UK Government

Bureau of Energy Efficiency
Ministry of Power, Government of India

Knowledge Exchange Platform
Transmitting Knowledge through Best Practices

ASPIRE PROGRAMME

Accelerating Smart Power & Renewable Energy in India

Domestic Study Tour of

ADITYA ALUMINIUM PLANT, LAPANGA, ODISHA

21st November 2022

Hosted by:
Aditya Aluminium, Lapanga, Odisha
(A Unit of Hindalco Industries Ltd.)

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About ASPIRE Program
Accelerating Smart Power and Renewable Energy in India (ASPIRE) is a bilateral program implemented by Foreign Commonwealth and Development Office, Government of UK in association with Ministry of Power and Ministry of New and Renewable Energy, Government of India. KPMG is the lead delivery partner for the ASPIRE programme. Idam Infrastructure Advisory Private Limited (India) and Carbon Trust (UK) are the key consortium members.

ABBREVIATIONS

Abbreviations	Acronyms
ASPIRE	Accelerating Smart Power and Renewable Energy in India
ATV	Anode Transport Vehicles
BALCO	Bharat Aluminium Company Limited
BEE	Bureau of Energy Efficiency
BFP	Boiler Feed Pump
CEP	Compensate Extraction Pump
CFD	Computational Fluid Dynamics
CPP	Captive Power Plant
CuCB	Copper Inserted Collector Bar
FCDO	Foreign Commonwealth and Development Office
GAP	Green Anode Plant
IEED	Industrial Energy Efficiency and Decarbonisation
ID	Induced Draught
JNARDDC	Jawaharlal Nehru Aluminium Research Development and Design Centre
MTT	Metal Transport Truck
MU	Million Unit
MW	Megawatt
NALCO	National Aluminium Company Limited
PAT	Perform Achieve Trade
PTM	Pot Tending Machine
R&D	Research and Development
RTA	Rio Tinto Alcan
TPA	Tonnes per annum
VFD	Variable Frequency Device

01

BACKGROUND

The Indian Aluminium industry **is the second largest producer** in the world with a share of ~**5.3%** of the global output. Indian aluminium industry is highly concentrated with majority of the country's aluminium being produced by the top five companies. Indian aluminium industry in India is thriving at an enviable growth rate of 7% per annum, which is one of the highest in the world.

The Aluminium sector is one of the designated sectors covered under Bureau of Energy Efficiency's (BEE) Perform, Achieve, Trade (PAT) scheme. The fourteen industries from aluminium sector, covered under the PAT scheme, cumulatively consume **10.85 MTOE** and emit **37.13 MTCO2e** annually. These industries offer an energy saving potential of **1.06 MTOE** and decarbonisation potential of **3.63 MTCO2e**. Leading Indian aluminium industries have recently announced several initiatives as part of their decarbonisation and net-zero commitments.

In view of this, a **domestic study tour of Aditya Aluminium, Lapanga** unit in Odisha was organised on 22nd November 2022 under ***Accelerating Smart Power and Renewable Energy in India (ASPIRE)' programme***. The purpose of the study tour was to demonstrate and disseminate the various **best practices**, new and innovative industrial energy efficiency and decarbonisation **(IEED) technologies** adopted by the above-mentioned aluminium unit. The study tour was jointly organised by FCDO and Bureau of Energy Efficiency (BEE) with the support of Aditya Aluminium and Hindalco Industries Ltd. (part of Aditya Birla Group). The study tour was preceded by a sectoral workshop on ***"Best Practices in Energy Efficiency & Decarbonisation in Aluminium Sector"*** on 21st November 2022 at Aditya Aluminium.

Objective of the study tour

- To disseminate and demonstrate new and innovative IEED technologies and best practices adopted by Aditya Aluminium
- To enable other industries in the aluminium sector, reduce their overall specific energy consumption and adhere to the compliance requirements under BEE's PAT scheme
- To foster an ambitious, mutually beneficial, and outcome focused relationship between industry stakeholders

Highlights

50+ **Participants**

Visit to key areas of the plant to understand various IEED measures adopted across the plant including the pot room, smelting plant and captive power plant (CPP):

- Copper insert collector bar/ Cathode (CuCB) deployed in the potline
- Power BI and AI based energy management and analytic platform
- De-staging of boiler feedwater pumps
- Retrofitting of cooling tower fan blades
- Implementation of Variable Frequency Drive (VFD) on condensate extract

Active participation from the government agency, industrial organisations, and technology providers from India

02

OVERVIEW OF ADITYA ALUMINIUM PLANT
(A UNIT OF HINDALCO INDUSTRIES LIMITED)

Figure: Nightview of Aditya Aluminium Plant, Lapanga, Odisha

Hindalco Industries Limited is one of the **largest integrated primary producers of aluminium** in Asia. The organisation is an important player in aluminium and downstream value-added products and carries out many activities in this field such as **bauxite mining, alumina refining, aluminium smelting, downstream rolling, extrusions and recycling**.

Aditya Aluminium Smelter is a flagship unit of Hindalco located at Lapanga, Sambalpur, Odisha. The plant has a production capacity of **380,000** tonnes per annum (TPA) powered by a **900 MW captive plant**. The smelter plant is based on **AP-36S technology** (RTA) from Aluminium Pechiney, France involving numerous processes, quality parameters, and safety aspects at different levels. The process is quite intricate in nature as it handles very high electric current levels to the tune of **368 kA** and new-generation controls.

The unit is certified by M/s LRQA for QMS (ISO 9001:2015), EMS (ISO 14001:2015), EnMS (ISO 50001:2018), and OHSMS (ISO 45001:2018). Both its primary products i.e., Pig Ingot and SOW Ingot are registered under **London Metal Exchange (LME)**.

Aditya Aluminium's performance is **one of the best** amongst all the twenty-two, **AP-36 smelters across the globe**, in terms of metal quality, producing the best grades of Aluminium i.e., P0404, P0405 & P0406. Globally, products of this plant are recognised as ***'Good Western Metal'***. To overcome the challenges of cost, quality, and sustenance and to emerge as a global leader in the primary aluminium sector, Aditya Aluminium has evolved itself as a ***'Smart Manufacturing Setup'***. The energy performance of the plant is depicted in the table below:

Description	Unit	2019-20	2020-21	2021 22
Annual production - Hot Metal	Metric Tonne	3,65,734	3,55,881	3,65,464
Annual electrical energy consumption	Million kWh	5,162.9	5,049.1	5,160.6
Specific electrical energy consumption	kWh/ tonne	14,117	14,187	14,121

03

STUDY TOUR OF CORE ALUMINIUM PROCESSING COMPLEX

1. SMELTING & CASTING COMPLEX

Aditya Aluminium plant has its own smelting and casting complex with a smelting capacity of **380,000 TPA**. The plants first metal production began in January 2014. Overview of the specifications of the plant has been provided in the table below:

1.	Smelter Capacity	380,000 TPA
2.	Technology	Rio Tinto Alcan (AP36S)
3.	First Metal Production	January 2014
4.	360th Pot Start-up	March 2016
5.	Total area of plant	~3300 Acres

The aluminium smelting process adopted at Aditya Aluminium is represented in the process flow diagram below:

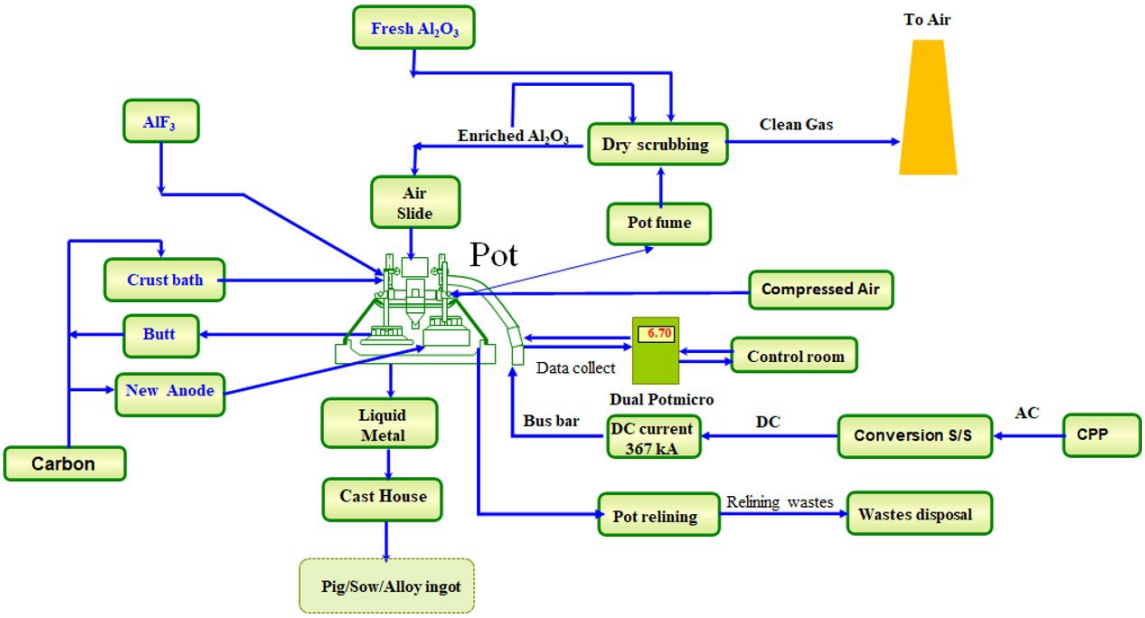


Figure: Process flow diagram of aluminium smelting process at Aditya Aluminium

Overview of the casting and smelting process adopted at Aditya Aluminium is provided below:

- Alumina is primarily sourced from Utkal Alumina, Rayagada, Odisha (a 100% subsidiary of Hindalco)
- Smelter complex primarily converts Alumina (Al_2O_3) into molten aluminium which is used to make sow and cast ingots
- The smelter uses AP-36S technology supplied by Aluminium Pechiney
- The smelter plant has three major production units, i.e., **Pot Line, Carbon Plant, and Cast House**
- **Carbon Plant** produces anode paste for the electrolytic cell (for captive consumption) along with a nominal quantity of sales paste
- Carbon Plant consists of three key production units to produce anodes, viz., Green Anode Plant (GAP), Baking Furnace, and Rodding Shop
- Green anodes, created at GAP, is transported to a baking furnace where it is baked and then stacked inside the baking furnace's pit at controlled heating
- The three primary components of the rodding shop are the butt-crushing system, the bath-crushing system, and the rodding unit
- The cast house comprises of holding furnaces and melting furnaces
- Metal from the pot line is brought to the furnace through metal transport truck (MTT)
- Molten metal from the furnaces is cast into ingots, sow moulds, billets, strips, foil, etc.

Figure: Birdeye view of the Potline at Aditya Aluminium

HOT METAL FROM POT ROOM

INGOT SKIMMING

CASTING CONVEYOR

PRIMARY COOLING

DEMOULDING

STRAPPING

WEIGHING

STACKING ROBO

CAST ID PRINTING

SECONDARY COOLING

Figure: Process flow for pig ingot casting

Key Takeaways

To overcome the challenges with respect to cost, quality, and sustenance and to emerge as a global leader in the primary aluminium sector, Aditya Aluminium has evolved as a **smart manufacturing setup**. Some of the important IEED measures implemented by Aditya Aluminium are highlighted below:

(1) Use of energy analytic platform based on Power BI with AI

Electrical energy is a key input to produce aluminum and the process requires extensive monitoring to minimise consumption, reduce wastage and achieve operational efficiencies in smelter. To achieve this goal cost-effectively, Aditya Aluminum has deployed an **energy analytic platform** based on Microsoft's **Power BI** with **artificial intelligence (AI)** to enhance its energy efficiency -

- Smart meters capable of transferring data on a **real-time basis** are installed across substations at the **Power Control Center (PCC)** and **Motor Control Center (MCC)** levels and integrated with the energy server
- Metering data captured by smart meters is analysed through the **Power BI** & AI based energy analytic platform to generate deeper insights for sustainable decision-making

Impact

- Above process innovation resulted in transition from a **reactive** system to a **predictive** and **preventive** system for better **energy management** of critical equipment
- Implementation of **energy analytics platform** has resulted in **reduction** of smelter auxiliary **energy consumption** to the tune of **10 kWh/tonne** of aluminium produced in the gas treatment centre induced draught (ID) fans along with additional energy savings in compressed air system

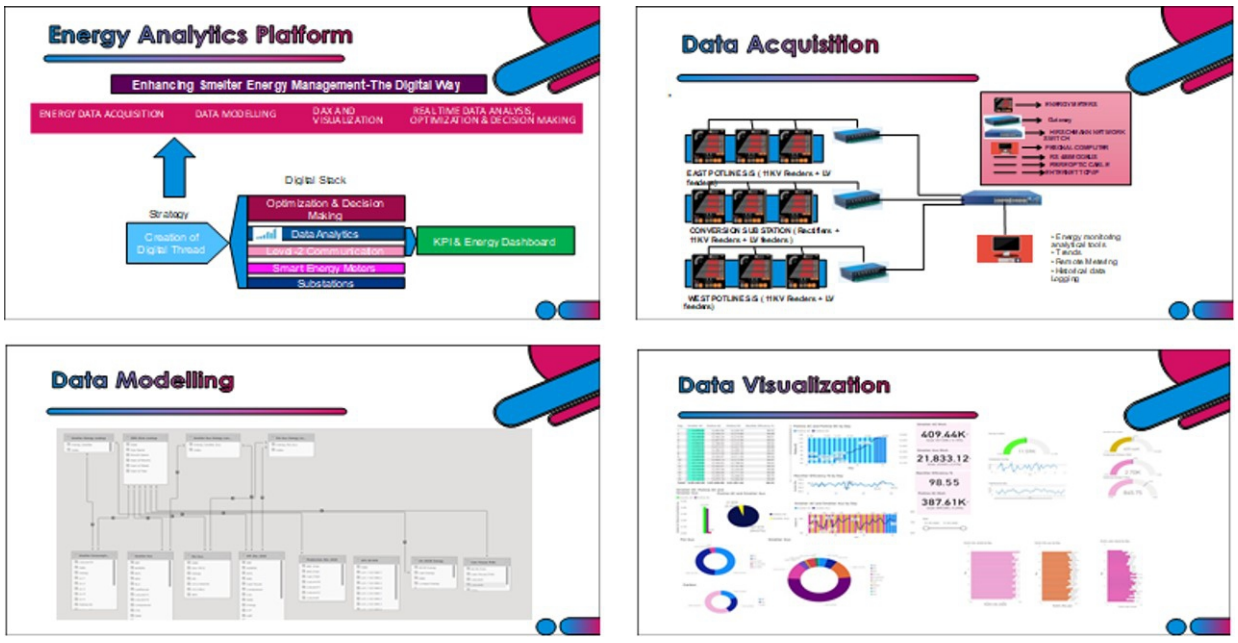


Figure: Few snippets of the data analytic platform deployed by Aditya Aluminium

(2) Copper insert collector bar/ Cathode (CuCB)

Conventional collector bars are made of steel that carries the current of the cathode from one pot to another, resulting in certain voltage drops. To eliminate the voltage drops, Aditya Aluminium implemented the following IEED measure -

- A specially designed **Copper (Cu)** is inserted **inside** the collector bars to reduce the **voltage drop** and thus savings in energy consumption
- Collaborated with Aditya Birla Science and Technology Company to convert **110 pots** to **CuCB** in FY 2022

Impact

- **CuCB** project resulted in energy saving of more than **200 kWh/tonne** of aluminium produced as compared to the standard collector bar pots
- **1.1% higher aluminium production** per annum due to **1%** increase in current efficiency

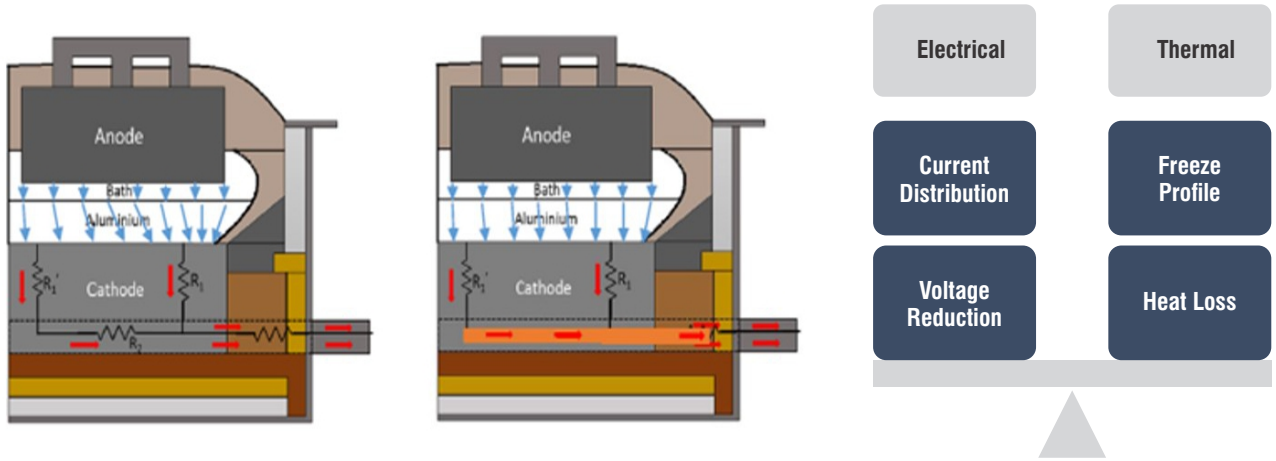


Figure: A representative diagram of the electrical and thermal aspects in pots

2. CAPTIVE POWER PLANT (CPP)

Figure: Aditya Aluminium's 900 MW Captive Power Plant

Aditya Aluminium has a **900 MW** captive power plant (CPP) along with **30 MWp** solar power plant at its premise, synchronised through Composite Islanding Load Management System (**CILMS**). The **entire power demand** of the plant is met through the above CPP and solar plant. The first CPP unit was commissioned in December 2013. An overview of the CPP is provided in the table below:

1.	**Total capacity of CPP**	**900 MW (150 MW x 6 Units)**
2.	**Annual Power Generation**	**~5665 million units**
3.	**Primary Fuel**	**Coal from nearby mines and Hindalco's captive mines**
4.	**Key equipment supplier**	**Bharat Heavy Electricals Limited (BHEL)**
5.	**Date of commissioning of 1st CPP Unit**	**December 2013**
6.	**Date of commissioning of 6th CPP Unit**	**December 2016**

Key Takeaways

Key initiatives undertaken by Aditya Aluminium's to reduce auxiliary power consumption (APC) of its CPP:

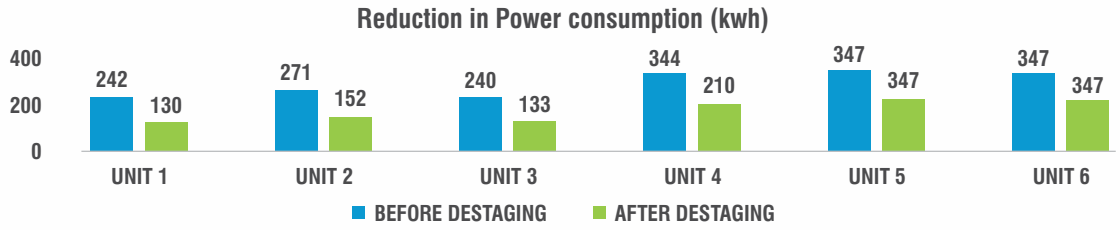
(1) Boiler Feedwater Pump De-staging

Three boiler feed pumps (BFPs) were **de-staged** in 2022 and in total 11 BFPs have been de-staged till now. A boiler feed pump has many stages, to develop the feed water pressure more than steam pressure. While designing, a high BFP pressure is kept. However, during its operation, if it becomes evident that with slightly lower feed water pressure, an operation can be safely handled. In that case, a few impeller stages are removed. This process is called destaging.

De-staging reduces the number of stages, which directly **lowers the amount of energy** imparted to the system fluid and lowers both the flow and pressure created by the pump in stages, which in turn **reduces the power consumption**.

Impact

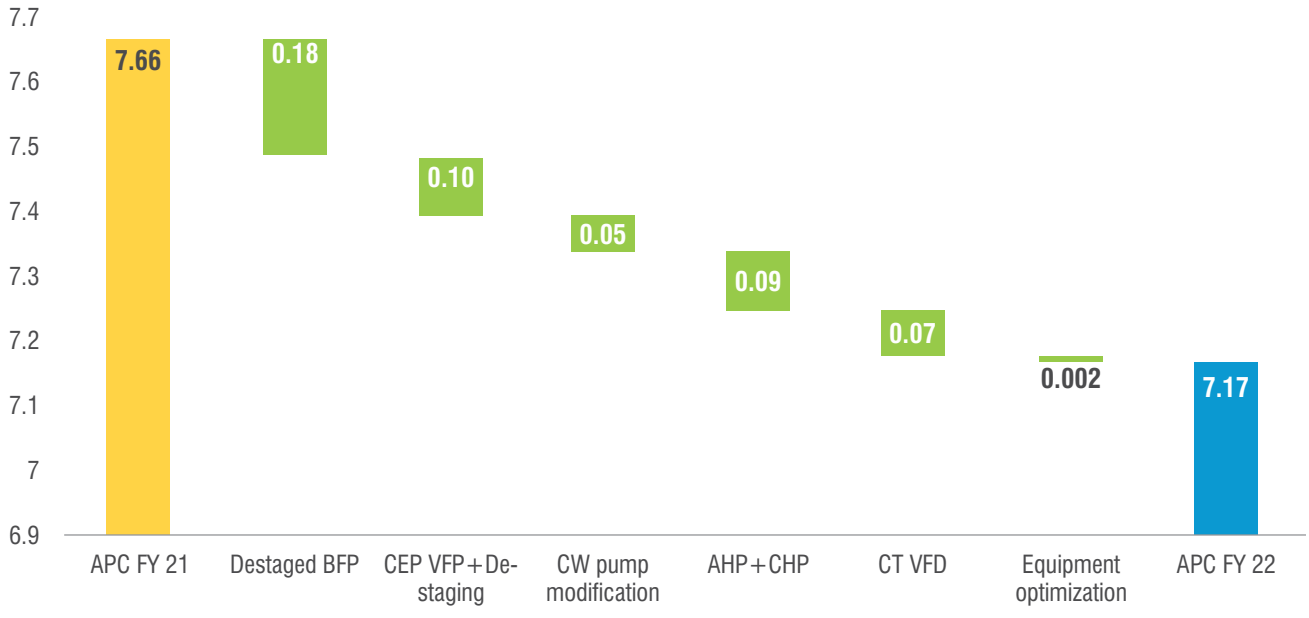
35% reduction in APC across all 6 units as depicted below:



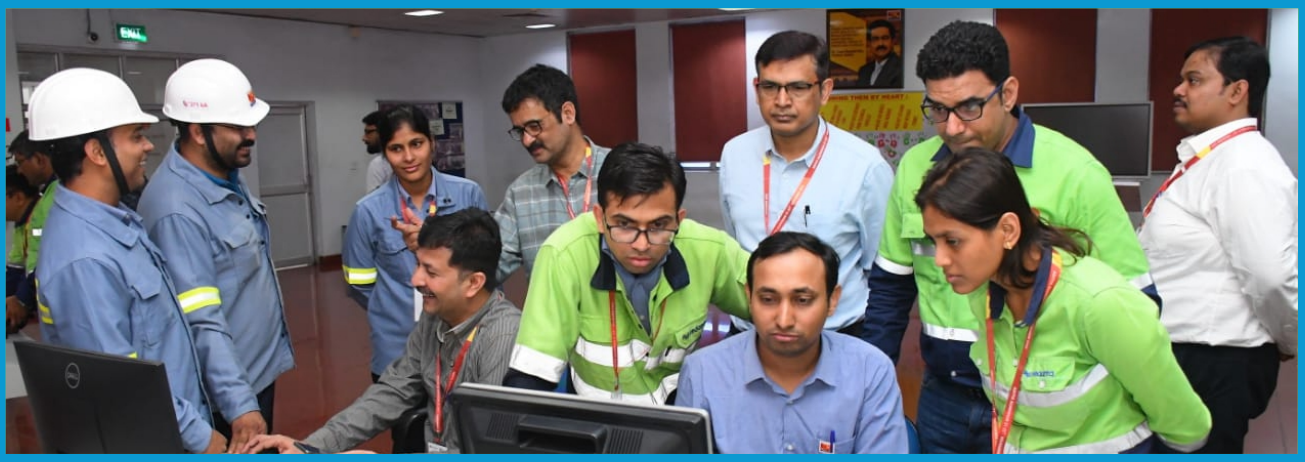
(2) Implementation of **Variable Frequency Drive (VFD)** on five condensate extract pumps (CEP) and seven cooling tower (CT) fan motors along with **retrofitting of 28 CT fan blades** with **encon blades**.

Impact

6.2% reduction in APC consumption from 7.66% in FY21 to 7.18% in FY22 as shown below.




Digital Twin: Sudden rise in HP Turbine Exhaust Temperatu



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FEEDBACK FROM THE PARTICIPANTS

- About **67%** of the participants responded that they were **more than satisfied** with the outcomes of the study tour *(provided a 7+ rating on a scale of 10)*
- About **67%** of the participants rated the quality and content of the delivery as **more than satisfactory** *(provided a 7+ rating on a scale of 10)*
- Many participants recommended similar study tours/ visits to be organised in future for aluminium sector
- The following technologies/ measures adopted by Aditya Aluminium plant were identified by the participants to be the most useful:
  - **Copper insert collector bar/ Cathode (CuCB)** deployed in the potline
  - **Power BI and AI** based **energy management and analytic platform**
  - **De-staging** of boiler feedwater pumps
  - **Retrofitting** of cooling tower fan blades
  - Implementation of **Variable Frequency Drive (VFD)** on condensate extract pumps and cooling tower fan motors

> *"The study tour provided a good opportunity for sharing learnings about the various IEED measures undertaken at Aditya Aluminium"*
>
> ***Mr. Prafull Chandrakar***
> *Associate Manager, Vedanta Limited, Jharsuguda*

> *"A good tour of plant to understand the smelter process and new energy efficiency measures implemented in captive power plant"*
>
> ***Mr. Abhijit Sarkar***
> *Product Manager - Team Lead, Forbes Marshall Private Limited*

> *"Insighful study tour to learn new & future techniques/ initiatives for energy saving and environment friendly manufacturing. Helped to understand how the global market is going to take initiatives for zero carbon emission"*
>
> ***Mr. Vivek Kumar Singh***
> *Assistant Manager, Mahan Aluminium*

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CONCLUSION

The response to the study your/ visit has been positive with participation of key stakeholders including senior officials from central government agencies - BEE (Ministry of Power) and JNARDDC (Ministry of Mines), executive leadership and mid-level officials of leading Indian aluminium industries, technology providers from India. The study tour appears to have served its purpose of providing an opportunity to industry and technology firms to share best practices and technologies for enhancing adoption of IEED measures across the aluminium sector. The study tour promoted gender equality and social inclusion (GESI) through the active participation of women stakeholders from large energy-intensive industries. It is expected that this study tour would have a demonstrable and long-lasting on-field impact in due course of time. Further, to keep up the momentum, the following activities are envisaged under ASPIRE to enable wider adoption of IEED measures and technologies by Indian aluminium industries to achieve their net-zero targets:

- Organise a national level workshop and launch the rejuvenated KEP portal with database of proven/ emerging global technologies, technology providers and financial institutions
- Provide handholding support including B2B interactions/ webinars to large energy-intensive industries (incl. textile sector) to support in identifying technologies & solutions, and technology suppliers to enhance IEED measures
- Organise cross-sectoral workshops, national-level-policy roundtable on similar lines for key industrial sectors including textile sector in collaboration with global technology suppliers including from the UK
- Create more **discussion forums** to facilitate exchange of knowledge and information that will aid in the formulation of policies

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ANNEXURE

ATTENDANCE SHEET

S.No.	Name	Designation	Organisation
1	Dr. Anupam Agnihotri	Director	JNARDDC, Nagpur
2	Mr. S.K. Khandare	Director, BEE	Bureau of Energy Efficiency
3	Mr. V. Jagadeesan	Aluminium Sector Expert	Bureau of Energy Efficiency
4	Mr. Mrinmoy Dhang	Assistant Manager	Aditya Aluminium Limited
5	Mr. Hitesh Bhamra	AGM (Process Head Potline)	Vedanta Ltd, Jharsuguda
6	Mr. Shailesh Kumar Sahu	AGM (Cast House)	Vedanta Ltd, Jharsuguda
7	Mr. Rajesh Tiwary	Head Carbon Process	Vedanta Ltd, Jharsuguda
8	Mr. Pradeepta Acharya	AGM Carbon	Vedanta Ltd, Jharsuguda
9	Ms. Nikita Gayake	Assistant Manager (Smelter Mechanical)	Aditya Aluminium, Lapanga
10	Ms. Prerna Dipti	Assistant Manager (Smelter E & I)	Aditya Aluminium, Lapanga
11	Mr. Kiran Vanama	Associate GM	BALCO
12	Mr. Krishna Kishor Suryawanshi	Dy Manager	BALCO
13	Mr. Yogendra Singh Bhati	Deputy Manager	Mahan Aluminium, Singrauli, Madhya Pradesh
14	Mr. Karnindra Chaturvedi	Manager	Mahan Aluminium
15	Mr. Suresh Biravan	Deputy Manager	Mahan Aluminium
16	Mr. Reddy	Zonal Sales Manager	Atlas Copco (India) Ltd
17	Mr. Koustav Ghosal	Territory Manager	Atlas Copco (India) Ltd
18	Mr. Mukesh Patidar	AVP	ABB GISPL
19	Mr. Balwant Joshi	Managing Director	Idam Infra
20	Mr. Rajiv Shukla	Executive Director	Idam Infra
21	Ms. Dhaarna Rawat	Analyst	Idam Infra
22	Mr. Anurag Singh Sirola	Manager	KPMG
23	Mr. Lingaraj Jena	General Manager	NALCO
24	Mr. Tarun Kumar Tripathy	General Manager	NALCO
25	Mr. Jagadish Mishra	Senior Manager	NALCO
26	Mr. Saroj Kumar Gouda	Senior Manager	NALCO
27	Mr. Manoj Keshari	AVP	Vedanta Limited

S.No.	Name	Designation	Organisation
28	Mr. Rajesh Rajput	Assistant General Manager	Vedanta Limited
29	Ms. Kajal Singh	Associate	Vedanta Limited
30	Mr. Prashant Singh	Associate GM	Vedanta Limited
31	Mr. Pankaj Kumar	Associate Manager	Vedanta Limited
32	Ms. Angali Kumari	Asst. Manager	Hindalco
33	Mr. Nitesh Pal	Energy Consultant	Atlas Copco India Ltd.
34	Mr. Hitesh K	Zonal CTS Sales	Atlas Copco India Ltd.
35	Mr. Kuntal Dey	Senior Sales Engg.	Atlas Copco India Ltd.
36	Mr. Mukesh Chaddha	Former Sr. Scientist	JNARDDC, Nagpur
37	Mr. K.K. Chakarvarti	Sr. Advisor	Knowledge Exchange Platform
38	Mr. Siddhalingesh NG	AM-production	Hindalco Industries Ltd. Belagavi
39	Mr. Kaushal Gupta	AGM-T&P	Hindalco Industries Belgavi
40	Mr. Saitarun Madireddy	AM-Engineering	Hindalco Industries Ltd. Belagavi
41	Mr. Abhishek Bondre	Deputy Engineer -Engineering	Hindalco Industries Ltd. Belagavi
42	Mr. Aritra De	Dy Manager (Potline Process Control)	Vedanta Ltd, Jharsuguda
43	Mr. Ramesh Chandra Patra	Manager (Energy Cell)	Vedanta Ltd, Jharsuguda
44	Mr. Sridhar Nayak	Dy Manager (Compressor House)	Vedanta Ltd, Jharsuguda
45	Mr. Sachin Kumar Gupta	AGM (Power & Services/Energy Cell)	Vedanta Ltd, Jharsuguda
46	Mr. Prafulla Chandrakar	Efficiency I/C Power Plant	Vedanta Ltd, Jharsuguda
47	Mr. Abhijit Sarkar	Team Lead Jamshedpur Branch	Forbes Marshall
48	Mr. Rudra Chatterjee	Sr Engineer	Forbes Marshall
49	Mr. Santosh Gupta	Main Plant Operation – Energy Auditor	Hindalco Hirakud
50	Mr. Anuj Kumar Panda	General Manager	NALCO
51	Mr. K A V Singh	Manager	Vedanta Limited
52	Mr. Homagni Deka	GIF	Forbes Marshall