# Right Time to Invest in India for Greenfield Aluminium Smelters and EIL's Role as EPCM Consultant

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## Abstract

India's per capita consumption of aluminium is too low compared to other developed countries like USA, Europe, China, Japan and Brazil. The continuing trend of economic growth and population growth, the overall demand and per capita consumption of aluminium are bound to increase in India. Furthermore, the demand of aluminium metal is greater than the supply in international markets. India can play a major role to bring down this demand-supply gap by increasing its production. Availability of bauxite, huge coal deposits, coupled with trained manpower, makes India an investment heaven for aluminium smelters. Indian business house is already seeking either to increase the existing productivity/production by debottlenecking, or brownfield/greenfield expansion. Engineers India Limited (EIL) as EPCM consultant for aluminium smelters has its vast presence in most of the smelter constructions in India. Recently EIL has also been involved in preparation of a detailed project report (DPR) on high amperage pots (APXE500) for smelter expansion. Under the flagship program of "Make in India" launched by the Government of India, EIL is ready to use its technical and engineering capability to develop vendors in critical activity such as fabrication of pot shell, pot superstructure, busbars and pot tending machines (PTM) and to develop Indian suppliers for various handling systems of raw materials such as alumina, coke, pitch, etc. EIL is also engaged to develop Indian contractors with technical back-up of foreign equipment suppliers (Solios, Outotec, Danieli Corus, etc.) to install green anode plant (GAP), fume treatment plant (FTP), etc. This paper will bring the details how EIL has brought down the CAPEX significantly with this combination of skills for high amperage potline. This paper will enable us to describe the opportunity and benefit in terms of CAPEX and OPEX to build a smelter in India, where EIL can contribute immensely to detailed engineering, procurement and construction management (EPCM).

**Keywords:** Greenfield smelter, High amperage potline, Basic and detailed engineering, Engineering procurement and construction management (EPCM) for smelters.

## 1. Introduction

Modern Aluminium Industry was born in1886 with the invention of Hall-Héroult process. For more than 135 years of technology development efforts to increase productivity have never been stopped. During later part of twentieth century the industry was further transformed due to introduction of automation, PLC and computer aided control system to enhance productivity. The aluminium industry in India also tried to match with the global pace and from 2017-2018, the country has become net exporter from the position of net importer. Flagship program and well mechanized strategy by Government of India like "Make in India", development of smart cities coupled with rapid urbanization for growing middle class set the per capita consumption target from 2.5 kg to 5 kg in the next five years. To meet this huge demand the Indian aluminium industry needs to gear up to produce and meet the demand. This will avoid imports and make India self-reliant. Considering the compounded annual growth rate (CAGR) of consumption more than 8 % from 2013-2014 to 2017-2018. With the same pace it is expected that India will need

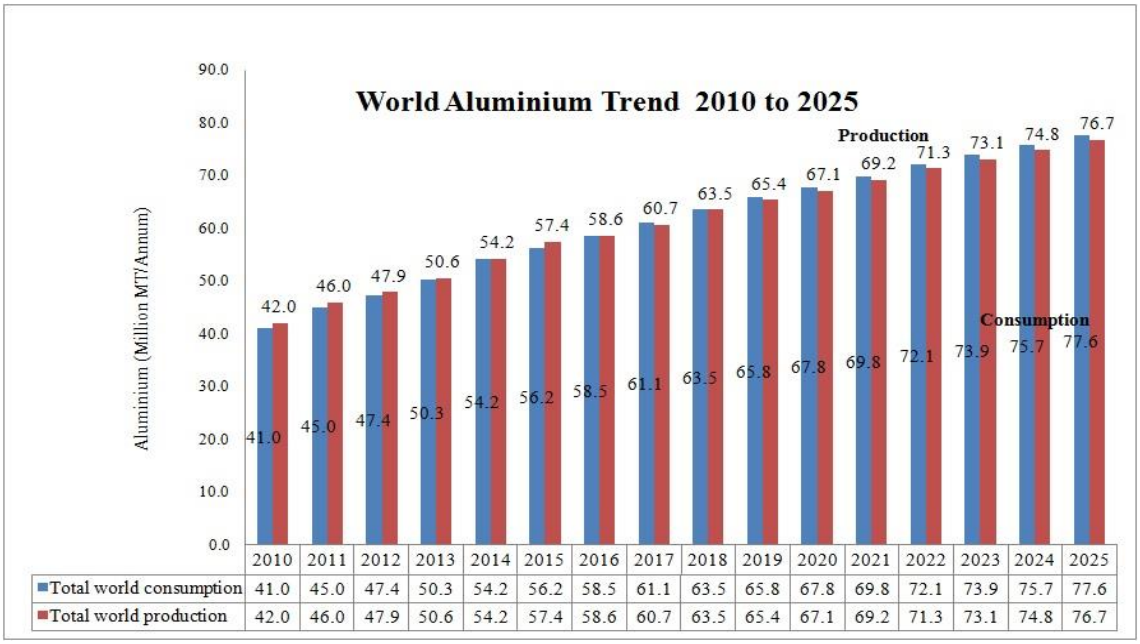
around 3.5 to 4.0 million tonnes of new supply of primary metal in the market. This makes more interesting the right time to invest in India for green field project.

## 2. Aluminium and Its Market

Aluminium metal is of significant importance in the present world economy. Aluminium finds wide range of applications as both a durable and consumable product. In comparison to other basic metals such as steel and copper, aluminium is relatively new metal with better opportunities for growth and expansion. Aluminium is light weight, durable and corrosion resistant metal that can be extruded, rolled, formed and painted for use in a wide range of applications. In almost all its uses, it is alloyed with other metals to increase its strength and mechanical properties. There are over hundred alloys in everyday use and the development of other alloys is a part of the continuing process to find new uses and to enhance the metal's demand.

## 3. Global Aluminium Market

The world Aluminium production maintains the steady trend of growth which is average 4.5 to 5.0 % for last 10 years annually and 2 to 3 % for the coming years. China continues to dominate world market with higher production and higher rate of consumption. China will produce almost 55 to 58 % of world's total metal production.




| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total world consumption | 41.0 | 45.0 | 47.4 | 50.3 | 54.2 | 56.2 | 58.5 | 61.1 | 63.5 | 65.8 | 67.8 | 69.8 | 72.1 | 73.9 | 75.7 | 77.6 |
| Total world production | 42.0 | 46.0 | 47.9 | 50.6 | 54.2 | 57.4 | 58.6 | 60.7 | 63.5 | 65.4 | 67.1 | 69.2 | 71.3 | 73.1 | 74.8 | 76.7 |

**Figure 1. World aluminium trend 2010 to 2025**

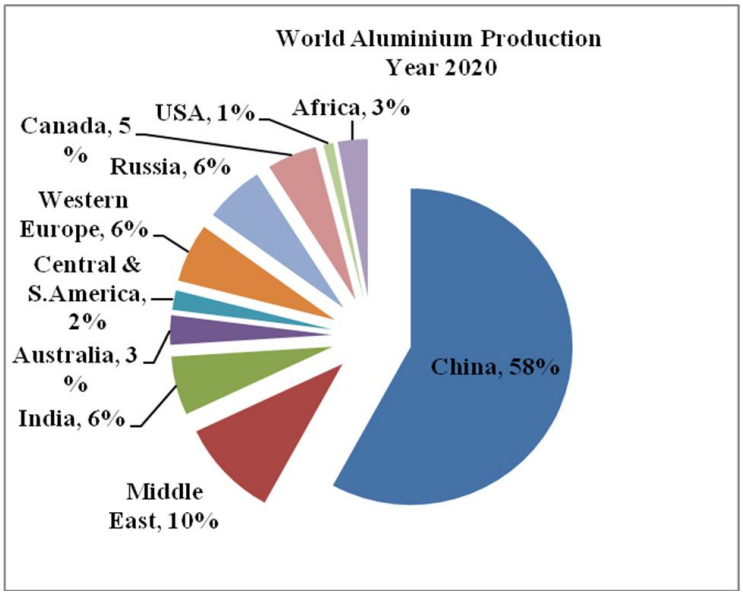



**Figure 2. World aluminium production - Year 2020**

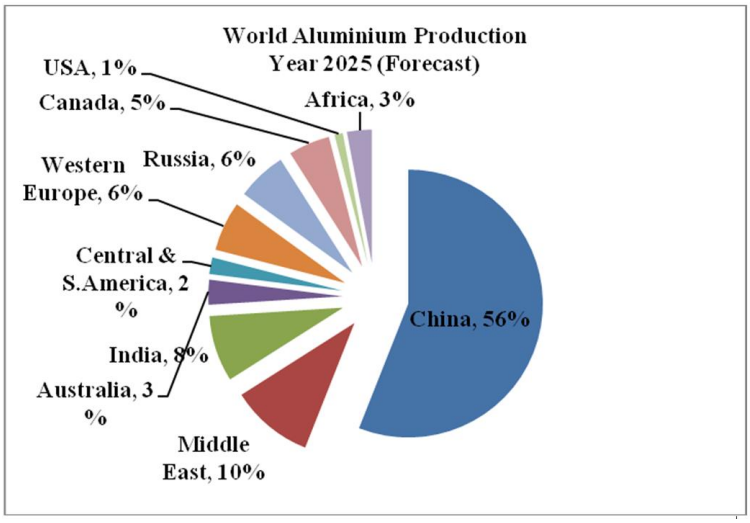
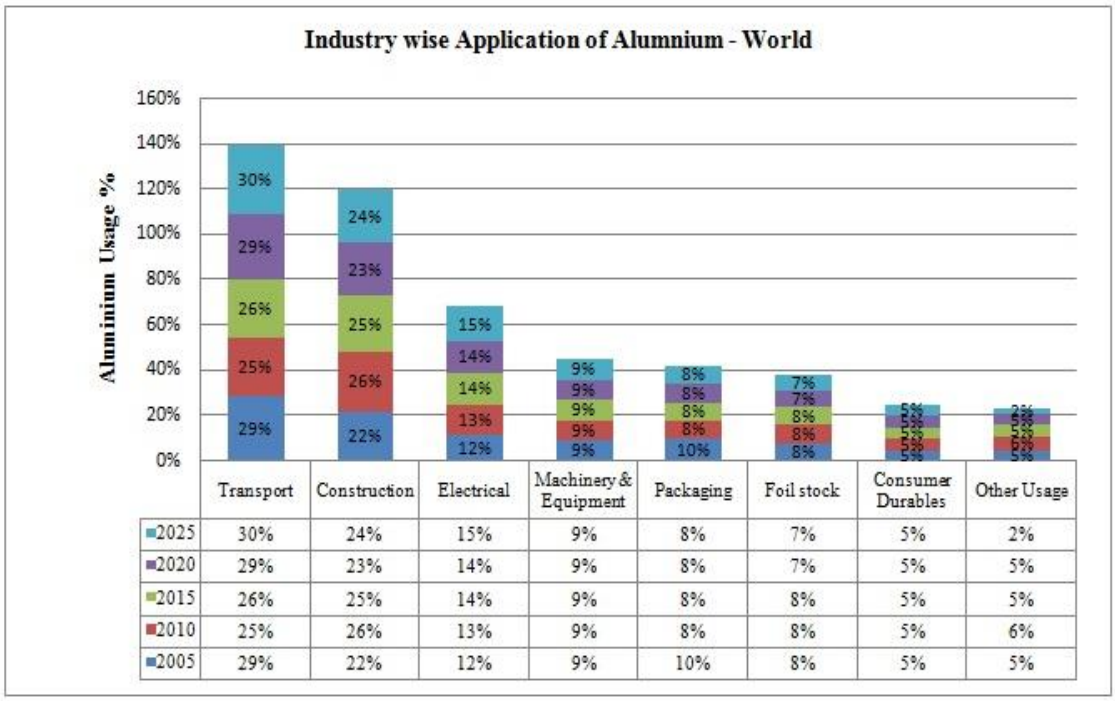



**Figure 3. World Aluminium Production – Year 2025 (Forecast)**

According to market analysis, approximately 65 % to 70 % of global consumption is used in the construction, transportation and electrical sectors while the remaining 30 to 35 % is used in consumer, capital goods, machineries equipment, packaging and foil stocks etc. The rate of global demand is contributed largely due to significant growth in construction and automobile industry which is increased by 4.5 % and 3.5 %, respectively.




| | Transport | Construction | Electrical | Machinery & Equipment | Packaging | Foil stock | Consumer Durables | Other Usage |
|---|---|---|---|---|---|---|---|---|
| 2025 | 30% | 24% | 15% | 9% | 8% | 7% | 5% | 2% |
| 2020 | 29% | 23% | 14% | 9% | 8% | 7% | 5% | 5% |
| 2015 | 26% | 25% | 14% | 9% | 8% | 8% | 5% | 5% |
| 2010 | 25% | 26% | 13% | 9% | 8% | 8% | 5% | 6% |
| 2005 | 29% | 22% | 12% | 9% | 10% | 8% | 5% | 5% |

**Figure 4. Industry wise application of aluminium – World.**

Though India's per capita consumption of aluminium is too low (under 2.5 kg) comparing to world average 12 kg, with the continuing trend of economic growth and taking into account of population growth, the overall demand and per capita consumption are bound to increase. India will continue to grow at higher rate and growth of consumption will be remaining for 4.5 to 5.0 %.

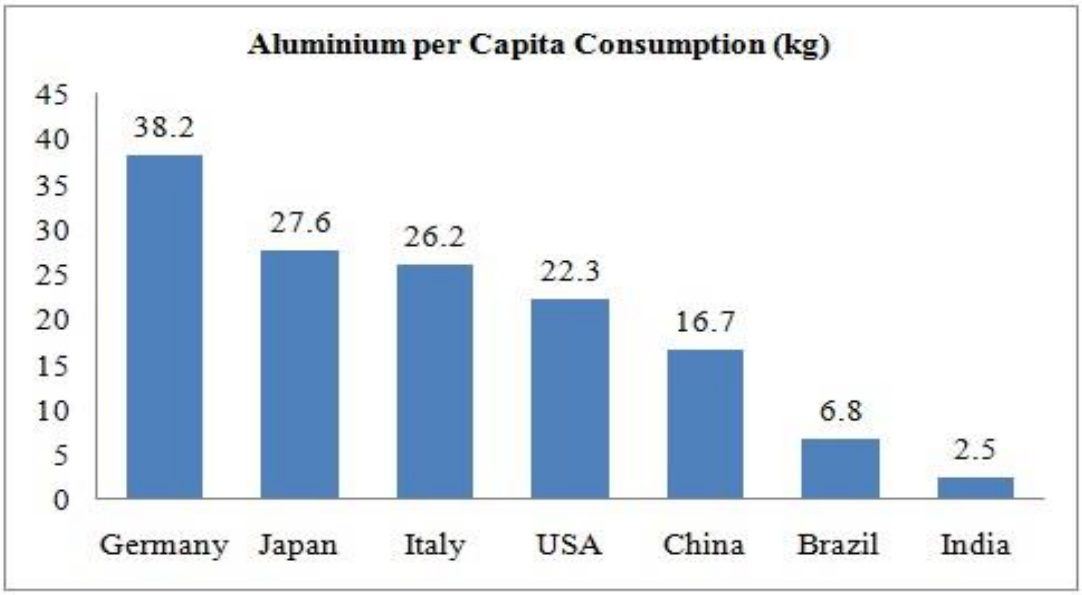



**Figure 5. Aluminium per capita consumption.**

## 4. Indian Aluminium Present Status

Aluminium industry in India is a highly concentrated industry with the top three companies: The state-owned National Aluminium Company Limited (NALCO) and private enterprises Hindalco and Vedanta constitute the majority of the country's production. Indian aluminium supply side expanded significantly in 2014 as projects completed for Hindalco's Mahan and Aditya smelters, with capacity of 359 000 t/y each, and it has started commercial operation.

Vedanta's Balco, Korba II smelter with capacity of 325 000 t/y was successfully commissioned with all 336 pots operational in Aug 2016. Vedanta's Jharsuguda smelter I started its first hot metal tapping in 2008 and within 4 years, crossed design capacity to achieve 530 000 t/y [1]. Jharsuguda smelter II with installed capacity of 1 250 000 t/y has been operational from 2016. All these developments aided the country's production growth of primary aluminium which expanded to 3.58 million tonnes in 2020 with average year on year growth of 13 % until 2020, from about 1.52 million tonnes in 2010.

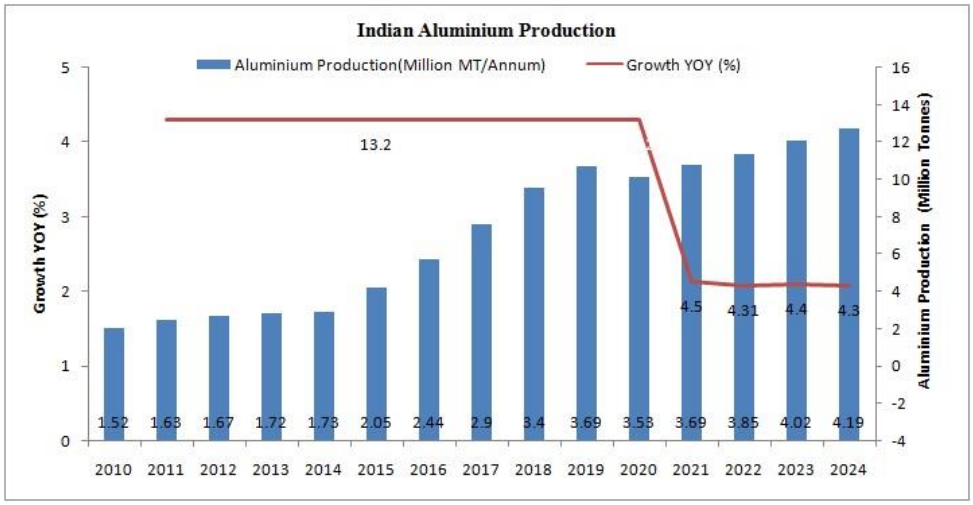



**Figure 6. Indian aluminium production and its growth.**

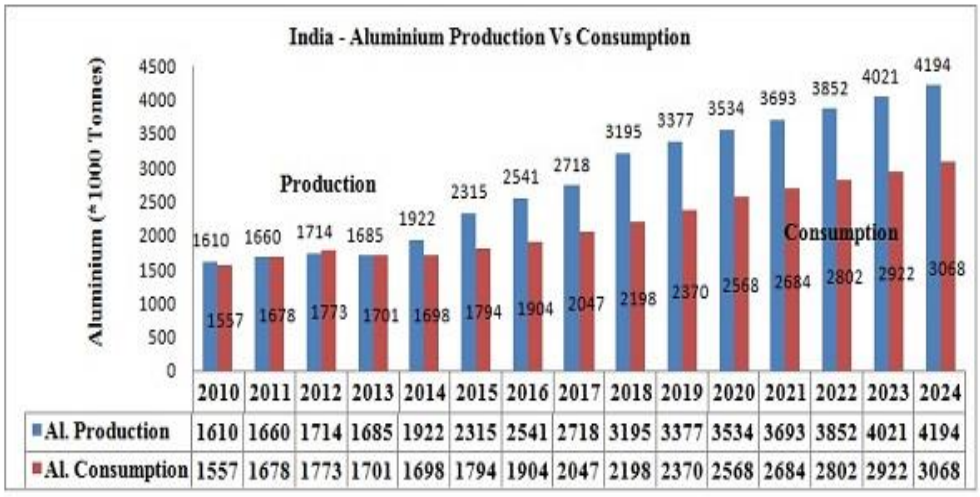



**Figure 7. India's aluminium production vs consumption.**

## 5. Growth Potential in India

### 5.1 Consumption Potential

Consumption pattern of aluminium in India is different from that of the world. The largest industry is electrical industry accounting for about 48 % of total aluminium consumed in the country followed transport sector with 15 %, construction with 13 %, machinery equipment with 7 % and consumer durables with 7 % of total consumption.

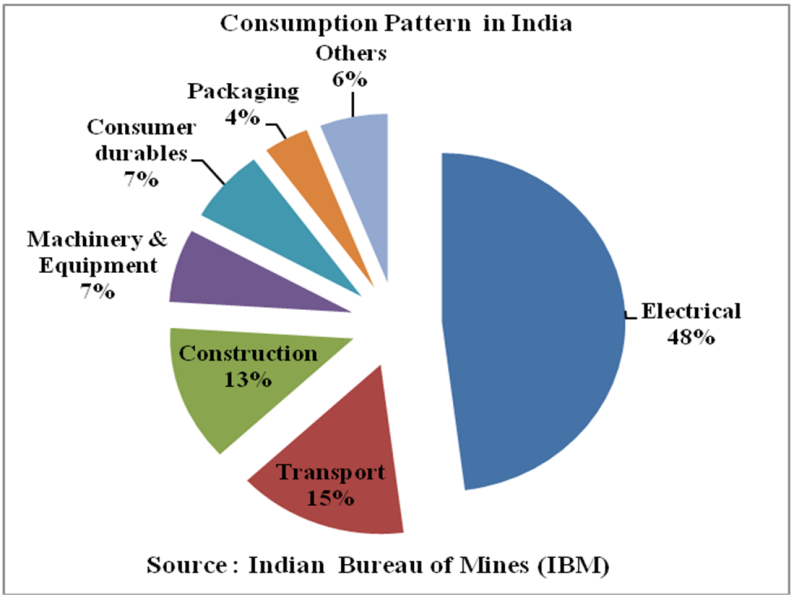
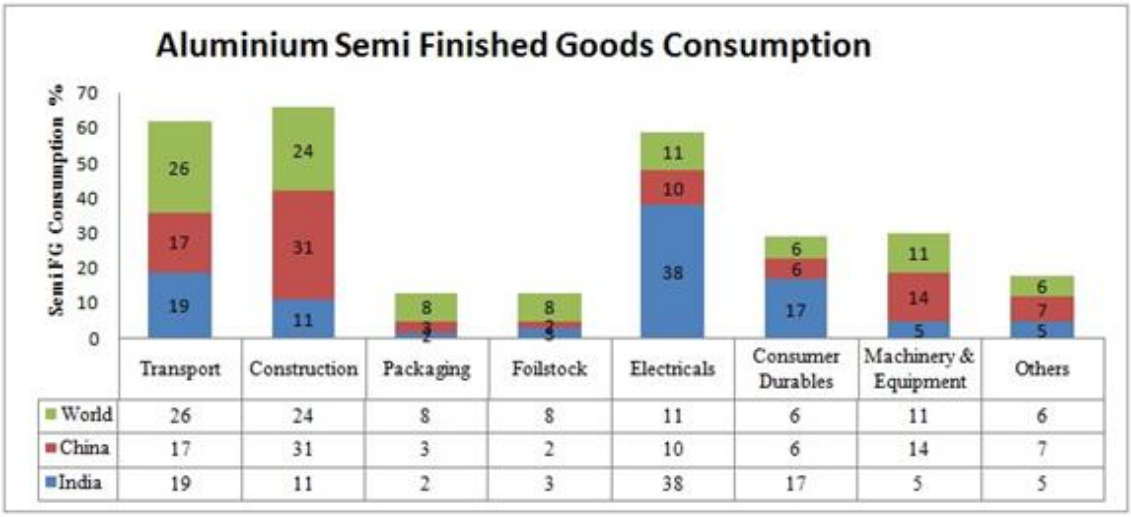



**Figure 8. Aluminium consumption pattern in India – 2015.**




| | Transport | Construction | Packaging | Foilstock | Electricals | Consumer Durables | Machinery & Equipment | Others |
|---|---|---|---|---|---|---|---|---|
| World | 26 | 24 | 8 | 8 | 11 | 6 | 11 | 6 |
| China | 17 | 31 | 3 | 2 | 10 | 6 | 14 | 7 |
| India | 19 | 11 | 2 | 3 | 38 | 17 | 5 | 5 |

**Figure 9. Aluminium semi FG consumption (Source: CRU).**

Now, Indian sectors show different consumption trend w.r.t. the world in key areas in:

- **Electrical (38 % vs 11 % globally):**
  Power - India is the third largest producer and consumer of electricity in the world. The target of renewable energy is 175 GW by 2022 and estimated power consumption is 1895 TWh by 2022. Solar panels have significant aluminium content and the target to achieve

100 GW during the same period [2]. As per National Electricity plan, the targeted capacity addition of transmission system until 2022 is 62800 ckm (circuit kilometers). Government of India (GOI) initiative like Ujwal Discom Assurance Yojana (UDAY) in distribution sector will further support sectoral growth, thereby enhancing aluminium consumption.

- **Transport (19 % vs 26 % globally):**
  India is expected the third largest passenger vehicle market in the world by 2024 and transport sector at present contributes 19% of consumption which will increase to 21 % by 2022 due to rapid urbanisation, increase in middle class and their raising incomes and manufacturing of electric vehicles.

- **Railways:**
  USD 115 billion investment planned over 5 years [2], aluminium coaches being used in India because of lighter weight carriages consume lesser energy, increasing speed of trains, safety of passengers and cost efficiency by weight reduction. Estimated demand of 500 aluminium coaches per year is estimated and forecasted by railway board [2].

  Environment norms ($CO_2$ emissions), manufacturing of electric vehicles, enhance safety by crash management system etc will enhance aluminium demand.

- **Packaging (2 % vs 8 % globally):**
  The Indian packaging Industry is poised to grow at 5% for next 5 years. Urban population share to reach 50% from current 33.6% will boost to generate demand in packaging industry. Further the change of new packaging format like light weight package, single serve packs, and environmental friendly packages will drive aluminium growth significantly.

- **Heavy Machinery Equipment (5 % vs 11 % globally)**

  **Defence**
  India spent almost 2 to 2.5 % of GDP on defence. At present more than 60 % of aluminium alloys used for defence are imported. The country has planned to spend USD 130 billon in next five years and GOI resolve for "Make in India" would pave way for foreign equipment manufacturer to enter into strategic business with Indian companies, which will enhance aluminium consumption.

  **Aviation**
  The passenger traffic at Indian airports is expected to increase by 30 % from present traffic 308 million. The national civil aviation policy lays special emphasis on promoting civil aerospace manufacturing indigenously. Air bus is planning to increase its cumulative sourcing from India to more than USD 2 billion from current value of USD 500 million. Boeing is also planning for sourcing from India. All these will increase the consumption of aluminium in the aerospace and civil aviation industry.

### 5.2 Competitive Advantage

India has the 7th largest bauxite reserves (3 896 million tonnes). With this abundant bauxite, India is self-sufficient to meet domestic and export demand. India is the 4th largest alumina producer, 3rd largest aluminium producer and 4th largest consumer of aluminium [1]. It is endowed with rich and good quality coal and this need to be leveraged to develop a globally competitive aluminium industry, which will also help to achieve our economic and development goals. Given our

competitive advantage in terms of natural resources, capacity can be increased multi-fold to cater to domestic demand without any reliance on imports.

### 5.3 Human Resources

The industry also has a high direct and an indirect employment generating potential creating close to 1 million jobs. Resources are generally based in the hinterlands of the country and aid in generating peripheral employment and development of the region. Abundant skilled, semi-skilled technical manpower is readily available with much cheaper cost w.r.t. world average.

### 5.4 Government Initiatives

Major growth shall be driven by the government's flagship programs like Make in India, national capital Good policy, development of 100 smart cities and renewable energy enhancement.

## 6. Challenges

Country like India having vast demography with huge population will certainly have few challenges like energy input and its cost, infrastructure development, availability of land and environment issues etc.

**Energy:**
Power cost constitutes almost 30% of total operating cost of smelter. High power tariffs and its duty take out a lot of margin from overall profitability. Importing of coal from South East Asian countries also have no significant benefit to control power cost. GOI is aware of the fact and now allocating captive coal mines to Indian producer to use power only for smelter use. This will have significant positive impact on cost of power.

**Infrastructure development for handling raw materials and finished products:**
Development of infrastructure and its logistics for material loading unloading facilities at mines, refineries, smelter, coal transportation for captive power plant, ash handling and handling of finished goods for any upcoming smelter is a challenge. However, GOI plans to spend USD 1.4 trillion on infrastructure during 2019 to 2023 for port facilities and railways to overcome some challenges.

**Environmental challenges:**
Fluoride emission from smelter and carbon in thermal power plant remains a major challenge to fulfill GOI commitment of total carbon emission. The various initiatives taken by GOI like using LED bulbs, CNG/PNG for vehicles, electric vehicles, solar power reduces carbon net consumption to balance with rapid industrialization.

## 7. Engineers India Limited

Engineers India Limited (EIL) is one of the Asia's leading global engineering/consultancy company providing design, engineering, procurement, construction and integrated project management services and project implementation on turnkey basis. Established in 1965 by Government of India (GOI) jointly with Bechtel International Corporation ("Bechtel") to provide consultancy services in the hydrocarbon sector. In 1967, EIL became a wholly owned GOI company under Ministry of Petroleum and Natural Gas. Established track record of over five decades of experience in working with Indian and international oil and gas companies, EIL have also diversified into mining, non-ferrous metallurgy and infrastructure sectors.

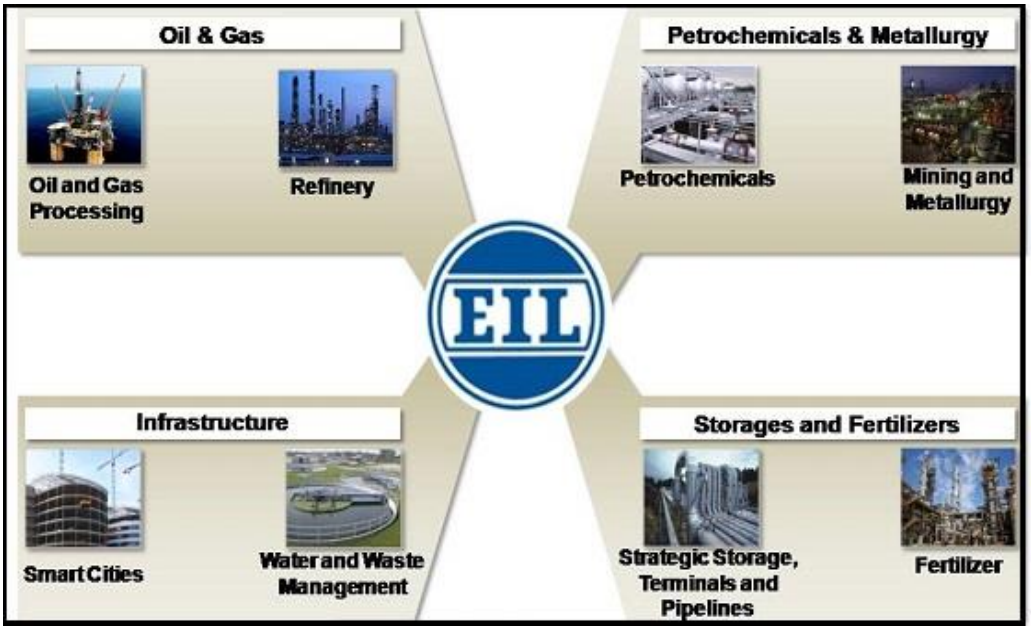



**Figure 10. EIL – Business portfolio.**

**Hydrocarbon on-shore and off-shore:**
Refineries, petrochemicals, pipelines, gas processing, well platform, off-shore pipelines – Provide a broad range of engineering consultancy services in India and internationally.

**Non-Ferrous metallurgy:**
Provide a broad range of engineering consultancy services in India from concept to commissioning.

EIL has its presence for various overseas projects across Middle East, North Africa and South East Asia for project management consultancy (PMC) services.

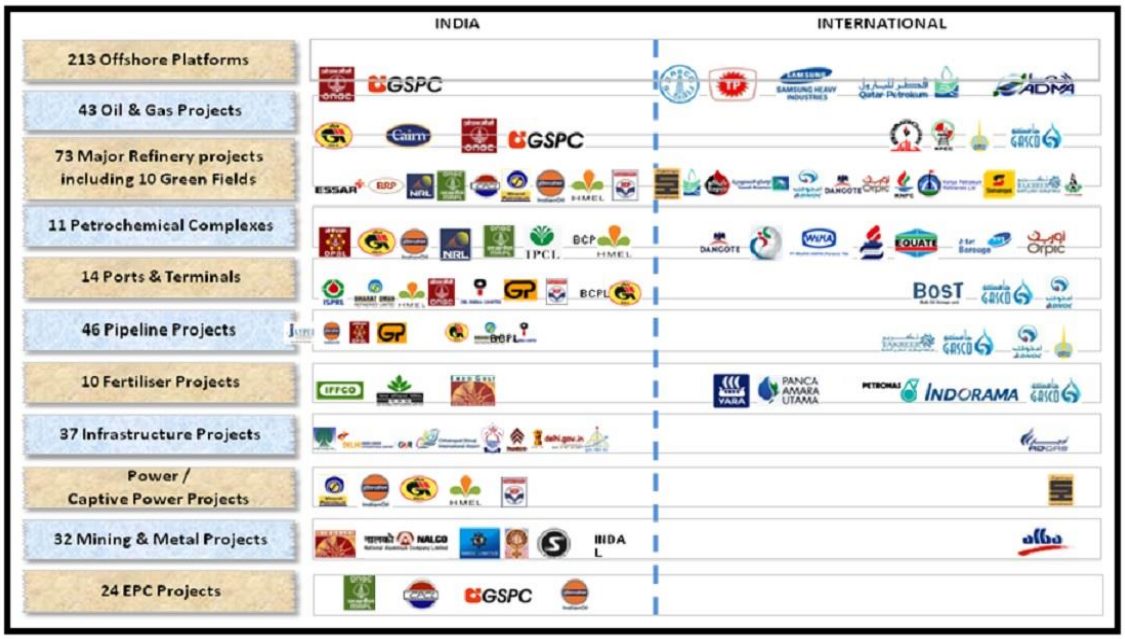



**Figure 11. EIL with diversified client base.**

EIL as engineering procurement and construction management (EPCM) consultant has its vast presence in most of the aluminium smelters in India since 1982. EIL as a 'Total Solutions' engineering consultancy company provide design, engineering, procurement, construction and integrated project management services from 'Concept to Commissioning' with highest quality and safety standards under one roof with their own manpower internal resources.

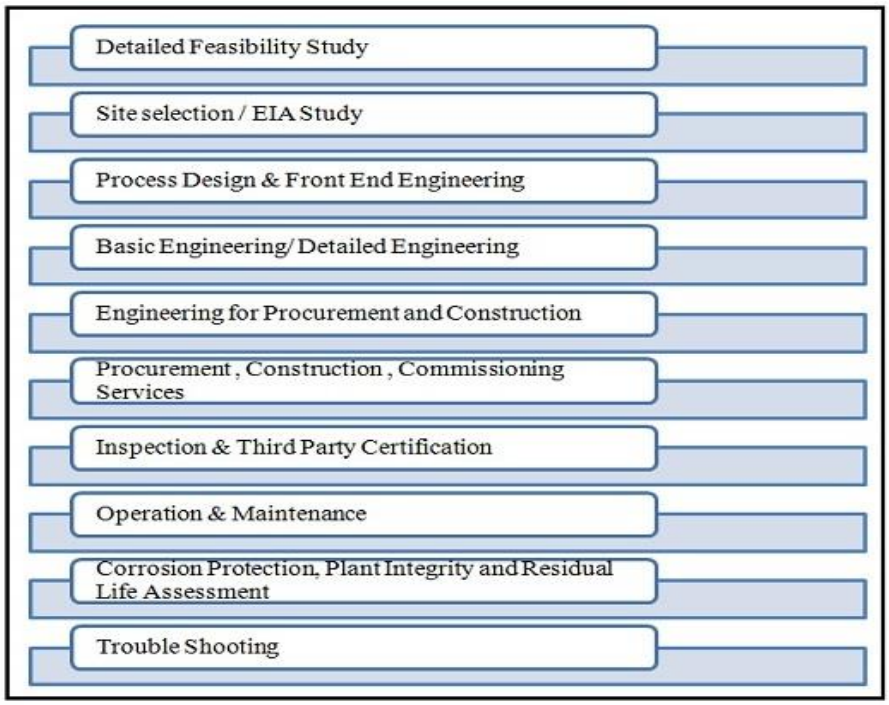



**Figure 12. EIL- A total solution provider company at smelter/alumina refinery.**

### 7.1 EIL Strength on Aluminium Smelter

EIL is committed for completion of projects as per scope of the contract and it is EIL's mission to provide the best engineering solution for smelter with proper value of time and cost. EIL practices technology-neutral approach – with no affiliation with any licensor and technology selection is done with the objective of meeting process objectives. EIL possess basic and detail design capabilities, construction expertise and it continues to up-grade design procedures based on operating plants feedback and provide value added suggestions for optimized design. EIL possess updated Indian Foreign vendor database, which help optimization, scope matrix between Foreign Indian vendors/contractors. It has comprehensive in-house data base with respect to project costing. EIL possess experience in commissioning including performance guarantee (PG) test and contract closure. EIL is also actively associated with IPICOL, the nodal agency for allotment of land in Government of Odisha and actively involved to assess the land requirement for different kind of plant to be established at Odisha state. This has given them a better opportunity to understand and to develop good networking with government authorities. Recently EIL has been involved in preparation of detailed project report (DPR) for high amperage pot line for NALCO Smelter.

### 7.2 Major Scope for DPR

- **Land requirement:** Assessment of additional land at site for high amperage pot line.
- **Power requirement:** Estimate total power requirement for pot line and its auxiliary facility to determine sizing of power plant capacity and its individual unit configuration.

- **Raw material requirements and its logistics:** Requirement of alumina, coke, liquid pitch, heavy fuel oil, $AlF_3$ etc. including new railway siding inside the plant for receiving the raw materials and dispatch of finished products.
- **Engineering:** Engineering for utility services and off-site facilities for accurate cost estimation.
- **Environmental aspects:** Impact on the environment due to proposed capacity addition.
- **Cost estimate and financial analysis:** Prepare cost estimates calculation of internal rate of return (IRR) for proposed smelter.
- **Risk analysis:** Identification of potential risk areas and its mitigation plan

## 8. Methodology Adopted for Cost Estimate

Process licensor equipment list and technical specifications, in-house cost data, budgetary quotations from different suppliers and package vendors are the basic input to arrive upon the capital cost.

EIL considered their already developed Indian vendors in critical activity like fabrication of pot shell, pot superstructure, bus bars and stem bracket assembly. Licensor specified European materials conforming to European code are substituted with Indian equivalent.

In lining relining area, major equipments like induction furnace, heating system and shot blasting machines are procured separately and integration of cathode sealing area is done deploying local vendors. EIL developed Indian agency to do cathode sealing, pot lining cathode placement and ramming.

In Pot line, gas treatment center (GTC), hyper dense phase system (HDPS) and alumina handling are considered separate packages. In GTC and fume treatment center (FTC), except main duct and filter house (design technology) balance activity is considered at Indian vendor's scope including construction.

All handling system like coke handling, alumina handling, liquid pitch handling, carbon recycling are dealt as separate package. Engineering concept is developed by EIL in-house engineering and implementation is carried out by Indian vendors having past experience to do similar activity in smelter. Battery limit, interface for various packages etc., are formulated and monitored by EIL engineering construction team.

For major packages in carbon area, such as green anode plant, anodes handling system and bath handling system, anode rodding shop optimization, scope matrix between Foreign Indian vendors/contractors are planned, where supply of major equipment and system and its engineering are done by foreign vendor. The construction activity is carried out by Indian vendor under the supervision and commissioning assistance by foreign vendor.

In baking furnace, imported refractory bricks used in half section and equivalent bricks already developed by Indian producer have been used in another half of the section as it is already being established in some of the running smelter. Process know-how / licensor fee for basic engineering, startup assistance, cost provision towards project management, detailed engineering, procurement services and construction supervision (PMC /EPCM) service cost are considered.

## 9. Capital and Operating Cost Estimation

Considering philosophy mentioned above the capital cost per tonne of aluminium has been worked out as USD 3050 ± 15 % and operating cost per tonne of aluminium as USD 1430 ± 10

% for high amperage technology pot line. The total construction period has been considered as 30 months plus 6 months for pre project activity, which includes receiving of basic design and engineering package (BDEP) from process licensor in stages, and acquiring of land.

## 10. Conclusion

Indian aluminium production will continue to increase its installed capacity in the next two to three years. The lower capital cost per tonne of aluminium production makes it attractive to have a viable destination to invest in India. EIL being an engineering powerhouse with exposure in most aluminium smelters in India provides an added advantage to business houses for achieving lower investment cost. Availability of bauxite, huge coal deposits, coupled with trained manpower, makes India an investment heaven for aluminium smelters. GOI also acknowledges the fact that with proper policies and strategies in place, environment and other issues could be addressed simultaneously and country's growth path follow a new model based on equitable, inclusive and sustainable development.

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