

# Engineering Better Futures by Co-creating solutions



Hindalco is expanding upstream and downstream capacities to cater to the growing domestic and international aluminium markets



## Manufactured Capital

### KEY HIGHLIGHTS

Manufacturing Plants	50
Hindalco	19
Novelis	31
Mines (Bauxite and Coal)	25
Highest-ever Alumina production achieved in FY 2024-25*	3.86 million MT

\*The details provided are for India operations

### LINKAGES

#### Capital Linkages

Financial Capital	Human Capital
Natural Capital	Social and Relationship Capital
Intellectual Capital	

#### Strategic Priorities

- SP-2** Value-Enhancing Growth/ Double-down on Upstream Capacities
- SP-3** Strong ESG Commitment
- SP-4** Value Enhancement through Portfolio Enrichment

#### Material Topics

- Economic Performance & Market Growth

#### Key Risks and Opportunities addressed

- Increased focus on decarbonisation
- Supply chain risks
- Price volatility of commodities (aluminium, copper)
- Changes in regulatory requirements
- Increased import of aluminium
- Rising demand for aluminium and copper products
- Recycling and circular economy
- Emerging applications for specialty alumina

#### Contribution to SDGs





In an era defined by uncertainty, complexity, and rapid transformation, the global business environment is being reshaped by geopolitical shifts, commodity price volatility, and persistent supply chain disruptions. Amid these headwinds, one thing remains clear, change and disruption are the constants. In this spirit we continue to evolve as a dynamic, responsible, and future-ready enterprise. Our commitment to operational excellence and innovation enables us to diversify our product portfolio and reinforce our leadership in world-class manufacturing solutions.

This year marked a significant milestone with the launch of Hindalco's new branding that redefines the future of manufacturing. The new branding reflects how we are using advanced digital technologies, smart manufacturing, and circular economy principles to deliver high-performance, low-carbon solutions across important sectors. From electric vehicles and energy-efficient buildings to modern

electrical grids, our products are designed to reduce greenhouse gas emissions while enhancing performance, convenience, and user experience.

Sustainability is deeply embedded in our operations and product innovation. As we contribute to India's Net Zero journey, we remain committed to environmental stewardship and sustainable growth. Through innovation and purpose-driven action, we continue to be a force for sustainable solutions, enriching lives and shaping a better tomorrow.

Focus Areas

Expansions in aluminium, specialty alumina and copper

Driving operational excellence

Process digitalisation

ESG integration across the value chain



Our Copper Business supplies specialised copper alloys for metro and high-speed rails

Production Overview

Production Capacities

3.81 million MT\*  
Alumina

1.34 million MT  
Primary Aluminium

0.56 million MT  
Specialty Alumina

0.43 million MT  
Aluminium VAP

0.42 million MT  
Copper Cathodes

0.54 million MT  
Copper Rods

4.2 million MT  
Novelis Rolling Capacity

The domestic demand for aluminium and copper is expected to be more than double in the next decade, primarily driven by the increased utilisation of these metals in the electrical, automotive, building, and construction industries. The transition to green energy, the rise of electric vehicles, lightweight energy storage systems, and a growing focus on recycling and circularity has led to an expansion of our product portfolio and has fuelled business growth.

\* Name Plate Capacity

Aluminium Business

Our Aluminium business encompasses an integrated value chain that includes mining, refining, and smelting for the manufacture of primary metal and value-added products. Our finished products range from metallurgical alumina, specialty alumina, aluminium ingots, billets, and wire rods to value-added offerings such as flat rolled products, extrusions, and foils. At our Aditya and Mahan smelters, we produce high-purity grades of metal – P0202, P0303 and P33HP – used in aerospace, semiconductors, as well as high-end medical and research instruments.

We are making focused investments across our upstream and downstream businesses in terms of capacity expansions, to cater to the growing domestic and international aluminium markets.

Copper Business

The Copper business, which operates one of the largest custom copper smelting complexes in the world, is located at Dahej, Gujarat. With the addition of Asoj, our Copper business ranks among the top two Copper

producers globally (excluding China). We produce a wide range of products such as copper cathodes, Continuous Cast Copper rods (CCR) in various sizes and alloys, and precious metals like gold and silver.

In addition to our core operations, we are expanding our downstream capabilities to manufacture value-added copper products and establishing the circular economy for copper in India. A major milestone in this journey is the establishment of India's first copper e-waste and scrap recycling plant, which reinforces our commitment to the circular economy and sustainable resource management.

Specialty Alumina

We are a leading manufacturer of specialty alumina in the country, with our two manufacturing units in Belagavi and Muri enabling us to serve customers in 42 countries. Alumina's exceptional properties make it the preferred material for more than 45 applications. These range from refractory, ceramics, and polishing to electrical insulators, circuit boards, batteries, and other electronic applications.

The growing demand for these applications has fuelled double-digit growth of specialty alumina in the domestic market, highlighting its role in building high-performance solutions across industries.

Novelis

Novelis, with a rolling capacity of 4.2 million MT, is the world's largest producer of flat-rolled aluminium products and the world's largest recycler of aluminium. It operates 31 plants located across nine countries, 15 of which have recycling capabilities. These recycling facilities help Novelis to utilise approximately 63% recycled material inputs by recycling post-consumer aluminium, including used beverage cans, and post-industrial aluminium, such as class scrap. Aligned with our 3x30 vision, Novelis is committed to increasing the average recycled content in its products to 75% by 2030, reinforcing our leadership in sustainable aluminium solutions and circular manufacturing.

Production of aluminium and copper at Hindalco from FY 2021-22 to FY 2024-25 ('000 MT)					
Segment	Parameter	FY 2021-22	FY 2022-23	FY 2023-24	FY 2024-25
Aluminium Upstream	Total Alumina	3,235	3,525	3,665	3,857
	Primary	1,294	1,322	1,331	1,323
Aluminium Downstream	Flat Rolled Products	301	287	295	336
	Extrusions	50	64	72	75
	Foils*	28	29	26	30
Copper	Copper Cathodes	359	407	368	402
	Copper Cast Rods	277#	409#	488#	453#
Novelis	Flat-Rolled Products (Shipments)	3,858	3,790	3,673	3,757

\*Part of Flat Rolled Products  
# Inclusive of contract manufacturing



Freshwrapp’s Innovative Freshlock Shield

Traditional practices for food storage has been as using cloth or paper, which retain moisture and promote bacterial growth in India’s warm climate. Freshwrapp is driving awareness around safe, modern, and hygienic food storage. Tests by NABL-approved laboratories confirmed that Freshwrapp resists bacteria penetration for up to 36 hours (11 micron) and up to 48 hours (18 micron), including against common foodborne pathogens such as e.coli in one line, salmonella, staphylococcus aureus, and candida. The study also showed that when non-users were introduced to Freshwrapp foil, their willingness to switch increased substantially.

Freshwrapp’s aluminium foil is ISI-certified and versatile, perfect for wrapping, storing, cooking, freezing, and even serving. Consumer trials show that non-users found it easy to use, effective in retaining food freshness, and a clear improvement over traditional materials, which often leave food soggy and prone to spoilage.

While aluminium foil is not reusable and doesn’t absorb oil, users across the board ranked Freshwrapp high on hygiene, convenience, and freshness. Freshwrapp, has become India’s most preferred aluminium foil brand. It serves over 1.2 million households every month and has been recognised as ‘Superbrand’ for the past three consecutive years.



Expansions in aluminium, specialty alumina and copper

Expanding our Reach and Impact

The post-pandemic years have seen a series of global shocks, however, the world economy has remained broadly stable and resilient. Despite ongoing geopolitical tensions and trade uncertainties, the IMF projects global growth at 2.8% in 2025, with a recovery to 3.0% in 2026. In parallel, the Indian economy is poised for strong growth going forward, as the demand story remains intact, and the macroeconomic fundamentals are aligning to support continued expansion. Growth projections for India remain positive, with the IMF forecasting that India shall grow between 6.2% and 6.5% over the coming years.

Against this backdrop, global demand for aluminium and copper is rising, driven by a shift toward sustainable solutions and increased usage across the electrical,

automotive, building and construction sectors. We are well-positioned to meet this demand by doubling our production capacity in the coming years and reinforcing our role as a key enabler of industrial growth.

Expansions at Aluminium Upstream

In our upstream locations, we have achieved an integrated alumina capacity of 3.81 million MT through planned brownfield expansions and debottlenecking projects at various sites. At Utkal, the debottlenecking project was successfully commissioned and stabilised, elevating the refinery’s current capacity to 2.6 million MTPA. Parallely, we are undertaking a greenfield expansion project to set up an 850 KTPA capacity refinery at Aditya, Odisha. This project is expected to be commissioned by FY 2027-28 and will further strengthen the company’s backward integration and resource security. Further, we are undertaking a 180 KTPA brownfield smelter expansion at our Aditya facility in Odisha, with a planned commissioning by FY 2027-28.

In line with our decarbonisation roadmap, we have launched a comprehensive energy transition initiative. Two pilot projects delivering 100 MW of round-the-clock (RTC) renewable hybrid power for each location is being implemented for the Aditya & Mahan smelters and expected to be commissioned during FY 2025-26 and FY 2027-28 respectively. On successful implementation, this model shall be replicated in our other smelters. For facilitating bulk renewable power import, the grid connectivity at these units is being upgraded from 220 to 400 KV. Additional project for supply of 200 MW of renewable RTC power is being planned for Aditya smelter by FY 2027-28. These initiatives shall help us in advancing towards the company’s aspiration to enhance share of renewable to 30% in overall energy mix by FY 2030-31 and thereby enhancing share of low-carbon aluminium in our portfolio.

To further enhance energy security and reduce dependence on external coal sources, we are developing two

large-scale captive coal mines in Jharkhand and Odisha. The Chakla coal mine in Jharkhand, with a capacity of 4.5 million TPA, is expected to be operational by FY 2025-26, while the Meenakshi coal mine in Odisha, with a capacity of about 12 million TPA, is targeted for commissioning by FY 2028-29. The mines shall play a critical role in ensuring uninterrupted, cost-effective energy supply for Hindalco’s smelting operations, supporting both operational resilience and the company’s broader sustainability goals.

Expansions at Copper Upstream

To meet India’s rising demand for copper, we are expanding our operations. A major brownfield expansion at our smelting complex in Dahej will add 300 KTPA capacity, increasing total refined copper output to 721 KTPA. With an investment of US\$1.13 billion, this expansion will make us the largest single-location copper smelting complex (outside China). This project is expected to be commissioned by FY 2028-29.

Also in the works is India’s first integrated copper and e-waste recycling facility which will enable recovery of high-value metals from electronic waste, supporting circular economy goals. This facility, built on an investment of US\$290 million shall have an initial capacity of 50 KTPA, scalable to 200 KTPA, and expected to be commissioned by the first half of FY 2026-27.

The facility is being built at a time when e-waste and non-ferrous metal regulations in India are becoming increasingly stringent, with the government reinforcing Extended Producer Responsibility (EPR) norms and pushing for formalisation of the recycling sector. By entering a space traditionally dominated by informal operators, we aim to set new standards for compliance, safety, and environmental stewardship. Apart from supporting regulatory goals, the facility will help transform the sector by introducing advanced technologies,

creating environmentally focused jobs, and positioning India as a global leader in responsible e-waste management.

Expansions at Novelis

Novelis continues to execute a robust growth strategy anchored in sustainability, innovation, and circularity. As part of its US\$5 billion organic growth programme, Novelis is undertaking a series of high-impact projects to expand capacity, enhance recycling capabilities, and meet growing demand across key end markets such as beverage packaging, automotive, aerospace, and specialty products.

The centrepiece is the construction of a US\$4.1 billion greenfield rolling and recycling facility in Bay Minette, Alabama. Expected to commission in FY 2026-27, the plant will add 600 KTPA of finished goods capacity for beverage packaging, automotive and other flat-rolled products. The facility will be powered by low-carbon energy and feature an integrated recycling centre, enabling Novelis to further increase recycled input material.

In FY 2024-25, Novelis has completed and commissioned key projects:

- + A US\$365 million automotive recycling and casting centre in Guthrie, Kentucky, with 240 KTPA of casting capacity, operational in FY 2024-25.
- + A US\$65 million recycling and casting centre at Ulsan Aluminum Ltd. (UAL), South Korea, with 100 KTPA capacity, also commissioned in FY 2024-25.
- + A US\$20 million debottlenecking project at Yeongju, South Korea, unlocking 50 KTPA of additional capacity.

A US\$50 million debottlenecking investment at Pindamonhangaba (Pinda), Brazil, to unlock full 70 KTPA of rolling capacity is underway and is expected to be completed by FY 2025-26. Additional debottlenecking projects at Oswego, New York with an investment of US\$130 million for an additional 65 KTPA, and Logan,

Kentucky with an investment of US\$150 million for additional 80 KTPA are ongoing. In Europe, a US\$90 million expansion at the Latchford, UK, recycling centre is expected to double its used beverage can (UBC) recycling capacity by FY 2026-27, supporting our target of meeting 75% recycled content by FY 2029-30.

Expanding our Specialty Alumina Capabilities

Our primary goal is to expand our portfolio of value-added products and our in-house capabilities for halogen-free fire retardants and high-end ceramic products.

Our products have garnered significant attention across various industries, such as semiconductors and lithium-ion battery separators for electric vehicle batteries. To cater to this demand, our business is expanding operationally, integrating modern technologies to enhance processes and product quality. Our Muri refinery has expanded operations to supply 55% of its total production towards non-metallurgical grade alumina for the business. This facility now produces multiple specialty grades serving the water treatment, refractory, and ceramics markets in India and East Asia.

We are in the process of commissioning a precipitate hydrate facility in Belagavi with a capacity of 20 KT by FY 2025-26. The product, fine particles approximately 1 to 2 microns in size, is essential for meeting the new safety standards required to manufacture halogen-free wires in flame retardants. The precipitated superfine hydrate is also used in manufacturing paints.

We started selling White Fused Alumina, our business’s first trademark product FUSALOX™, in the market through strategic partnerships. This high-purity, high-performance material is essential in advanced refractories and precision abrasives. Owing to the demand and existing customer

base, a 60 KTPA greenfield project has been approved and planned to be commissioned by FY 2026-27.

To support our aim to double the shipments of our specialty alumina products, in addition to the existing grade, we also plan to cater to new grades like spherical alumina, boehmite, hydratable alumina and bimodal hydrate.

To become more customer-centric and enhance our relationships with stakeholders, we are expanding our presence worldwide. We aim to widen our reach by expanding our network of warehouses and sales offices.

Expanding our Downstream Capabilities

Expanding our Aluminium Downstream

Hindalco's downstream business is undergoing a strategic transformation to deliver high-margin, value-added products across aluminium and copper segments. With a strong foundation in upstream integration, the Company has for the past few years, been focused on expanding its downstream footprint to cater to high growth sectors such as EVs, renewable energy, building and construction, and consumer durables.

In Aluminium downstream, we are enhancing our flat-rolled products (FRP) and extrusion capabilities. A 170 KTPA FRP plant with advanced casting and cold rolling infrastructure at Aditya, Odisha, is on track for commissioning by FY 2025-26. We are also developing a 26 KTPA coated aluminium AC fin facility at Taloja under the PLI scheme, targeting HVAC and automotive applications.



Our battery materials portfolio is gaining strong momentum. We have commissioned India's first aluminium battery enclosure facility in Pune, which is a milestone in EV component manufacturing. Our Chakan (Pune) facility is also expanding into aluminium bicycle components with a capacity of 26 KTPA, strengthening our extrusions portfolio. We have also commissioned a high-tech die manufacturing unit at Silvassa with a capacity of 5,000 Nos per annum. Additionally, a 24 KTPA battery foil mill is being built at Aditya in Odisha, which will further strengthen our position in the energy storage and electric mobility segments. At our Mouda facility in Maharashtra, we are producing battery-grade aluminium foil, a key component of Lithium-ion and Sodium-ion cells.

Expanding our Copper Downstream

In copper, we are scaling up our downstream capabilities with a 300 KTPA continuous cast rod (CCR) facility in Asoj, Gujarat, to meet the growing demand for the metal in the electrical segment. We have also commissioned India's first integrated inner grooved copper tube facility with capacity of 22.5 KTPA in Vadodara, Gujarat. We are also building a 11.5 KTPA battery-grade copper foil facility to cater the EV and battery ecosystem in India.

Integrated and Robust Management Systems

At Hindalco, our strong systems and processes across all locations ensure we consistently deliver top-quality products and maintain optimal standards. All our offices and manufacturing plants in India operate under integrated management systems certified on ISO standards, for quality, environmental management, and occupational health and safety. Additionally, seven of our plants hold ISO 50001 certification for energy management.

Our extrusions plants at Renukoot and the Hindalco-Almex Aerospace Limited have earned AS 9100 certifications,

qualifying them to produce aerospace and automotive-grade products. The Mouda plant is licensed by the Bureau of Indian Standards (BIS) to manufacture marine-grade materials. Plus, our extrusions plants in Alupuram, Belur, and Renukoot are certified under NABL ISO/IEC 17025.

Kuppam and Taloja plants have achieved IATF 16949 certification, reflecting their capability in producing high-quality aluminum for the automotive sector. Kuppam, Alupuram, Hirakud, and Belur are also certified to develop products for naval applications. Our Alupuram, Belur, Belagavi, Mouda, Hirakud FRP, Renukoot, Kuppam, and Taloja plants have received certifications from the Aluminium Stewardship Initiative (ASI), underscoring our commitment to responsible production. We also ensure compliance with the Restriction of Hazardous Substances (RoHS) directive, with regular testing conducted in NABL-accredited laboratories.

At Novelis, 29 of our manufacturing plants are certified with ISO 14001 for environmental management, while 25 of our plants are certified with ISO 45001 for occupational health and safety management standard. We recently re-certified the Koblenz plant, bringing the total to 10 certified plants with ISO 50001 for energy management. Automotive-focused sites such as Oswego and Nachterstedt also hold IATF 16949 certification, ensuring compliance with rigorous automotive industry requirements.

All Novelis facilities across Asia, Europe and South America have earned the ASI Performance Standard and ASI Chain of Custody (CoC) certifications. In North America, seven of our 13 sites have achieved dual certification. The plants in Germany and China, which manufacture for the aerospace segment, have received accreditations in quality management, environment management, heat treating, and non-destructive testing.

Elevating Operational Excellence

At Hindalco, we are deepening our commitment to operational excellence by strategically investing in the right capabilities, expanding capacities and benchmarking global best practices. Through the adoption of modern technologies, we aim to enhance efficiency, reduce costs, and accelerate the development of innovative, sustainable products.

Our core initiatives – World Class Manufacturing (WCM), the Maintenance Strategy and Execution Framework (MSEF 2.0) for upstream operations, and the Build Quality in Process (BQiP) framework for downstream quality – have already delivered measurable improvements across our operations. At Novelis, we drive operational efficiency through the Novelis Operating System (NOS), which is built around key Centres of Excellence (CoEs) such as Specific Improvement, Operator Care, Planned Maintenance, Progressive Quality, and Education & Training. The operating system provides a structured framework for continuous improvement and performance management.

To proactively manage risks, we leverage our Enterprise Risk Management (ERM) framework, which is integrated into a company-wide, multi-disciplinary process. This framework enables us to assess risks across short, medium, and long-term horizons and guides the identification and prioritisation of projects that drive operational excellence.

Our management approach is designed to systematically identify opportunities that enhance the profitability of our operations through:

- + Inorganic growth: Acquiring world-class assets and technical capabilities to meet rising global demand, particularly in the automotive sector.
- + Organic growth: Investing in debottlenecking, recycling, and capacity expansion.

- + Product portfolio optimisation: Focusing on high-potential segments while exiting less attractive ones.
- + Talent development: Identifying top talent and providing them with a range of growth opportunities.

To engage employees and develop problem-solving skills, we continue to host Kaizen competitions across all our plants and mines. This year, we have achieved significant savings by implementing 35,954 Kaizens and 2,542 continuous improvement projects.

Various other improvement opportunities have also helped us to boost productivity and efficiency at our plants. For instance, introduction of HiPoT technology at the Hirakud smelters have helped to improve cell stability and reduce specific energy consumption. Further, Aditya smelter has set a benchmark by achieving Fe content below 500 ppm in one-year average, positioning it as one of the best smelters globally in Fe content in Hot Metal. Aditya also added a new grade in its high purity product portfolio and increased production of the high-purity grade by 32% this year.

Improving Reliability through Streamwise Maintenance Assessments

As part of Hindalco's Engineering and Maintenance Excellence initiative, the “Stream-wise Maintenance Assessment Framework” was launched in January 2024. This was designed to delve deeper into the quality of core engineering, design, and maintenance practices across the Mechanical, Electrical & Instrumentation (E&I), and Civil & Structural (C&S) streams. The primary objective was to identify weaknesses, uncover opportunities for improvement, and drive standardisation across aluminium upstream – smelters, power plants, and refineries.

The framework focuses on seven engineering areas: safety, adequacy of engineering and maintenance checks, implementation of engineering and corrective actions, validation of equipment care through equipment history, risk-based maintenance strategies, spares classification and preservation norms, and the use of digital and predictive analytics. These assessments are conducted alongside the existing Maintenance Strategy and Execution Framework (MSEF), ensuring a holistic evaluation of technical and systemic aspects of plant operations.

A cross-functional taskforce comprising subject matter experts from various plants conduct the assessments. This collaborative approach provides deep insights into improvement areas and fosters cross-pollination of best practices across plants. The initiative has already become a regular practice, leading to the identification of critical improvement areas that are essential for stable and reliable operations.

In FY 2024-25, the assessments yielded comprehensive insights into the current condition of engineering practices, based on which we have implemented recommended actions, resulting in improved equipment uptime and reliability.

Driving operational excellence

Novelis Operating System (NOS) – Driving Operational Excellence

We have implemented the Novelis Operating System (NOS) – a structured, company-wide framework that integrates the principles of Total Productive Maintenance (TPM), Total Quality Management (TQM), and Lean Six Sigma. NOS is designed to standardise best practices, drive continuous improvement, and ensure consistent performance across all plants. It operates through an “Infinity Loop” model that balances two core cycles: sustaining performance through rigorous adherence



to standards and empowering teams, and improving performance by identifying losses, launching targeted initiatives, and institutionalising new benchmarks.

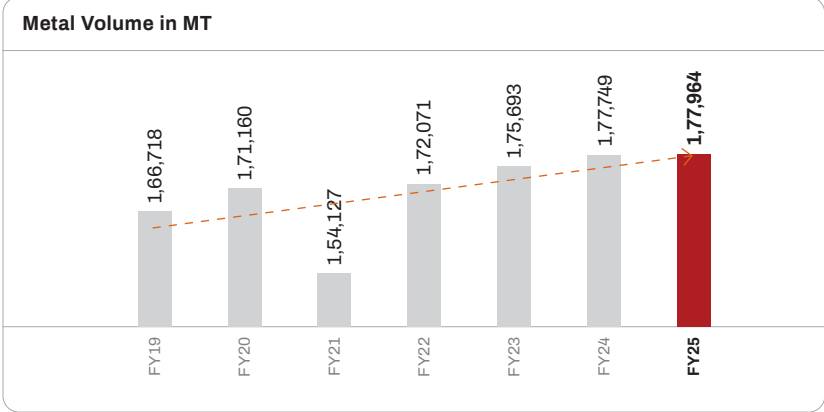
Each plant develops a “Single Agenda,” which consolidates 50 to over 100 improvement projects aligned with specific goals. These projects are led by dedicated Centres of Excellence (CoEs) focused on areas such as Specific Improvement, Operator Care, Planned Maintenance, Progressive Quality, and Education & Training. The structured governance model ensures that each initiative is reviewed and supported by plant managers and functional leaders. In FY 2024-25, four plants underwent NOS Bronze Pre-Certification reviews, with our Pindamonhangaba (Pinda) plant becoming the first to achieve Bronze Certification, marking a milestone in our operational journey. As we continue to scale NOS across our network, it remains a cornerstone of our strategy to align people, processes, and performance with long-term business goals.

Record Production at Hirakud Smelter

Hirakud achieved its highest-ever production of 177,964 MT, since inception. This milestone is testament to the combined efforts and excellence demonstrated across all facets of smelter operations. The factors that contributed to this achievement are:

- + Increased Number of Pots in Operation: Enhanced pot availability and optimisation of potline operations have led to higher active pot count, directly boosting output.
- + Highest Current Efficiency Achieved: Consistent focus on process control has led to a notable improvement in current efficiency,

- maximising metal yield per unit of energy.
- + Stable Power Supply: Reliable and uninterrupted power has been a critical enabler, ensuring continuous operation of pots.
  - + Improved Equipment Reliability: Proactive maintenance strategies, timely upgrades, and improved asset management have resulted in higher equipment availability.
  - + Reduction in pot turnaround time: With meticulous planning and seamless collaboration of various agencies, TAT reduced to 7.3 days.



Energy Reduction Solutions through Design Modification of Cathodes at Aditya

The specific energy consumption at Aditya was reduced to 13.3 kWh/ kg of Al from 13.5 kWh/ kg of Al, through retrofitting copper insert collector bar in cathode. To reduce energy consumption further, the existing lining design was modified to incorporate new high insulation material, side wall block shape changes and a new version of copper on-sert collector bar in place of insert which were developed in collaboration with ABSTC. Start-up laws and operational

procedures were also adjusted to accommodate the newly designed pot lining. The modified pot lining has been implemented in 17 test pots during FY 2024-25. When compared to pots of similar age with the previous design, the new configuration demonstrated a reduction in total pot voltage by about 50 mV, translating to an energy saving of 190 kWh/T of aluminium produced.



Better Stability and Reliability at Aditya & Mahan through 400 KV Grid Connectivity

At Hindalco, the electricity requirements of all our smelters are met through our coal-based captive power plants, connected via 220 and 132 KV transmission lines.

Uninterrupted power supply is critical for aluminium smelting. However, due to the long transmission distances, both power plants experience multiple instances of islanding during grid disturbances. These disrupt stable operations at smelters.

To enhance operational reliability, we undertook projects to establish 400 KV grid connectivity.

This project is currently at various stages of erection and commissioning:

- + Aditya Aluminium is being connected to the 400 KV OPTCL STU (State Transmission Utility) Grid at Lapanga Substation, with targeted commissioning in FY 2025-26



- + Mahan Aluminium is being connected to the 400 KV ISTS (Inter State Transmission system) Grid via a dedicated transmission line with targeted commissioning by FY 2027-28.

- + The 400 KV connectivity will also enable the withdrawal of uninterrupted round-the-clock renewable energy from offsite sources.

Enhancing Alumina Recovery and Energy Efficiency at Muri

Muri refinery works on double digestion for the extraction of alumina from bauxite. The bauxite source of Muri contains Boehmite or Mono Hydrate Alumina which is hard to digest and requires a high temperature digestion unit for recovery. We were able to solve this through continuous process improvements which resulted in higher Overall Alumina Recovery, Precipitation Liquor productivity and reduced specific energy consumption.

**Improvement of Overall Alumina Recovery:**  
The overall recovery of any double digestion plant lies in the range of 91-92%. The recovery part contains 2 major divisions – Chemical

Extraction and Post Digestion recovery. We faced issues in Chemical Extraction which was solved by improving PDS Density, Boehmite Reversion reduction, Flocculant Dosing Philosophy change and Granulometry trials. These improvements led to an increase in Overall Recovery from 90.6% to 91.8% between FY 2023-24 and FY 2024-25. The level has sustained at 92.5-93% since October 2024.

**Benchmark efficiencies of energy consumption:**  
The average energy customised of Muri refinery used to be in the range of 13-14 GJ/T in FY 2020-21 and FY 2021-22, with a steam

consumption of 3.2 T/T. We undertook a series of steam reduction debottlenecks, such as replacement of heater tubes of LT and HT digestion, 2nd effect tube replacement to improve evaporation steam economy. We also reduced the size of miscellaneous steam ring header to cut process losses and installed an SFT agitator. These measures have resulted in reduction of steam up to 2.62 T/T in FY 2024-25.

Reduction of Steam Consumption at Renukoot Refinery

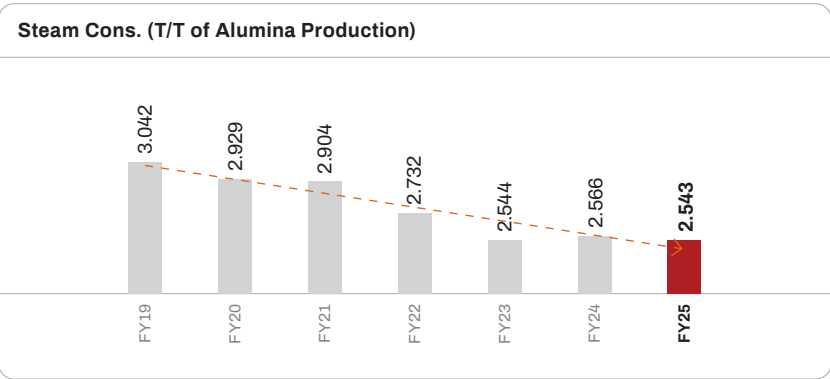
Renukoot Alumina Refinery is one of the oldest refineries, using various evaporation technologies like Multistage Flash Evaporation, Multistage Falling Film Evaporation and Multistage Rising Film Evaporation. In order to improve steam economy of evaporation unit and Condensate Heat Recovery, we adopted an innovative approach, achieving a reduction of overall steam consumption per unit of alumina produced, of plant from 3.042 T/T to 2.543 T/T (16%) over a period of seven years.

The refinery also initiated Condensate Heat Recovery by unused condensate routed through a heat exchanger. This innovative approach resulted in a significant reduction in condensate temperature by 25-30°C, simultaneously elevating the temperature of the vanadium lean

liquor by 25°C. Consequently, this led to substantial savings in live steam consumption and a notable decrease in freshwater utilisation at the boiler end as a higher proportion of condensate is now utilised as DM feed water.

A comprehensive analysis was carried out to assess the drawbacks in existing system and identify actionable points to attain our objective.

Methodologies adopted were process reengineering, adopting statistical tools and data analytics, refinement in process control and improved operational practices. Steam economy of evaporation units improved from 2.65 T/T against 3.63 T/T earlier.



Improved Dust Control System to Enhance Copper Wire Drawing Performance

Copper wire rods are widely used in electrical and industrial applications because of their excellent conductivity and durability. However, during production and downstream processes like wire drawing, fine copper dust is generated, which can cause surface defects, reduce coating quality, and lead to material loss.

Investigations using advanced techniques like XRF and XRD showed that this dust consists primarily of elemental copper with traces of cuprous oxide. These particles

entered the emulsion, affecting quality. The root cause was identified as rough patches formed during the hot rolling process, which released fine particles into the emulsion used in manufacturing. These particles were then carried forward into the final product, affecting its quality and performance.

To solve this issue, a customised dual-stage filtration system was developed. This system is designed to remove particles smaller than 100 microns and includes independently

operating units with high-capacity pumps that adjust based on dust levels. The filtration system effectively cleans the emulsion, preventing dust from re-entering the copper rod.

The system led to enhanced operational efficiency with improved product quality and process cleanliness. The system reduced significant amount of dust during rod and wire drawing operations at customer sites, enhancing overall customer satisfaction.

Accelerating Hard Alloy Production in Alupuram

To enhance operational efficiency and market competitiveness, Hindalco’s Alupuram unit launched a focused initiative to improve hard alloy casting and extrusions capabilities. The alloys serve high-demand sectors like aerospace and defence. There were challenges such as billet cracking and low productivity, which were addressed through a series of interventions.

A data-driven approach revealed the potential reasons for billet cracks and prompted adjustments in alloy composition, changes in casting parameters, cooling rates, and grain refinement leading to improved productivity and recovery of extrusions.

This project led to nearly 4x increase in production over the 4 years, increased EBITDA, and substantially improved pit recovery for AA7075. Beyond financial gains, the initiative supported market expansion and fostered cross-functional collaboration

Stabilisation of Wider-width Litho at Hirakud FRP

To reduce the dependency on imports, we decided to boost the production volume of lithographic aluminium sheet (litho) at Taloja. Teams from marketing, planning, production, and quality from Taloja and Hirakud plants collaborated on this project to enhance supplies. The focus was on metal planning to meet litho production targets. Spares management and prioritising issues helped in increasing reliability of the operations. Dashboards were developed to monitor recovery and turnaround time (TAT) which helped the Taloja team to track key KPIs.

These initiatives helped us to achieve increased line speeds from 150 to 195 MPM by resolving equipment issues and boosting operator confidence. Using the DMAIC approach, the TAT was improved, moreover, cross-functional teams conducted Pareto analysis on coil breaks. The digital monitoring and Pareto analysis helped improve litho recovery in terms of length and width.

The efforts ramped up volume from 15.9 KT in FY 2023-24 to 17.6 KT in FY 2024-25, improved recovery by 1.1%, and increased utilisation from 76% to 83%, resulting in an EBITDA improvement of ₹4.5 crore per annum.



Cold Rolling Mill Productivity Enhancement at Mouda

To meet the demand for foil catering to pharma and food segments, Mouda used to source >200 TPM of Cold Rolled Coil (CRC) from Hirakud FRP which was at a higher cost than inhouse CRC. To enhance the capacity of in-house CRC at Mouda, a team comprising members from production, process, engineering, and operations initiated a project. The project focused on improving productivity, reducing quality rejections, and increasing equipment reliability. Kaizen events and problem-

solving approaches like RCA and DPS were utilised to implement systematic action plans through MOC, DOE trials and HIRA.

The project reduced turnaround time from 7 to 4.6 minutes, increased production tonnage per hour by reducing errors and boosted mill speed from 455 to 489 MPM. Eliminating black line and pit/skid mark issues through process standardisation improved the quality performance. Reliability was

improved by reducing the unplanned downtime via a preventive maintenance plan and root cause analysis.

The efforts resulted in an annual production gain of 2.6 KT, resulting in financial benefits of ₹20 crore due to improvement in mill utilisation, increasing monthly passes, and reduction in power consumption per tonne.



### Reducing Energy Consumption in Soaking Pit at Renukoot FRP

To reduce energy costs in the Hot Mill and FRP operations at Renukoot, we undertook a revamp of the Soaking Pit. This pit, essential for preheating aluminium slabs before hot rolling, was consuming excessive power. The revamp project aimed to achieve a recurring energy saving of 125 kwh/ MT.

The project involved a detailed energy consumption study, optimisation of heater banks, and replacement of edge-wound heaters with more efficient bundled heaters. We also upgraded the outdated contactor control system to a thyristor power controller for better energy regulation. An automatic fire suppression system was also installed to enhance safety.

The project helped to reduce energy consumption, improve equipment reliability, and made operation easier through an integrated SCADA interface.

### Reducing Coating Defect NCs through Emulsion Optimisation at Taloja

High rate of coating defects in coils was found to be a major contributor to Non-Conformities (NCs) at the Taloja plant. A process improvement initiative was taken up at Soaking Pit operations to solve the problem.

The plant team optimised the emulsion oil mix used in the hot mill to add HIC and Houghton oils in the same ratio, vis-a-vis maintaining a 70:30 ratio earlier. The revised approach was

### Product Development at Renukoot Extrusions for Automotive Parts Manufacturer

Renukoot successfully qualified its AA6061 HS alloy for a leading automotive parts manufacturer, through a rigorous end-to-end process. This included ensuring billet quality from both Renukoot casting stations using microstructure analysis and manual ultrasonic testing (UST). Multiple extrusion trials were conducted to meet stringent mechanical property requirements, followed by a successful Production Part Approval Process (PPAP) submission.

In the machine shop, 100% UST, hardness testing, and dimensional checks were carried out, with laser marking introduced for full traceability from casting to packaging.

This initiative not only led to the alloy's successful adoption by the customer but also enabled a major production ramp-up. Component supply increased from 1,803 units in September 2024 to 147,061 units by March 2025 while meeting global automotive standards.

## Process digitalisation

### Digitalisation: Higher Efficiency, Performance, Transparency

In FY 2024-25, Hindalco accelerated its digital transformation journey, embedding advanced technologies across the value chain to drive operational excellence, sustainability, and customer-centricity. We implemented numerous digital initiatives leveraging AI, ML, IIoT, Digital Twins, blockchain, and augmented reality to transform how we operate, monitor, and deliver.

In manufacturing, digital twins have been deployed at the Hirakud and Aditya power plants and the Green Anode Plant at Mahan, enabling real-time process optimisation and improving energy efficiency. Further, AI/ ML-driven analytics projects, such as yield optimisation at Renukoot, particle size distribution prediction in Specialty Alumina plants, and pinhole detection at Mouda, have significantly boosted process outcomes and product quality. We are also putting in place Operations Data Management platform in 12 upstream plants to aggregate dispersed data and visualise KPIs for faster decision-making on the shopfloor.

In safety and quality inspection, computer vision-based video analytics are being used for coal sieve analysis at Hirakud, cathode quality at the copper operations in Dahej, and switchyard safety at Renuagar and Aditya. Over 70 AR/ VR (Augmented Reality & Virtual Reality) models are deployed for operator training and safety enhancement. In logistics, our Logistics Insight Tower (LIT) 2.0, smart warehouse systems and blockchain-based toller management system



Power plant employees sharpen their skills through real-time simulation training

at Taloja are enabling real-time tracking, inventory visibility, and improved reconciliation.

We have also made significant strides in predictive maintenance. Over 400 critical assets have been integrated with AI/ML-based asset performance models, improving uptime and Mean Time Between Failures (MTBF). Additionally, 300+ heavy earth-moving machines have been digitally enabled, leading to better utilisation and fuel efficiency. These tools are enhancing reliability and contributing towards our Net Zero goals by reducing energy use and extending asset life. Further, we are leveraging Gen-AI technology in multiple use cases such as getting market insights, operations insights, and legal assistance.

To support this transformation, we have invested in building digital capabilities across the organisation. Through DISHA (Digital Shiksha) programme, over 3,500 employees have been trained in digital technologies and analytics tools. More than 650 shop floor employees have received 500+ hours of analytics training. Through our Citizen Data Scientist initiative we have trained 17 engineers in data science who have delivered 10+ high-impact projects, with 15 more underway.

Our digital roadmap is anchored in four strategic pillars: Smart Manufacturing, Smart Supply Chain, Customer Centricity, and Smart Workplace. These are supported by a robust IT and data foundation, including enterprise-wide data lakes, cloud-based ERP (Ekaayan), in addition to a stronger IT & OT security posture and modernised network infrastructure. We have also adopted tools aligned with our ESG goals, such as energy monitoring systems, predictive maintenance platforms, and digital dashboards to track sustainability KPIs.

As we scale our Industry 4.0 journey, we continue to collaborate with startups and technology partners to bring innovations like blockchain, computer vision, and Gen-AI into our operations. Our Connected Plant programme and Plant of the Future framework are already delivering measurable business impact, reinforcing our commitment to build a future-ready Hindalco.

### Lithographic Sheets Ramp-up at Taloja

In response to the rising domestic demand for wider width Litho coils, Hirakud FRP undertook a product stabilisation initiative for such Litho offerings. The objective was to develop high-strength Litho sheets with stringent flatness and surface finish tolerances, critical for consistent and high-quality printing applications.

As this marked the plant's first foray into Litho product manufacturing, initial challenges included surface defects, waviness, scoring marks, and flatness variability -- primarily due to differences in mill capabilities and specifications.

The Hirakud and Taloja teams worked closely together to solve the issues. They identified the root causes, optimised machine parameters, introduced targeted training programmes, and introduced process innovations to meet the required quality standards.

This initiative delivered significant improvements in product quality, enhanced productivity, and reduced turnaround times. Financially, it contributed to increase in EBITDA, while also elevating customer satisfaction and reinforcing the Company's leadership in the domestic Litho market.



Data Management Platform Launched for Upstream Plants

Hindalco launched a centralised Data Management Platform (DMP) initiative, with the objective of accelerating digital transformation across its upstream operations. The platform integrates real-time data from aluminium smelters, power plants, alumina refineries, and copper to enable data-driven decision-making and improve operational efficiency.

The DMP consolidates various digital initiatives such as IIoT-based condition monitoring, drone surveillance, and predictive analytics, into a unified system. It supports real-time tracking, advanced analytics and seamless integration with ERP systems. The rollout is planned in two phases, with Phase 1 covering Hirakud, Muri, Aditya, Mahan, Utkal and copper operations in Dahej, and Phase 2 covering Renukoot and Renusagar.

At Hirakud and Muri, DMP implementation has shown measurable improvements in efficiency and energy use. Once fully deployed, the DMP will serve as the digital backbone of Hindalco’s “Plant of the Future,” aligning with its Industry 4.0 goals.



Smart infrastructure for smart power plant operations

Leveraging Digital Twin for Operational Efficiency

At Hindalco, we are leveraging Digital Twin technology to optimise performance and energy efficiency across critical operations. At our Hirakud and Aditya power plants, Digital Twin are helping improve plant heat rate through boiler performance optimisation and asset performance monitoring. To optimise boiler performance under varied operating conditions and fuel quality, we connected over 100 assets and deployed more than 200 analytics models. These improvements have reduced ignition loss, specific steam consumption and boosted asset reliability.

Similarly, at the Green Anode Plant in Mahan, the Digital Twin is improving anode quality and reducing rejections. Real-time prediction of raw material quality, recipe optimisation, and KPI tracking have resulted in 78% of recommended actions. Improvements have been observed across seven KPIs, including reduced energy consumption at the smelter.

Using Time Study to Improve Cold Rolling Mill Productivity in Taloja

To meet the growing market demand for high value aluminium FRP products like CLAD, fin stock, and automotive applications, we needed to improve mill productivity and eliminate MUDA (waste).

Improvement in mill productivity shall increase plant capacity, reduce power consumption, enhance equipment efficiency, and boost EBITDA. Mill availability was identified as a constraint to productivity due to downtime and extended mill turn-around time (TAT). We leveraged IIOT platform and improved the productivity by breaking down TAT into micro-processes, conducting time studies, and holding Kaizen events with mill workers. This IoT module made data access easy at the shop floor and enabled daily discussions with crew members to share best practices.

Extensive digitalisation helped to enhance mill operations. Field sensors were installed to monitor 29 micro-processes and several modifications were made. These include automating manual operations using computer vision improving buggy speed, optimising uncoiler and coiler operations and maintaining hydraulic circuits for quick response. These efforts reduced the average TAT from 3.83 minutes in FY 2020-21 to 2.92 minutes in FY 2024-25, increased mill availability by 72 hours per month, thus improving productivity by 540 MT per month.

In addition, we achieved the lowest TAT of 2.72 minutes per coil, the highest pass of 5,582 in a month, and the lowest power consumption of 123 kWh per pass. These measures have improved operational efficiency and cost savings.



Novelis' innovation journey is supported by its network of 11 R&D centres

Blockchains Enabling Tolling Management System at Taloja

We faced multiple challenges due to manual management of tolling systems at Taloja. There were instances where information required for audit was missing or unreliable. To overcome this problem, we successfully digitalised the Tolling Process using blockchain technology to streamline interactions with job workers and enhance operational transparency.

The solution digitised the Master Service Order (MSO) and Quality Clearance workflows. It integrated seamlessly with our ERP system and provided a comprehensive dashboard for real-time visibility of MSO status and inventory at toller sites. The initiative enabled accurate reconciliation of finished goods, scrap, and packing materials. With built-in validation workflows, audit trails, and automated checks, the system minimised data entry errors and led to better decision-making. Going forward, this initiative shall save packing material, improve tracking of work-in-progress and finished goods, thus enabling transparent tolling operations.

Predictive Maintenance Transformation at Pinda, Novelis

The Pinda facility implemented a cutting-edge predictive maintenance solution to enhance equipment reliability and operational efficiency, as part of Novelis’s “Plant of the Future” initiative. The project involved the installation of over 700 IoT sensors on the Hot Mill, which were integrated with an advanced Asset Performance Management (APM) system. This system leverages artificial intelligence and machine learning to monitor equipment health in real time, detect anomalies, and predict potential failures before they occur.

The APM solution is built on a hybrid architecture combining cloud scalability with edge computing for low-latency data processing. This solution enables the plant to move from reactive to predictive, and eventually prescriptive maintenance, where the system forecasts issues and recommends corrective actions. As a result, the Pinda plant has achieved a significant reduction in unplanned downtime, improved maintenance planning, and optimised resource utilisation. This initiative has become a benchmark for digital reliability practices across operations.

Operational Excellence Diagnostic at Ulsan, Novelis

The Ulsan facility undertook a comprehensive Operational Excellence Diagnostic to align its performance with our strategic goals and the principles of the Novelis Operating System (NOS). This diagnostic was designed to assess the plant’s current capabilities, identify improvement opportunities, and build a roadmap for sustainable performance enhancement.

The initiative focused on foundational NOS practices: defining purpose and strategy based on customer value, setting measurable targets, identifying and analysing operational losses, aligning improvement efforts to a unified agenda, and executing structured problem-solving. Through this initiative, the Ulsan team identified several key levers to improve Cold Mill throughput by FY 2026-27.

Despite increased quality inspection requirements, the plant successfully enhanced productivity and significantly reduced its overall claim rate. The diagnostic delivered tangible operational gains and strengthened the plant’s alignment with the broader “Novelis Way” of continuous improvement and excellence.