



BRIGHT FUTURE OF ALUMINIUM INDUSTRY IN INDIA

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ABSTRACT

The 1980s saw the biggest shifts in the 100-year history of the global aluminium and bauxite industries. The traditional role of poor countries in providing bauxite and alumina feedstock to multinational corporations has shifted dramatically. Bauxite ore, which is processed to generate aluminium oxide ('alumina'), which is smelted into aluminium metal. Easily recycled without losing quality, aluminium is suitable for the circular economy. The International Aluminium Institute (IAI) estimates that 75% of the 900 million tonnes of aluminium produced since 1880 is still in use. Buildings, autos, and electrical cables currently stored metal may be recycled to equal up to 17 years of current annual primary aluminium production. In order to achieve its economic growth ambitions, India's aluminium sector will be vital. With its expanding economic might, India should be able to create enough high-quality metal to meet its own defence and critical infrastructure needs, avoiding global supply and price volatility. Aluminium's quality is not harmed by recycling, hence it has a high scrap value. Almost all aluminium scrap is recycled. India's aluminium capacity utilisation increased from 56% in 2015 to 90% in 2019-20, and is expected to reach 98% by 2025. Due to its endurance and recycling qualities, 75% of all aluminium produced is still in use.

KEYWORDS: Domestic Aluminium, Aluminium Production, Trade Policy, Aluminium Market, Future Outlook, Production and Stock.

INTRODUCTION:

Aluminium is the world's most frequently used metal, second only to steel. Aluminium is produced more than any other non-ferrous metal, with substantial environmental and social implications. Aluminium consumption has risen by nearly 5% annually in recent years. Despite increased efforts to capture and recycle aluminium, primary aluminium production is expected to grow to meet rising demand. Its unique qualities including light weight, recyclability, conductivity, non-corrosiveness, and durability have made it a preferred metal for different uses in the industrial industry. Its 3x lighter than steel makes it a good choice for automotive, defence, and aviation applications. Due to its durability and non-corrosive qualities, the building industry relies on aluminium alloys for everything from external cladding to structural components. Aluminium's heat and electricity conductivity makes it a favourite in the electrical and electronics industries. Aluminium is a practical solution for packaging such as beverage cans and foils since it is infinitely recyclable.

Aluminium is not pure in nature. Primary aluminium metal is made from bauxite ore, which contains hydrated aluminium oxide (40-60%) combined with silica and iron oxide. 4-5 tonnes of bauxite ore are refined to make 2 tonnes of alumina. 2 tonnes alumina = 1 tonne aluminium. Aluminium production requires a lot of capital and energy. Alumina, power, and labour account for 75-80% of overall cost, depending on area. Construction (22%) is the second largest user of aluminium, followed by packaging (13%), electrical (12%), machinery and equipment (8.5%), consumer durables (4.5%), and other industries (4 percent). Since 2000, primary aluminium manufacturing hubs have shifted from the west to the east, mainly to China, India, and the Middle East.

Upstream and downstream aluminium industries exist. The upstream sector involves bauxite mining and generates primary or "unwrought" aluminium. Bauxite is then processed into alumina. Smelting turns alumina into primary aluminium. Aluminium ingots and billets are the raw materials used to manufacture aluminium goods. Primary aluminium production is a capital and energy demanding process, hence key participants are substantial. There is Hongqiao, Rusal and Alcoa in the primary aluminium business. China's primary aluminium production has grown rapidly over the previous fifteen years. (18%).

The downstream part of the industry processes aluminium into semi-finished commodities such as rods, bars, rolled products, castings, forgings, and extrusions. Depending on the final product's specifications, these aluminium products might be made from primary or secondary aluminium. Aluminium recycling is secondary production. Aluminized flat rolling products (FRP) include aerospace and civil aviation sheets/plates, car body sheets, can body stick and building sheets. FRPs are widely used in transportation, construction, and beverage cans and packaging. After extrusions, FRPs are the world's second-largest wrought aluminium category.

LITERATURE REVIEW:

Martchek, Kenneth J. (2006) This case study details the creation and implementation of a global, quantitative model of current and forecast aluminium and life cycle inventory mass flows. The model and major findings were intended to

assist technical specialists, executives, and external stakeholders in the global aluminium business in better understanding potential paths toward more globally sustainable aluminium. The model is the first to quantify yearly global aluminium and life cycle inventory flows quantitatively. The results include a quantitative estimate of the global aluminium product inventory by major market, system losses, recycle rates, as well as chosen resource requirements and associated air emissions.

Ermolli, Sergio R. (2010) The present article provides an analytical overview of some prominent aluminium systems that contribute to the structural sustainability of buildings. The features of aluminium have been highlighted, as well as the influence of these systems on the overall performance of the construction in terms of the environment and economy. The article discusses the features of aluminium elements, such as their high reflectivity and recyclability, as well as their importance in life cycle analysis (LCA). The relationship between energy efficiency and conservation in buildings, as well as the use of aluminium, is also highlighted. Additionally, numerous creative ways are launched that utilise aluminium elements in conjunction with other systems to generate renewable energy, such as solar panels and photovoltaics. Finally, environmentally friendly improvements such as enhanced ventilation mechanisms and light and shadow management systems based on aluminium members are demonstrated.

Susan M. White, Madhusudan G. Soni (2001) Aluminium is a non-essential metal that is regularly ingested by humans. Aluminium in food is derived from natural sources, food preparation water, food ingredients, and tools used in food preparation. Aluminium is present in trace amounts in the diet, compared to the amounts seen in antacids and some buffered analgesics. The healthy human body has strong barriers (skin, lungs, and gastrointestinal tract) that prevent aluminium from being absorbed systemically through water, food, medications, and air. Aluminium is expelled primarily in the urine and, to a lesser extent, in the faeces. There are no published reports of dietary aluminium toxicity in healthy individuals.

Bertram, Marlen, Buxmann, Kurt, and Furrer, Peter (2009) This article quantifies the greenhouse gas savings associated with lightening automobiles with aluminium using a life cycle assessment approach. The study assesses mass reduction through a pragmatic approach that compares specific examples of components satisfying identical performance criteria. The four examples offered in this examination are from real-world aluminium uses. The car manufacturer supplied the relevant mass of aluminium and the substitute component for each case study. Materials and procedures A thorough life cycle study of the greenhouse gas emissions and cost savings associated with various aluminium applications in automobiles was conducted in comparison to the same applications in steel or cast iron. The case studies are based on real-world examples of aluminium being used in serial production. The investigations are based on a greenhouse gas lifecycle model created in accordance with ISO standard 14040.

Ashkenazi Dana (2019) Aluminium has a brief history, having been found in the nineteenth century, yet it has become an integral aspect of modern life. This article examines the history of aluminium through technological advancements as

well as cultural and social perspectives, beginning with its discovery and continuing through the nineteenth and twentieth centuries to the present, with the goal of identifying potential future trends and applications for aluminium alloys. Aluminum has a high strength-to-weight ratio, great thermal conductivity, and a high resistance to corrosion. As a result, aluminium is a desirable material for a wide variety of applications, including transportation, electrical and packaging industries, architecture, and food. Additionally, it is a recyclable metal, which has both environmental and economic benefits. Aluminum's commercial use began towards the end of the nineteenth century and continues to rise now as new advanced aluminium alloys are developed. As a result, aluminium is regarded as a sign of modernity from a cultural standpoint. Economic prosperity and societal advantages result from technological advancements. Aluminum's current applications include novel ones such as 3D printing, composite materials, nanorods, biomedical devices, and aerospace applications.

OBJECTIVES OF THE STUDY:

The study will look into the overall aspects of aluminium industry in India. However, the study will specifically probe into the following objectives:

- To examine the efficiency of Aluminium production which include bauxite exploration and development.
- To know the productivity of Aluminium consumption, uses and specification, Trade policy, import and export.
- There is going to be a lot of demand for aluminium in coming years, so its value is increasing.

Aluminium and India:

Aluminum Consumption in India at 2.5 kilogramme per capita is far below the global average of 11 kg per capita. India will need an additional annual consumption of 16 million tonnes to achieve the global average of 11 kg per capita, making it the world's second largest user (absolute terms). Aluminum contributes 2% of manufacturing GDP (steel 12 percent, cement 9%) even at low consumption levels, and this is likely to rise as consumption rises. This increase is crucial for India's industrial objective of generating 25 percent of GDP from manufacturing by 2022. According to studies, the forward and backward linkages in the aluminium industry are more than 1. The industrialization process can be accelerated by increasing investment in industries with large backward and forward multipliers, resulting in faster economic growth.

In addition, the industry has a strong direct and indirect employment multiplier, generating about 800,000 jobs. Plants are typically located in the country's hinterlands, where they help to provide local employment and development. Going forward, the sector will play an important role in the government's flagship programmes, such as Make in India, the National Capital Goods Policy, the development of 100 smart cities, and the government's ambition to reach a solar capacity of 100 GW by 2022, up from 20 GW currently. Its light weight, good electrical conductivity, non-corrosive nature, durability, limitless recycling, and ability to aid in fuel efficiency make it suitable for use in a variety of essential production areas.

Enhancing fuel and cost efficiency in railways, commitment to CO₂ emission norms and adoption of EVs in the transportation sector, target to increase renewable energy share to 40% and even higher by 2030, indigenously designed defence equipment, increasing indigenisation of the aerospace and aviation sector, and increasing footprint in consumer durable and packaging sector as a result of growing urbanisation are some of the ways it can contribute to key sectors in India. As a result, the industry has significant forward and backward links to other important industries.

RESEARCH DESIGN AND METHODOLOGY:

The present study is based on secondary data and cover the period from 2017 to 2019. To examine the objectives of study, the data has been drawn from Indian Minerals yearbook (INDIAN BUREAU OF MINES).

Bauxite is basically an aluminous rock that contains hydrated aluminium oxide as main constituent and iron oxide, silica & titania as minor constituents present in varying proportions. Hydrated aluminium oxides present in the bauxite ore are diasporite and boehmite, Al₂O₃.H₂O (Al₂O₃-85%; Al-45%); gibbsite or hydrargillite, Al₂O₃.3H₂O (Al₂O₃- 65.4%; Al-34.6%), and bauxite (containing colloidal alumina hydrogel), Al₂O₃.2H₂O (Al₂O₃-73.9%; Al-39.1%). The iron oxide in bauxite ore is present as haematite or goethite; silica as clay; and free quartz & titania as leucosene or rutile. Bauxite is the principal ore of aluminium which is one of the most important non-ferrous metals used in the modern industry. It is also an essential ore for Refractory and Chemical industries. The country has 3,896 million tonnes of resources of bauxite which is sufficient to meet both domestic and export demands.

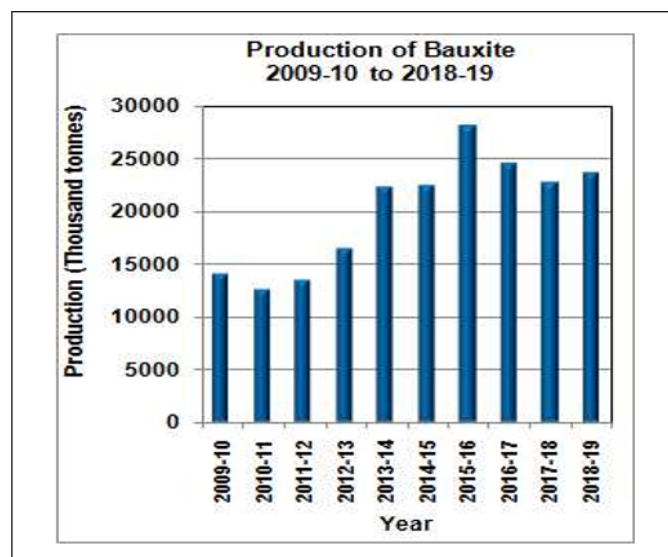
Reserves/resources:

According to the NMI database, the country's bauxite reserves/resources as of 1.4.2015, based on the UNFC methodology, were 3,896 million tonnes. There are 656 million tonnes of Reserves and 3,240 million tonnes of Remaining Resources among these resources. Metallurgical grade resources account for

around 77 percent of all resources. Refractory and chemical grades have limited resources, accounting for around 4% of the total. Odisha alone contributes for 51 percent of the country's bauxite deposits, followed by Andhra Pradesh (16 percent), Gujarat (9 percent), Jharkhand (6%), Maharashtra (5%), and Madhya Pradesh and Chhattisgarh (4%). (4 percent each).

Production & Stocks:

When compared to the previous year, bauxite production climbed by 4% to 23,688 thousand tonnes in 2018-19. In 2018-19, there were 154 reporting mines, compared to 163 the previous year. Moreover, six mines reported bauxite production as an associated mineral throughout the year. In total, 64 bauxite producers reported production in 2018-19. With 39 mines, these ten major producers accounted for 88 percent of total production. NALCO's Panchpatmali bauxite mines contributed 31% of total production. In 2018-19, public sector mines accounted for around 46 percent of overall production, up from 36 percent the previous year. During the year under review, about 81 percent of total bauxite output was of the 40-45 percent Al₂O₃ grade, 11 percent was of the Cement grade, and the rest was recorded in various grades except two (55 percent -60 percent and 60 percent & above grade). In 2018-19, the average daily employment of labour in bauxite mines was 5,829, down from 6,632 the previous year.



Consumption:

In 2018-19, the consumption of bauxite estimated at 22.19 million tonnes increased marginally by 8% as compared to 20.63 million tonnes in the previous year.

Alumina/Aluminium Industry was the principal consumer of bauxite and accounted for 89% consumption in 2018-19 followed by Cement (9%) and Calcination (1%).

Trade Policy:

As per the Foreign Trade Policy 2015-2020 and policy on export and import, imports of aluminium ores and concentrates including natural bauxite, calcined and activated bauxite and others are permitted free. There are no policy restrictions on the export of bauxite.

Gujarat was the main supplier of abrasive and refractory grade bauxite. Besides, Madhya Pradesh also produces refractory grade bauxite. Alumina plants draw supplies mostly from their captive mines.

Table 1: Consumption* of Bauxite 2016-17 to 2018-19 (By Industries)

(In tonnes)

Industry	2016-17	2017-18 (R)	2018-19 (P)
All Industries	20936700	20630600	22188800
Abrasives	71400	65700	35900
Alumina	18892600	18385500	19714000
Calcination	282800	283800	283800
Cement	1553900	1806200	2075100
Ferroalloys	17800	15900	13500
Pulverising	7300	7300	-
Refractory ^{1/}	110200	65500	65600
Others (ceramic, chemical, iron & steel, etc)	700	700	900

Figures rounded off

* Includes actual reported consumption and/or estimates made wherever required. Due to paucity of data, coverage may not be complete.

1/ Includes consumption of calcined bauxite.

Uses & Specifications:

Bauxite is largely utilised in the Bayer process to generate alumina. Bauxite with a minimum Al_2O_3 content of 40% is commonly used in the aluminium industry. However, depending on other qualities such as solubility in caustic soda and the lack of silica, slightly poorer grades with an appropriate blend are also used. For metallurgical grade bauxite, the BIS has established IS:5953-1985 (Reaffirmed 2008 & 2014) requirements. The industries are described in detail in a separate Review titled 'Aluminium and Alumina.' Aside from the chemical standards, the item passing through must meet the physical requirements.

90 percent maximum passing through 90-micron IS sieve but retained on 212-micron IS sieve; 1 percent maximum by mass passing through 300-micron IS sieve; and 10% maximum passing through 212-micron IS sieve but retained on 300-micron IS sieve.

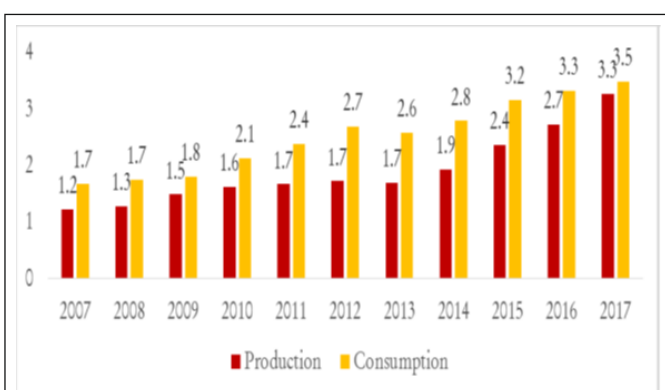
Foreign Trade:

Exports: Bauxite exports declined by 1% to 1,510 thousand tonnes in 2018-19, down from 1,529 thousand tonnes the previous year. China (74%) received the majority of exports, followed by Kuwait (14%), Nepal (7%), Qatar (3%), and Slovenia (2%). (1 percent). Bauxite (aluminium and concentrate) exports totaled 1,503 thousand tonnes in 2018-19, up 10% from the previous year's figure of 1,369 thousand tonnes. China (74%) received the majority of exports, followed by Kuwait (14%), and Nepal (14%). (6 percent). Bauxite (other aluminium & concentrate) exports fell by 96 percent to 6,823 tonnes from 1,59,979 tonnes the previous year. The majority of the exports went to Nepal (97 percent).

Imports: Imports of bauxite grew by 54 percent to 2,254 thousand tonnes in 2018-19, up from 1,461 thousand tonnes the previous year. Guinea (37%) was the leading source of imports, followed by Brazil (32%), Trinidad (12%), Pakistan and Ghana (8%), and China (8%). (3 percent). Bauxite (other aluminium & concentrate) imports declined by 18 percent to 179 thousand tonnes from 219 thousand tonnes the previous year. Pakistan supplied almost all of the imports (99 percent). Bauxite (aluminium & concentrate) imports, on the other hand, climbed by 67 percent to 2,075 thousand tonnes from 1,243 thousand tonnes the previous year. Guinea (40%) was the leading source of imports, followed by Brazil (35%), and Trinidad (35%). (13 percent).

Table 2: Exports of Bauxite (By Countries) export of bauxite (other Aluminium ore)

Country	2017-18 (R)		2018-19 (P)		Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)		Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	1529308	2705041	1509737	3045300	All Countries	159979	250261	6823	17662
China	1273189	1877226	1113661	1710739	Nepal	470	2672	6592	13400
Kuwait	106270	183754	206992	376268	Thailand	150	3152	75	1901
Nepal	45634	100843	103494	252175	Ethiopia	10	137	124	1718
Slovenia	6180	69042	9428	128031	Kuwait	++	2	22	370
Italy	633	13155	4625	102615	Vietnam	18	362	7	188
UK	901	20136	3400	93220	UAE	13	106	2	46
Qatar	1203	26590	52050	65303	Bangladesh	54	406	2	38
Germany	139	3016	2450	47724	Kenya	-	-	++	2
France	2797	39101	2908	39472	France	-	-	++	++
Japan	522	12002	1020	27177	China	159199	242639	-	-
Other countries	91840	360178	9709	202575	Other countries	66	784	-	-



India production and consumption of Aluminum, MT

Companies ranging from completely integrated to product experts make up the industry in India, which is both horizontally and vertically spread. With a pro-

duction of around 3.5 MT and a capacity of 4.1 MT, the upstream industry is dominated by three key players: NALCO (PSU), Hindalco, and Vedanta. Since 2007, production has increased by threefold. There are more than 150 large and mid-sized enterprises in the downstream category, as well as a far larger number of smaller and unorganised players.

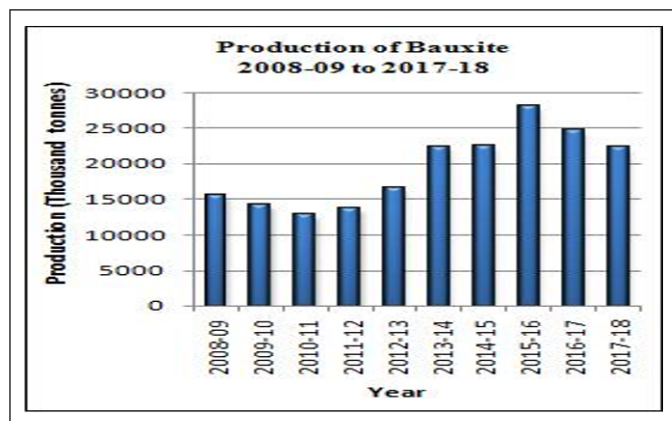
Due to low entry hurdles and capital expenditures, the recycled aluminium business is extremely fragmented, with roughly 10 medium-sized firms and around 150 to 200 small players. In India, castings account for roughly 70% of recycled aluminium consumption; billets, re-rolling units, and steel de-ox account for the remaining 30%. In India, the primary uses of recycled aluminium are transportation (mostly automobiles), followed by building and construction, consumer durable products, and other industrial applications. When compared to the primary route, the aluminium recycling process is less capital demanding and uses only 5% of the energy.

Going future, India's construction, packaging, and transportation sectors may see considerable expansion, necessitating a strengthening of our downstream sector beyond existing capabilities. This would necessitate substantial expenditures from the aluminium industry as well as strong legislative support to encourage metal adoption in new applications.

Table 2: Production of Bauxite, 2016-17 to 2018-19 (By States)

States	2016 - 17		2017 - 18		2018 - 19 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	24745487	14865504	22786106	15784174	23687721	17168410
Chhattisgarh	1954234	1365345	2558701	2199036	1532600	1573656
Goa	-	-	4378	876	518	104
Gujarat	5881257	3127056	3559241	2129517	2181064	1293201
Jharkhand	2289825	1642791	2593647	2275062	2412484	2198169
Karnataka	386	171	-	-	-	-
Madhya Pradesh	676478	543776	593633	442907	722549	577694
Maharashtra	1946032	942724	2028765	955340	1424864	721898
Odisha	11990006	7238829	11447741	7781436	15413642	10803688
Tamil Nadu	7269	4812	-	-	-	-

The amount of bauxite produced in 2017-18 was 22,313 thousand tonnes, a 10% reduction from the previous year. In 2017-18, there were 152 reporting mines, down from 165 the previous year. Moreover, six mines reported bauxite production as an associated mineral throughout the year. In total, 64 bauxite producers reported production in 2017-18. The 44 mines owned by these ten major producers provided 86 percent of total production. The Panchpatmali bauxite mines of NALCO contributed 32 percent of the total production. In 2017-18, public sector mines accounted for around 37% of total production, compared to 31% the previous year. During the year under review, 71 percent of total bauxite output was of the 40-45 percent Al₂O₃ grade, 16 percent was of the Cement grade, and the remaining 13 percent was of other grades. Odisha emerged as the leading producing state in 2017-18, contributing for nearly 51% of overall production. In 2017-18, the average daily employment of labour in bauxite mines was 6,031 compared to 6,491 the previous year.



Consumption:

In 2017-18, the consumption of bauxite was estimated at 20.34 million tonnes as compared to 20.93 million tonnes in the previous year. Alumina/ Aluminium Industry was the principal consumer of bauxite and accounted for 90% consumption in 2017-18 followed by Cement (8%) and Calcination (1%).

Substitution:

There is no substitute for bauxite as source for aluminium metal extraction carried out on a large scale. However, calcined clay can be substituted for refractory bauxite but only with reduction in time and stock resistance. Sillimanite, alumina, silicon carbide, magnesite-chromite and carbon-magnesite refractories are the other alternatives for high alumina material but these would entail higher cost. Silicon carbide and diamonds can substitute for fused aluminium oxide in abrasive use but these would entail again at higher cost. Synthetic mullite is a probable substitute for bauxite-based refractories. Silicon carbide and alumina-zirconia are costlier substitutes for bauxite-based abrasives. The raw material like alunite, anorthosite, coal wastes and oil shales are other potential sources of alumina. The extraction, however, would require new plants with different technology. These non-bauxitic materials could satisfy the demand for primary metal, refractories, aluminium chemicals and abrasives.

Future Outlook:

The total resources of bauxite that comprise various grades, as found to occur in the country as on 1.4.2015, are estimated at 3,896 million tonnes. The resources of Metallurgical grade bauxite are adequate while those of the Chemical and Refractory grade bauxite are relatively limited considering the future requirements. India's strength in aluminium is production due to its rich reserve of bauxite, a core resource used in production of aluminium. As per provision made in Mineral (Auction) Rule 2015, a total of 7 bauxite blocks were auctioned till June, 2020 in the State of Maharashtra (6 blocks) & Madhya Pradesh (1 block). As per the FITCH Report, the production of bauxite has been estimated to grow

from 30.9 million tonnes in 2018 to 50.7 million tonnes by 2027.

CONCLUSION:

Aluminium is a long-lasting, corrosion-resistant substance that is also a superb conductor of electricity and heat and a brilliant reflector. It is non-toxic and non-magnetic. Building and construction, the electrical sector, consumer items (e.g. cutlery), transportation containers and packaging, machinery, and communications are only a few of the applications. Aluminium is the most plentiful metal in nature, accounting for approximately 8.2% of the earth's crust. Bauxite is the main commercial raw material for the manufacturing of aluminium, and it is made up of hydrated aluminium oxide (alumina) combined with impurities such as iron oxide, silica, titania, and other minerals.

Non-bauxite sources of aluminium, such as nepheline syenite and alunite, are technically possible, but the Bayer bauxite method currently has a significant economic advantage over the alternatives. As a result, approximately 95% of the alumina produced in the world comes from bauxite, and over 90% of that alumina is generated using Bayer's technology.

India is the world's fifth largest aluminium producer, with a production capacity of roughly 2.7 million tonnes, accounting for nearly 5% of global aluminium production. With a Bauxite reserve of 3 billion tonnes, India is also a large reservoir. In the last five years, India's aluminium production has increased significantly. Aluminium output increased in response to increased demand from the building, electrical, vehicle, and packaging industries. Whoever controls the resources runs the globe, and India has the potential to rule in the future.

Developing countries are currently participating in aluminium production and use at all levels. They smelt primary metal in addition to mining bauxite and refining alumina. Brazil and India, for example, are large users of the metal for use in their respective construction, telecommunications, aerospace, and other industries. The most important priority in the industry for developing countries must be the development of their own technological skills. This may be accomplished in certain cases by shrewd bargaining with some of the large aluminium producers, who could be convinced to provide licences that would allow licensees to develop and appropriate the technologies over time.

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