

Manufactured Capital



Striving for excellence with a vision to lead the aluminium industry as the partner of choice for innovative solutions.

We proudly produce metals for the new age which will play a key role in India's transition to Net zero. Aluminium and copper will shape the coming decade, supporting industry megatrends of urbanisation and digitalisation, clean energy & renewables, e-mobility & storage, and electricity as the primary source of energy.

We are the largest flat rolled aluminium producer in the world and the largest downstream aluminium player in India, with a geographical spread across 10 countries with 50 manufacturing units. We are the largest copper player in India serving more than half the requirement of the country. We are working on developing downstream products that will be important in the context of these megatrends.

Key Highlights

17
Manufacturing units in India

2
facilities acquired - Asoj (Cu CC Rods) and Kuppam (Al extrusions)

2
Operational captive Coal mines

19
Operational Bauxite mines

33
overseas units of Novelis

500 kt
Alumina Utkal brownfield expansion completed

Contributions to SDGs



Value Enhancing Growth

SP-2 Value enhancing growth	SP-3 Strong ESG Commitment	SP-4 Portfolio Enrichment
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Interlinkages with Material Topics and Other Capitals

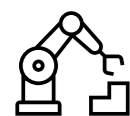
Material Topics	Capitals Connected
Economic Performance	Financial Capital
	Human Capital
	Intellectual Capital
	Natural Capital
	Social & Relationship Capital



Our Focus Areas

Expanding downstream capacities	Driving operational excellence
Process digitalisation	ESG integration

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Production Capacity

3.6 MN MT

Alumina

0.36 MN MT

Specialty Alumina

1.3 MN MT

Primary aluminium

0.35 MN MT

Aluminium VAP

0.42 MN MT

Copper cathode

0.54 MN MT

Copper rods

4.0 MN MT

Novelis rolling capacity

2.5 MN MT

Novelis recycling capacity

Our strong focus on world-class facilities, backward and forward integration in the value chain, and our competent workforce makes us one of the world's leading producers of aluminium and copper. This is achieved by our investments in manufacturing capability growth, equipped with robust control measures over our operations and processes. Our manufacturing operations span across the globe with a major market share in aluminium and copper sales.

Our aluminium operations in India encompass the entire value chain from bauxite mining, alumina refining, coal mining, captive power generation to

aluminium smelting, downstream value addition of aluminium rolling, extruding and foils of different specifications. This makes us the largest fully integrated aluminium player in India. Our Utkal Alumina refinery is among the lowest cost, best quality producers of alumina in the world.

At Dahej, we have one of the largest custom copper smelters at a single location in Asia consisting of refinery, and manufacturing of value-added products. Copper operations also include oxygen plants, sulphuric acid plants and precious metals recovery units supported by a co-gen captive power plant.

Novelis, our wholly owned subsidiary, is the world's largest flat rolled aluminium producer and recycler with a rolling capacity of 4 Million MT and recycling capacity of 2.5 Million MT. Our Novelis operations cater to the requirements of the customers of the aerospace and automotive industries in 9 countries with 33 operating units. Out of these 33 units, 15 units have recycling capabilities. This helps us to achieve the objective of sustainability by increasing recycling capabilities and capacities, innovating new technologies, optimising processes, and increasing low carbon logistics.

Our Production during FY2021-22

Aluminium



Hindalco India	FY2018-19	FY2019-20	FY2020-21	FY2021-22
Alumina	2,893	2,768	2,699	3,235
Aluminium Metal (Primary)	1,295	1,319	1,229	1,294
Flat Rolled Products (FRP)	289	291	233	301
Aluminium Extrusions	47	41	37	50
*Aluminium Foils and Converted Products	17	18	19	28

Copper



Copper Cathode	347	326	262	359
Copper Cast Rods	245	245	235	259

*Foil is a part of FRP production

Growing our Manufacturing Capability

As a part of our strategic focus on portfolio enrichment, we are expanding downstream capacities in various business segments. On the back of robust domestic aluminium demand, our estimated market share in downstream FRP is expected to grow by 47%. Extrusion and foil market shares are expected to rise to 11% and 15%. We have invested ₹609 Crore in Silvassa to build new extrusions plants with a planned capacity of 34 KTPA. This will serve the fast-growing market for extruded aluminium products in Western and Southern India.

We are entering two new segments in copper– Cu-Mg Alloy rods for railways and Inner Groove Tubes for ACs. The latter is qualified under the Government of India's PLI scheme. With this, Birla Copper is on the cusp of a strong growth trajectory.

Expanding Geographic Footprint

Despite the pandemic, we effectively used the opportunity to strengthen our manufactured capital. We have expanded our scale by the successful acquisition of two facilities-Kuppam and Asoj.

Kuppam, formerly Hydro's SAPA extrusions facility, has a 15 KTPA capacity with high-end value addition capabilities for surface finishing and fabrication. The Kuppam facility, acquired at ₹247 Crore of enterprise value, offers custom aluminium extrusion products and solutions for auto, building and construction and industrial applications. This will further extend Hindalco's footprint in the Southern part of India, which is the country's second largest extrusions market. The aluminium extrusions market in India is expected to grow from the current level of around 373 KTPA to reach about 850 KTPA by 2030. With the addition of Kuppam



The acquisition of Ryker plant strengthens our portfolio of Copper downstream value-added products

and Silvassa, our total aluminium extrusions capacity will jump from 60 KTPA to 109 KTPA.

The acquisition of Ryker Base Private Limited, now Asoj, is a key step in enriching our downstream portfolio of copper rods. The acquisition made at an enterprise value of ₹323 Crore, provides several strategic benefits, including increasing the Company's presence as a copper rod manufacturer, time-to-market advantage and diversifying its product and customer portfolio.

Also, the plant is well aligned with Hindalco's ESG focus. Asoj's copper wire rod facility uses German technology, consumes less energy and has significantly low carbon emissions.

Future Growth and Expansion Plans

With the objective of expanding our aluminium downstream business, we have announced various projects. The 34 KTPA capacity extrusions plant at Silvassa is scheduled to produce its first billet in FY2022-23. We have started to expand the FRP production capacity at Aditya Aluminium and Hirakud plants by 170 KTPA with a planned investment of about ₹2,690 Crore.

To support the increased volume of downstream production, we are planning brownfield expansions at Utkal Alumina, Aditya Aluminium and Mahan Aluminium. Utkal Alumina has already expanded by 500 kt in FY2021-22 at a rough investment of ₹1,788 Crore and another 0.2 MMTPA increase in capacity is planned this year. Our plants at Aditya and Mahan are due to get an 18-pot expansion each at a cost of ₹417 Crore and ₹429 Crore

Under the Prime Minister's Atmanirbhar Bharat campaign, we are adding AC coated fin-stock capacity of 26 KTPA at Taloja under the Production Linked Incentive (PLI) scheme. This project will serve the requirements of downstream customers.

Novelis has also announced a \$2.5 Billion (₹18,997.50 Crore) greenfield, fully integrated rolling and recycling plant in the US to support strong demand for aluminium beverage packaging and automotive solutions. This will be the first fully integrated aluminium facility built in the US in 40 years. It is expected to provide up to 1,000 high-paying jobs in modern manufacturing. The plant will make significant use of state-of-the-art automation including Artificial Intelligence, augmented reality and robotics. In addition, we are well-positioned to efficiently expand capacity at this facility in the future – above the 600 KTPA announced previously – to capture ongoing strong demand.

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Project Management Framework

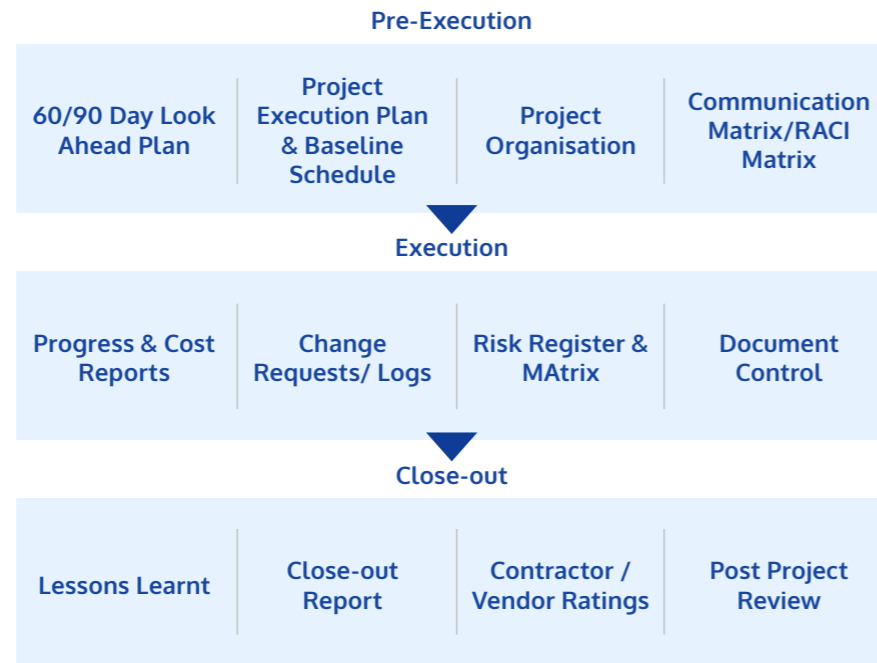
We have developed a Project Management Framework (PMF) to establish a consistent approach to manage complex capital project over their lifecycle and ensure we achieve the cost and time targets. This will enable better visibility and accountability on project execution and strengthen our decision making. Key processes in the PMF are:

Reinforcing Operational Excellence : Way to Continuous Improvement

We strive to accomplish operational excellence by investing in right capabilities and capacities. To boost yields and improve efficiency, we rapidly adopt new-age technology solutions and streamline costs, processes and methodologies. Our initiatives such as Maintenance Strategy and Execution Framework (MSEF), introduction of Opportunities, Ideas and Concepts (OICs), etc., complement our aim to achieve operational excellence. We carry out World Class Manufacturing (WCM) and several other initiatives to enhance the current processes.

As a part of our efforts to strengthen our management system and processes, all our corporate offices and 17 of our manufacturing units have been certified with integrated management systems. This includes all the necessary certifications for Quality Management System (ISO 9001), Environment Management System (ISO 14001) and Occupational Health and Safety Management System (ISO 45001). In addition, six of our units - Aditya Aluminium, Utkal Alumina, Renukoot complex, Mahan Aluminium, Hirakud Power and Smelter and Birla Copper at Dahej are ISO 50001 certified.

In the world of rapid digitalisation and dependence on information technology systems, data security has become critical to business and consumers. Hence, we have further strengthened



our systems and implemented the Information Security Management System (ISO 27001) across our operations in the previous financial year.

Our Alupuram extrusion, Renukoot downstream and Hindalco-Almex Aerospace Limited (HAAL) plants are certified with AS 9100 certifications, qualifying them to make automobile and aerospace grade products. Additionally, our Mouda plant has been granted a Bureau of Indian Standards (BIS) license and has received the approval for manufacturing of marine class supplies. Along with Alupuram, Belur and Renukoot downstream plants have also qualified for NABL ISO/IEC 17025 certification. Our Talaja operation has received IATF 16949 certificate for high quality automobile grade aluminium production. Mouda has become our first plant to achieve Aluminium Stewardship Initiative (ASI) performance standard certification. All our products are Restriction on Hazardous Substance (ROHS) compliant, and we conduct periodical testing

through National Accreditation Board for Testing and Calibration Laboratories (NABL) accredited labs to ensure that we do not exceed the prescribed limit of restricted materials.

To meet the requirements and expectations of our customers, all the Novelis's manufacturing sites are certified with internationally recognised management systems – ISO 9001 or ISO/TS 16949 Quality Management System Standards. Over 80% Novelis locations are ISO 14001 or EMAS certified, while seven sites have internally certified Environment Management System.

Novelis also caters to the requirements of aerospace customers through two certified plants at Koblenz, Germany and Zhenjiang, China. Both these plants are certified with accreditations of DIN EN ISO 9001, EN 9100/AS 9100, ISO 14001, NADCAP – Heat Treating, and NADCAP – Non-destructive Testing.

Maintenance Strategy and Executive Framework

Maintenance is one of the key levers to deliver business outcomes. For a manufacturing unit, it is imperative to have a sustainable equipment management policy to ensure that there are no unplanned or unforeseen breakdowns of equipment or systems. To avoid such circumstances and minimise the magnitude of risk, we have developed a comprehensive asset management policy, termed as Maintenance Strategy and Execution Framework (MSEF). Successful implementation of MSEF has helped us achieve better plant uptime.

The entire framework is based on a continuous loop of Plan, Do, Check, Act (PDCA) principles. This constitutes dipstick testing on a bi-annual basis, formulation of an implementation plan, implementation assistance, re-checking improvements in the next assessment, and the cycle of maintenance continues.

The framework is divided into multiple sub-process areas which directly or indirectly aids in equipment maintenance. Each sub-area has a collection of best practices either in form of strategic initiatives, practices, or results that are produced. The MSEF audit is a robust system which uses a lifecycle approach to manage assets.

Downstream reliability

We have been continuously upgrading our current installations to deliver value to our customers. Some notable technological upgrades for Reliability & Productivity Improvement in Hindalco Downstream are:

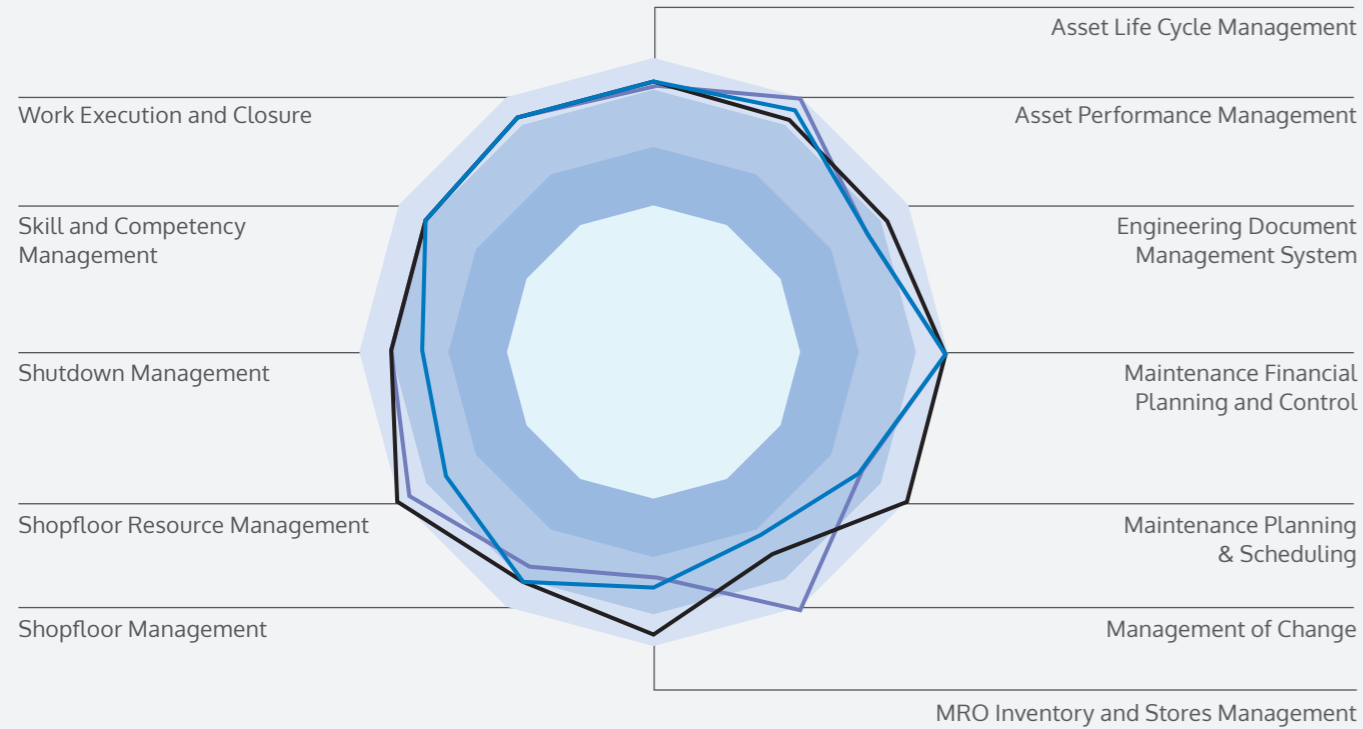
- New CBL Line @ Renukoot – Augmenting capacity of Circle Blanking by 700 MTPM.
- New Degreasing Line at @ Renukoot – 2000 MTPM.
- New 6" Press @ Renukoot Extrusion – Press No. 9 – approx. 4000 MTPA - With advanced quenching system, Log Heater facility- Giving Recovery & productivity advantage and higher specific pressure enabling to cater critical profiles.



All of Novelis's manufacturing sites are certified with internationally recognised management systems

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MSEF framework checklist



- Downline Upgrade at Press 2 – By Sunwoo, Korea giving us advantage to serve critical products and cater the market where manual dragging is prohibited.
- X Ray Upgrade at Belur SMS Mill – Upgraded to IMS from earlier Thermofisher make - giving Reliability advantage, almost 3% jump in Utilisation.
- New Anodising station at Taloja.
- Re-Commissioned RFI & Overhauled EMS (Electro Magnetic Stirrer) at Hiraakud DC4 Cast House for critical product casting like CBS.

ARTIFICIAL INTELLIGENCE (AI) IN PREDICTIVE MAINTENANCE FOR ASSET RELIABILITY

Appreciation Asset maintenance is critical for maintaining manufacturing plant efficiencies. We are leveraging the technologies available in the new digital era of Industry 4.0. Digital sensors are being mounted on equipment to monitor the health of the equipment. Data collection, data analysis, failure prediction and prescriptive maintenance are being followed depending upon the criticality of equipment.

We have partnered with leading technology providers to drive predictive maintenance initiatives across our plants. How equipment responds to process variation is mapped by a Machine Learning algorithm which triggers alerts when inputs cross a certain threshold.



Hindalco's deployment of mechanical and robotic automations has helped us improve process efficiencies

Progressing Towards Industry 4.0

At Hindalco, we have identified and deployed several mechanical and robotic automations opportunities to improve equipment reliability, productivity and process efficiency. Our team engaged with leading industrial robotic solution providers to implement suitable solutions to the identified opportunities.

Advancements of new technologies have helped us to improve process efficiencies, optimise resource consumption, and deliver better quality and energy reduction. Below are some of the key technological and digitalisation initiatives taken by plants in collaboration.

- Caustic reduction in alumina refineries through new filtration technology
- In-house patented new cathode design change for energy efficiency improvement
- In-house magnetic compensation loop for pot lines

- Digital twin for smelters and refineries.
- Equipment health prediction with data analytics.

Machines at Work

We are working on several projects and solutions to drive the Company's digitalisation and automation projects through use of robotics.

WORKPLACE SAFETY IN CONFINED SPACES

To ensure workplace safety, we have deployed robotic system with a remote operation to perform hazardous operation of sludge cleaning in a risk-free manner.

This technology can be used to remove the sludges from confined spaces like tanks, vessels, pits, sumps, underground drains, and cooling tower basins without manual intervention.

ROBOTICS IN RELIABILITY ENGINEERING

There are many digital survey activities, inspections, Non-Destructive Testing (NDT), etc., being carried out at our plants, utilising advanced methods such as-

- Drone survey of stacks to eliminate huge scaffolding erection works and associated risk with height works.
- Robotic lizard-crawler with ultrasonic thickness measurement instruments to measure the thickness of tanks, vessels, chimneys, boiler tube thickness mapping.
- Digital scanning to develop drawings for the entire steel and civil structure in a complex including static asset condition appraisal etc.

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Future of Technology

HOT METAL HANDLING AREA – SAFE WORK PRACTICE IN HARSH ENVIRONMENT

To protect our workers from workplace hazards and prevent or minimise work-related injuries and diseases, we pursued a developmental initiative with one of the service providers. We will make use of robotics for skimming of dross from moulds of the ingot casting machines.

Our Manufacturing Centre of Excellence (MCoE) team along with the plant team is exploring options to automate this process. One of the viable solutions that has been considered is Automatic Tuyere Punching Machine for PS Converter. The tuyere hole punching operation will be done from remote location and thus, the operator need not be experiencing hot and harsh environment. This will eliminate manual intervention and thus improve workplace safety.

DIGITISATION AT BIRLA COPPER: POWERING DIGITAL TRANSFORMATION WITH INDUSTRY 4.0

Key digitisation initiatives undertaken through FY 2021-22 include:

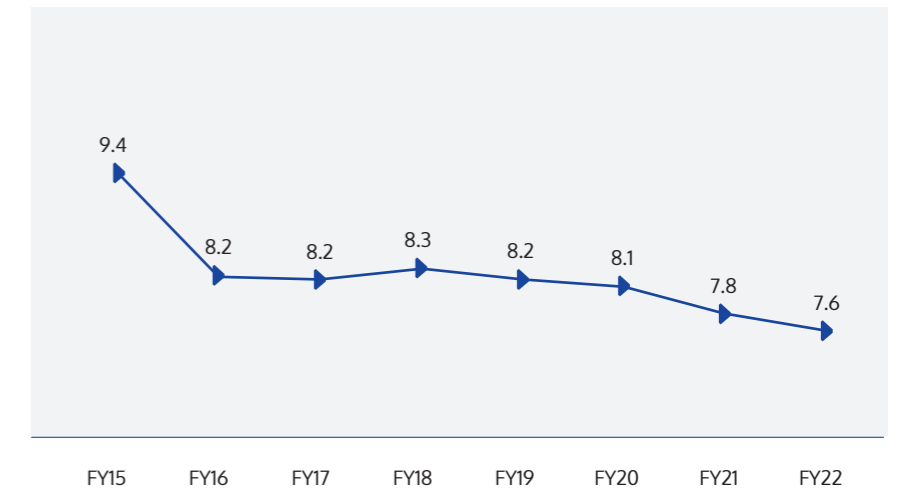
Acoustic Steam Leak Detection system (ASLD)
Implementation of ASLD has helped in detecting the sound waves emanating from the steam leak or tube leakage transforms into electronic voltage signal, which is then amplified, filtered and processed. This system indicates the quantum of steam leak and the location. By using these methods, the leaks were detected and secondary damages and unscheduled outages were avoided.

Electronic Level Drum Indicator (ELDI)
The importance of water level monitoring in a boiler drum cannot be over-emphasised. We installed Electronic Level Drum Indicator (ELDI) that helps in monitoring water level including alarm and tripping at pre-set levels. This eliminates the need for periodic maintenance or calibration unlike other level monitoring solutions.

Working Towards a Common Goal

As a part of Hindalco's Operation Collaboration projects, our teams across different plants have taken up various projects to improve operational efficiency. One such significant project is reducing Auxiliary Power Consumption (APC) in Captive Power Plants (CPP). At Hindalco, we have CPPs operational at Aditya, Mahan, Hirakud and Renusagar. As part of the mega collaboration initiative across these four locations, our teams worked together with the objective of finding possible ways to reduce APC. The result was encouraging and led to a significant reduction in APC from 8.2% in 2015-16 to 7.6% in FY2021-22. This also resulted in reduction of 55,000 tCO₂ GHG emission.

Consistent reduction in the Auxiliary power consumption in CPP Benefits - 180cr/Annum as per baseline figure



Hindalco has a comprehensive quality management process to ensure customer satisfaction

Improving Downstream Quality through Build Quality in Process (BQiP) Framework

We continue to monitor quality and delivery parameters in downstream businesses. To complement the effort, we developed BQiP framework which helps in identifying the strengths and opportunities for improvement in downstream operations.

The BQiP assessment is carried out at Hirakud, Taloja, Renukoot FRP and Extrusion, Belur, Mouda and Alupuram. The evaluation process comprises 24 criteria including Material Handling, Packing and Storage Standard, RCA & Horizontal replication of learning (Reliability Calls), Computerised Maintenance Management System (CMMS), and others. The result of the BQiP assessment shows a 4% yoy improvement for the FY2021-22 over FY2020-21.

During the year, we implemented additional process improvement projects resulting in efficient utilisation of resources, reduced energy consumption and enhanced product quality and safety.

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Some of the additional process improvement projects taken up by our units in FY2021-22 as below:

Alupuram

Alupuram completed several process improvements projects such as log heater reliability improvement, "D"-furnace temperature uniformity improvement, and tear off concept - deep tongue die. To improve the reliability of log heating system, we undertook a series of actions. For instance, we started to track the use of data history for

troubleshooting of any log heater issue and avoided illogical discard by installing two new sensors in line.

As a result of it, log heater utilisation has improved substantially over the last years. We were also able to save cost and improve efficiency by elimination of manpower and time involvement for cutting billets and its transportation.

Mouda

Mouda took up a project to improve the running speed and utilisation of M5 Finishing mill from 60% to 75%. In foil business, we use M5 finishing mill which caters to the entire light gauge product portfolio. However, during the manufacturing process, we observed flatness issue. With the objective to resolve the flatness issue of light gauge foil, our team collected and analysed data for eight to ten months.

After comparing different combinations of coil specifications, we found the importance of entry tension in the physical shape of light gauge foil.

As a result of the implementation of project, there was a drastic reduction in the number of bad shape coils over the month. We developed a dashboard in Intelligent Plant Framework (IPF) platform for close monitoring of critical KPI's related to M5 flatness and interlinked SMS alert in case of any deviation against standard operating range of rolling parameters.

We also created a digital platform to integrate parameters of upstream process for ease in data analysis on a daily basis. The project is in its early stage and is targeted to achieve the desired outcome by December 2022.

NOVELIS DELIVERING VALUE-ADDED PRODUCTS (VAPS)

Our subsidiary Novelis is among the world's leading suppliers of high-quality aluminum rolled products for the aerospace and industrial plate industries. To support aerospace customers' sustainability targets, we built a 151-feet (46 m) multi-spindle, five-axis Computerised Numerical Control (CNC) milling machine in our Zhenjiang, China facility.

The goal was to automate the manufacturing process that can offer products with improved buy-to-fly ratio. With multi-spindle CNC, we were able to reduce cycle time and improve productivity.



IMPROVING SMELTER PRODUCTION USING COPPER COLLECTOR BAR (CUCB)

To improve the current distribution and productivity, copper-inserted collector bar has been proven as a standard choice. During the year, we undertook several initiatives to reduce energy consumption such as:

- New lining design incorporating copper insert collector bar pots
- Digital twin in trial phase for predicting and improving pot performance
- Improving current efficiency by operating at optimised pot parameters

- Better pot instability control and temperature control
- Pot voltage adjustment in CuCB pots by optimising Force Convection Network (FCN).

As a result, we were able to achieve an average current of 368.8 ka at Mahan and 367.5 ka at Aditya, respectively. This led to a production gain of 5.7 kt in FY2021-22.



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Hindalco has focused on operational efficiencies under WCM to stay future ready

World-Class Manufacturing

The concept of 'World-Class Manufacturing' helps us to implement best practices, focus on operational efficiency and develop cost-efficient methods which keep us future-ready in today's fast growing and competitive world.

We held Kaizen competitions across all our mining units. With the implementation of 1,067 Continuous Improvement (CI) projects, we were able to achieve a saving of ₹72.05 Crore in FY2021-22. A total of 25,919 Kaizens were submitted from our employees across locations demonstrating active participation.

₹72.05 CR
Saved through continuous improvement projects

Aditya

A total of 4,519 Kaizen projects were submitted by the employees working at Aditya aluminium. The team submitted a project with an objective of achieving sustained improvement in the processes by reducing auxiliary power consumption by 50 kWh/pump in Aditya CCP.

As a result, the unit was able to save power of 80 kWh/pump and overall annual saving of 3.5 Million kWh. It resulted in a total cost saving of ₹1.3 Crore in FY2021-2022.

Mahan

Mahan submitted 6,492 innovative ideas, completed 101 CI projects and was able to save ₹1.71 Crore from the implemented projects in FY2021-22.

These activities were targeted at improving operational efficiency and reducing overall costs. Following are some of the projects which have resulted in changes at various levels:

- Enhancement of productivity in coal handling plant by installing 50 additional carrying idlers and reducing space between idlers from 1,200 mm to 400 mm
- The existing hexagonal bolt was replaced with counter shrunk to avoid breakdown time of Cast House Tending Assembly (CHTA) block gear box assembly

Hirakud Complex

Our employees at Hirakud submitted a total of 5,943 kaizens, aimed at improving asset reliability and efficiency. Some of the projects are:

- Eliminating the issue of bladder safety valve damage, resulted in saving of ₹3 Lakh in two months
- Enhancing coolant quality by avoiding mixing of sludge and hence minimising the regrinding of roll. With this initiative, we were able to save a total of ₹50,000



IDEAS OF ALL SIZES-EMPLOYEE-LED INNOVATION PROJECTS

Our culture of innovation and technological excellence has led to process improvement. This was evident again at our Utkal operation. Our Utkal plant experienced a sudden breakdown at Rotating Magnetic Field (RMF) due to which support beam of the pressing plate filter got damaged and production was halted. The OEM team gave a timeline of 10 months to deliver the spare, which was not feasible for the plant. Hence, we fabricated the same at the workshop.

Our team came up with a solution to convert the existing lathe machine to planner machine by reversing the operation of the lathe machine (tool fixed on to the chuck and job on the tool piece). Because of this, we were able to avoid ₹28.33 Crore of production loss. This was an example of operational excellence achieved by our teams.

Some of the other kaizens that resulted in optimised performance at reduced production cost are:

- Avoided plant blackout in case turbine generator in island mode trips, resulting in a cost saving of ₹1.59 Crore
- Installed screw charger in place of table feeder to control the dust in Milk of Lime (MOL) area. This project is expected to save ₹1.07 Crore/year

Utkal has been able to submit a total of 132 Kaizens and 126 completed CI projects in FY2021-22.