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EMISSION INTENSITY REDUCTION THROUGH ENHANCED RECOVERY COGEN PERFORMANCE AND IMPLEMENTATION OF ADVANCED ENERGY EFFICIENT SCHEMES IN SESHASAYEE PAPER

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Abstract

In Seshasayee Paper Erode plant, through increased firing and efficient energy conversion of Black liquor solids in High Pressure Recovery Cogeneration unit, green power and steam to process had been enhanced to a significant extent. Station power consumption reduction through implementation of state of the art energy efficient schemes had resulted in net green power enhancement.

Besides the above, the cycle efficiency of CPP encompassing coal fired high pressure boiler and the 21 MW double extraction condensing steam turbo-generator had been significantly increased through implementation of Clean energy schemes viz., High calorific lower moisture coal with low C/H ratio, energy efficient BFP, Modified boiler (Bubbling to Spouted) with rated steam generation and high thermal efficiency etc.

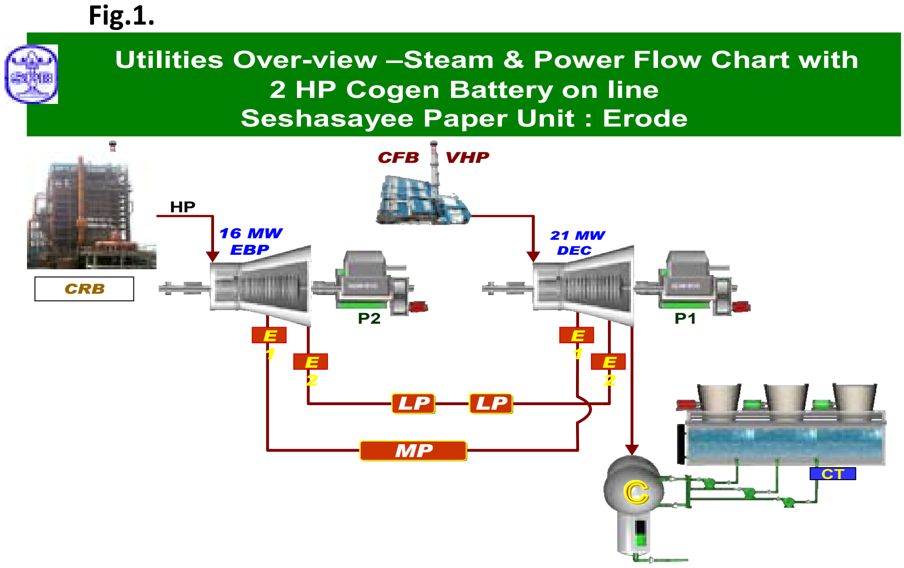
All of the above had resulting in emission intensity reduction of a high order. The paper highlights with detailed illustration of the energy efficient schemes implemented along with Carbon footprint reduction results. Emission intensity defined as the ratio of total GHG emission within the plant premises to Paper and Market pulp production. Emission intensity reduction following Science Based Target achieved had been around 5 % /annum over the last 3 years.

To cap it all, Environment ambient quality had been improved in terms of lowered stack emissions with continuous usage of the imported envirocoal as it is low in ash (3to 4 %) and sulphur (0.1-0.4%) content . Specific Abiotic depletion reduction of fossil fuel is ensured.

1.0 INTRODUCTION

Advanced Energy efficient Best practices implemented in Coal fired HP cogeneration plant had realized high level of reduction in fossil energy intensity. Alongside, Green energy for the process could be enhanced through increased firing of Carbon Neutral Black liquor solids [BLS] in Chemical Recovery Cogen Boiler. [Fig. 1] These are detailed in the following section preceded by brief about the 2 HP Cogen units[Table -1]. To cap it all, implementation of energy conservation schemes millwide had ensured lowering energy intensity further.

Fig.1.



2.0 Boiler 10–Conversion of Bubbling bed to Spouted bed Combustor with increased heating surface

Since the furnace foot print (area) is limited restricting the bed coil area, which had resulted in limiting Boiler 10 (Mitsui-Babcock design) high pressure boiler steam generation to 85 TPH (max), it was decided to explore other options for enhancing steam generation keeping in view of the constraints.

The best option chosen and succeeded to a large extent is by going in for Spouted bed combustor design (design, engineered and supplied by M/s Enmas) with increased bed coil depth and add-on heat transfer surface relating to enhanced volumetric heat absorption in bed. Refer Fig.2 for comparative study of the design of the 2 combustors.

The enhanced bed volume with high fluidized bed heat transfer coefficient ensured increased steam generation from the modified boiler. Because of increased bed heat absorption due to higher bed volume available, bed temperature is limited to 920°C even at rated steam load of 110TPH. In addition to the above is water wall heat absorption resulting in lowered furnace exit flue gas temperature. This had necessitated the addition of 1 set of newly designed vertical superheater coils being accommodated in the existing open space between PSH 1B and PSH 1C sections (Refer Fig.3).

Main steam outlet temperature could now be effortlessly maintained at the rated 510ºC (compared to earlier figure of 490 ºC) at all operating loads. The boiler, after modification , was put on service during end April 2015.

PA fan conveying fuel and air , though envisaged in the original design and operated during initial phases of revamped boiler operation, was stopped since last June 2015. The attendant power saving of ~ 2000 units/day on a continuous basis since July last year is an additional

Table-1

SPECIFICATIONS OF THE 2 HP COGEN UNITS

CPP		Chemical Recovery Cogen
Boiler #10	Parameter	Boiler #11
AFBC Boiler	Type	Chemical Recovery Boiler
117 TPH ECR : 106 TPH	Rated Steam Evaporation	95TPH(Phase1*) 140TPH(Phase2)
106 kg/cm²	SOP	65 kg/cm²
510˚C	SOT	465˚C
135˚C	Feed inlet temperature	135˚C
Imported coal	Fuel	Black liquor @ 70% solids concn.
21 MW- DEC	STG	*16 MW- EBP*
10.5/4.0 kg/cm²	E1/E2	10.5/4.5 kg/cm²
0.09 ata	Condensing	--
20.4 MW	Rated Capacity	11 MW(Phase1*) / 16 MW(Phase2)

Fig. 2

Conversion of Bubbling to Spouted AFBC Boiler with increased bed heating surface area for enhanced and efficient Steam & Power generation

Description: In Spouted bed combustion the fuel is discharged through nozzles above the bed coils where the fuel is evenly spread over the entire cross section of furnace.

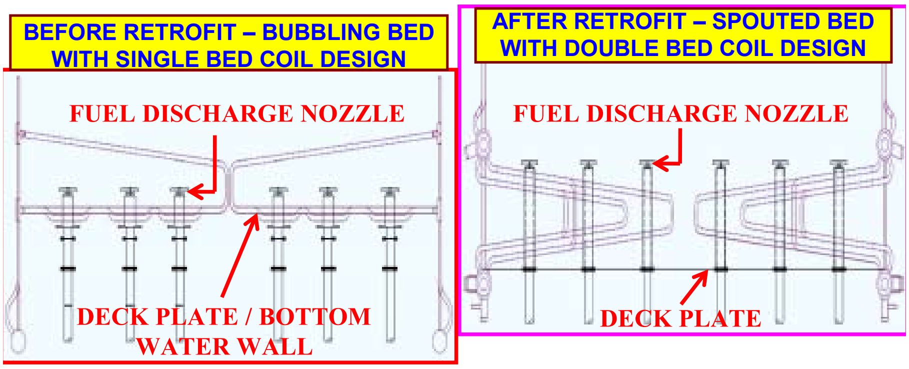
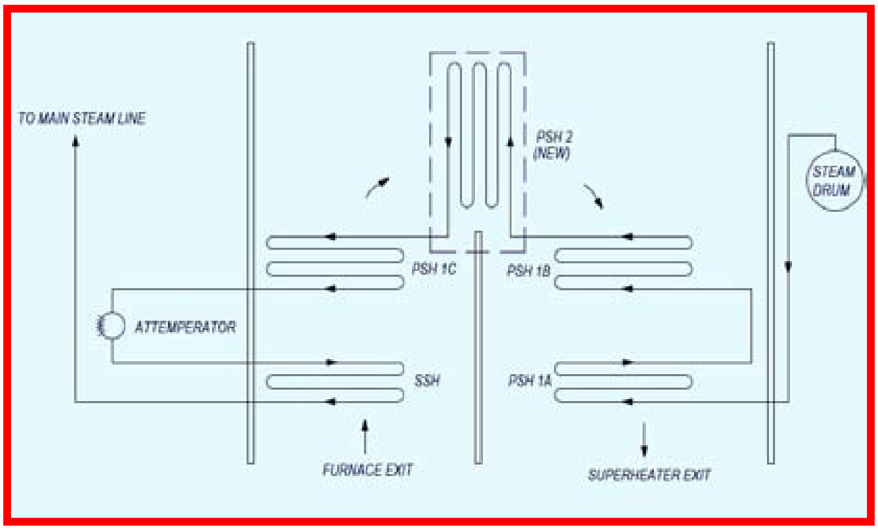


Fig.3. Disposition of the Superheater Banks in Modified Boiler



feature of the spouted bed combustion boiler design.

2.1. Quantum increase in Performance efficacy of 21 MW STG

Enhanced steam generation at Rated main steam pressure [105 bar] and temperature [510ºC] had resulted in cascading gains -realized through the 21MW Double Extraction Condensing Steam turbo-generator –which are of a very high order. Increased steam load to the steam turbine and with increased extraction steam loads , the extraction heat rates had improved considerably. Added to all of the above, the exhaust steam for Condensation had also gone up considerably (catering to export power) further enhancing cycle efficiency (with attractive heat rate). Since the steam turbo-generator had been operating at a higher load factor (0ver 90 % as against 65% earlier) with high Power factor as before , the generator efficiency had gone up by further 0.2 to 0.3 % .

2.2 Consolidated Outcome / Gains achieved by Project Implementation

- Increase in Steam generation from Boiler 10 by ~ 25% [85 to 105 TPH]
- Running of Boilers 6 & 7 (inefficient) had been greatly reduced and that also with lower steam generation as and when required/ in need. Specific coal consumption (related to steam and power for process) could be greatly reduced because of the higher thermal efficiency (82 to 84%) of modified boiler (# 10) with improved net heat rate as compared to lower efficiency (4 to 5 per cent points lower) of inefficient medium pressure boilers (# 6 & #7).
- Power generation from 21 MW STG is maximized [13MW to 19 MW], aiding in excess power [10 Million units] available for export to grid on a sustained basis. Over and above, additional Power was available to process to the tune of 15 million units.
- Total Station Power consumption of Coal fired block had been reduced by ~15%, thus further enhancing Net Power availability for Process use.
- Grid Power drawl had been drastically reduced by 10 million units over the year.
- Excess Power generated from CPP is being exported to the grid to the tune of around 3 MW on a sustained basis.

2.3 High grade climate and enviro-friendly imported coal

Imported coal used in the Coal fired Power Boiler is:

- Enviro-friendly : due to low ash & sulphur content present. &
- Climate –friendly : Lower C/H ratio & higher GCV value; as can be seen from the detailed analysis (Table – 2).

Table -2 : Imported Coal Elemental Analysis

Parameter	Units	2015	2016
C	%	52.9	51.7
H	%	4.05	4.3
S	%	0.4	0.1
N	%	0.9	0.8
O	%	17.7	19.95
Ash	%	3.9	2.5
Moisture	%	20.2	20.5
GCV	Kcal/kg	5473	5532

2.4 Carbon Emission Gains through energy efficiency gains:

Annual GHG Emission reduction through the implementation of the above scheme with sparse running of old inefficient medium pressure boilers had been around 40000tCO2 e.

3.0 Increased firing and efficient conversion of BLS in Chemical Recovery Cogen to Green steam and power

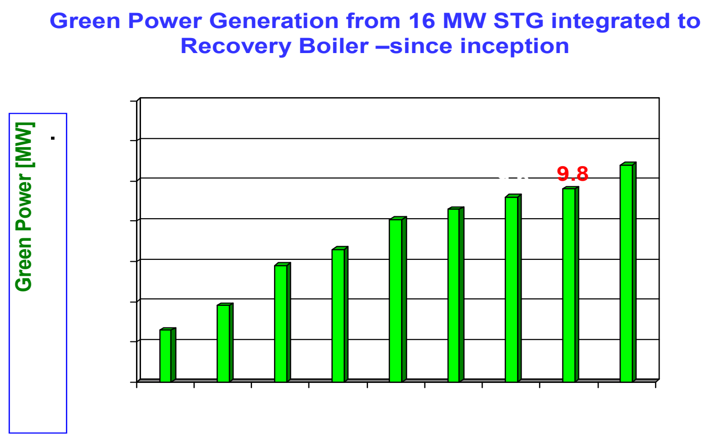
Green Energy (more specifically green power) generation could be enhanced on a sustained basis (Fig.4) , ever since the commissioning of HP Chemical Recovery Cogeneration unit through gradual increase in BLS firing and efficient energy conversion and implementation of energy conservation schemes in Chemical Recovery Complex.

Select Energy saving schemes successfully implemented in Recovery Cogen Complex are briefly elicited in the following section.

3.1 Maximizing Green Power generation in Recovery Cogen through:

- Minimal extraction and maximizing Exhaust LP flow in 16 MW STG
- Maximizing steam inlet temperature through operating the Recovery Boiler at high SOT(460 °C) and effecting reduction in steam temperature loss through highly effective advanced state of the art insulation of Main steam pipe-line

Fig.4



3.2. Energy Conservation Scheme in Recausticizing

- Reducing usage of fresh LP steam in hot water tank generation of 78°C hot water from Slaker scrubber (both Pre and Post)
- Savings Realized: 10 TPD of LP steam
- Implementation Date : 12 Nov 2015

GHGE Reduction : 300 tCO_2e [2015-16].

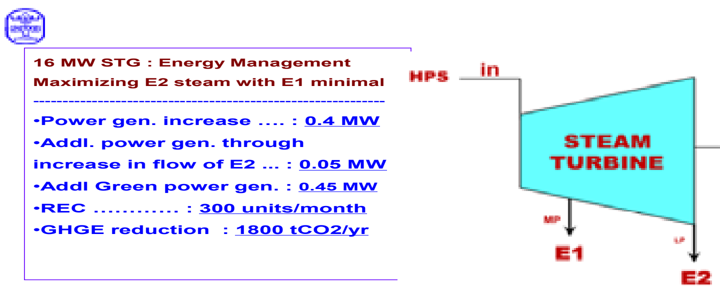
4.0 Specific Energy Consumption [SEC] /Energy Intensity[EI] reduction

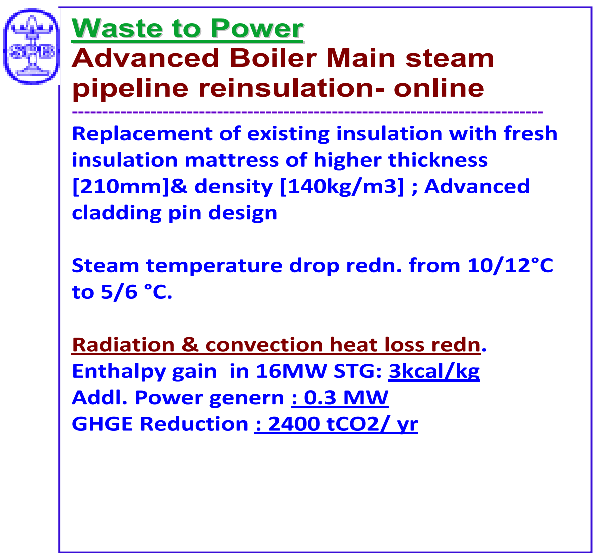
Specific Energy Consumption[SEC] for Industry sector is based on total input energy to final equivalent product leaving the plant. It is also referred to as Energy Intensity [EI].

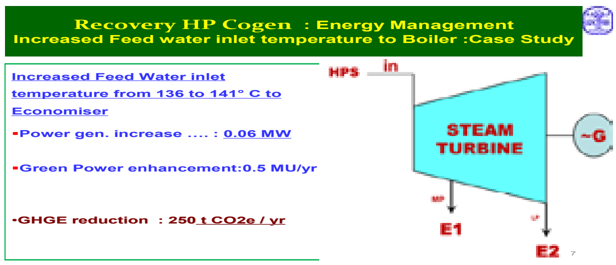
Energy Intensity is defined as ratio of total energy consumption (input available energy) to the final manufactured product quantity. It is being expressed in GJ/t (as it integrates both electrical as well as thermal energy components) . In SPB-Erode plant, production refers to finished paper and market pulp leaving the plant premises.

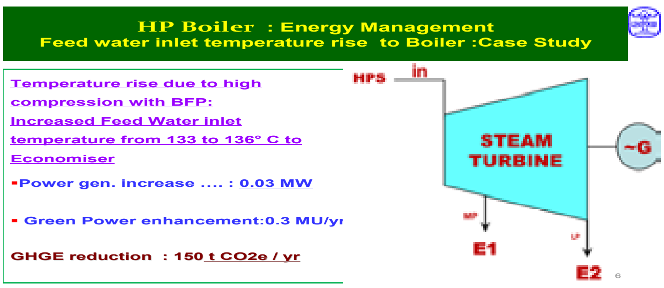
Total energy consumption encompasses both fossil as well as biomass components. Hence it is strongly recommended and is justified to split EI into two major components –one based on Fossil energy & the other based on Biomass energy consumption. Plants which have a mix of both fossil and biomass fired high pressure boilers (Cogen) for meeting the steam and power requirements of the process are highly energy intensive; more so in case of mills having Black liquor solids [BLS] fired Chemical Recovery boiler[CRB] alongside high efficiency coal fired boiler, as is the case with SPB.

As compared to coal fired boilers (with thermal efficiency on GCV of coal at 80 to 85 %), the thermal efficiency of BLS fired boilers (55 to 60%) is markedly lower .Compared to conventional biomass fired boilers (with efficiency around 70 to 72%), the thermal efficiency of CRB









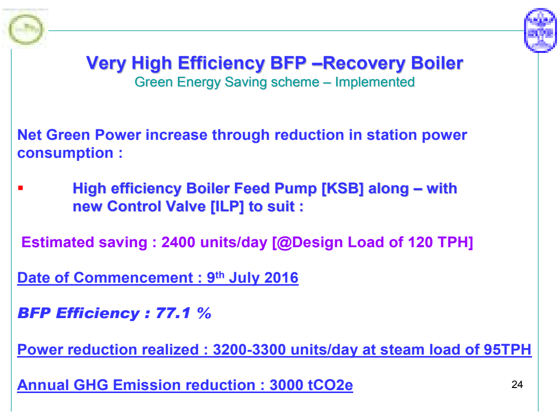
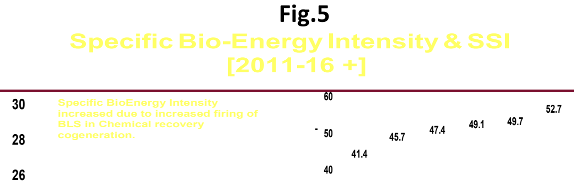


Fig.5



is much lower , because of the inherent characteristics of the combustion process (endothermic reaction , increased moisture and lowered GCV of the fuel). It is clear that for equivalent energy to be made available to the process, it would call for 50 to 55% increase in BLS energy input (and a low of 15 to 20% with conventional biofuels) as compared to fossil energy input.

In Paper & Pulp sector having Chemical Recovery complex , with emphasis on reducing fossil fuel intake with increased usage of BLS(Biomass), the input energy (in the absence of energy reduction schemes in place) is bound to go up because of the reasons stated above. This would result in increased input energy through increased usage of BLS-for same output energy. Hence EI is bound to up with increased BLS intake, resulting in pushing EI value up.

As the accent is on Emission intensity [EmI] reduction for Climate Change betterment, this can be achieved through lowered fossil energy input ; as the former is directly related to fossil energy intensity. It is to be noted that Biogenic emission is considered as Carbon neutral.

Energy Intensity reduction in SPB- Erode unit

As an illustration , the actual case study in Seshasayee Paper –Erode unit had been taken up to clearly bring out the impact of increased usage of BLS as input energy (Fig.5) both on total energy intensity as well as on fossil energy intensity (Table -3).

Specific Fossil energy reduction, which in turn directly relates to Emission intensity reduction, had been achieved through :

a) successful implementation of energy efficient schemes (utilities and process) and

b) increased and efficient conversion of BLS in Chemical Recovery Cogen to Green steam and power.

5.0 Emission Intensity Reduction

Select Energy efficient schemes contributing to GHG emission reduction are summarized in Table-4.

Through successful implementation of Energy efficient best practices mill-wide and through increased and efficient conversion of Black liquor solids (biofuel) in Chemical Recovery cogeneration unit, Emission intensity reduction had been of a high order (around 25% (tantamount to 5 to 6 % on annual average) as elicited in Fig.6.

Fig.5

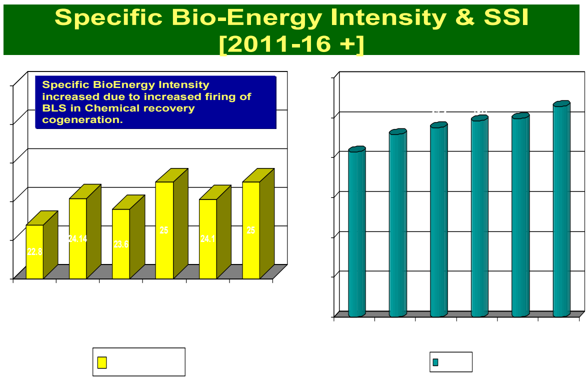


Table -3 : Energy Intensity [EI]-GJ/t reduction over the years [2011-16]

2011-12	2015-16	Reduction(-)/ Increase(+)
54.6	48.3	- 12 %
31.75	23.2	- 27 %
22.85	25.1	+ 9 %

Table -4

Projects implemented to achieve Emission reduction

S. No	Project title	Achieved Reduction in GHG emission eq. [tCO2e]
1	Boiler 10 Mod. from BFB to SFB for enhanced & efficient steam & Power gen. from 21 MW STG [incl. PA fan stoppage]	40000
2	Station Power redn. – Energy Efficient BFP with low DP Control Valve	2400
3	Energy Conservation schemes	4000
4	Chemical Recovery HP Cogen –Increased Green energy Generation	5000 [incl.BFP]
5	Limestone & Coal/FO reduction in RLK	500

Fig.7.

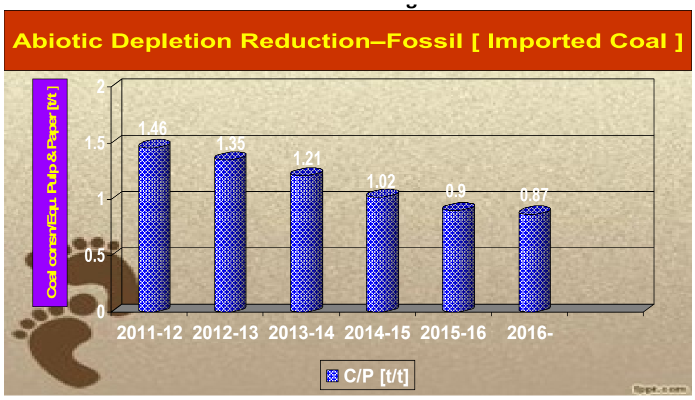


Fig.6

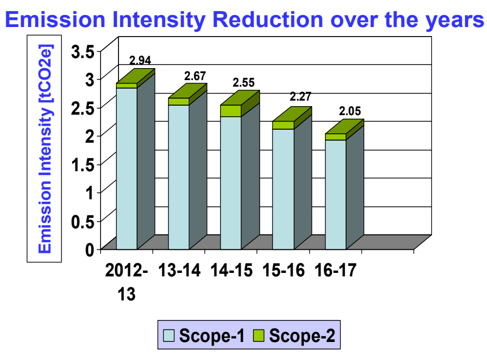


Fig.7.

Abiotic Depletion Reduction–Fossil [Imported Coal]

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5.1 Lowered N_2O Emission

As compared to coal fired boiler, N2O [a strong GHG gas with GWP of 310] emission is lower in the case of Chemical Recovery boiler, because of adoption of Vertical air multilevel admittance into the combustion chamber and high combustion temperature [1100 -1200°C]. With increased BLS usage displacing the fossil fuel in coal fired boiler to a limited extent, the integrated overall reduction in N2O emission is not a negligible entity. Emission intensity is further lowered.

5.2 Abiotic depletion reduction

Through continued specific coal consumption reduction related to productivity , abiotic depletion of fossil reserve is minimized as can be seen from Fig. 7.

6.0 Closure

In Energy intensive industries , carbon emissions are certainly of a high order. This is being offset with increased usage of Black liquor solids as fuel (being Carbon Neutral).

This apart, through adoption of Best Energy practices mill-wide , emission intensity is significantly lowered. In addition, with increased productivity, emission intensity reduction achieved had been of a high order. In all of the above areas, there would be sustained efforts for achieving continued reduction in emission intensity over the coming years.

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