	2020-21	8463	3.13%	6347
2	2021-22	21936	7.97%	16452
3	2022-23	30000	10.30%	21875
4	2023-24	31500	10.63%	23695
5	2024-25	35852	12.40%	24585
6	2025-26 (Up to Jan 26)	29534	12.71%	22150



**Fig. 7** Wood dust %

**Table 6** Probable challenges and action to be taken

Challenges in using Chipper dust	Action to be taken
Selection of suitable agro waste and non-hazardous Alternative fuel (AF)	Chemical composition to be checked on periodic basis through analysis of fuel to check the permissible limit to avoid any reliability issue in the boiler
Storage and safe handling of AF (i.e. mixing, shifting & feeding to boiler)	Explore new storage area for the chipper dust storage and blending
Unloading of AFR in storage location to comply safety	Maximized Utilization of Hydraulic tipper for unloading to avoid human intervention
CHP throughput reduced due to low bulk density chipper dust with Coal Mix	Additional belt with hopper system to be made for direct feeding to secondary screen out let belt.
Jamming of chipper dust material in Coal handling system	Proper mixing of chipper dust to be take care
Dust emission during the Agro Paste feeding/unloading of carbon black powder in bunker	Check of bag filter performance and start the mist system in transfer tower and feeding points to control the fugitive dust emission
Increasing of LOI in fly ash due to the Low bulk density chipper dust	Tune the optimax (APC) in accordance to fuel variation and air flow to optimize the LOI and critical parameter
Chances of Fire due to high volatile chipper dust accumulation	Implement daily check list to avoid gaps and ensure cleanliness of the system

**3) Proper Mixing of Bio Mass with Coal:**

Proper Mixing of bio mass i.e. wood dust with coal is very important. Otherwise may lead to non-uniform heat in furnace and will have consequence affects.

WCPM adopted mixing of wood dust and coal before crushing to the size so , during crushing affect mixing of wood dust with coal will also takes place and working satisfactorily (fig. 8).



**Fig 8** Wood dust blending

#### IV) Use of Bio-fuel

Rotary Lime kiln is major energy consuming equipment in Pulp and paper sector (Furnace oil). Bio oil from biomass pyrolysis can be used as a renewable substitute for fossil fuels in rotary lime kilns, offering cost savings, lower carbon emissions, and waste utilisation. However, its high oxygen content, acidity, and variability require blending, pre treatment, and burner modifications to ensure stable combustion.

Bio oil from biomass pyrolysis is a promising renewable fuel for rotary lime kilns, especially in regions like India where biomass is abundant. To maximize benefits, plants often adopt a hybrid approach—blending bio oil with furnace oil or natural gas, upgrading bio oil for stability, and installing emission controls. This strategy balances economic savings, sustainability, and operational reliability.

##### Benefits of Using Bio oil in Rotary Lime Kilns

- Renewable fuel source: Bio oil is derived from biomass pyrolysis, making it carbon neutral compared to furnace oil or coal.
- Lower greenhouse gas emissions: Substituting fossil fuels with bio oil reduces CO<sub>2</sub> and SO<sub>2</sub> emissions, supporting sustainability goals.
- Waste utilization: Converts agricultural residues, forestry waste, or municipal biomass into usable energy, reducing disposal problems.
- Comparable energy potential: Bio oil has a calorific value of 3500-4500 kcal /kg, sufficient for lime calcination when blended or upgraded.
- Circular economy contribution: Rotary pyrolysis kilns enable continuous processing of biomass, integrating waste to fuel pathways

##### WCPM is in process of Using Cashew Nut shell Liquid Bio-fuel (MV CNSL)

In touch with CASHITRON RESINS PVT. LTD Ankola, discussion are under progress.

This Bio fuel can also be used in Chemical recovery boiler for increasing boiler capacity as calorific value is equivalent to Furnace oil

#### V) Utilization of Wind and Solar Energy.

Pulp and Paper industry using Cogeneration is generating power for its self-use. Still to meet full electrical need it is required to generate power is condensing mode for fossil fuel. This is about 20 to 25 % of total electric energy consumed is by condensing power & may vary from plant to plant. This condensing power can be met through Hybrid solar / Wind captive power plants. In this way Paper industry can move towards Carbon neutral.

WCPM is planning to go for 5 to 7 MW Captive solar Captive plant is near future.

#### Results

1. There is scope of waste heat recovery from Main dissolving Tank at Chemical recovery Boiler
2. Wood dust is the best option for increasing Renewable energy %.
3. Use of Micro Turbine in place of Pressure reducing station saves Fossil fuel.

#### Conclusions

The use of wood dust biofuel in paper industry power plants represents a technically viable, environmentally responsible, and economically attractive energy solution. By effectively utilizing biomass residues, paper mills can reduce fossil fuel dependence, lower greenhouse gas emissions, and enhance overall energy efficiency. With appropriate fuel handling systems and modern combustion technologies, wood dust biofuel plays a crucial role in enabling a more sustainable and competitive paper manufacturing industry.

Increasing Solid concentration and control of Residual alkali is the need of present requirement in Paper industry. Whenever industries are going for capacity expansion boilers working pressure to be optimized for getting benefit of cycle efficiency and reducing dependency on fossil fuel.

#### Path forward

- ★ Planning to go for 63 kg/cm<sup>2</sup> of chemical recovery boiler
- ★ Planning to go for 105 kg/cm<sup>2</sup> of CFBC coal fired boiler with full utilization
- ★ Under study of how to utilize all solid waste into energy form.
- ★ Exploring installing of micro steam turbine in different sections.

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