Best Practices in HP Cogeneration in Pulp & Paper Sector for Exceeding Energy & DeCarbonization Targets

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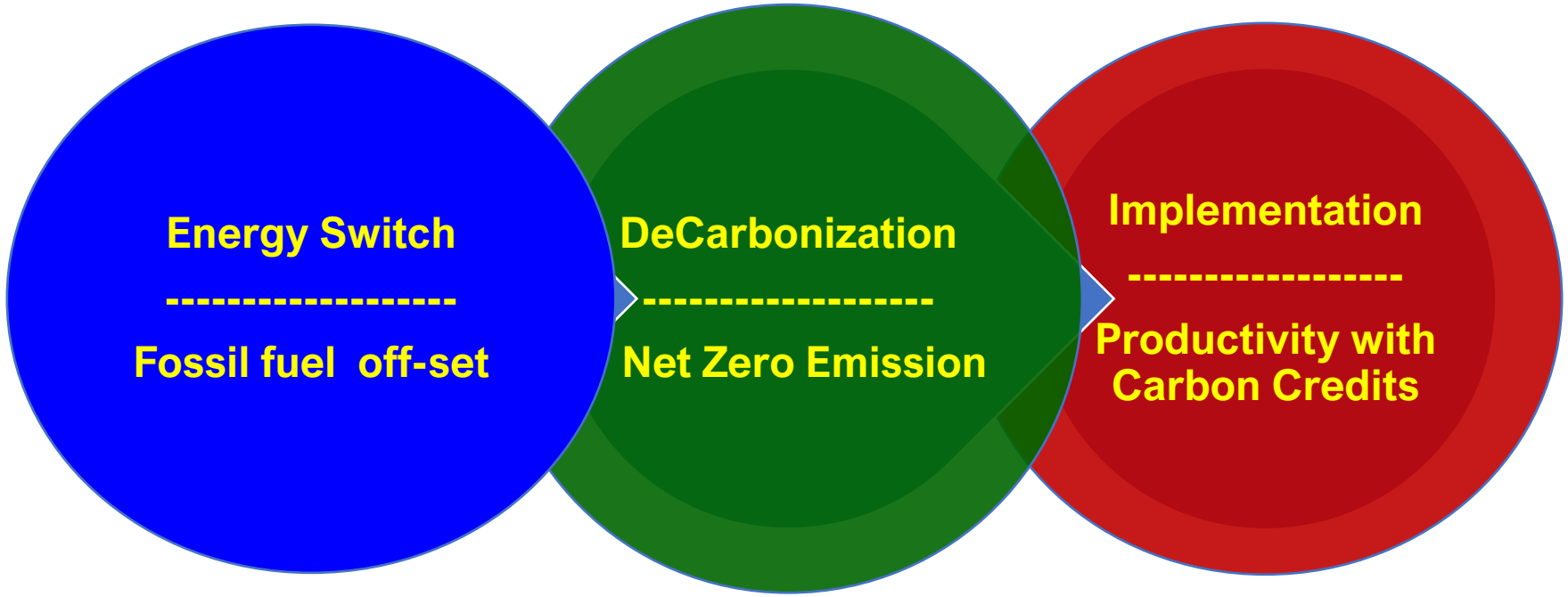
Best Practices in Energy Efficiency in Pulp & Paper Sector-
A Path for DeCarbonization

BEE- FCDO Workshop
Amritsar

13th Feb. 2024

EDI – APPROACH TO DC TARGET EXCEEDANCE



Cross – Sector Energy Efficiency & DeCarbonization Scheme Exchange

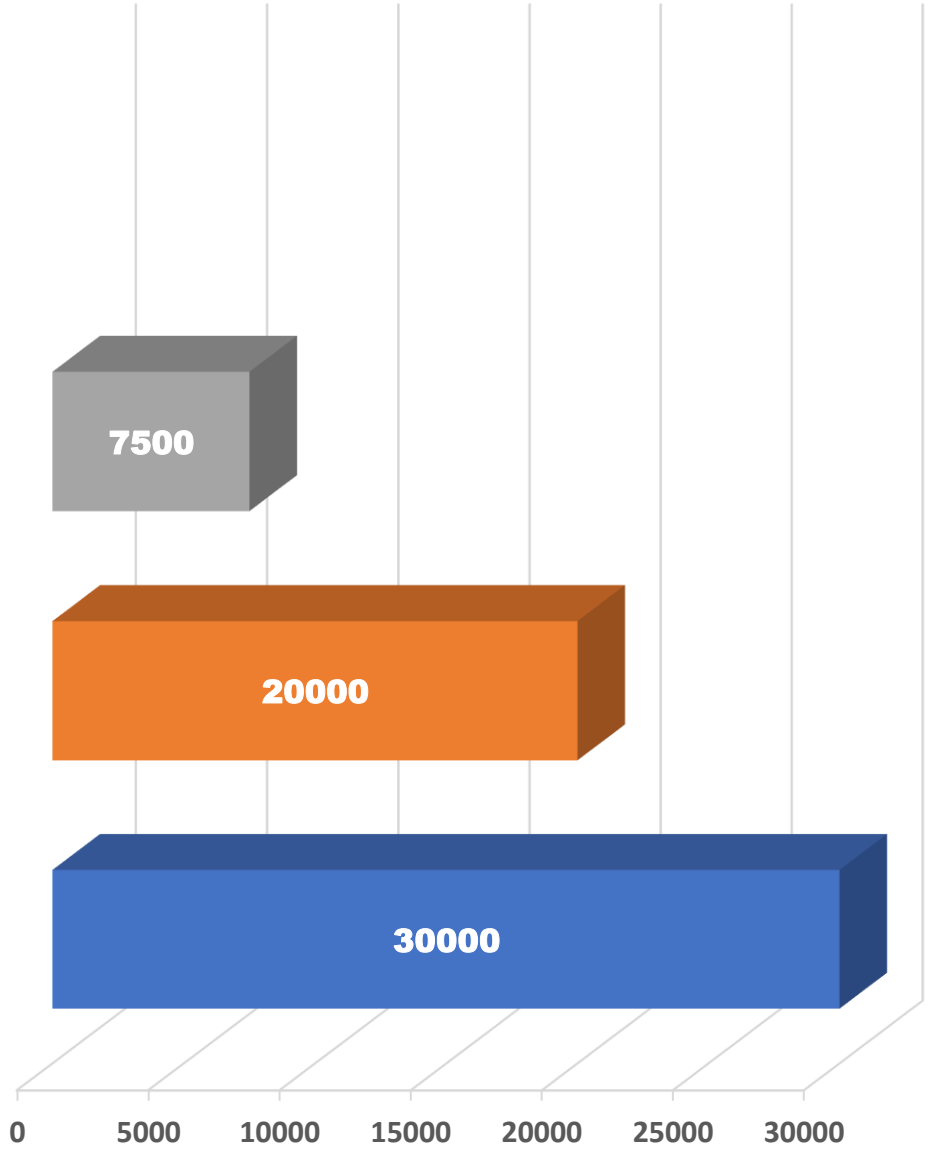
ENERGY SECTORS - PAT

- **A.** Thermal Power plants
- **B.** Iron & Steel
- **C.** Cement
- **D.** Fertilizer
- **E.** Aluminium
- **F.** Pulp & Paper
- **G.** Textile
- **H.** Chlor-Alkali
- **I.** Petroleum Refinery
- **J.** Sugar
- Chemicals, Zn, Cu,glass, tyre, dairy, ceramic, foundry etc
- Independent Captive Power Plants

EMISSION REDUCTION PROJECTION by 2030 [Pulp & Paper sector] –INDIA -PWC Report 2022

	2019-20		2030-31 [Projection]		CO_2e Savings/yr
	Emission Intensity	Production Annual	Emission Intensity	Production Annual	
	Kg CO2e/t	Mil tonnes	kgCO2e/t	Mil. tonnes	Mil.tonnes
Value	2170		1010		21
Projection		18 .0		34.22	39.7
Production Increase			90%		
Emission Reduction/yr			39.7 Mil.tonnes		
Emission Intensity Reduction			54 %		

PAT –QUAL. LIMITS: ENERGY CONSUMPTION [MTOE /YR]



Carbon Credits Notification –MoP & MoEF & CC

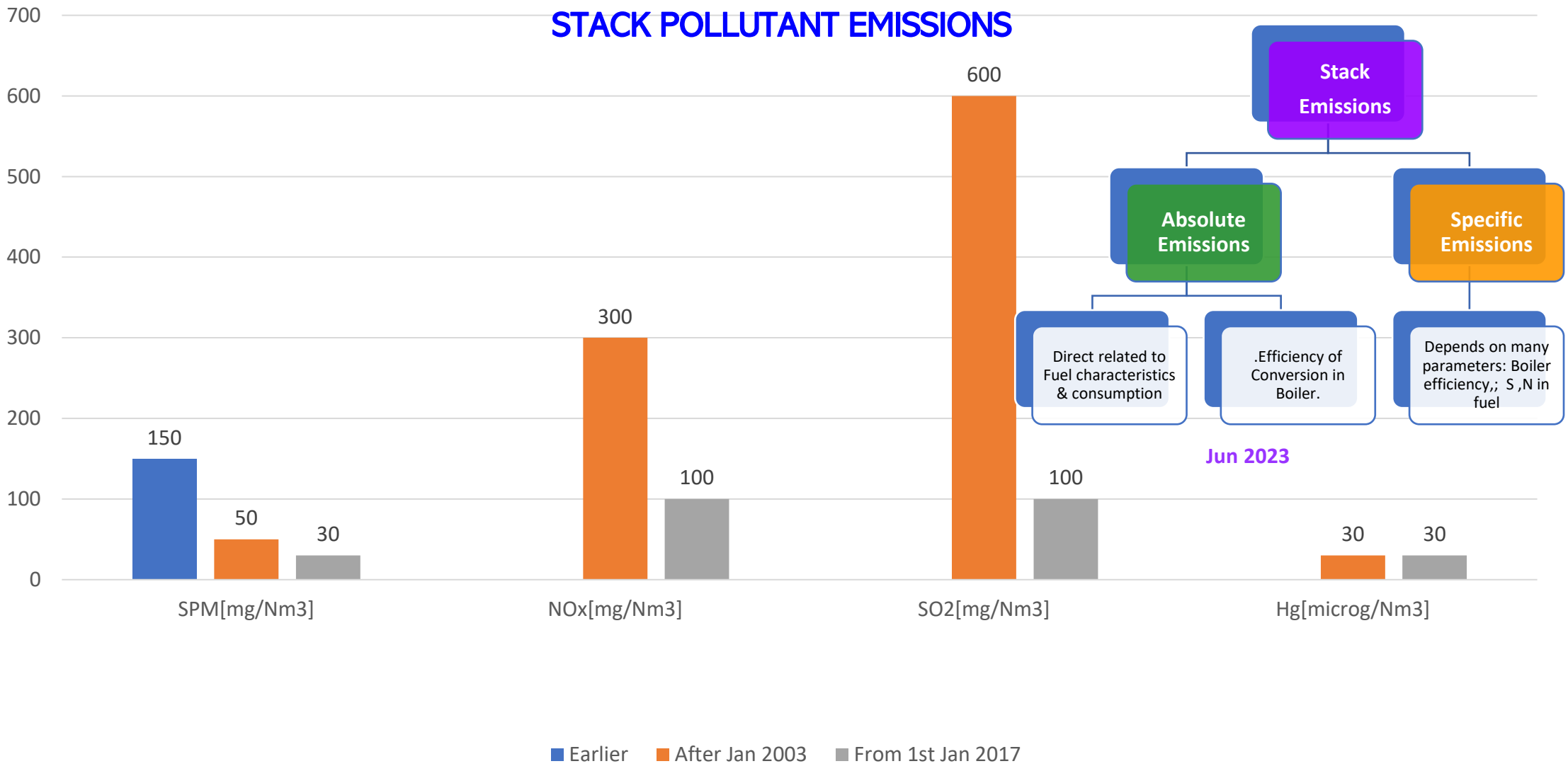
Ministry of Power – Notification [June 2023]
CARBON CREDIT TRADING SCHEME -2023

- **The Notification** empowers Central government to specify **Carbon credit trading** scheme.
- Carbon credit implies a tradeable permit to produce a specified amount of carbon emissions.
- Central government or any authorised agency may issue **Carbon credit certificates** to entities registered under and compliant with the scheme.
- The entities will be entitled to purchase or sell the certificate. Any other person may also purchase a Carbon credit certificate on a voluntary basis.

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 and 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]



RAW MATERIALS

PULPING PROCESS

WASHING / BLEACHING

White Liquor

CHEMICAL RECOVERY

Black Liquor

USER

TISSUE/PAPER MACHINE

RECAUSTICIZER

MULTIEFFECT EVAPORATOR

Green Liquor

Burnt Lime

Lime Mud

ROTARY LIME KILN

CO-GENERATION

CPP

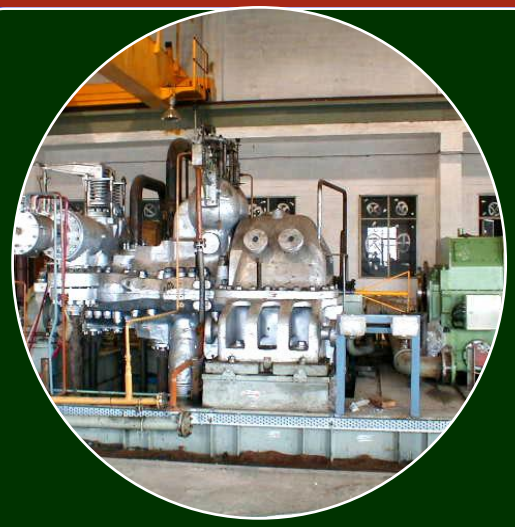
RECOVERY BOILER

STG

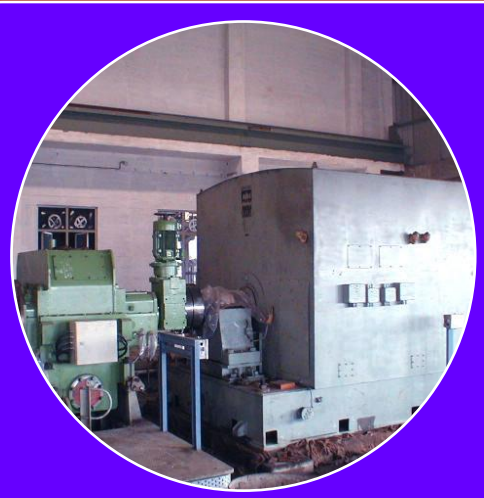
COAL FIRED BOILER

CPP – GROSS CYCLE EFFICIENCY
HP Boiler Integrated with Steam Turbine & Generator

Boiler Thermal Efficiency *



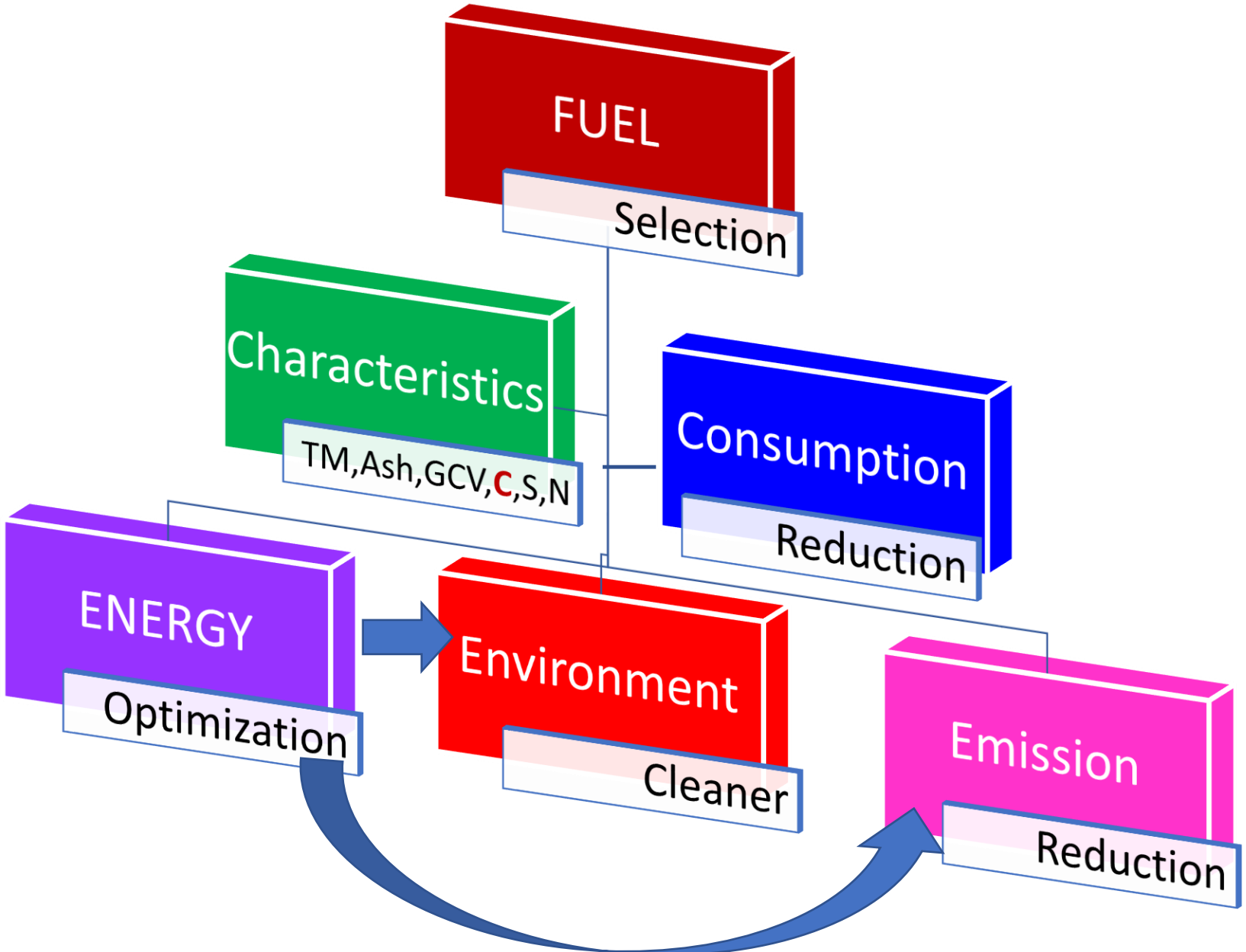
Turbine Efficiency *



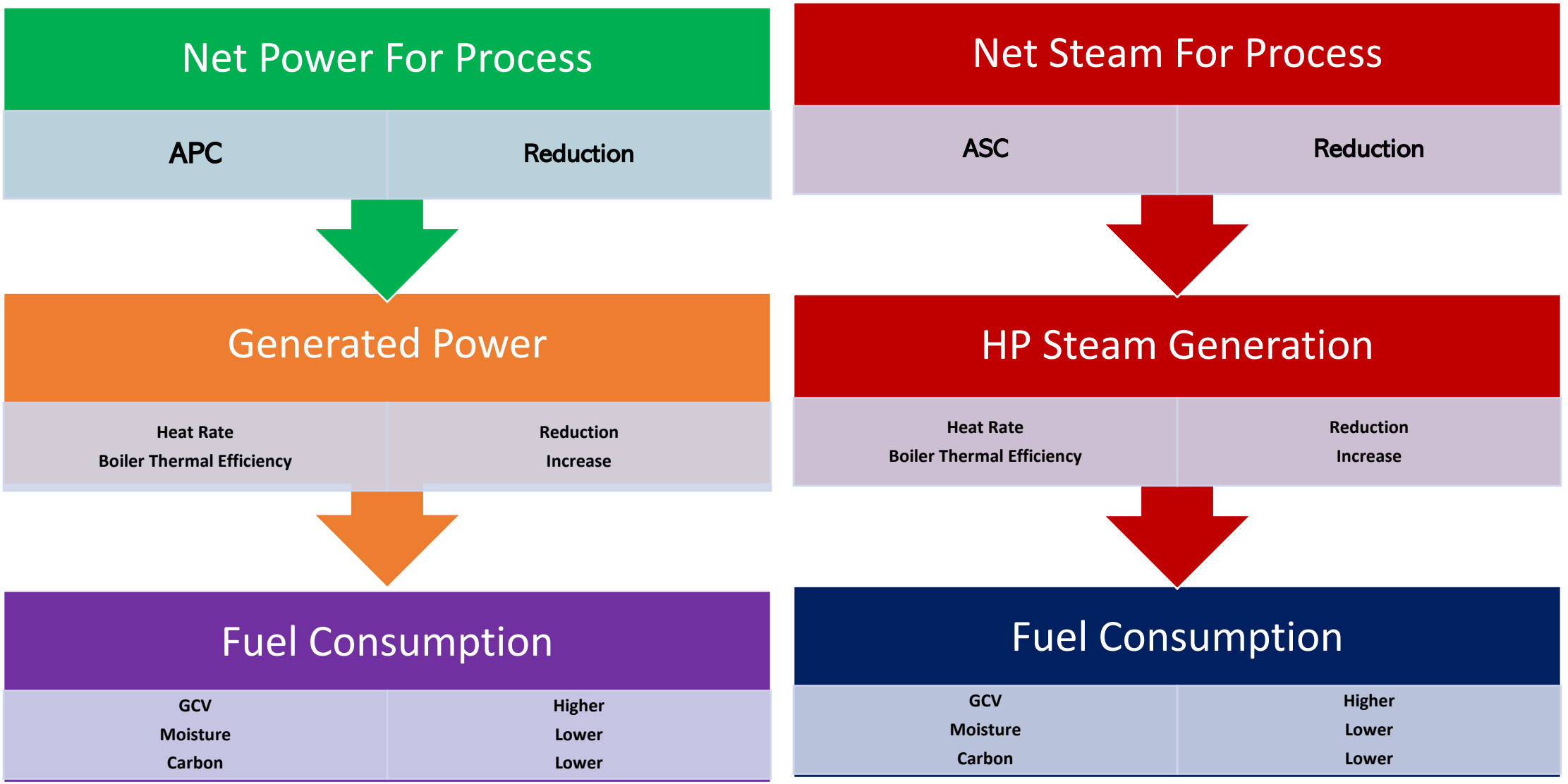
Generator Efficiency

GHR [kcal/kWh]= 86000 / Cycle Efficiency [%]
NHR= GHR/(100-APC%)/100

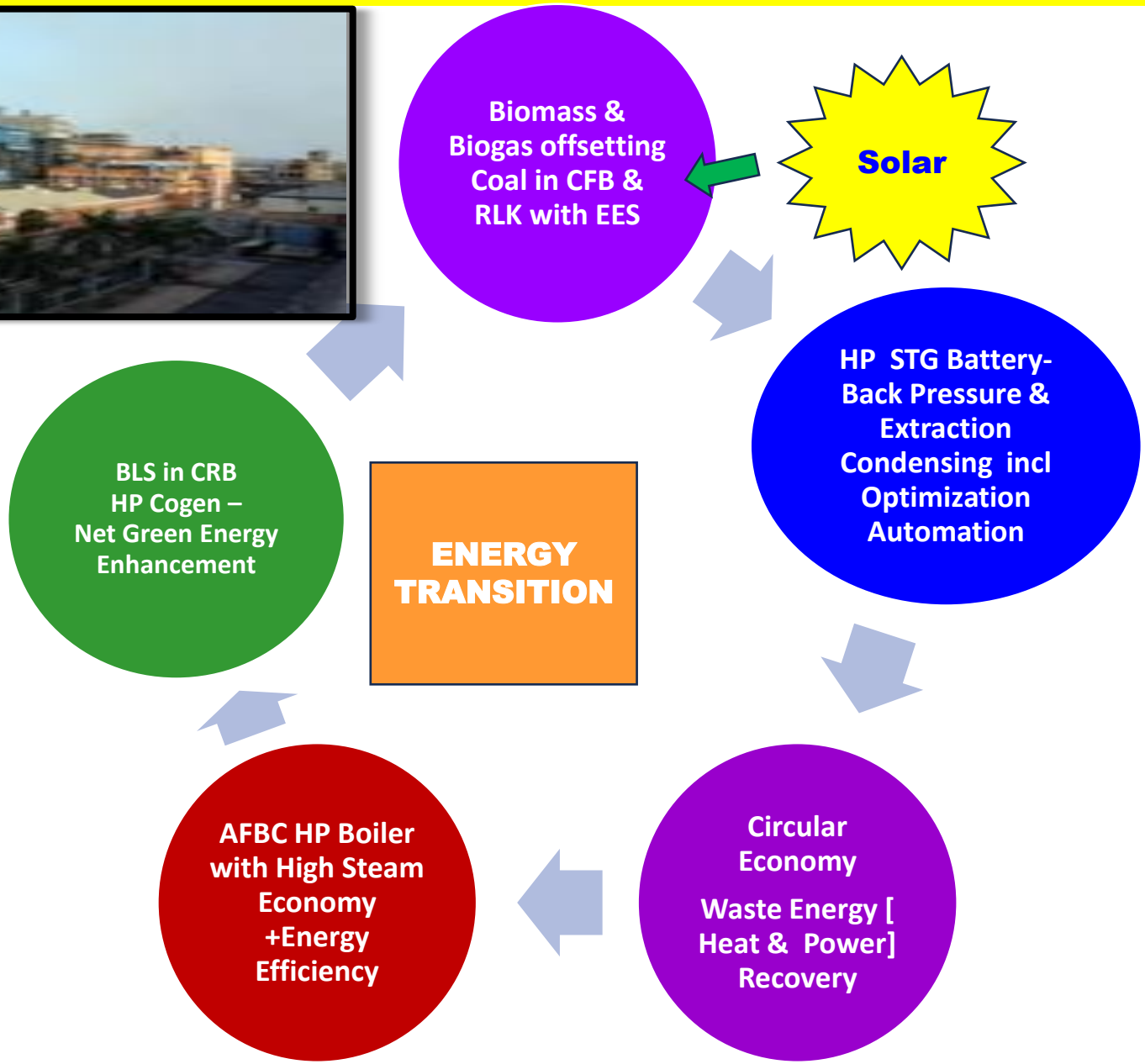
TOTAL PRODUCTIVITY OPTIMIZATION with 3 E's



TOTAL ENERGY OPTIMIZATION –HP COGEN UNIT



Orient Paper Mill -Amlai - ENERGY TRANSITION- Available Options -Implementation Mill-wide –March towards Net Zero Emission



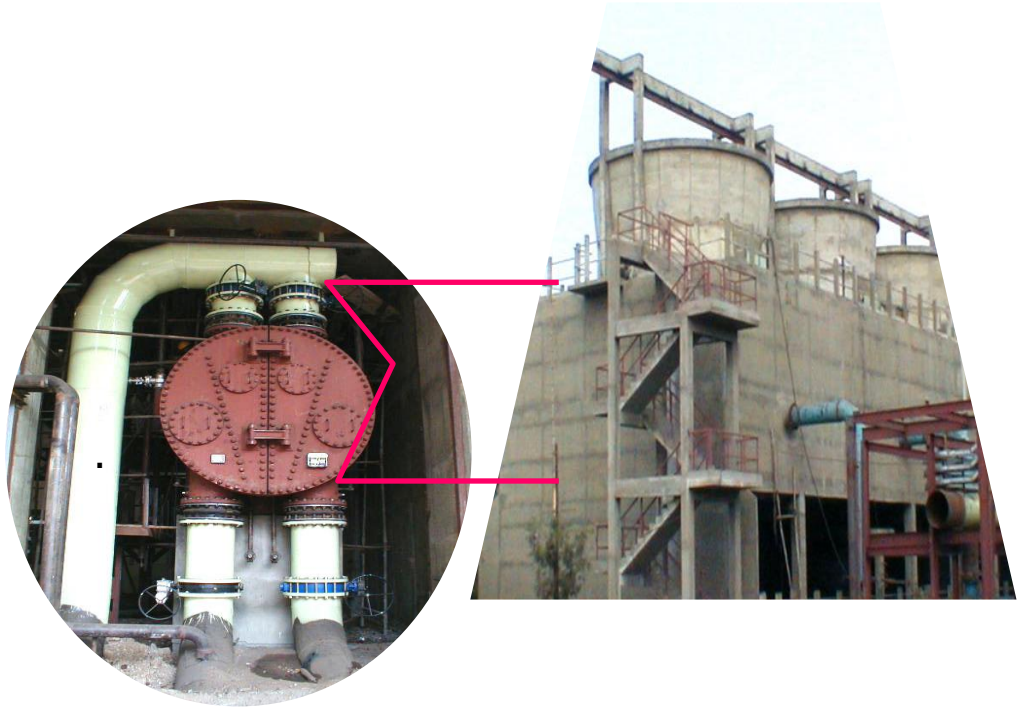
Impact Maximum on Net Heat Rate of CPP

Boiler –Stack

Heat Losses : [18% to 25%]

Turbine –Cooling Tower

Heat Losses : [20% to 60%]



RECOMMENDATORY ADVISE FOR BEE's KIND CONSIDERATION FOR PAT -DECARBONIZATION

- For Carbon Emission Reduction [CER] computation, it is standard practice is to go with that stipulated for Grid Emission factor for India
- As Grid Power in take comprises of mix of Net Power from TPS as also Renewable Power viz., Wind, Solar etc.], Carbon Emission factor [0.82 tCO_2e] taken as default for computation is a low figure.
- Since Energy consumption reduction is off-setting Coal [as fired in Boilers within the plant premises], it is apt to go in for equivalent reduction in coal consumption/fired in Boilers.
- Hence for CER computation, it would be justified if one goes for equivalent coal consumption in-house, from wherein CER is computed.

CARBON EMISSION FROM COAL-BASIS : Ultimate analysis of Coal

Functional Unit : 1 te Indigenous High ash Low GCV Coal [Illustration]

Parameter	Units	Case A	Case B
Coal fired in AFBC Boiler	t	1.0	1.0
Carbon in Coal	%	40	38
CO_2 Produced	t	1.47	1.40
N_2O Produced [10- 20 ppm]	t	0.02-0.04	0.03
CH_4	Traces	0	0
Total GHG generation from Boiler	t	1.5	1.43
HP Steam Generation	t	5	5
Gross Power Generation	MW	1.1	1.1
Aux. Power Consumption	MW	0.132	0.132
Net Power available	MW	0.968	0.968
CO2equiv. For unit Power avail for process [/MW]	tCO2e	1.54	1.47
EI –Grid Power Import [/MW]	tCO2e	0.84	

EMISSION REDUCTION IN OPM – KEY TO EXCEEDING DECARBONIZATION TARGETS

- Coal off-set through increasing proportion of Biofuel & [Biogas firing planned]
- Importance to lowered Carbon content in Coal selection
- AFBC Boiler Thermal efficiency enhancement
- Maximize Recovery Cogen [High Steam Economy] Green HP Steam
- Lower APC & ASC in CRB resulting in Maximized Net Green Steam & Power for Process

Stack flue gas Waste Heat Recovery

Biomass drying with boiler exhaust Flue Gas to stack.
Reduction in Stack heat loss by 8 to 9 %.
Steam Economy is enhanced by 8 to 9%.
Off-setting Coal consumption , thereby lowering Net Carbon Emission

HYBRID DRYER

BIOMASS DRYING & FLUE GAS CLEANING

Enviropol Engineers Pvt Ltd

NHR/NER reduction :Leveraging Aux. Steam Gen/Consn

Process condensate polishing with HRU	**Reduced DM water consumption and lowered Deaerator steam consumption**
Higher Boiler feed water temperature[195ºC & 140ºC]	Increase in Steam economy & NHR reduction
Advanced Nanoinsulation coating of Main steam pipe connecting Boilers & turbines	**Cogen Net Heat rate reduction & CER**
Combustion intake luke warm air reducting in FD /PA fan advocated	LP steam consumption lowered
CPP Air Compressor	WHR & Lower Pressure reset+IOT 5.0

CCU-CARBON CAPTURE OF CO_2 IN BOILER FLUE GAS FOR USE IN PCC

CO_2 in Stack flue gas from AFBC Boiler captured & utilized for Carbonation in PCC

Net CER : 2500 tCO2e/annum

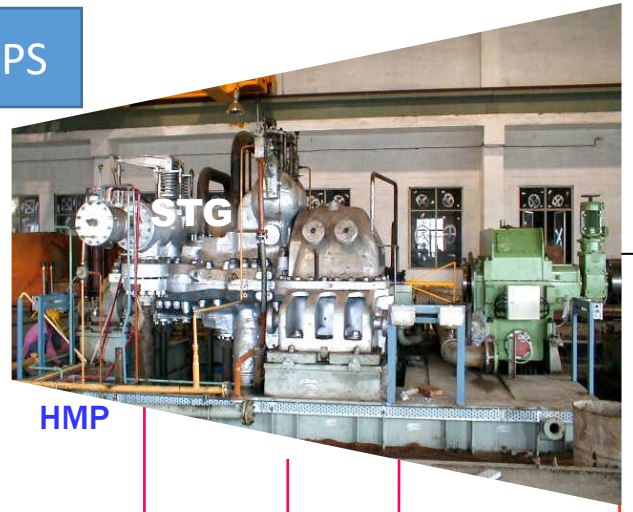
CER due to Value addition to Final Product

View of OPM - Onsite PCC Plant

AFBC & CRB HP COGEN BATTERY

Orient Paper Mills - Amlai

HPS



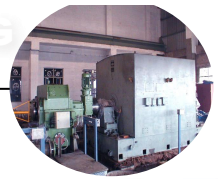
HMP

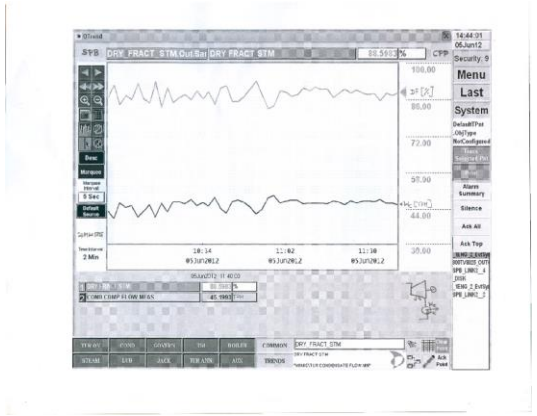
LP

LLP

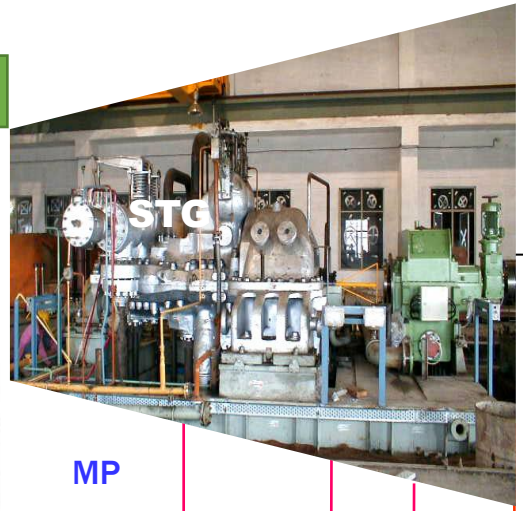
C

30 MW





HPS



MP

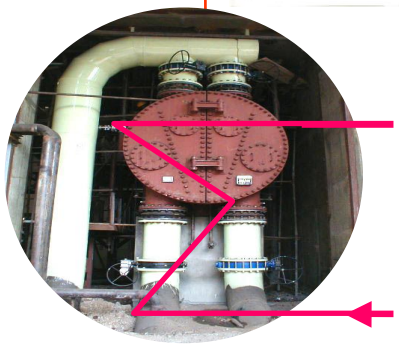
LP

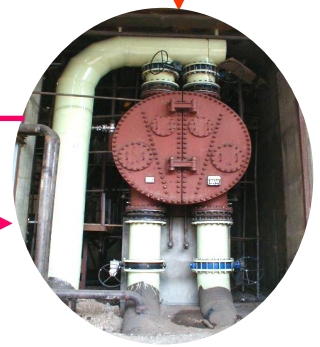
LLP

C

EXH

25 MW





EMISSION REDUCTION IN OPM – KEY TO EXCEEDING DECARBONIZATION TARGETS

- 30MW STG- HP COGEN [Fossil fuel fired CPP- High Steam Economy with HP & LP heaters in place] & 25 MW STG -CR HP COGEN
- Energy efficient Multi- Extraction Condensing 30 MW STG
- LP & HP Heaters for increasing Overall Cycle efficiency & lowered Heat Rate
- Conversion of MEC to Extraction Back Pressure* 25 MW STG with increased inlet steaming conditions [56 to 63 ksca]
- Split condensing to single condensing exhaust steam lowering SSC /Unit Power
- APC significant reduction with one CW pump off & other New EE CWP* with lower rating
- PRDS HP steam flow avoidance*

* Planned

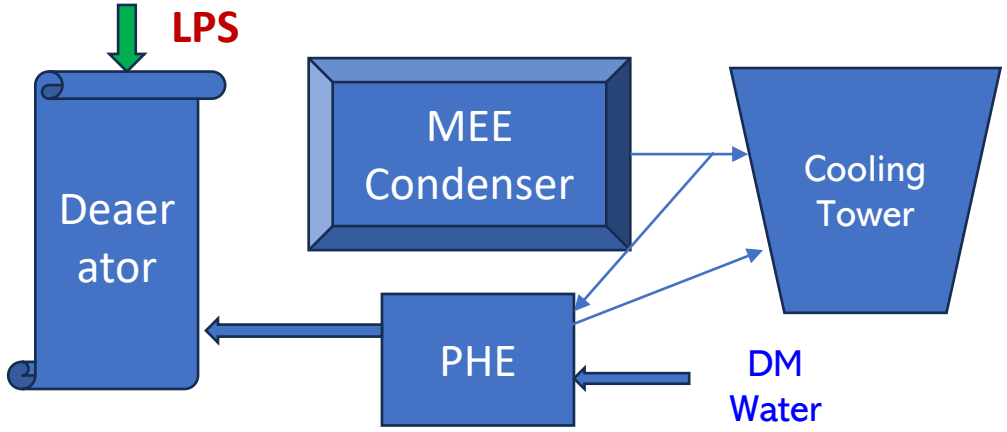
Innovative Unique & First of its kind Energy Conservation / DeCarbonization Schemes

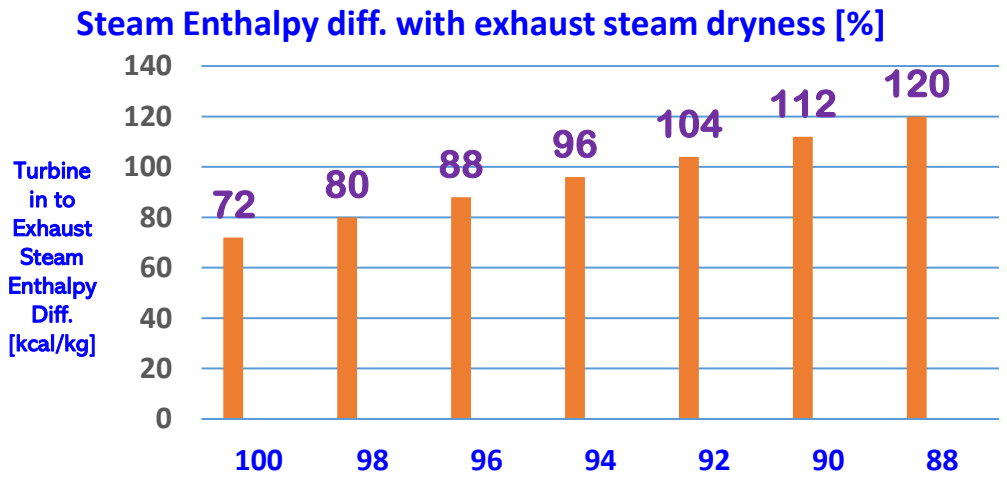
Utilizing part of MEE condenser Lukewarm cooling water return diverted for DM water heating [first of its kind] during summer as well as in winter-24x7

CW flow optimization through Condensers for NHR reduction

Scheme planned to link Turbine Exhaust steam Dryness with varying Cooling water flow [first of its kind] in ST Condenser of CPP

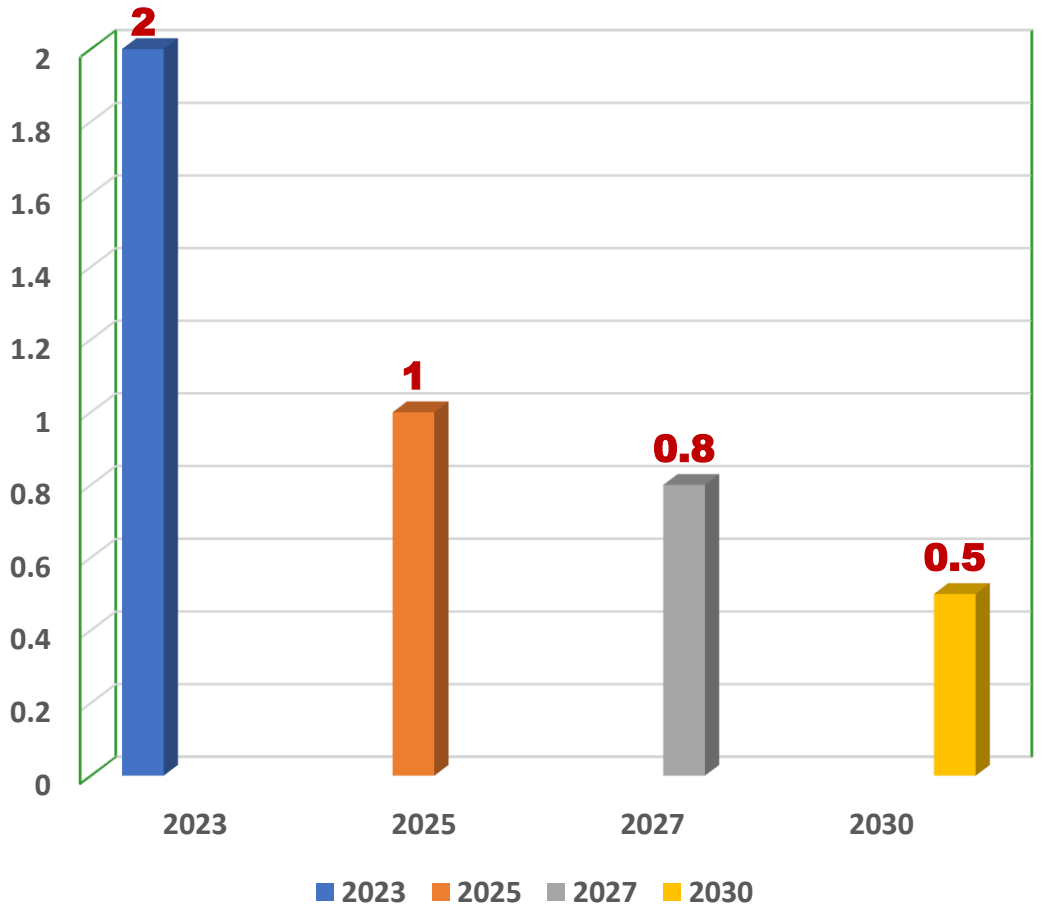
MP & LP steam flows apportioning optimization within 2 STGs



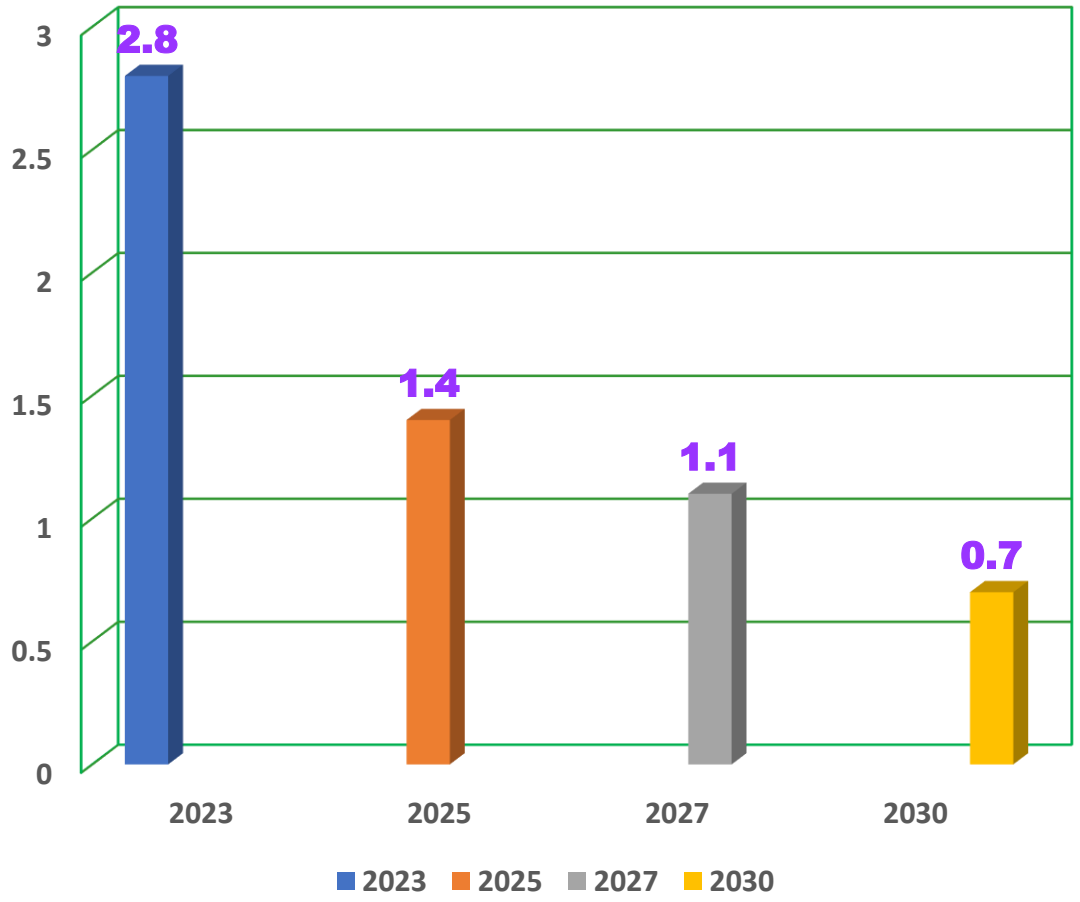


Path to Net Zero Emission –Giant Strides -OPM

Specific Coal Consumption [tCoal/ tPaper]



Emission Intensity [tCO2e/tPaper]



INNOVATIVE ENERGY SAVING SCHEMES-SUMMARY

BOILER COMPLEX	TURBINE GENERATOR-CONDENSER STATION	APC & ASC reduction MISCELLANEOUS	ROTARY LIME KILN CENTRE	PAPER MACHINE STATION
• Coal : [C/H]-Lower • Lower Stack flue gas temp.	• Genr.η Max. • Genr. DM-C switch • Blr–STG connect- R & C losses min. [Nano-insulation]	• High η BFP & CWP • High η Fans • High η Air Compressor& WHR	• Biogas offset of FO	• Air to Steam switch-Carrier [Partial/ Total]
Fuel Drying : • Flash Biomass drying with WESP – Stack Flue gas • Solar Drying	• TG design Improvsn • ST Condsn flow design optimizn • Cdsr warm CW return divert for DM water/Proc water heating • Dryness fraction of Cond steam[<0.9] lowering & sustain	Steam consn redn • Deaerator, • Soot blower, • SCAPH • [PR]DS to ECT	• Heat Recovery from Flue gas/ Product • Lime mud Belt Dryer–Flue gas	• DC Insulation • Dry steam to DC • Nip/ shoe Press for dewatering sheet • Metal Belt Calendering
• Renewable Energy Enhancement- Biofuel & Biogas	• Cooling water flow adjust with Condensing steam flow & DF exh steam	• Hot Water /LPS VAM for Power& Process Condensate	• R & C losses min. [Nano-insulation coating of shell & SC]	• Latent heat in Waste steam vapour Heat recovery

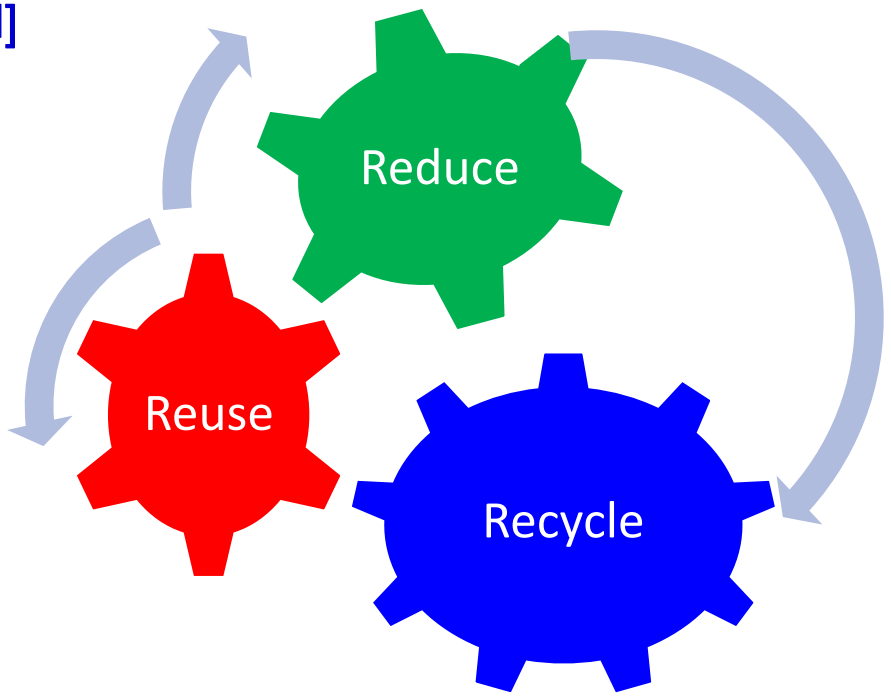
VISION – Following footsteps of Fossil free Anaekoski Biproduct Mill-Chemical Recovery Boiler –Green Energy

High main steam pressure&temp	111 kscg &515 C
Exhaust flue gas tube condenser	Vent gases from Dissolving tank heat for preheating boiler feed water
Exhaust stack flue gas cooler	Feed water further heating
Pressurized Deaerator/FW tank	Higher operating FW temp.with pressure losses minimized from LP Steam extraction to FW tank
Feed water preheater and interheater – higher feed water temp cycle effy incr.	Feed water preheating between Economizer and Inter-heater using MP Extr. steam
High BLS Concentration : 83 %	High Steam Economy ; ER : 4.35
Vent and exhaust flue gas coolers	High combustion air temp; LP steam replaced for first stage heating

Energy Benefits integrated to Water Conservation & LiFE [MoEF&CC Rules-2023]

- Water conservation through CPU - PHE in CPP [Rc]
- Cooling Tower Make-up Water reduction through use of heat in warm water return from surface condenser [Rd & Ru]
- Water conservation through lowered Dryness Fraction in Extraction Condensing Steam Turbine steam exhaust [Rd]
- ACC instead of WCC[Rd]

Avoidance



MoEF & CC Rules 2023 - LiFE

8 Sustainable Building & Infra-structure : Encourage construction of Buildings and other infrastructure using sustainable technologies and materials.

SPRAY POND & CANAL

Recovery Boiler ESP -Stack

PENETRON–GREEN PRODUCT- Proposed

- **Penetron application over the entire Spray Pond Concrete Basin and canal relates to Water saving –connected to MoEF/CC Rules 2023- LiFE [Carbon Credits]-as water seepage through the floor, pores , cracks etc. can be totally arrested.**
- **Crystalline technology of Penetron shall ensure permanent closure of leaking concrete towers & tanks as also protection of casing ,flue gas duct & to Stack.[CC]**

Scope 3 Emissions -Accounting & Reporting Standard -SBT

1: Purchased Goods and Services **Vendors**

2: Capital Goods

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

4: Upstream Transportation and Distribution

5: Waste Generated in Operations

6: Business Travel

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

DECARBONIZATION-
ACCELERATING NET ZERO EMISSION : ADVISORY

1) Energy Efficiency with Innovative & Proven Schemes for Total Energy Solutions
2) Renewable Energy Mix Augmentation off-setting Fossil fuel.
3) Circular Economy: Waste to Valued Resource Conversion
4) Maximizing Waste to Thermal /Electrical Energy Conversion
5) SGR/SEC reduction per unit of Product.
6) Absolute Gaseous /Solid/liquid pollutants discharge reduction
7) Scope 3 Emission [CFP] lowering through Logistics optimization - Raw Material & Fuel Sourcing, Vendor selection etc.
8) Digitalization –Automation & Controls +IIoT 5.0 Manufacturing
9) Carbon Capture & Utilization & Green Product Utilization
10) Water Conservation

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