

Engineering the Next Generation of Aluminium Expansion in India

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Abstract

India's domestic aluminium demand is projected to reach 8.5 Mt by FY30, 18 Mt by FY40 and 28 Mt by FY47. Meeting this demand while capturing a meaningful share of growing global requirements could create the potential for India to build about 37 MtPA of aluminium capacity by FY47, implying an overall capacity Compound Annual Growth Rate (CAGR) of about 8.3 %. Existing primary producers, secondary aluminium players and prospective new entrants have announced additions across refineries, smelters and cast houses; however, the scale and speed of future expansion will depend critically on assured bauxite and scrap availability, competitive round-the-clock power, timely infrastructure and project execution. Unless these enablers are addressed in parallel, capacity creation may lag the FY30 and FY47 aspirations.

China demonstrated how rapid aluminium capacity growth can be enabled by large-scale investment in raw materials, infrastructure and energy, historically with a major dependence on coal. India cannot replicate that pathway in today's carbon-constrained world. The next generation of Indian expansion must therefore be engineered for both speed and progressively lower carbon intensity. This requires highly energy-efficient smelting technology, brownfield and modular expansion wherever feasible, optimal sizing of common facilities for ultimate capacity, increased use of renewable energy backed by firming and storage, improved heat and material efficiency, and a larger role for recycling. India may also need a ring-fenced portfolio of certified low-carbon aluminium capacity to serve carbon-sensitive export markets, including Europe, as mechanisms such as Carbon Border Adjustment Mechanism (CBAM) and other carbon- or quality-linked trade measures evolve.

Accordingly, accelerated and low-carbon growth of the Indian aluminium sector requires coordinated action along the following routes:

- Accelerated exploration and conversion of bauxite resources into mineable reserves, creating a sufficiently large inventory of auctionable/captive blocks capable of supporting economically sized alumina refineries and long-life expansion programmes.
- Collaboration among State and Central public-sector entities, private producers and State Governments to enable long-term, competitively priced bauxite supply, faster mine operationalisation and supporting logistics infrastructure.
- Rapid development of a domestic non-ferrous scrap collection, traceability, segregation and processing ecosystem, supported by appropriate tax, Extended Producer Responsibility (EPR) and incentive frameworks, to progressively increase closed-loop recycling and secondary aluminium production.
- A competitive and progressively decarbonised power architecture for smelters, combining reliable baseload with renewable energy, storage/firming and efficient transmission. Policy impediments affecting captive and group-captive power, electricity duty, green-energy corridors/open access and dependable fuel logistics for the transition period need to be addressed while smelters continuously reduce specific energy consumption.

Engineering choices must simultaneously reduce project lead time and lifecycle carbon intensity. Brownfield expansion, standardisation and modularisation, early execution of enabling works, common facilities designed for ultimate capacity, digital engineering/ Building Information

Modeling (BIM), integrated project controls, advanced process control and data-driven commissioning can shorten schedules and improve ramp-up performance. For energy-intensive smelting, technology selection should explicitly evaluate specific DC energy consumption, current efficiency, anode performance, heat balance, flexibility for renewable-power integration and future carbon constraints - not merely initial CAPEX. Decarbonisation should therefore be embedded in the project configuration from concept and Detailed Project Report (DPR) stage rather than retrofitted after commissioning.

Supply-side expansion alone will not create a resilient industry. When raw materials and energy are scarce or uncompetitive, producers have less incentive to invest in market development, and domestic demand can either moderate or be increasingly served by imports. Growth must therefore be complemented by demand-shaping policies, standards and product innovation. In mobility, this includes greater lightweighting, efficiency norms for Electric Vehicles (EVs), higher aluminium penetration in battery enclosures, crash-management systems and structural applications. In packaging, construction, electrical and other sectors, stronger product standards and enforcement can improve quality, prevent sub-standard imports and build confidence in Indian downstream products.

The Aluminium Vision for India conceptualises three taskforces that can provide an institutional mechanism for implementing this transition:

- Resource Security Taskforce: to develop actionable measures for bauxite exploration and mine operationalisation, improve domestic scrap collection and recycling, and address regulatory and logistics constraints across the raw-material chain.
- Applications Development and Demand Generation Taskforce: to develop standards, strategic application programmes and research priorities for increased aluminium usage in automotive, transport, construction, packaging, electrical, defence and other emerging sectors.
- Green Transition Taskforce: to define 'green aluminium' in the Indian context and develop a practical pathway for creating globally competitive low-carbon capacity, covering renewable-power integration, energy efficiency, Recovery Point Objective (RPO) and carbon-market obligations, recycling, emerging technologies and the economics of transition.

India has a strong domestic resource base and a compelling demand opportunity, but the next phase of growth cannot be delivered by capacity addition alone. It must be engineered as an integrated system in which resource security, low-carbon and reliable power, technology selection, modular and digital project execution, circularity, downstream market development and policy support advance together. The central proposition of this paper is that accelerated growth and decarbonisation need not be competing objectives: when embedded at the concept and engineering stage, decarbonisation can become a design constraint that drives more efficient technology, infrastructure and execution. This integrated approach can enable India to expand at the required pace while building a competitive, resilient and progressively low-carbon aluminium industry.

Keywords: Indian aluminium capacity accelerated growth, Low carbon engineering, Certified low-carbon aluminium capacity, Engineering for reduced project time, Renewable energy.