ENERGY EFFICIENT INITIATIVES AT VEDANTA LANJIGARH

Driving Efficiency & De Carbonization for Climate change Through its NET ZERO efforts

Team Members:-

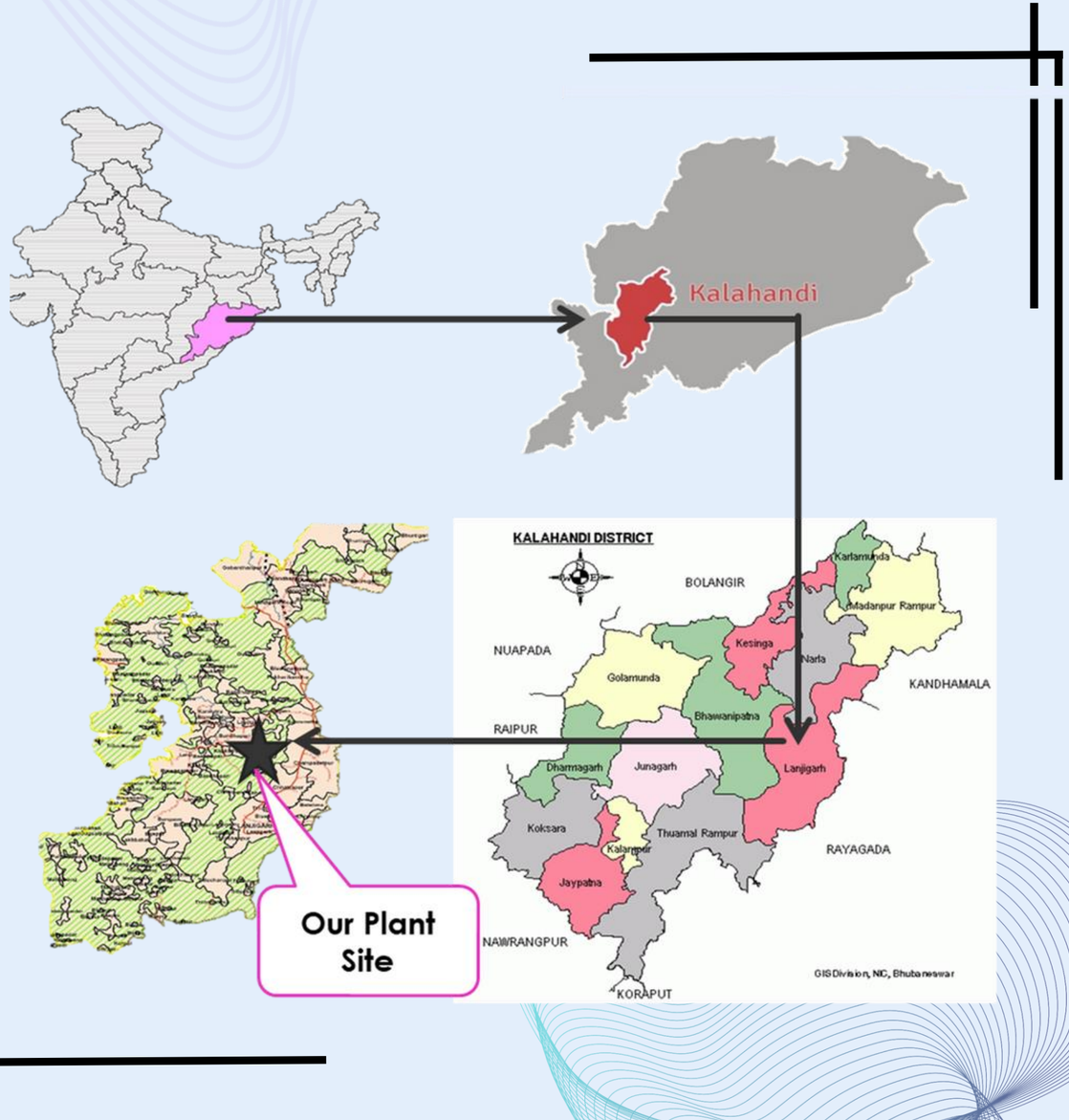
Sanjaya Kumar Jena – Deputy Head Commissioning & EM

Soumava Das - Deputy Manager, Energy & Carbon- Lead

Nihar R. Malla - Deputy Manager, CGPP Operation

Plant Profile

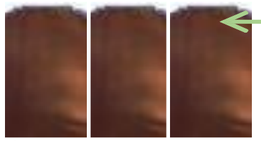
- Vedanta Limited, Lanjigarh (An ISO 9001, 14001, OSHAS 18001 certified Company) is a 2MTPA Alumina refinery plant which provide Smelter grade Alumina to its smelters in Jharsuguda and Balco
- 2 MMTPA Alumina production with 90 MW CGPP
- Comissioning is in progress : 2 to 5 MMTPA
- 32 Km long railway line
- 65 Km water pipeline
- Dry red mud disposal using press filter
- The 1st Organization to be ISO 50001 certified



Agenda

1. Alumina Manufacturing Process
2. Current Energy Trends and Major Projects taken
3. Benchmarking with Peer Groups
4. Top Projects
5. Emission Trends
6. Energy Management Systems
7. People Involvement in Energy Activities
8. Awards & Accolades

Alumina Manufacturing Process



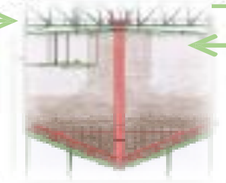
Pre-Desilication

Grinding

Crushing

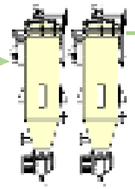
Bauxite Handling

Digestion



Settiers

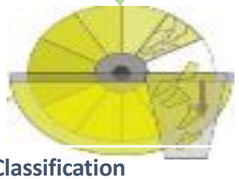
Washers



Security Filters

Precipitation

Cyclones



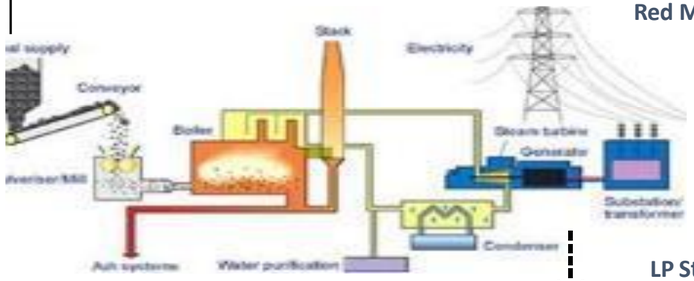
Classification

HP Steam

Red Mud pond

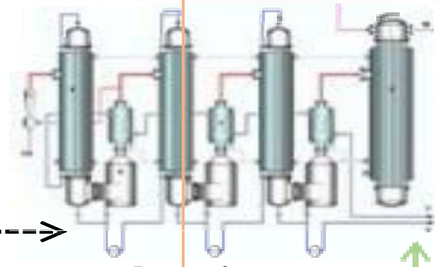
Red Mud Filter

Red Mud pond



Power Plant

LP Steam



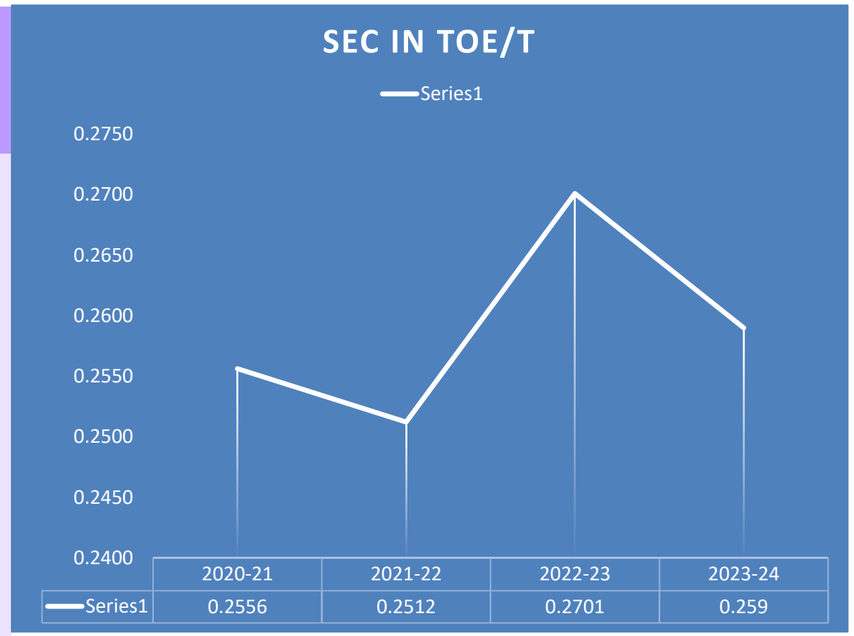
Evaporation

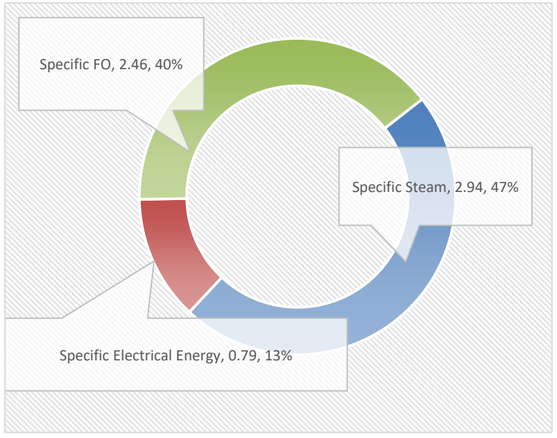
Calcination

C

Energy Mapping & Energy Distribution Chart

Year	Hydrate Alumina (MMTPA)	Calcined Alumina (MMTPA)	Power (Kwh/T)	FO (Kg/T)	Steam (T/T)	Total Energy (GJ)
FY - 20	18.25	18.11	216.8	1.73	70.59	7.27
FY - 21	18.48	18.41	215.7	1.72	71.13	7.25
FY - 22	19.69	19.68	217.5	70.63	1.68	7.16
FY - 23	18.55	17.92	226.7	72.05	1.68	7.17
FY - 24	18.03	18.13	227.5	69.05	1.74	7.24*





* **H1 Energy Consumption is 7.88 GJ/T due low bauxite availability . H2 Energy Consumption is 6.98 GJ/T**

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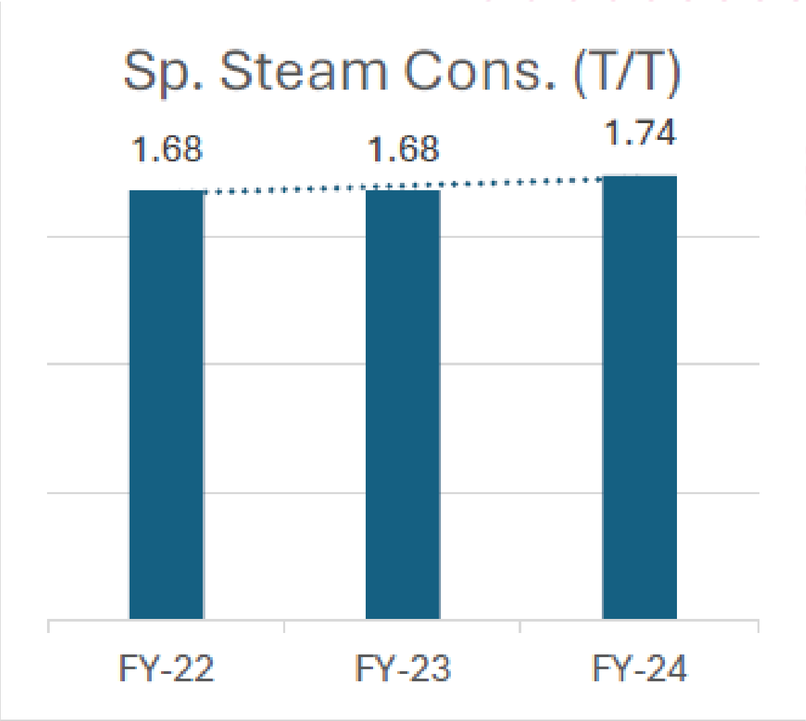
FY 23-24	Steam (T/T)	FO (Kg/T)	Electrical (Kwh/T)	Total Energy (GJ/T)
H1	1.87	69.28	231.05	7.90*
H2	1.68	68.79	217.23	6.98

Specific Steam

All the units are in T/T

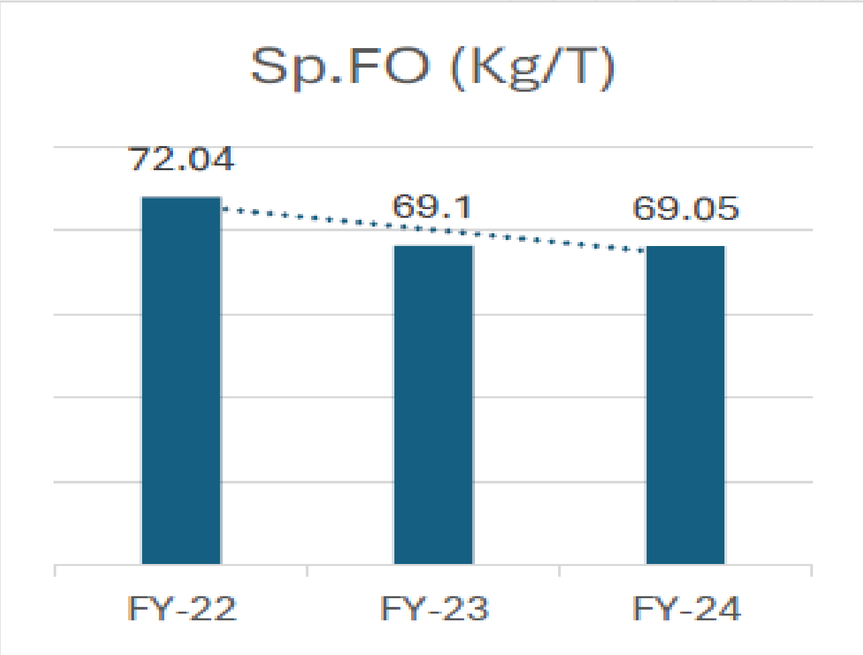


Projects

- Replacement of 4 nos. of Digestion heaters. Annual savings of 120 KT of steam.
- Calandria 1 replacement in Evaporation 1 & 2. Annual Savings of 40 KT of steam.
- Max HT dosing in Evaporation Units resulting in steam saving of 20 KT per annum.
- APC in Evaporation units Specific Steam improvement by 0.01 T/T.
- Replacement of Steam traps in Digestion and Evaporation units.
- Specific Steam improvement by cleaning and overhauling indirect pass heaters of Digestion unit

Specific FO

All the units are in Kg/T

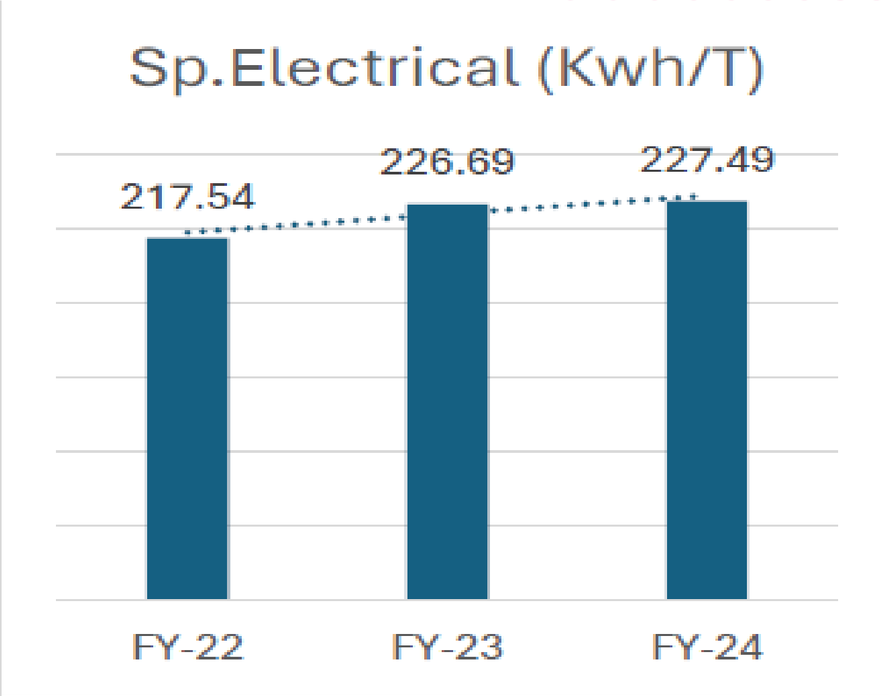


Projects

- Air ingression arrest in Calciner 1&2 venturi/ESP/other cyclones. Annual savings of 100 KT of HFO.
- Refractory replacement and overhauling of Calciner 1 and 2. Annual savings of 100 KT of HFO
- Advance Process Controllers in Calciner units to improve Specific FO by 0.1 Kg per Ton.
- Implementation of online blind system for anytime CCl of Pan filter-0 & trail of Filter-Max 482FM to reduce hydrate moisture with potential saving in Specific FO by 0.1 Kg/T

Specific Electrical

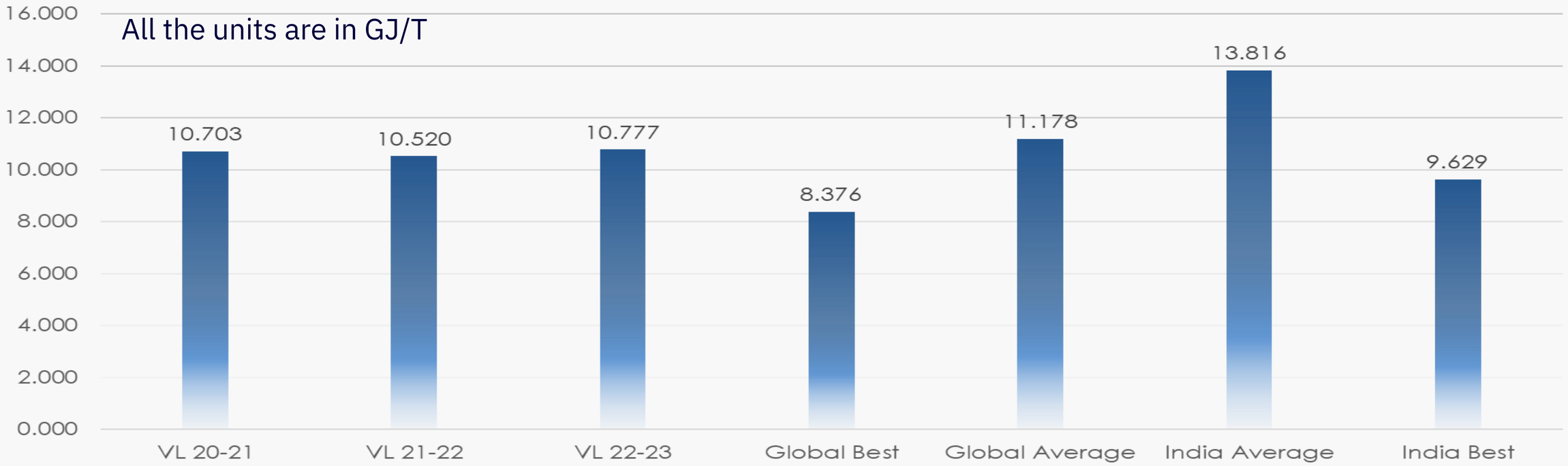
All the units are in Kwh/T



Projects

- Conversion of Condensate pumps in Digestion & GQC pumps in Evap unit from DOL to VFD. Annual Savings of 6.9 lakh units of electrical energy.
- Conversion of one HST overflow motor from DOL to VFD. Annual Savings of 4.32 lakh units of electrical energy.
- Energy Saving initiatives in main air compressor house. Annual Savings of 22.74 lakh units of Electrical Energy.
- Antfrictional Coating in Alkaline CW pumps (2 nos.) Annual savings of 4.7 lakh units of electricity
- Net liquor productivity improvement froom 82 gpl to 85 gpl to yield savings of 2 Kwh/T per GPL improvement.
- Power factor improvement from 0.81 to 0.94 across all substations
- Installation of ASVG in SWR 4.1 to mitigate harmonics as per IEEE norms.
- Replacement of 172 nos. of IE 1 motor to IE 3 motors . Annual savings of 1800 Mwh per year.

Performance Benchmarking

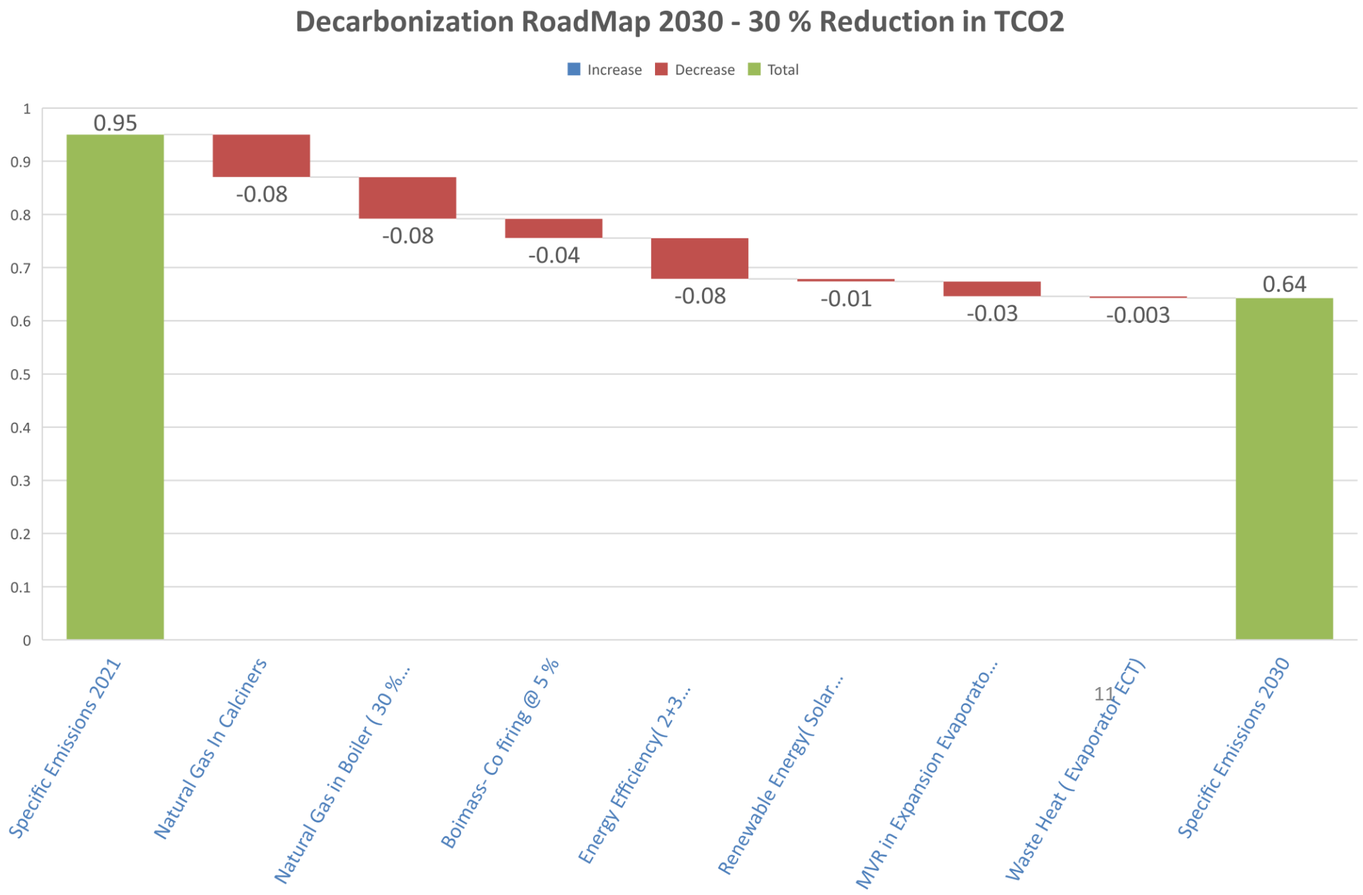


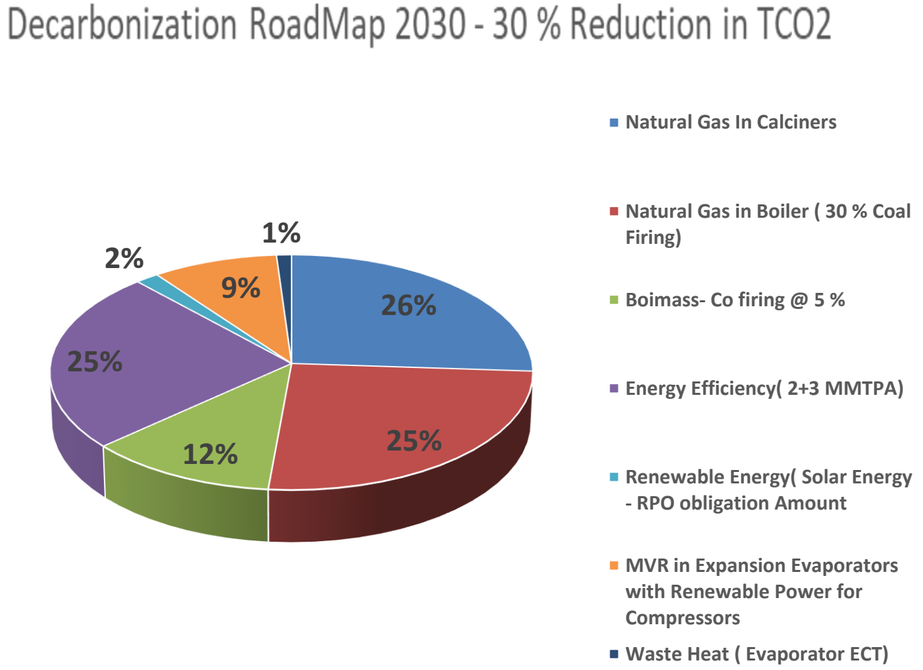
Energy Parameters	Global Benchmarking (Alunorte, Brazil)	National Benchmarking (Utkal Alumina, Tikri)	Vedanta Lanjigarh (Best Achieved)
Specific Steam	1.55	1.74	1.56
Specific FO	78.8	69.8	68.33
Specific Electrical	160	153	206.33
CGPP Energy Consumption	1.23	3	3.08
Total Energy Consumption	8.38	10.02	9.63

Key Projects towards path of Decarbonization

- Usage of Natural Gas in 5 Calciners instead of Furnace Oil
- Setting up of Biomass supply chain for Biomass firing in Boilers @ 1000 T per month.
- Waste Heat Potential Recovery Evaporator (ICT turbine) in Evaporators , Calciner Waste Heat recovery in Cooling tower
- Anti frictional Coating in 16 nos . Water Pumps for 6-8 % Energy Saving
- Compressor Energy Saving initiatives like ZLDS, Demand controller in precipitation area
- Improvement of Heat Transfer Coefficient in Digestion heaters
- Reduction in Specific Coal Consumption and improvement of SHR by 3 Boilers Senior APH tube replacement and Economizer Coil replacement
- Improvement of Liquor Productivity to 88 gpl
- Exploring Solar potential in plant up to 4.6 MWp & PPA with Serentica Energy for 10 MW Hybrid plant

Roadmap Towards Green Alumina





Major Implemented Projects

Key projects impacting Specific Coal consumption and Station Heat rate

TG 2 steam economy improvement: - Overhauling of Governing Valve & Condenser cleaning .Steam Economy of Turbine Main Steam Improved by 0.1 T/MW. GHG savings of 8800 tons of Co2.

Boiler 1&3 APH performance improvement : - Air preheater replacement in boiler to improve specific coal and Thermal efficiency with coal savings of 23.4 KT. Energy Saving of 2.98 Lakh GJ and GHG savings of 28113 tons of Co2.

Key projects impacting Specific Steam consumption

Digestion Heater performance improvement: -Replacement of 2800 tubes in 4 passes of live 2 steam heaters and complete tube replacement of 3 heaters resulting specific steam consumption reduction of 0.05 T/T alumina and annually 17000 tonnes of Co2 GHG savings

Evaporation 1 & 2 Calandria 1 tubes replacement: - Scaling inside calandria tubes affect Specific steam consumption. Energy Saving of 0.8 Lakh GJ and GHG savings of 8134 tons of Co2.

Major Implemented Projects

Key projects impacting Specific Electrical & FO consumption

Calciner 1 Efficiency Improvement: - To minimize heat loss in calciner. To arrest air ingress in furnace and to improve Specific FO. Energy Saving of 0.86 Lakh GJ and GHG savings of 5900 tons of Co2.

Installation of Capacitor Banks in 5 Substations: - Power factor in all Substations improved from 0.87 to 0.95 with installation of HT capacitors. Annual GHG savings of 898 tons of CO2.

Ball Mill 1 & 2 Throughput improvement :- Throughput improvement of both ball mills with modifications in Product pump and Grinding media segregation leading to throughput improved from 210 TPH to 280 TPH. Annual savings of 5500 tons of CO2.

Anti frictional Coating in CW pumps :- Alkaline CW pumps anti frictional coating were done resulting in 4.8 lakh units of electrical energy savings

Implemented Projects- Innovative

<u>Project-1 :</u> Evaporation 1 & 2 Steam Economy improvement from 3.5 to 3.8 T of moisture/T of steam

Description of the Project :

- Steam Economy was less at 3.5 T/T against the design of 4.1 T/T
- Evaporation rate of 520 tph required against running of 440 tph in Calendria
- Requirement of running 3rd evaporator with increase in running hours
- Replacement of 4600 tubes in two calendria with tubes with more surface area

Implementation:

- Replacement of tubes 2300 per calendria in both evaporators
- Maxtreat anti-scalent dosing system installation for further prevention of dosing

Horizontal Deployment:

- **Evaporation 3 steam Economy improvement**

Parameters	Target	06-05-24			MTD		
		TR-1	TR-2	TR-3	TR-1	TR-2	TR-3
Feed Al2O3 (gpl)	93-98	105.29			105.75		
Feed RP	0.65	0.71			0.70		
Feed Density (T/m3)	1.25	1.259	1.241		1.254	1.241	
Discharge flow (m3/hr)		794	810		771	808	
Discharge temp (0C)	85	90.21	90.72		90.49	89.26	
Discharge Na2O (gpl)		207.08	206.19		201.33	197.34	
Discharge Al2O3 (gpl)		147.16	145.44		141.21	137.09	
Discharge RP		0.71	0.71		0.70	0.69	
Discharge Density (T/m3)		1.33	1.33		1.32	1.33	
Test Tank Na2O (gpl)	180	184.76			185.80		
Test Tank Al2O3 (gpl)		129.83			127.01		
Test tank RP	0.632	0.70			0.68		
Evaporation Rate (tph)	270	250	247	0	230	228	204
Steam Economy (T/T)	3.8	3.78	3.76	0.00	3.97	3.86	3.77
Hotwell in caustic (gpl)	<1						
Hotwell out caustic (gpl)	<1			0.00			
Cooling tower caustic (gpl)	<1	0.93			0.75		
Raw caustic dosage (TPH)		0.00			20.77		
Raw caustic dosage Operating Hour		0.00			12.99		

Tangible Benefits

- **Steam Energy Savings: - 40000 T per annum (in two evaporators)**
- **GHG savings: - 9500 T Co2 per annum**

Intangible Benefits

- **Improvement in evaporation rate from 440 tph to 500 tph**
- **Running hour reduction of 3rd evaporator**

Implemented Projects- Innovative

Project-2 : DBNK Cooling Water Pump Interconnection line

Description of the Project :

- Two separate trains of cooling water in operation with 2 pumps in 2 trains
- 4 pumps were running 1300 m3/hr with 65 % of the capacity
- CBM issues were high due to lower flow with high pump breakdown
- 3 pumps were sufficient to provide the total flow of 5200-5400 m3/hr

Implementation:

- Pump manufacturer meeting and TCE team was involved in flow & line size determination
- An interconnection of 20 Inches sufficient for 1 pump flow with two interconnect valves were made in the Discharge supply header

Tangible Benefits

- **Electrical Energy Savings: - 2150 Mwh per annum**
- **GHG savings: - 1520 T Co2 per annum**

Intangible Benefits

- **Improvement in flow Rate in 3 pumps 1800 m3/hr**
- **Cell shutdown activities can be planned**

Implemented Project- Innovative

Project-3 : Anti frictional Coating in Alkaline Cooling water Pumps

Description of the Project :

- Flow & Head in Cooling water pumps was less than design , resulting in running of 3rd pump
- Antifrictional (bellazona) coating to reduce the frictional losses in the pump
- Loss reduction to increase flow

Implementation:

- Ball Blasting of the pump impeller to smoothen impeller edges
- 3 layer coating of the impeller & casing by Kirloskar Pumps
- Trial taken in 2 pumps of Alkaline Cooling Tower area

Horizontal Deployment:

- **In stage -2 14 more pumps to be coated with Anti frictional coating**

Tangible Benefits

- **Electrical Energy Savings: - 469 Mwh per annum**
- **GHG savings: - 355 T Co2 per annum**

Intangible Benefits

- **Increased flow in the two pumps coated**
- **Prevention of running of 3rd pump**

Project & Striving for Continual Improvement

69000 Tons of CO2 saved in FY 2024 from ENCON projects

Year	No. of Energy Saving Projects	Investment(in crores)	Electrical Savings (million Kwh)	Thermal Savings (GJ)	Savings (In Crores)
FY 2020-2021	7	1.12	34.2	13.4	11.97
FY 2021-2022	15	7.63	5.5	339759	15.92
FY 2022-2023	32	44.72	20.12	914709	61.5
FY 2023-2024	**29**	**40.88**	**10.54**	**591585**	**48.25**

Project Year	No of Projects	Total Savings in GJ	Total Investment(in crore Rs)	Annual finacial savings(in crore Rs)	Impact on GHG(TCo2)	Imapct in SEC (GJ/Tof alumina)	$/T of alumina Impact
2024-25	25	1037514	51.89	71.32	103902	0.518	3.26

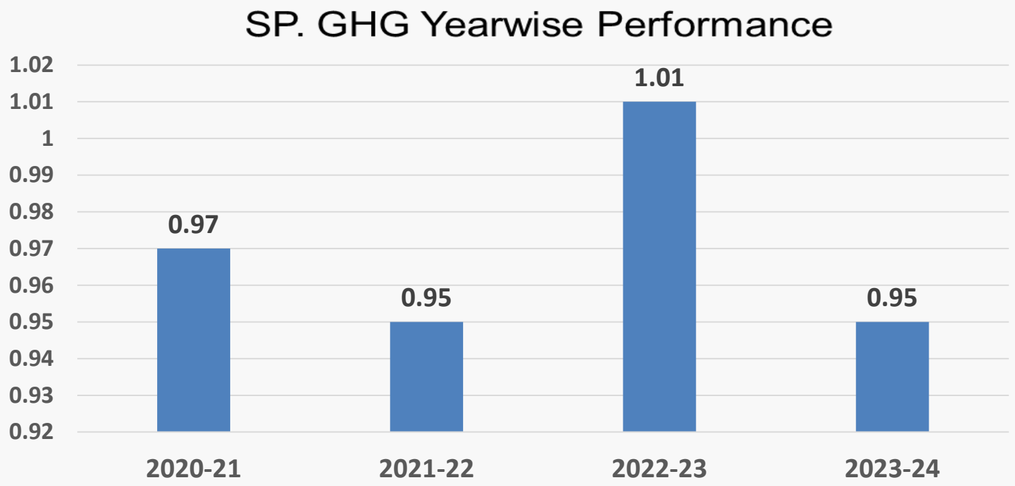
Renewable Energy Sources

FY	Installation Capacity	Generation (in Million Kwh)	Import (IEX/PXIL) (in Million Kwh)	Percentage share
FY-22	180 KWp	0.084	0.671	0.145
FY-23	180 KWp	0.138	6.667	1.32
FY-24	180 KWp	0.038	0	0.148

Key Highlights

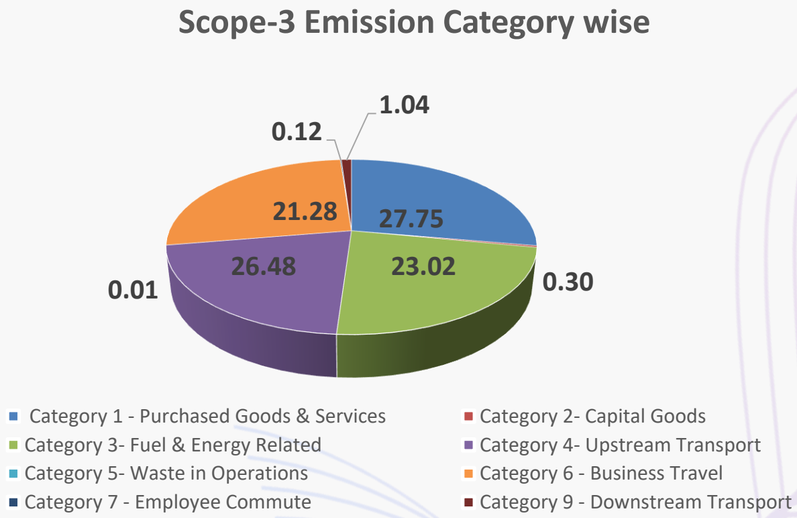
- 6667 MU of Renewable energy imported through IEX and PXIL platforms in FY 23
- Feasibility study of 4.6 MWp carried out by Evolve Solar in Lanjigarh Plant area
- 458 T of Biomass fired in our Co-gen Boilers & 1000 T/Month FY 25 is planned
- First Bio- diesel trial taken in Trucks (Red Mud Discharge Unit) & EV Charging Station Set up in Colony

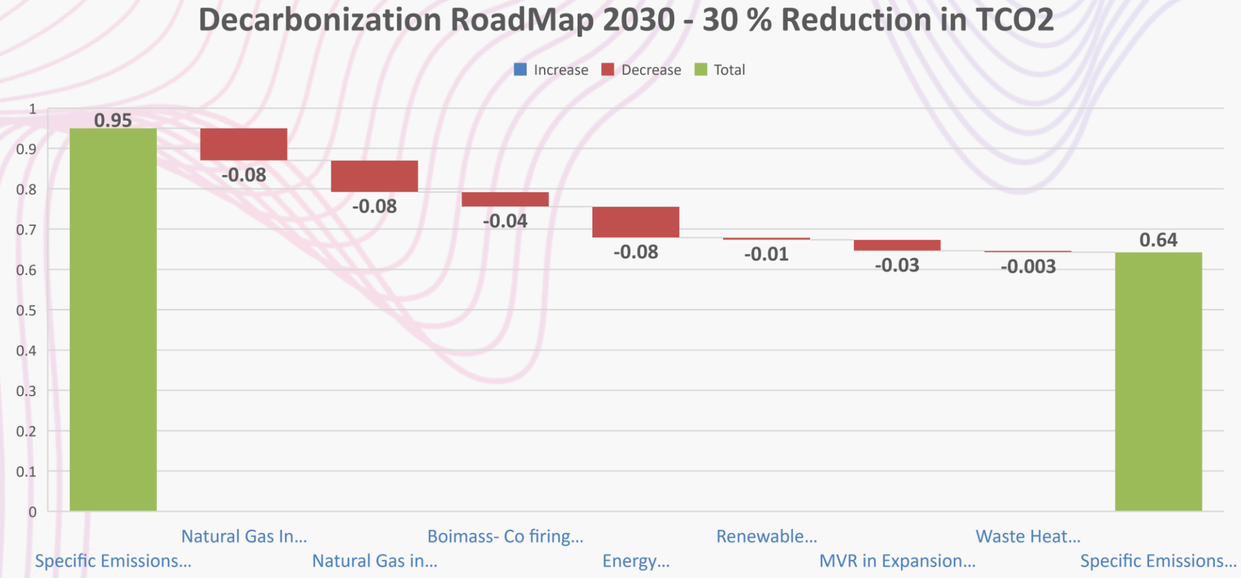
TCO2 Emission Trend & Reduction plan



*** TCO2 Emissions Scope 1 & 2**

- Proper Categorization of TC02 Emissions with Monthly Reports & Online Tracking sheets
- Scope emission category definition & calculation on quarterly basis
- Digital Enablon reporting of Scope 1,2 & 3 Emissions
- Reduction plan preparation on category wise





Waste Management – Circular Economy

❖ **Ash Utilization :**

- 5.50 Lakh MT/Annum of Ash utilized in FY24 .
- Given free to 130 local brick manufacturing units that are developed in the plant vicinity.
- Partnered for road construction inside the plant & in nearby villages.
- Utilized in dyke strengthening of the tailing dams like BRDA & PWL etc. and in wick drain Project.
- Fly Ash is being utilized by sending it to NHAI Vendors for road construction.

❖ **Red Mud Utilization projects :**

- **Long-term MOUs with cement industries:** Site has signed MOUs with cement industries like M/s Ultratech, M/s Wonder Cement and M/s Bharathi Cements for red mud utilization.

❖ **Lime Grit Utilization :**

- Lime grit is majorly sent to Local brick manufacturers for free to increase the local people engagement.
- It is also used internally for filling the road bags .

Details	Unit	Generation	Disposal	%Utilisation
Ash	MT	386803	550599	142.3
Red Mud	MT	2420999	109094	4.5
Lime Grit	MT	10768	13257	123.1

Hazardous Waste Management

Hazardous Waste Management - As per Hazardous and Other Wastes (Management and Transboundary Movement Rules), 2016.

Hazardous Wastes	Utilization / Disposal Method
Used Oil	Sale to SPCB Authorized recyclers
Spent Resin	Co-incineration in CPP
Sludge contaminated with oil	Co-processing in SPCB authorized cement kiln
Oily Cotton Waste	Co-processing in SPCB authorized cement kiln
Hazardous Containers	Dispatched to actual user authorized by SPCB
Mercury wastes	Disposal to CHWTSDF
Vanadium Sludge	Sale to SPCB Authorized recyclers
Unused copper cable	Sale to SPCB Authorized recyclers

Other Waste Management

Other Wastes	Utilization
Housekeeping Waste, Waste Gunny bags	Municipality
Food Waste	Biogas Plant
Horticulture Wastes	Vermicompost Pit
Paper/ cardboard	Scrap recycler
Packaging Wood	Scrap recycler
Plastic Scrap	Scrap recycler
Metal Scrap	Scrap recycler
Rubber Scrap	Scrap recycler
Empty Drums (Plastic / Metal)	Scrap recycler
Empty Lime Bags	Scrap recycler
E Wastes	Sale to authorized recyclers.
Used Batteries	Buy back to supplier

MUNICIPAL SOLID WASTE MANAGEMENT

- All the MSW wastes from Plant & Township **are disposed to Cement plant for coprocessing through Municipality.**
- **Waste segregation** at source for Dry Waste & Wet Waste

PATHWAY FOR SCRAP DISPOSAL

Collection and segregation of scrap in Red Tag area → Regular scrap **transfer to Scrap yard** → Auction and sell of **scrap to Recyclers**

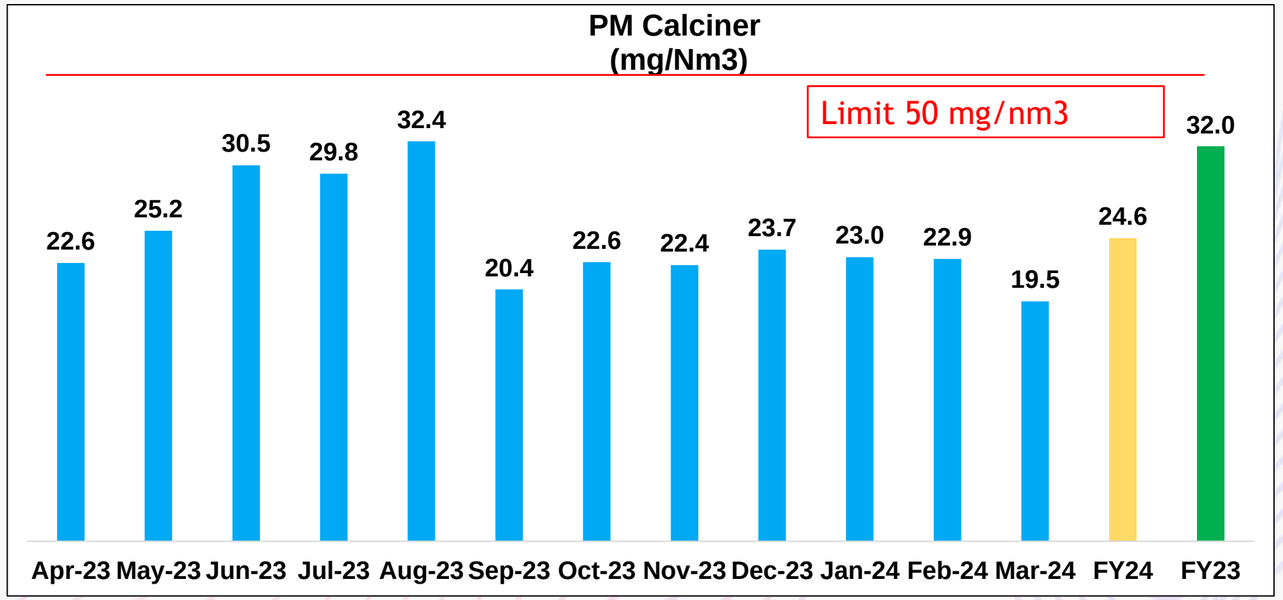
Air Quality Management

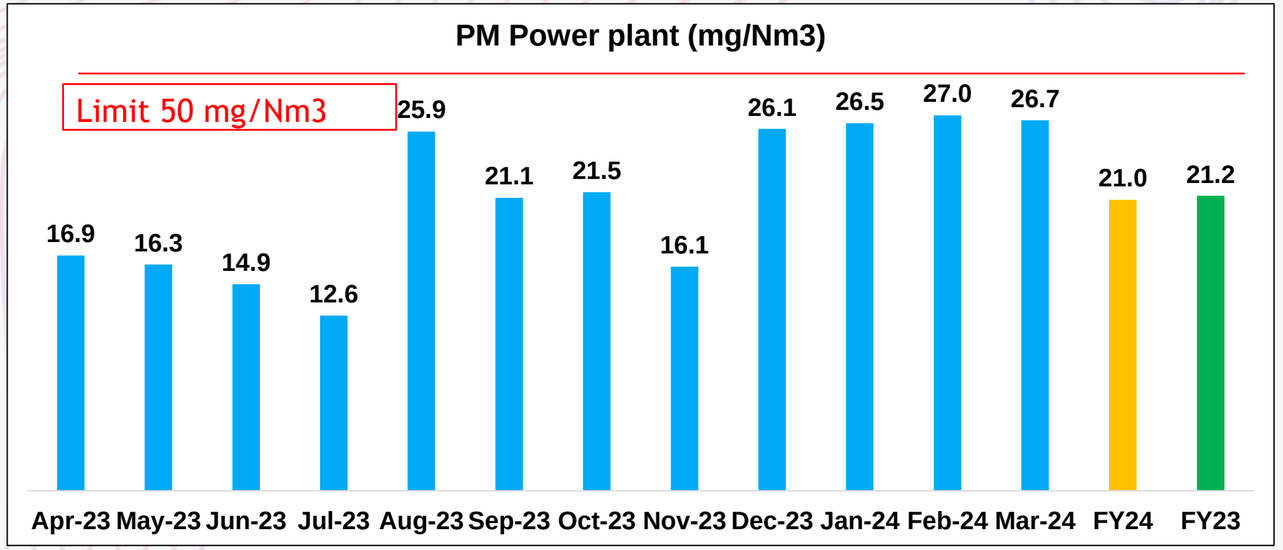
Continuous Ambient Air Quality Monitoring Station (CAAQMS)

CEMS at Power Plant

CEMS at Calciner

Water sprinklers at bauxite handling





Natural Carbon Sink

- Greenbelt development in more than 33% of the total occupied area.
- Plantation of 10.30 lakhs up till FY24.

BIRD CONSERVATION DRIVE

MASS PLATATION DRIVES

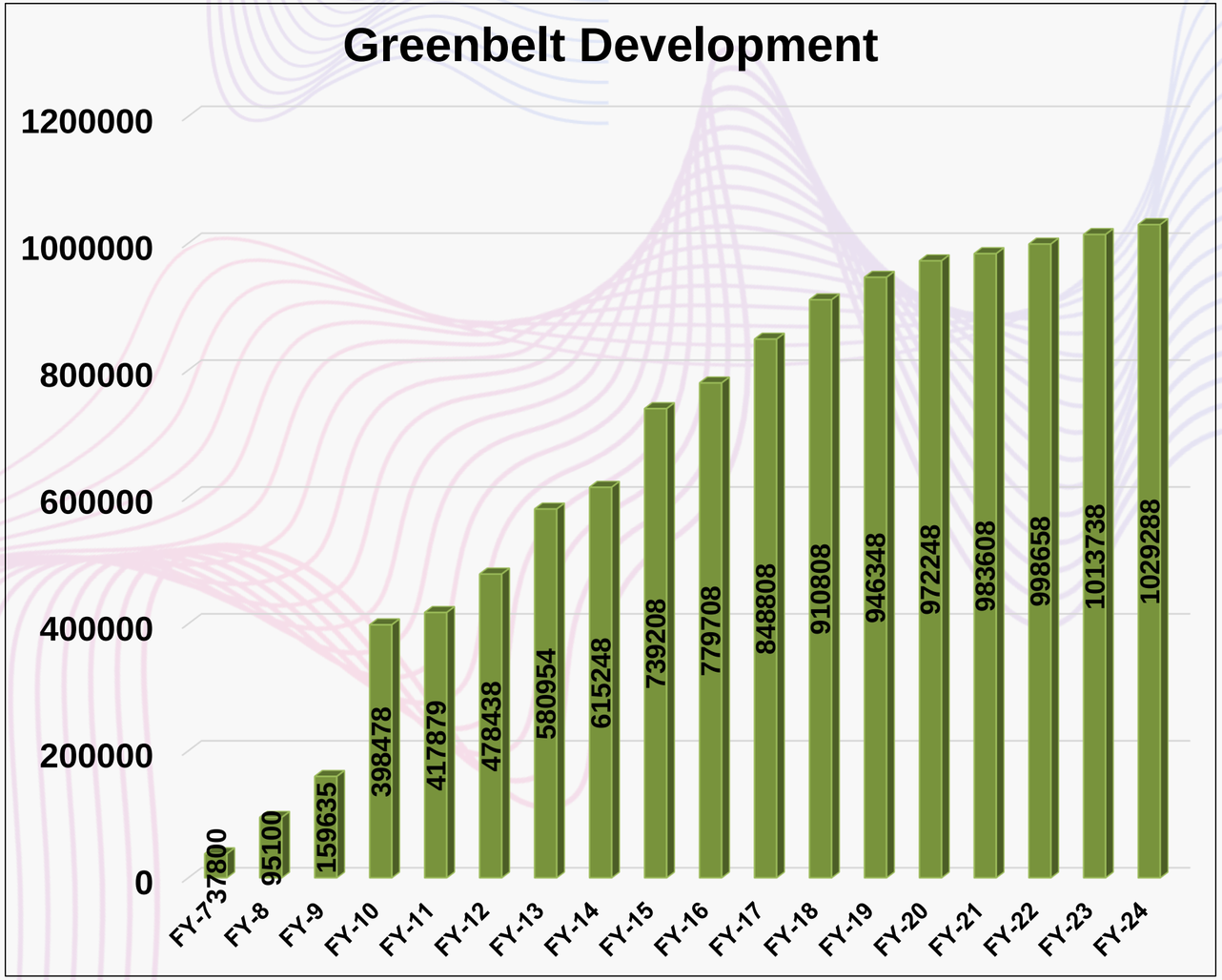
AWARENESS CAMPAIGNS

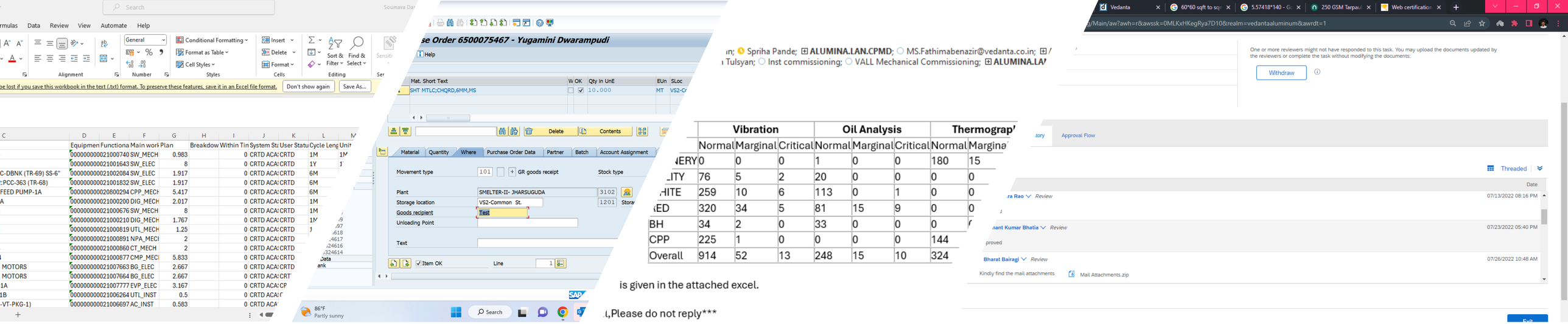
Biodiversity Management & Green Belt Development

TOWNSHIP

RED MUD POND AREA

PLANT SITE





Best Digital practices – Energy Management

- MES based energy data back up
- Digital Dashboards for Energy Review
- SAP based Coal , FO & Power tracking
- SAP – ARIBA based Energy procurement
- Digital Health monitoring of Energy Intensive Assets

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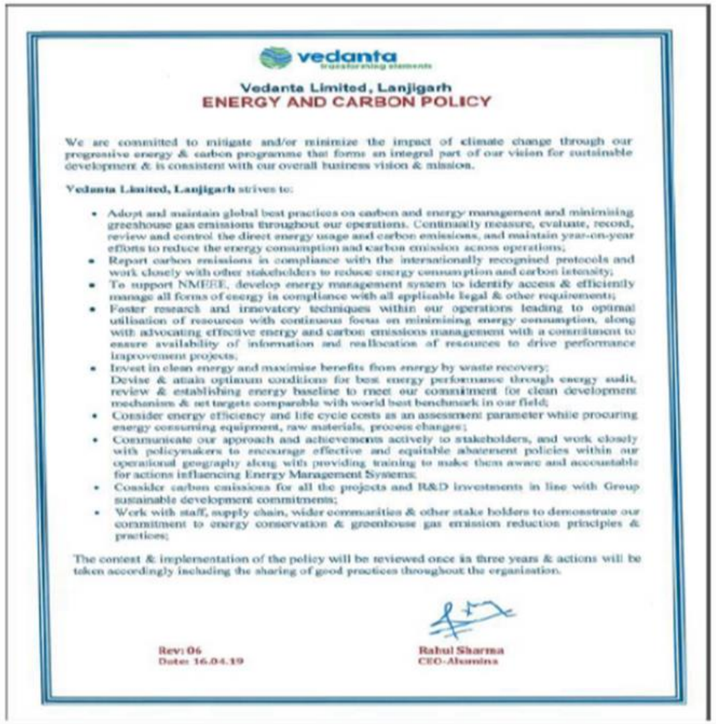
N.AO; Vrinda Sharma

	M Within Timeline	PM Within Scheduled Period	PM Closure Compliance	PM Timeline Compliance	PM Schedule Compliance	PM Past Required by date by > 7 days	Total Open PM	PM > Days Overd
J	10	10	52.63	52.63	52.63	0	9	0
10	9	10	34.48	31.03	34.48	0	19	0
0	0	0	0	0	0	0	10	0
.6	2	2	2	12.5	12.5	12.5	0	14	0
152	127	125	127	83.55	82.24	83.55	0	25	0
26	1	1	1	3.846	3.846	3.846	0	25	0

EnMS ISO 50001:2018 & ESG



vedanta

Vedanta Limited, Lanjigarh

ENERGY AND CARBON POLICY

We are committed to mitigate and/or minimize the impact of climate change through our progressive energy & carbon programme that forms an integral part of our vision for sustainable development & is consistent with our overall business vision & mission.

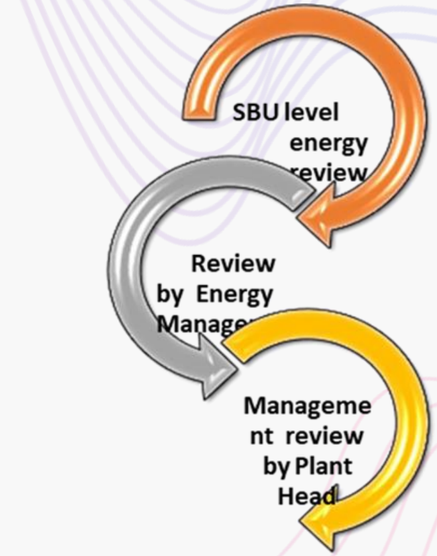
Vedanta Limited, Lanjigarh strives to:

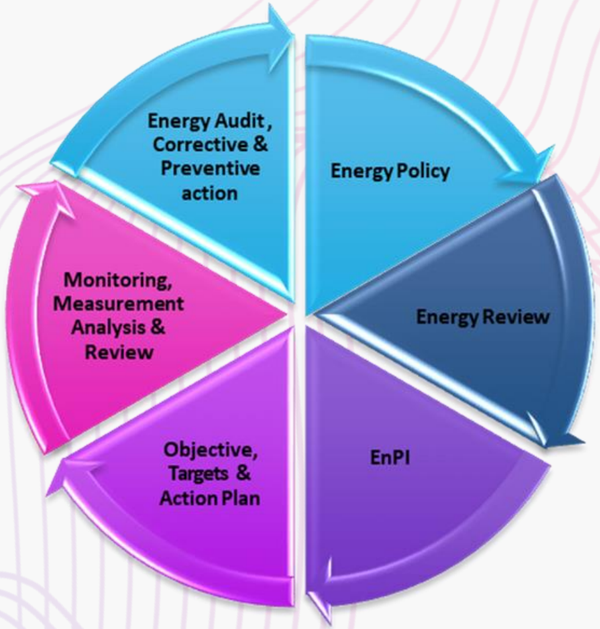
- Adopt and maintain global best practices on carbon and energy management and minimising greenhouse gas emissions throughout our operations. Continually measure, evaluate, record, review and control the direct energy usage and carbon emissions, and maintain year-on-year efforts to reduce the energy consumption and carbon emission across operations;
- Report carbon emissions in compliance with the internationally recognised protocols and work closely with other stakeholders to reduce energy consumption and carbon intensity;
- To support NMEEE, develop energy management system to identify access & efficiently manage all forms of energy in compliance with all applicable legal & other requirements;
- Foster research and innovatory techniques within our operations leading to optimal utilisation of resources with continuous focus on minimising energy consumption, along with advocating effective energy and carbon emissions management with a commitment to ensure availability of information and reallocation of resources to drive performance improvement projects;
- Invest in clean energy and maximise benefits from energy by waste recovery;
  Devise & attain optimum conditions for best energy performance through energy audit, review & establishing energy baseline to meet our commitment for clean development mechanism & set targets comparable with world best benchmark in our field;
- Consider energy efficiency and life cycle costs as an assessment parameter while procuring energy consuming equipment, raw materials, process changes;
- Communicate our approach and achievements actively to stakeholders, and work closely with policymakers to encourage effective and equitable abatement policies within our operational geography along with providing training to make them aware and accountable for actions influencing Energy Management Systems;
- Consider carbon emissions for all the projects and R&D investments in line with Group sustainable development commitments;
- Work with staff, supply chain, wider communities & other stake holders to demonstrate our commitment to energy conservation & greenhouse gas emission reduction principles & practices;

The content & implementation of the policy will be reviewed once in three years & actions will be taken accordingly including the sharing of good practices throughout the organisation.

Rev: 06
Dated: 16.04.19

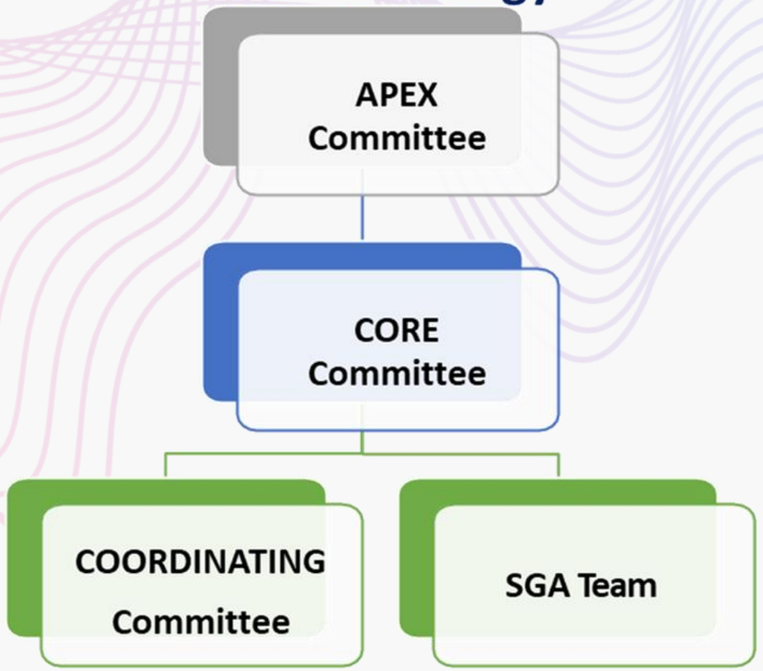
Rahul Sharma
CEO-Alumina



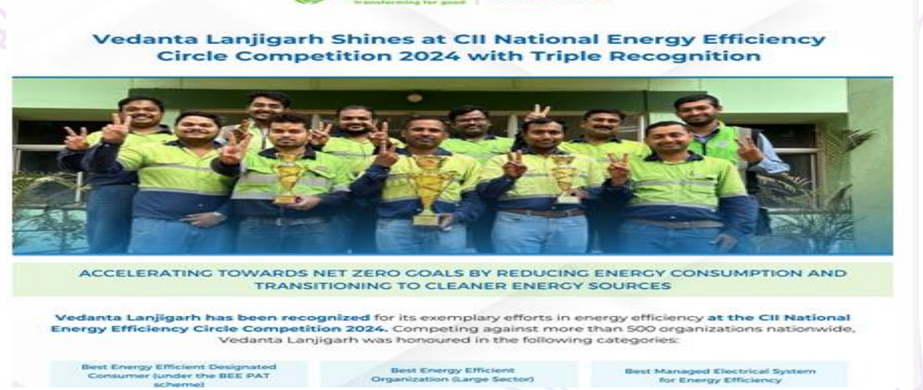


EMS (ISO-50001:2018)

Formation of Energy Cell



PAT , Escerts & Awards



VL-Lanjigarh Received 15044 Escerts in PAT-II cycle compared to 762 certificates received in PAT-I cycle.

→ Organization received first ever National energy conservation award (first prize) for the year 2020 by BEE and MIP.

Till date 6852 nos. of EsCerts were sold generating a revenue of 1.2 Crore INR in FY 23-24

→ For FY 24-25 cycle till date 1050 Escerts sold

Energy Awards & Recognition:

- **CII Energy Circle Best PAT DC , Energy Efficient Unit & Best Electrical Distribution System**
- **CII Hyderabad – Excellent Energy Efficient Unit award**
- **Orissa State Energy Efficiency Award – SDA BEE Cell (2 consecutive years)**
- **Kalinga Award : 5 star category 2024 in Energy Efficiency from IQEMS**

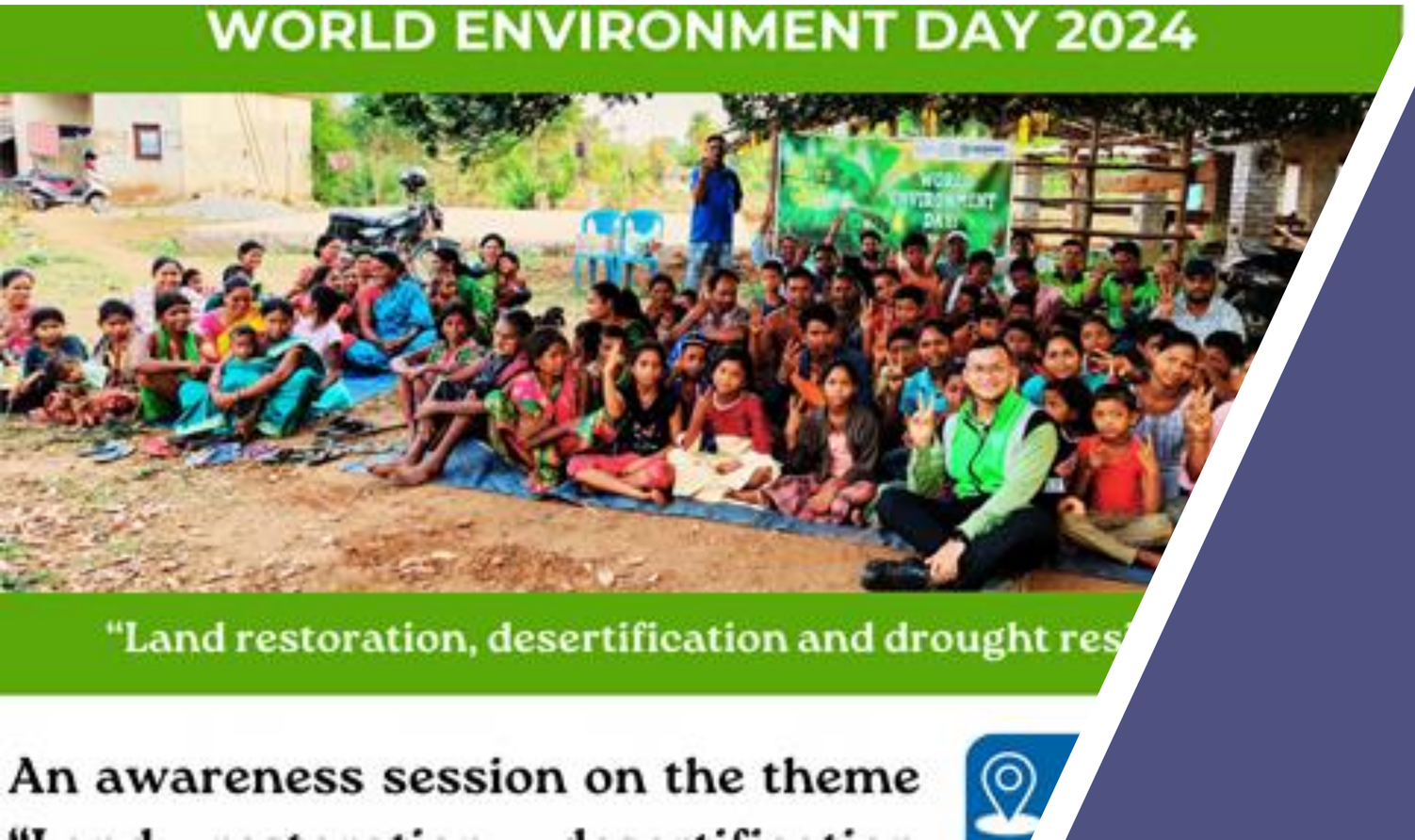
Vehicle Decarbonization Drive at Vedanta Lanjigarh

- 4 out 6 Forklifts converted to EV . 8 EV forklifts conversion targeted till FY 25
- Employee Friendly EV policy
- EV charging infrastructure in township
- Bio-dieseal trial in trucks

The Inauguration

Key handover to Mr. Subhashish Mund(1st buyer)

By setting up the first-ever EV stall, Vedanta Lanjigarh welcomes employees and business partners and aims to make sure they have a hassle-free experience by offering two-wheeled EVs at the doorstep. This aligns with our slogan as we work toward achieving our ESG (environment, social, and governance) objectives. As part of this program, we've teamed up with Ather to provide Vedanta employees with a special discount on their cutting-edge electric scooters. Our dedication to lowering our carbon footprint and promoting environment friendly mobility choices among our employees is demonstrated by the EV policy. The first buyer received the key from our respected CEO, **Mr. Pranab Kumar Bhattacharya**, who inaugurated the ceremony.



Energy Efficiency as Brand

Mr. Pranab Bhattacharya
(CEO- Vedanta Lanjigarh)

pranab.bhattacharyya@vedanta.co.in

9124570828

Mr. Sanjay Kumar Jena
(Deputy Head Commissioning & E.M)

Sanjaya.Jena@Vedanta.co.in

9937292875

Thank you !

Aiming to create a more beautiful, sustainable, clean planet . . .