

ENERGY TRANSITION – EFFICIENT ENERGY MIX - ACCELERATING DECARBONIZATION IN ORIENT PAPER MILL

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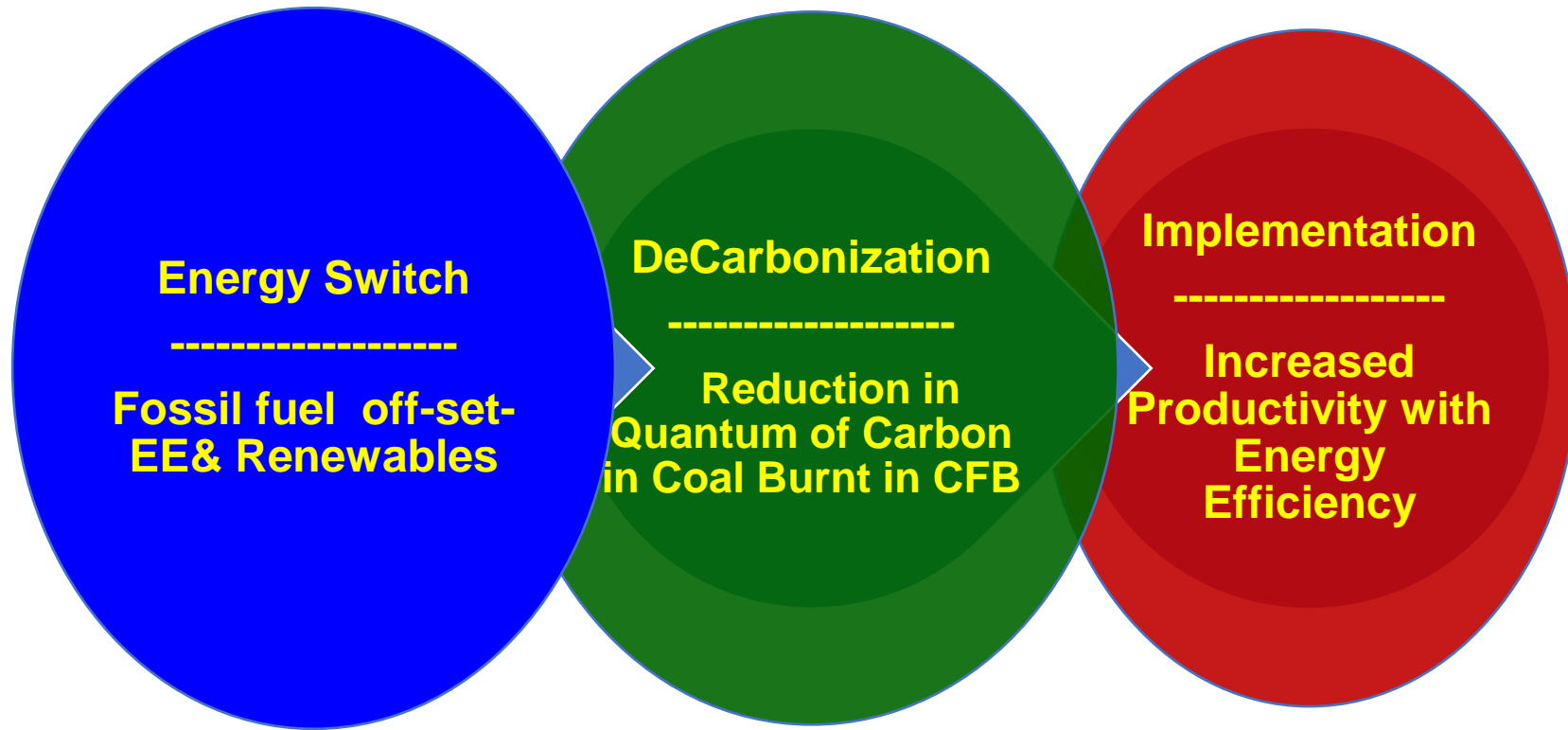
**CII Conference on Energy Efficiency in
Captive & Waste Heat Recovery Power Plants**

Hyderabad

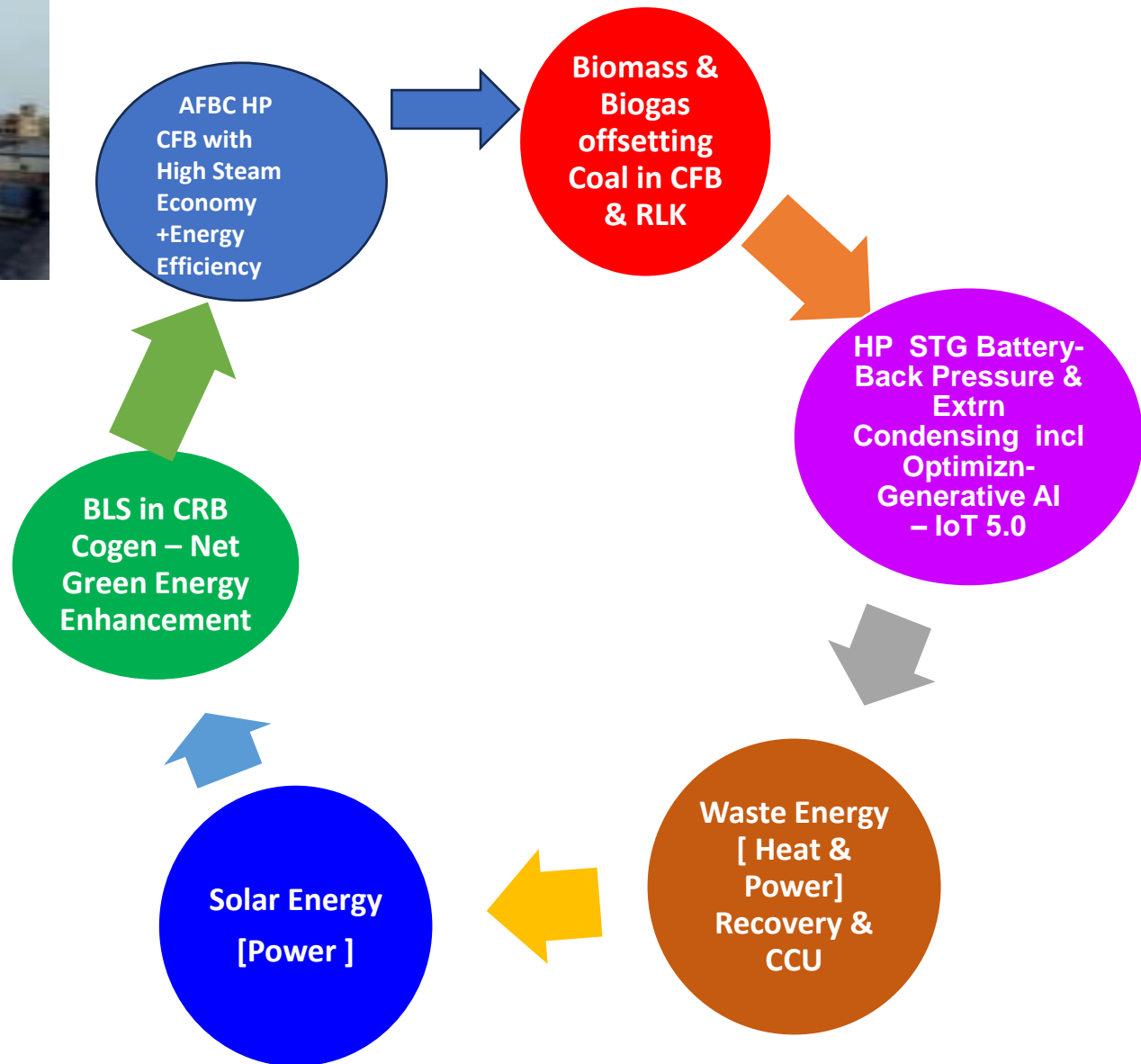
23rd May 2024

ENERGY TRANSITION STRATEGIES FOR ACCELERATING DECARBONIZATION

DeCarbonization Indicator : Reduction in amount of Carbon in Coal Burnt in CFB [Coal Off-set]



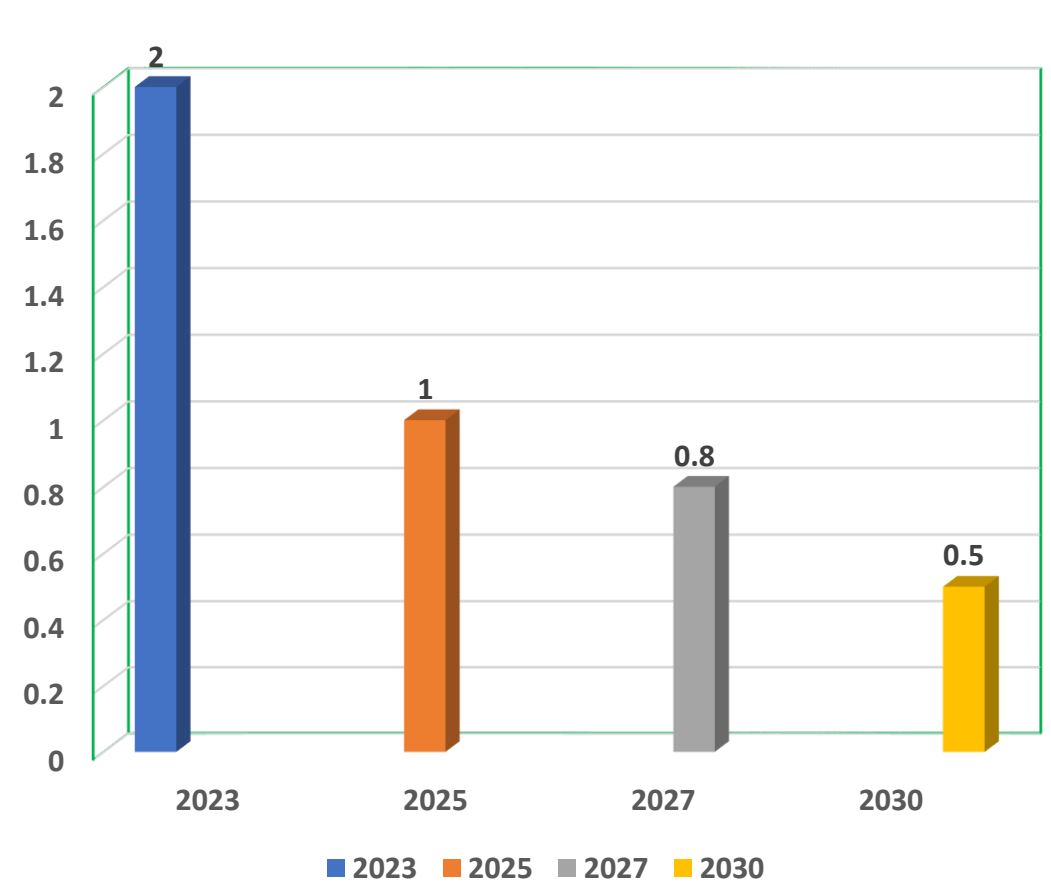
Orient Paper Mill -Amlai - ENERGY TRANSITION- Energy Efficiency Schemes – Implementation Mill-wide –March towards Net Zero Emission



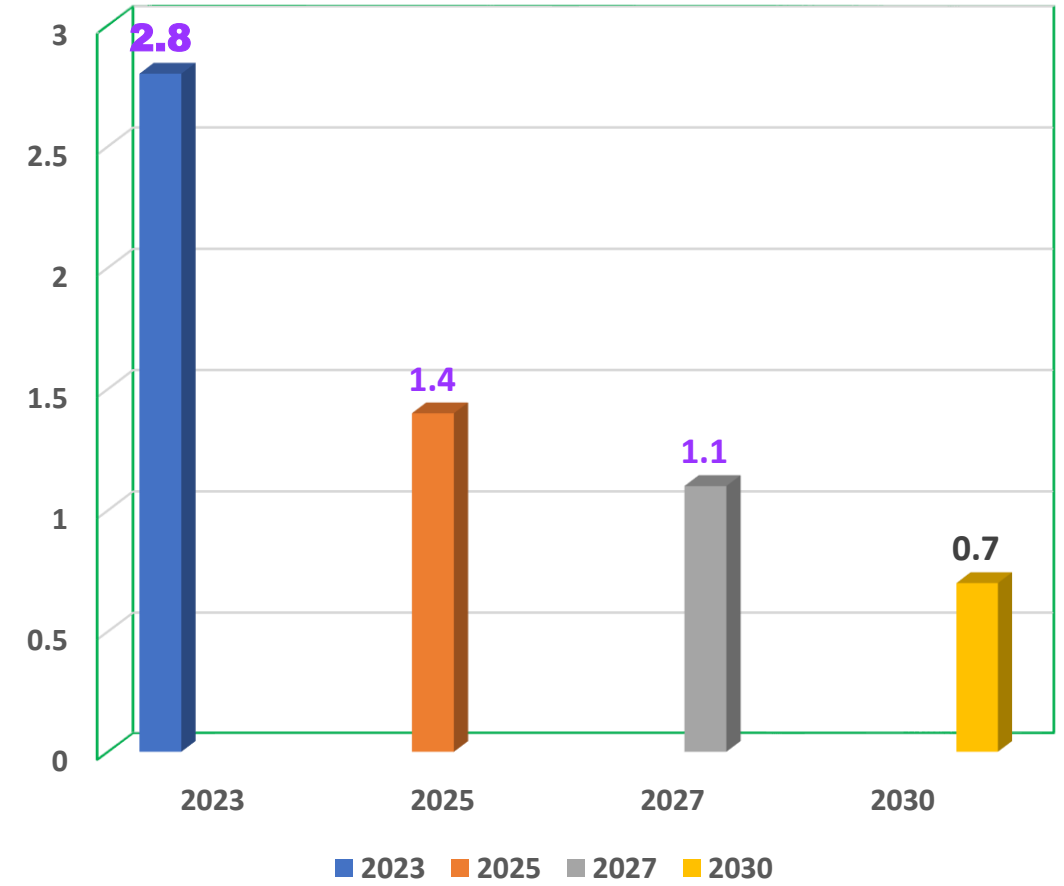
Path to Accelerated Decarbonization – Giant Strides -

OPM

Specific Coal Consumption [tCoal/ tPaper]

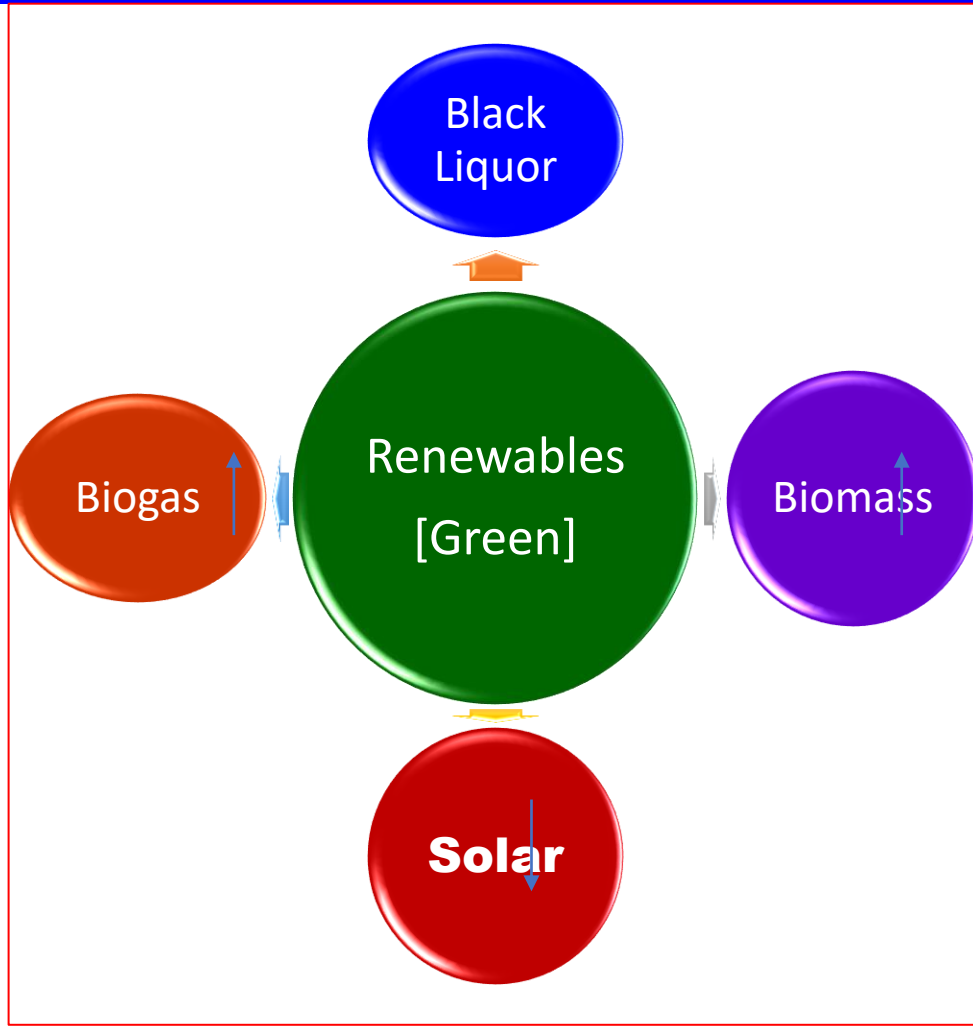


Emission Intensity [tCO2e/tPaper]



FOSSIL & RENEWABLE ENERGY-

LISTING



EMISSION FROM COAL FIRED in AFBC BOILER

High Ash Low GCV Indigenous Coal [arb] - Ash : 37%; Mois :9%; GCV:3870 kcal/kg

Parameter	Units	Value
Coal fired in AFBC Boiler [Functional Basis]	t	1.0
Carbon in Coal	%	45.8
CO ₂ Produced	t	1.68
N ₂ O Prod.[10/ 20 ppm]	t	0.02-0.04
UBC Loss	t	0.05
Total GHG gen. from Boiler	t	1.6
HP Steam generation	t	5.12
Gross Power gen.	MW	1.2-0.05
APC	MW	0.15
Net Power available	MW	1.1
CO ₂ equiv. for unit Power avail for process	tCO ₂ e	1.45
El –Grid Power Import	tCO ₂ e	0.82

Bio-Wastes Generated in Process & available in OPM & in Proximity

Parameter	Units	Chipper dust	Saw Dust	Bark	Screen rejects	Black Liquor Solids	MLSS
Total moisture	%	38.0	40 -53	42-45	45.0	30	85
Ash on Dry basis	%	2-3	2-3	4-6	4	22	32
GCV on Dry basis	k cal /kg	4150	4870	4900	4070	3300	4640
GCV on ARB	k cal /kg	2573	2100-2900	2900	2240	4720	700

Bio-Energy

- Biomass [Bark & Chipper Dust] as Secondary Fuel offsetting Indigenous Coal in AFBC & Power Boilers
- Biogas [Planned for future] – Napier Grass ,Cow-dung etc - for use in Rotary Lime Kiln & Coal fired Boilers
- BLS in HP Chemical Recovery Boilers as the fuel -Performance enhancement & APC reduction for increased Green Energy to Process
- Proposal on anvil for heat in flue gas leaving APH of CFB to be used in Flash Biomass Dryer. This results in lowered moisture in as fired fuel and increases Boiler Steam economy & Decarbonization with Coal off-set.

Flexible Power generation Accelerating DeCarbonization with Fossil & Renewable Mix –Grid Connected- as under:

☐ Priority-1 : GREEN POWER

Varying Solar Energy [During day time availability] though in small amount totally used on top priority.

☐ Priority-2 : GREEN ENERGY

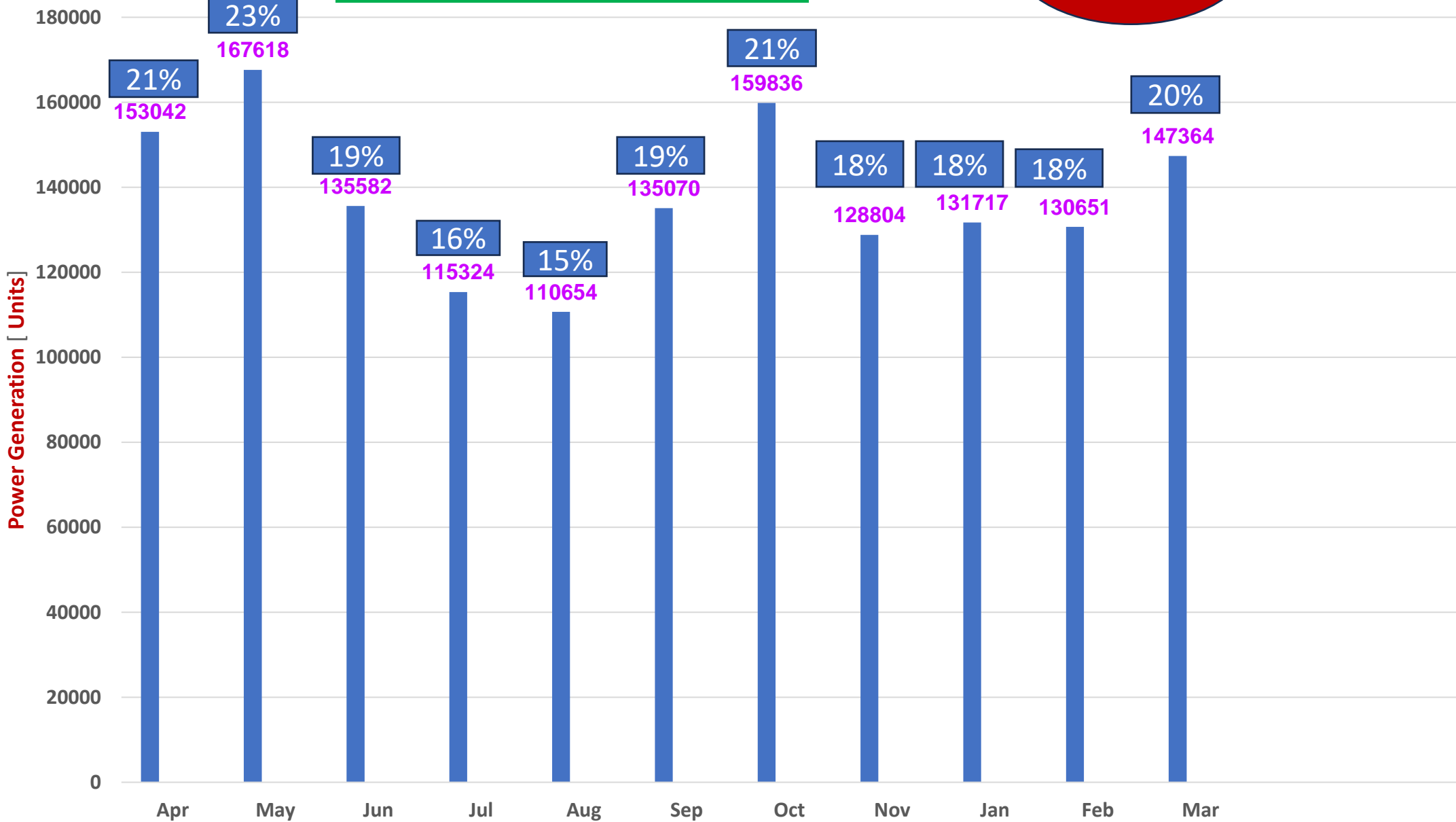
Maximize Renewable Power & Steam generation from [Black liquor [Biomass] as fuel fired Chemical Recovery HP Cogen Unit.

☐ Priority-3 : BLACK POWER

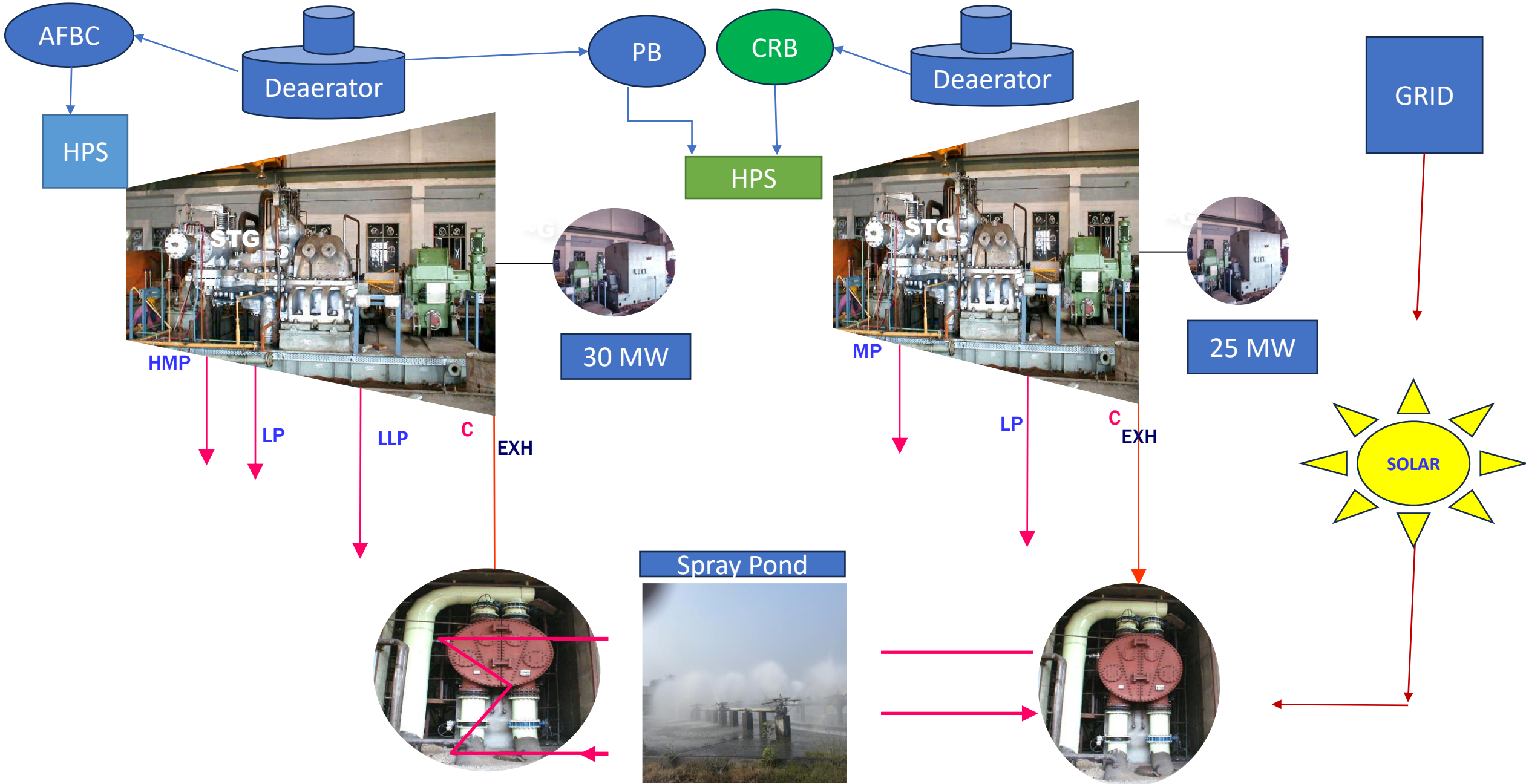
Balance Power as required for Process & Utilities obtained from Coal [Fossil fuel] fired HP Cogen Unit

OPIL 1 MW Solar Power Plant Monthwise Power Profile 2023-24

**Ann. Avg.
19%**



AFBC, PB & CRB HP COGEN BATTERY



MISSION REDUCTION IN CPP BATTERY IN OPM – STRATEGIES FOR EXCEEDING DECARBONIZATION TARGETS

HP COGEN BATTERY [Fossil fuel fired CPP]

- Coal off-set through steadily increasing proportion of Biofuel & Biogas firing planned
- Importance to lowered Carbon content in Coal selection for lowering GHG Emissions.
- Boiler thermal efficiency enhancement through stack waste flue gas heat recovery & UBC loss reduction schemes.
- Energy Conservation Steam turbine in lieu of existing PRDS.

Chemical Recovery HP COGEN

- Conversion of Extraction Condensing to Back Pressure STGs
- Maximize Recovery Cogen [Higher Steam Economy] Green HP Steam with increased BLS concn.in MEE
- Lowered APC & ASC in CRB resulting in Maximized Net Green Steam & Power for Process

NHR reduction with replacing 25MW Extraction Condensing to Back Pressure Extraction STG- Planned

- STG Inlet Steaming conditions shall be raised from 55 ksc / 430°C to 63 ksc / 450°C
- Energy Gains of Back Pressure from Ext-Condensation STG : Latent heat rejection [loss] in exhaust condensing steam to Spray Pond is avoided.
- Back pressure extraction with HP steam from CRB – Totally Green Power & Steam to Process.
- Exhaust steam condensation split leads to reduced condensation in the turbines resulting in increased SEC /MW power generation ; this shall give way to single STG exhaust steam condensation & lowered SEC/MW

Innovative Unique First of its kind EC schemes like –

CW flow optimization through Condensers for NHR reduction

1 of 2 MCW Pumps had been stopped [Winter]to start with

1 MCW Pump shall be stopped permanently; Replacement of other unit with EE MCW pump with VFD with varying flow rate to suit- Huge APC reduction.

Scheme planned with Gen.AI algorithm to link Enthalpy of exhaust steam with Cooling water flow variation [first of its kind] in ST Condenser of CPP

Utilizing part of ST condenser lukewarm CW return diverted from Cooling tower for DM water heating [first of its kind] during summer as well as winter-24 x7

Utilizing Vapour condensate & part of MEE condenser CW return diverted for DM water heating [first of its kind] during summer as well as winter -24 x7

MP & LP steam flows apportioning optimization within 2 STGs

Power generation from PRDS switch to Microturbine for MP [11 kscg] to LP [3.5 & 5 kscg] steam proposed

CIRCULAR ECONOMY – WASTE TO RESOURCE CONVERSION FOR DECARBONIZATION

- Unburnt Combustibles in Ash for re-firing for valued HP steam generation in CFB;
- Bioenzyme additive for reducing UBC in bottom/flyash of CFB
- MLSS /Effluent sludge as tertiary fuel in CFB
- Heat in Waste Stack flue gas from Boiler for flash drying of high moisture Biofuels.
- Plant-wide Lukewarm clarified water with waste heat in CW return from Turbine Condenser ensuring lowered make up water to Cooling Tower/Spray Pond .
- Emission Reduction through CO_2 in Stack flue gas for conversion to CaCO_3 - Resource in PCC.

CARBON CAPTURE & UTILIZATION [CCU] & LiFE Circular Economy

P C C [Filler in Paper Machine]

CO₂ in Stack flue gas of AFBC HP Coal fired Boiler captured & utilized for Carbonation in PCC

CER : 3300 tCO₂e/annum

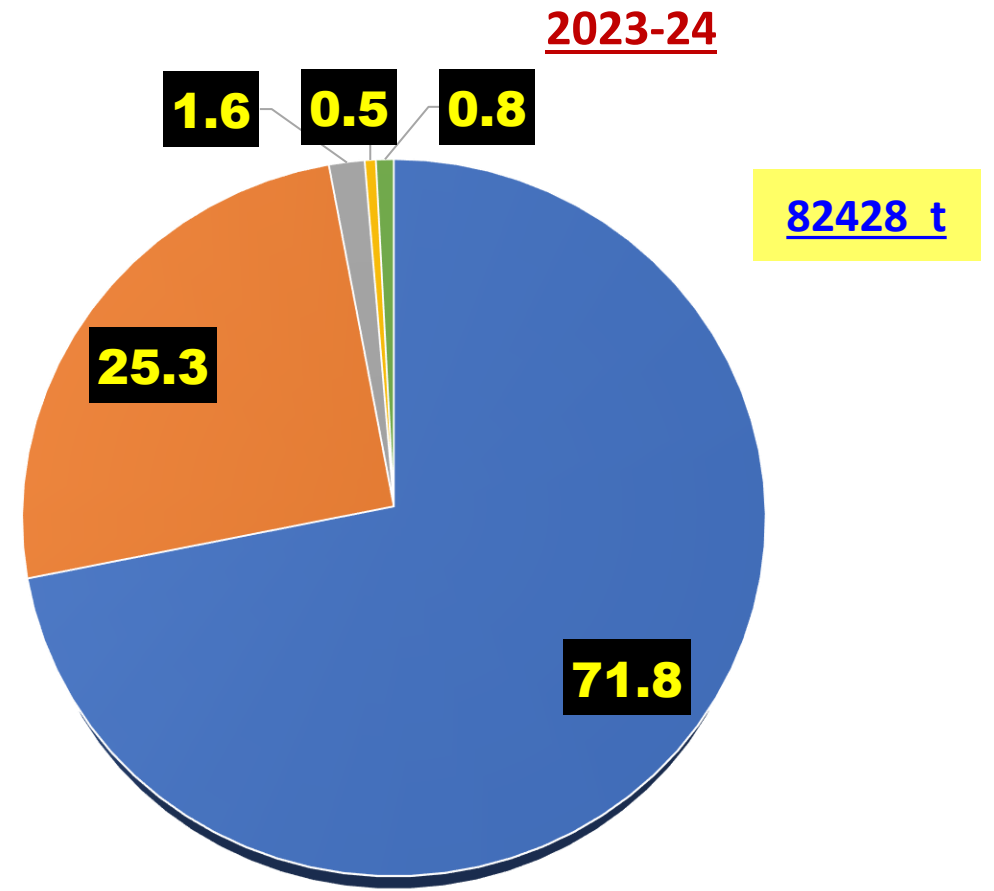
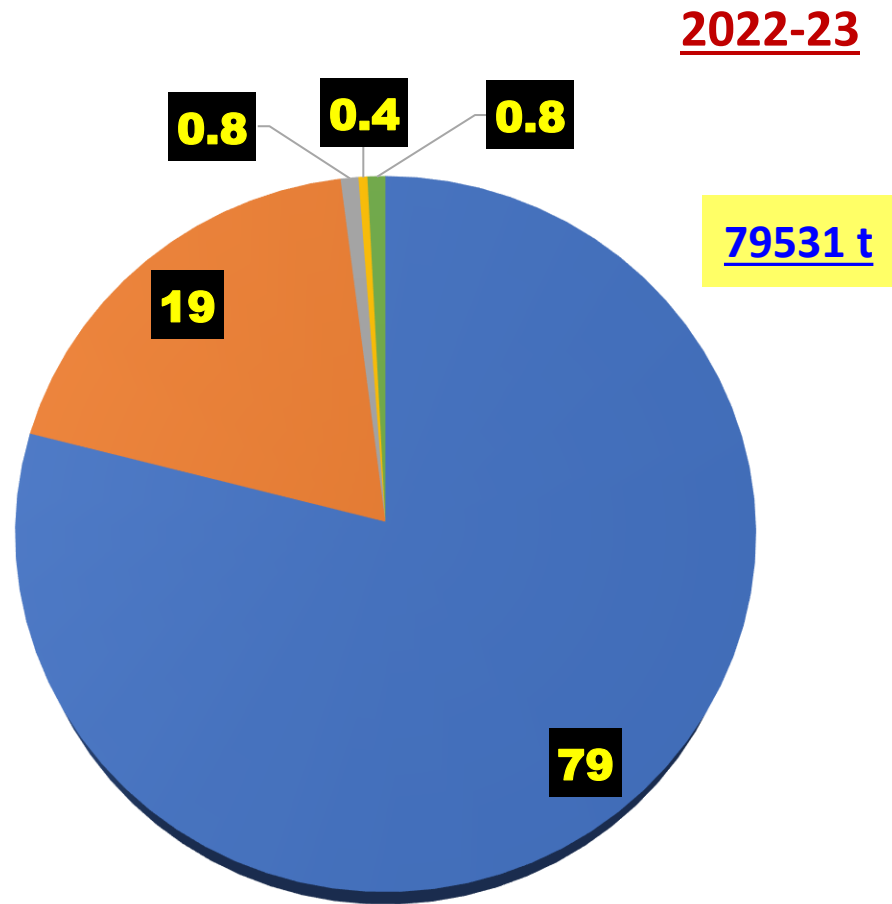
CER due with Value addition to Final Product

View of PCC Plant



View of OPM - Onsite PCC Plant

Energy Transition-Pathway to DeCarbonization



■ Coal ■ BLS-Green ■ Biofuel ■ Solar ■ CCU

■ Coal ■ BLS-Green ■ Biofuel ■ Solar ■ CCU

INNOVATIVE ENERGY SAVING SCHEMES -

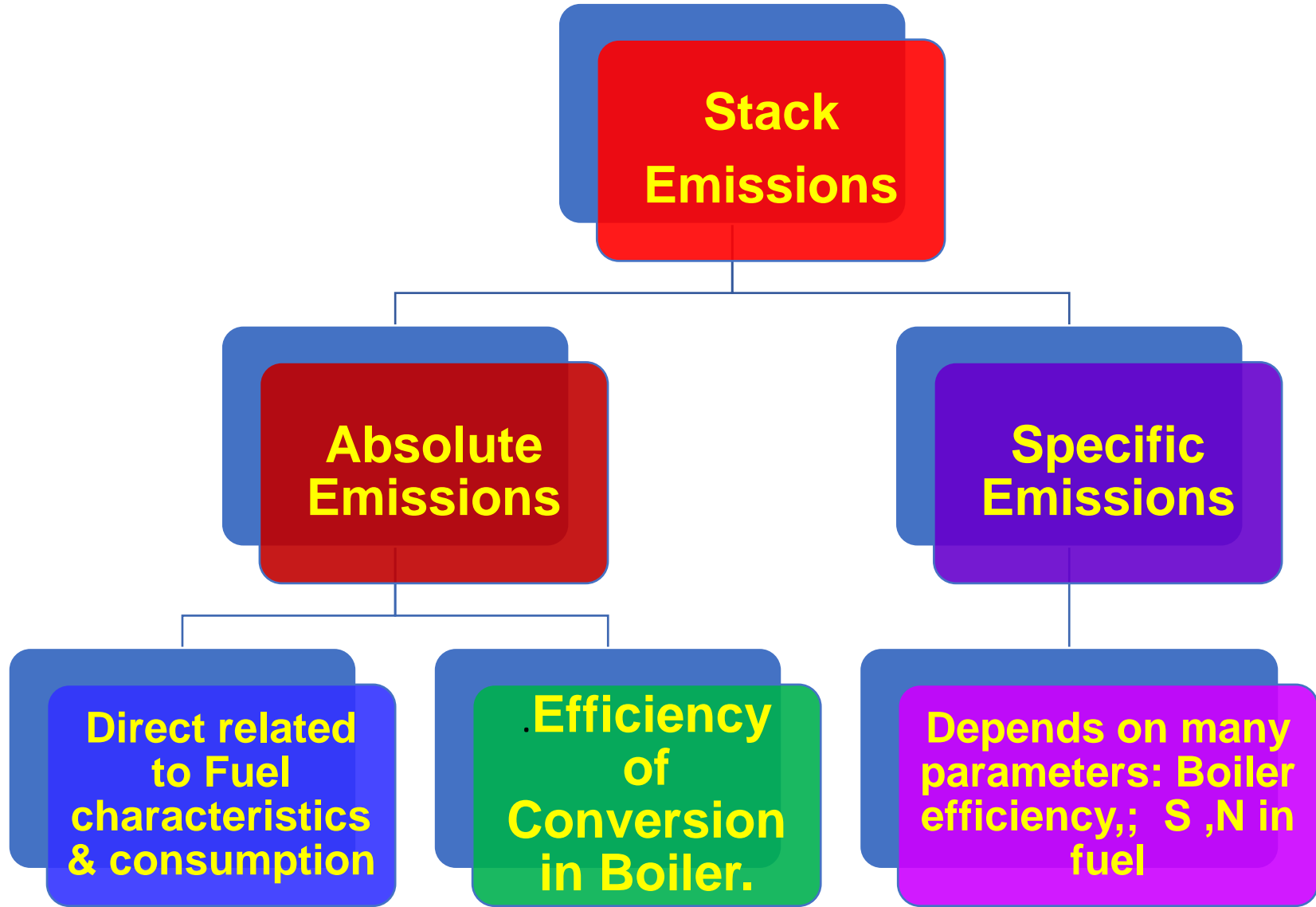
BOILER COMPLEX	TURBO-GENERATOR STATION	APC & ASC reduction MISCELLANEOUS	LIME KILN CENTRE	PULPING & PAPER MACHINE STATION
<ul style="list-style-type: none"> • Coal : Lower Carbon -SGR • Lower Stack flue gas temp. 	<ul style="list-style-type: none"> • Genr.η Max. [PF incr.] • Genr. DM-Cdste switch • Blr–STG connect- R & C losses min. [Nano-insulation] 	<ul style="list-style-type: none"> • High η BFP & CWP • High η Fans • High η Air Compressor+WHR 	<ul style="list-style-type: none"> • Biogas offset of FO 	<ul style="list-style-type: none"> • Air to Steam switch-Carrier [Partial/ Total] • Dual [LP/ MP] steam pressure Digester
<p>Fuel Drying :</p> <ul style="list-style-type: none"> • Flash Biomass drying with WESP – Stack Flue gas • Solar Drying 	<ul style="list-style-type: none"> • Lukewarm cooling water return from Turbine & MEE Condensers divert fromCT for DM water preheating • LP& MP steam extraction optimization in TG Battery 	<p>Steam consn redn</p> <ul style="list-style-type: none"> • Deaerator, • Soot blower, • SCAPH • [PR]DS to ECT 	<ul style="list-style-type: none"> • Heat Recovery from Flue gas/ Product • Lime mud Dryer–Flue gas 	<ul style="list-style-type: none"> • Drying Cylinder sides Insulation • Dry steam to DC • LPS reduction with water from MEE Condenser return for heating of water for Pulping Station
<ul style="list-style-type: none"> • Renewable Energy 	<ul style="list-style-type: none"> • Cooling water flow 	<ul style="list-style-type: none"> • Hot Water /LPS VAM 	<ul style="list-style-type: none"> • R & C losses 	<ul style="list-style-type: none"> • Latent heat in

MoEF & CC LIFE

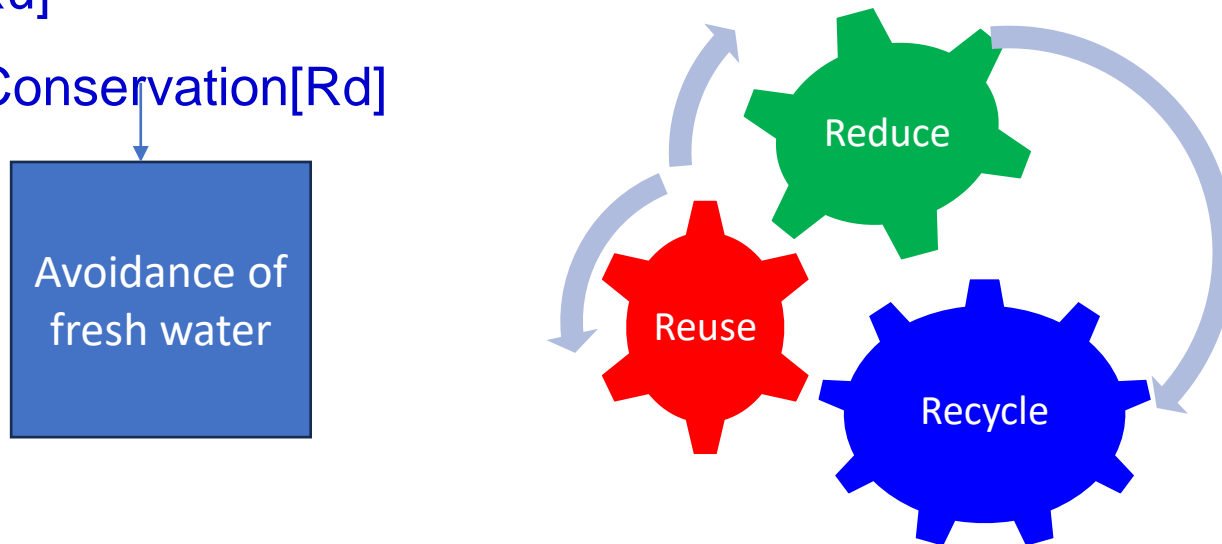
GREEN CREDITS PROGRAMME IMPLEMENTATION RULES 2023

	Activity	Requirement
1	Tree Plantation	Activities for Green Cover Increase
2	Water	Water Conservation, harvesting ,conservation ,use & savings
3	Sustainable Agriculture	Promote Natural Agricultural Practices & Land Restoration
4	Waste Management	Improved practices (incl. Collection, segregation & treatment
5	Air Pollution Reduction	Measures for Promotion for reducing Air pollutants & other Pollution Abatement activities
6	Mangrove Conservation & Restoration	Measures for Conservation & restoration
7	Ecomark	Encourage manufacturers to obtain Ecomark label for goods & services
8	Sustainable Building & Infra-structure	Encourage construction of Buildings and other infrastructure using sustainable technologies and materials.

Min. of Env.& Forests /Climate Change Gazette Notification Environment [Protection] Amendment Rules, 2018 [2003-2017] & LiFE [2023]



- Plant-wide Lukewarm clarified water with waste heat in CW return from Turbine / MEE Condensers ensuring lowered make-up water to Cooling Tower/Spray Pond [Rd]
- Reducing makeup water to CT through lowered exhaust steam enthalpy in Extraction Condensing Steam Turbine [Rd]
- Water conservation through CPU - PHE in CPP [Rc]
- Usage of RO rejects instead of fresh water for cleaning [Ru] & Leakage arresting [Rd]
- Water conservation through lowered Blow-down in Boiler & venting avoid + EE Steam traps [Ru]
- Water Conservation[Rd]



Scope 3 Emissions -Accounting & Reporting Standard -SBT

1: Purchased Goods and Services **Vendors [Penetron]**

2: Capital Goods

3: Fuel- and Energy-Related Activities Not Included in Scope 1 or Scope 2

4: Upstream Transportation and Distribution **Coal fm nearby mines/RM**

5: Waste Generated in Operations **CCU, Coal Fly-ash, Effluent**

6: Business Travel **Video/Audio Team Meet/ On-line Conference**

7: Employee Commuting

8: Upstream Leased Assets

9: Downstream Transportation and Distribution

10: Processing of Sold Products

11: Use of Sold Products

12: End-of-Life Treatment of Sold Products

13: Downstream Leased Assets

14: Franchises

15: Investments

ENERGY TRANSITION STRATEGIES FOCUS

DECARBONIZATION- ACCELERATING NET ZERO EMISSION

- **Renewable Energy [Biofuel & Biogas] Mix Augmentation off-setting Fossil fuel on a sustained basis.**
- **Continued Green Energy increase from Chemical Recovery HP Cogen**
- **Energy Efficiency with Innovative & Proven Schemes for Total Energy Solutions related to increased Productivity**
- **Circular Economy: Waste to Valued Resource Conversion**
- **Maximizing Waste to Thermal /Electrical Energy Conversion**
- **CO₂ Capture from AFBC Boiler exit & Utilization [CCU] in PCC**
- **Absolute Gaseous /Solid/Liquid pollutants discharge reduction -ECS**
- **Scope 3 Emission [CFP] lowering through Logistics optimization- Raw Material & Fuel Sourcing, Vendor selection etc.**
- **Digitalization– Automation & Controls, Gen. AI + IIoT 5.0 Manufacturing**