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ASSESSING THE IMPACT OF CBAM AND TARIFFS IN THE INDIAN ALUMINUM INDUSTRY

Anchal Arora

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ASSESSING THE IMPACT OF CBAM AND TARIFFS IN THE INDIAN ALUMINUM INDUSTRY

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New Delhi

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Abstract

Energy use in industry is considered as a major contributor towards global greenhouse gas (GHG) emissions. Therefore, decarbonization of heavy industry could have an immediate impact on reducing GHG emissions and slowing climate change.

As the effect of *climate change* is intensifying, various countries and industries are seeking new ways to decarbonize to meet emission targets and reduce energy costs. In this regard, the European Union institutions have recently adopted the ambitious target of reaching climate neutrality by 2050. Applying a "Carbon Border Adjustment Mechanism (CBAM)" is one approach put forward by European Commission. Aluminum is one of the five sectors covered by EU CBAM along with iron and steel, cement, fertilizers and electricity. This study aims to analyze the potential impact of CBAM in the downstream aluminum sector in India.

Aluminum is a strategic sector for India to move towards a sustainable economy. It could play an increasingly crucial role to help India to serve its commitment to CO2 emission norms if this metal is produced with the low carbon footprint. India should explore short-term ways to decarbonize and trade can become a practical tool to facilitate it. One such tool is the reduction of the import tariffs on primary aluminum with low carbon footprint that could raise the competitiveness of downstream aluminum sector. It can also encourage imports of low carbon primary aluminum from countries like Canada, Norway, Russia and Iceland that could be used to produce the finished goods domestically and in turn, promote export of green aluminum value added products globally. Using an Arellano bond estimation model, this study have empirically tested the feasibility of this policy tool that could have implications for improving the sustainability and competitiveness of downstream aluminum in India. The study suggests quick remedial action in the wake of other long-term solutions that cannot be implemented fast. Trade could be one of them and legislation could work on a policy framework to a) reduce the custom duty on primary aluminum to normalize the prices in the Indian market and b) abolish custom duty on green aluminum from the countries with the lowest carbon footprint for aluminum production. By doing this, the government could keep the prices of the inputs to the downstream sector in control and allow the downstream companies to stay competitive in the domestic market and maintain their export to the EU.

Key Words: Aluminum, green, decarbonization, trade, import tariffs, carbon tax

JEL Classification: F1, Q4, Q5

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She has received many prestigious International awards and fellowships. She is the recipient of European Summer school grant 2014 to participate in an International workshop and also EAERE grant 2015 to participate in its Annual conference in Finland. She also received fellowship from International Consortium of Agri-bioeconomy research in 2011,2012 and 2013 for participation in it's conference in Italy. She is also a recipient of prestigious grant from Beijer Institute of Ecological Economics, Switzerland, ZALF (Leibniz Centre for Agricultural Landscape Research), Germany, Canadian Association of Environmental and Resource Economists (CREEA) and University of Manchestor, UK to participate and present her research in various International Forums.

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Foreword

The issue of India's competitiveness in manufacturing is a well-documented one and therefore needs no repetition. It is in this context that the current government has been rolling out various incentives and schemes to promote the manufacturing industry. The aim to raise the contribution of manufacturing sector in the GDP from 16-17% to 25% by 2025 requires fundamental policy changes in the procurement of material, technology, human capital, and the likes.

Energy use in industry is considered as a major contributor towards global greenhouse gas (GHG) emissions. Therefore, decarbonization of heavy industry could have an immediate impact on reducing GHG emissions and slowing climate change. As the effect of climate change is intensifying, various countries and industries are seeking new ways to decarbonize to meet emission targets and reduce energy costs.

In this regard, the European Union institutions have recently adopted the ambitious target of reaching climate neutrality by 2050. Applying a "Carbon Border Adjustment Mechanism (CBAM)" is one approach put forward by European Commission.

Aluminum is one of the five sectors covered by EU CBAM along with iron and steel, cement, fertilizers and electricity.

Aluminum Secondary Manufacturers Association (ASMA) is a voice of nearly 3500 MSMEs in the downstream sector that aims to bring forth the issues faced by them to the attention of policy makers in the ministries. The dialogue between them is to assist the government and the downstream producers understand the problems and grab the opportunities jointly for the common good of India.

Valuable suggestions and necessary inputs provided for the study by ASMA under the active leadership of Sh. Anil Agarwal, Ex-President, Jindal Aluminum Limited and Dr. Biswajit Nag, Professor, IIFT are acknowledged. We believe that the study will help cooperation between government and downstream aluminum industry to cooperate faster to take relevant steps to counter the CBAM effect in a more scientific manner with economic reasoning and logic.

Preface

India is the fastest growing free democratic country in the world and is slated to be the 3rd largest economy in 10 years from now. India has also set the target of becoming a developed country by 2047. In order to meet this goal, the Indian economy will have to consistently grow at an average rate of around 8 per cent per annum.

The government of India has been at the forefront of easing pains of manufacturing industry by various schemes such as PLI (Production-Linked Incentive) and other measures such as lowering input costs. However, there are significant custom duty issues in the aluminum sector that need immediate attention and the study highlights the inverted duty structure and its detrimental effect on the downstream sector.

In this context the authors of the study are bringing forth the issues of trade policies and the tariff structures in the aluminum sector that currently provide a cost structure for raw material inputs to the MSMEs. The study also helps in understanding the related protection to the domestic sector that emanates from the import policies for primary and downstream products in the aluminum sector.

Combined with this is the comprehensive study of the FTAs and trade agreements between India and the rest of the world and their impact on the import and export of aluminum in India. The authors also touch on the future of the Indian Aluminum downstream sector viz-a-viz low carbon footprint inputs for the downstream sector to be compliant to environmental norms needed to export to EU and other markets in future. This is covered in the chapter 1 which is the update of previous study done on the ERP by IIFT.

India is a signatory to the Paris Agreement, under which countries must formulate and communicate long-term low greenhouse gas emission development strategies (LT-LEDS), taking into account their common but differentiated responsibilities and respective capabilities, in the light of different national circumstances. These initiatives of the government - to be successful, do require a holistic view of how we can grow at 8% YOY yet achieve the decarbonization goals of net zero GHG by 2070.

Chapters 2,3,4 are dedicated to this topic.

Chapter 2 will discuss the climate initiatives in Aluminum Industry in India as well as in other countries, short term and long term decarbonization goals. What lessons could be learned and incorporated from other countries particularly Canada, Iceland etc to decarbonize the aluminum sector.

Chapter 3 will analyze the impact of various economic factors such as import tariffs on primary aluminum, energy intensity, carbon tax etc and then draw policy implications from the findings.

Chapter 4 will assess the impact of CBAM on Indian downstream aluminum sector using an input-output model.

Acknowledgements

I am extremely grateful to Mr. Sanjay Gupta, Member, Aluminum Secondary Management Association (ASMA) for helping in collecting all the necessary data for this study as well as his valuable insights on various aspects of this report. I would also like to thank the participants of the seminar on "Trade, Sustainability and Competitiveness of aluminum sector in India in the presence of CBAM" organized by ASMA where this work was presented.

Glossary

HS-4 digit Codes used in Report	Aluminum Product Name	Category
7601	Unwrought Aluminum	Primary
7603	Powder and flakes, of Aluminum (excluding pellets of Aluminum, and spangles)	Downstream
7604	Bars, rods and profiles, of Aluminum, n.e.s.	Downstream
7605	Aluminum wire (excluding stranded wire, cables, plaited bands and the like and other articles of heading 7614, electrically insulated wires, and strings for musical instruments)	Downstream
7606	Plates, sheets and strip, of Aluminum, of a thickness of > 0,2 mm (excluding expanded plates, sheets and strip)	Downstream
7607	Aluminum foil, "whether or not printed or backed with paper, paperboard, plastics or similar backing materials", of a thickness "excluding any backing" of <= 0,2 mm (excluding stamping foils of heading 3212, Christmas tree decorating material)	Downstream
7608	Aluminum tubes and pipes (excluding hollow profiles)	Downstream
7609	Aluminum tube or pipe fittings "e.g., couplings, elbows, sleeves"	Downstream
7610	Structures and parts of structures "e.g., bridges and bridge-sections, towers, lattice masts, pillars and columns, roofs, roofing frameworks, doors and windows and their frames and thresholds for doors, shutters, balustrades", of Aluminum (excluding prefabricated buildings of heading 9406); plates, rods, profiles, tubes and the like, prepared for use in structures, of Aluminum	Downstream
7611	Reservoirs, tanks, vats and similar containers, of Aluminum, for any material (other than compressed or liquefied gas), of a capacity of > 300 l, not fitted with mechanical or thermal equipment, whether or not lined or heat-insulated (excluding containers specifically constructed or equipped for one or more types of transport)	Downstream
7612	Casks, drums, cans, boxes and similar containers, incl. rigid or collapsible tubular containers, of Aluminum, for any material (other than compressed or liquefied gas), of a capacity of <= 300 l, not fitted with mechanical or thermal equipment, whether or not lined or heat-insulated, n.e.s.	Downstream
7613	Aluminum containers for compressed or liquefied gas	Downstream
7614	Stranded wire, cables, plaited bands and the like, of Aluminum (excluding such products electrically insulated)	Downstream
7615	Table, kitchen or other household articles, sanitary ware, and parts thereof, of Aluminum, pot scourers and scouring or polishing pads, gloves and the like, of Aluminum (excluding cans, boxes and similar containers of heading 7612, articles of the nature of a work implement, spoons, ladles, forks and other articles of heading 8211 to 8215, ornamental articles and fittings)	Downstream
7616	Articles of Aluminum, n.e.s.	Downstream
HS-6 digit Codes used in Report	**Aluminum Product Name**	**Category**
760110	Aluminum, not alloyed, unwrought	Primary
760120	Unwrought Aluminum Alloys	Primary

** Aluminum waste and scrap (HS: 7602) is out of the study’s scope

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Executive Summary:

Aluminum is the second most used metal on the earth with estimated consumption of about 88 million tons in 2021 and expected to grow to 120 million tons by 2030. However, the consumption in India is merely 2.7 kg per capita in comparison to the average of 11 kg per capita.

The downstream aluminum sector is besieged with legislative policies of yester-years with no incentives to increase production and an import-parity pricing for primary aluminum that benefits the primary producers immensely. The policy matter gets further complicated with the FTAs/ Regional trade agreements that result in imports of finished goods at zero duties and having an inverted duty structure in the aluminum sector. The sector will now face more hardships because of carbon tax that will be levied by the EU on imports of aluminum products from India.

Aluminum is a strategic sector for India to move towards a sustainable economy. It could play an increasingly crucial role to help India to serve its commitment to CO2 emission norms if this metal is produced with the low carbon footprint. India should explore short-term ways to decarbonize and trade can become a practical tool to facilitate it. One such tool is the reduction of the import tariffs on primary aluminum with low carbon footprint that could raise the competitiveness of downstream aluminum sector. It can also encourage imports of low carbon primary aluminum from countries like Canada, Norway, Russia and Iceland that could be used to produce the finished goods domestically and in turn, promote export of green aluminum value added products globally.

In the first chapter in the study done by IIFT (Indian Institute of Foreign Trade), we have shown with the help of an analytical tools on effective rate of protection (ERP) that high tariffs on inputs result in increasing cost of primary aluminum to the downstream industry and strengthening the monopoly of primary aluminum producers. The study highlights that policies introduced by GoI like increase in import duties and introduction of trade measures have not helped. The key reasons are deep and systemic difficulties faced by the downstream sector in India, the main of which is high prices of raw material for their production.

The second chapter covered the issue of the decarbonisation of the aluminium sector in India, its short- and long - term goals. The conducted analysis of the GHG emission intensity showed that the amounts of generated emissions depend on the source of electricity that was used during the production process. It concluded that as still India highly relied on coal power, its domestically produced metal is extremely carbon intensive. The key lies in adoption of new technologies such as inert anodes, carbon capture and storage and biofuels to reduce direct emissions. For reduction of indirect emissions, alternate sources of electricity generation such hydro, nuclear, wind are important. However, it is also clear that these are long-term paths to decarbonization and therefore not a short-term solution. It also details out the countries that are producing cleanest and dirtiest aluminum in terms of tons of CO2 produced per ton of aluminum produced with cleanest being produced by countries such as Russia, Iceland, Norway and the dirtiest being countries such as China, India and South Africa, Bahrain and others.

The third chapter details an econometric model (dynamic panel data model) that shows the relation between the revenues of a downstream aluminum producer and import tariffs, energy intensity, capital investment, and size. This is based on prominent aluminum downstream companies in India. It shows that the downstream companies can grow in revenues by around 50-100% with a reduction in tariffs on the primary aluminum by 50%. Similarly, we can expect a significant rise in revenue with the improvement of energy intensity.

The fourth chapter clearly states the impending tsunami in the name of CBAM that will hit the Indian downstream companies exporting to the EU. It establishes that tariff the Indian companies

will face up to 47%. Extra costs resulting from CBAM would undermine the development of India's downstream sector and their competitiveness on the EU market will be at risk. Only green solutions will help India's downstream stay competitive in the internal and external markets

The study suggests quick remedial action in the wake of other long-term solutions that cannot be implemented fast. Trade is one of them and legislation should work on a policy framework to a) reduce the custom duty on primary aluminum to normalize the prices in the Indian market and b) abolish custom duty on green aluminum from the countries with the lowest carbon footprint for aluminum production.

By doing this, the government will keep the prices of the inputs to the downstream sector in control and allow the downstream companies to stay competitive in the domestic market and maintain and possibly of their export to the EU.

Time is of the essence and the government should act fast.

Introduction

- Background of the Study

The Indian Aluminum Downstream sector accounts for a major share in the Indian Aluminum industry's output and employment. However, it has been continuously suffering from an increase in the costs of the main raw material i.e. the unwrought aluminum whose price has been artificially increased.

At the international level, the aluminum industry has been the major focus of the debate on protectionist actions as the United States increased the import tariffs on the aluminum products. Since March 2018, the United States has imposed 10% tariffs on primary unwrought aluminum imports and 20% on a few semi-finished aluminum products in February 2020 on national security grounds under Section 232 of the Trade Expansion Act.

Also, increasing the capacity of the aluminum smelters is partly related to direct and indirect support from the government, which has raised concerns regarding the competitive implications. All attributed additional costs were added to the expenses of downstream sector which gained no state support and all consumers of primary aluminum now must pay more since tariffs always increase prices. More than that, spontaneously imposed tariff caused disruption of global supply & production chain and has prompted others to impose erroneous "protection". It is a mistaken idea that existence or increase of import tariffs without comprehensive measures in the country's economy can improve the situation in the industry. Instead, it is an imbalance when one gets protection and enjoy excessive profit at the expense of increasing costs for others. The economic absurdity is that financially weaker sectors provide additional profit to the financially strong ones.

In Indian Aluminum industry, we observe more support for the unwrought aluminum producers than the downstream sector, which requires more attention. There has been a continuous increase in the import duty on unwrought aluminum which favored aluminum smelters, but consumers of aluminum have to bear financial burdens of such policy. Increasing of import tariff on aluminum products will not balance the situation but exacerbate it.

Import tariffs on primary aluminum artificially increase the prices for the downstream sector resulting in their downfall in terms of their profitability and worldwide competitiveness. Import tariffs affect not only the imports but also the domestic industry as a whole and influence its stakeholders in various ways. India needs a pro-active policy towards downstream industries which create significant economic values and employment opportunities.

Further significance to decarbonization of the supply chains and imposition of carbon tax is gaining significance all over the world and this study aims at bringing this topic to the attention of the policy makers in India. To the extent that Indian MSMEs in the downstream sector do not get adversely affected by imposition of carbon taxes by EU and US.

Objective of the Study

With this background, the objective of the study is to provide an overview of the Indian Aluminum industry; to analyze the efficacy of the present policies with a focus on the trade policy and to recommend policy option to enhance the competitiveness of the downstream vis-à-vis the dynamics of global demand and supply and the CBAM impact in both short and long term.

Methodology Used

- The secondary data analysis has been done to provide an overview of the Indian Aluminum industry vis-à-vis global aluminum industry and assess the challenges faced by the Indian aluminum downstream sector and its future potential. Various data sources like Statista, World Aluminum, Niti Aayog, FICCI, Madras Consultancy Group, ITC Trade Map, the Ministry of commerce and industry statistics and other reports and newspaper articles have been used for this purpose.
- ITC Trade Map data has been used to analyze the trade structure of the domestic aluminum industry with focus on major exporters of primary unwrought aluminum in the world, particularly Russia which produces low-carbon aluminum generated through hydropower and assess its revealed comparative advantage and trade intensity with India in primary aluminum.
- Big's Easy Reference Customs Tariff (Imports) Different Editions by Arun Goyal, Central Board of Indirect Taxes and Customs website and Supply-Use Table have been used to analyze India's duty structure and calculate effective rate of protection in the aluminum industry during post FTA period.
- Secondary reports and newspaper articles to assess the rising requirement to "green" properties of the aluminum and awareness of the climate change mitigation and the future of the Indian aluminum industry
- World Integrated Trade Solution (WITS) SMART Analysis to build a hypothetical scenario to import high quality primary aluminum in India at lower tariffs with the reference case of Russia.
- Based on the above analysis, brief summary of the report and recommendations have been provided in the Conclusion to enhance the competitiveness and export performance of the Indian Aluminum downstream sector.
- The data has been taken from Prowess IQ database. This dataset is a product of the Centre for Monitoring Indian Economy Pvt Ltd. (CMIE) and includes all companies traded on the National Stock Exchange and the Bombay Stock Exchange, thousands of unlisted public limited companies, and hundreds of private limited companies. The database is built from Annual Reports, quarterly financial statements, Stock Exchange feeds, and other reliable sources. We have considered data for 10 MSME firms that constitutes the highest market share and for which power and fuel expenditure data was available. Our sample comprised of 90 observations which represented 10 largest downstream aluminum firms over 9 years (2014-22).

Chapter 1: Landscape of Aluminum Industry, Duties and Effective Rate of Protection

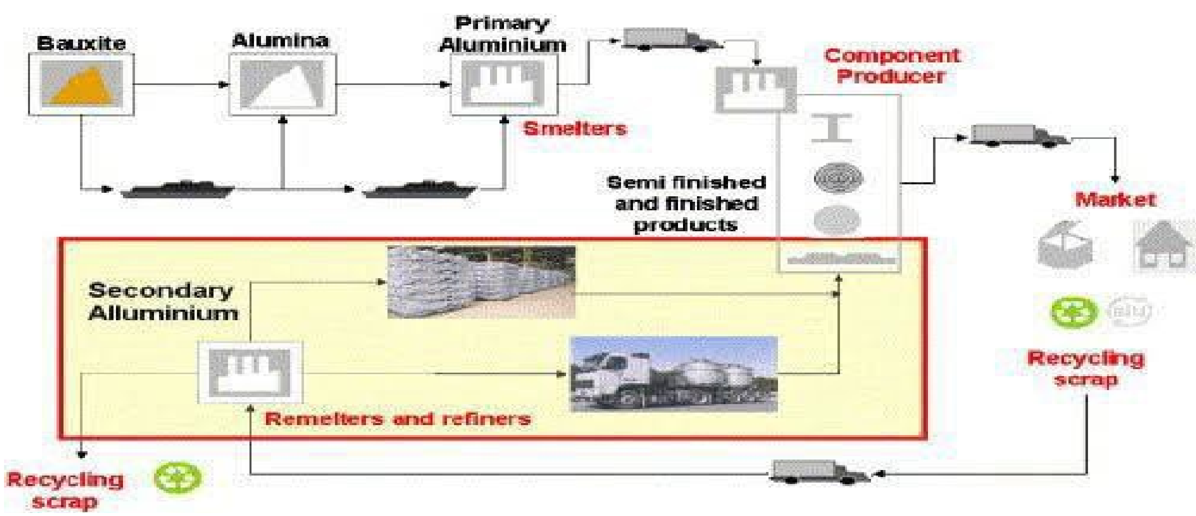
1.1 Background of the Aluminum Industry

Aluminum is the most abundant, naturally occurring metal in the earth's crust in the form of bauxite ore. The aluminum industry is one of the essential sectors for countries to modernize as the metal is lightweight, durable and infinitely recyclable. It is used to produce a range of highly differentiated products, especially in high-tech industries like in the manufacturing of high value-added investment goods (automotive, shipbuilding, aerospace, building and construction, mechanical and electrical engineering) and consumer goods (mobile devices, computers, recreational vehicles, household appliances, etc.).

Aluminum plays an essential role in moving the world towards more sustainable materials. Among its main properties that helped the aluminum gain attention in the world market is the resourceful use of the material, namely the reuse and recycle qualities – the environment friendly credentials. These could also contribute toward improvement of medium and small companies' environmental performance.

Aluminum can decrease energy costs and carbon emissions in several applications, for example, coated aluminum roofs can reflect up to ninety-five percent of sunlight, intensely growing structure's energy efficiency[1] (Roof India, 2020). In many advanced countries, aluminum is gradually substituting wood and steel in the building sector.

Figure 1: Aluminum Production Value Chain



Source: I.Ferretti, S.Zanoni, L.Zavanella, A.Diana (2007). "Greening the Aluminum supply chain", International Journal of Production Economics, Volume 108, Issues 1–2.

[1] https://roofindia.com/Roofindia/media/ITEGroup/Press%20Release/Aluminum-empowering-the-Green-Building-Revolution.pdf

The value chain involved in the aluminum industry comprises of various stages starting from the extraction of mineral raw materials to the production of intermediate and semi-finished products and final goods. It can be divided into 2 main segments:

A. The Upstream Segment:

The activities in this segment begin from the mining of bauxite ore which is an aluminum rich mineral in the form of aluminum hydroxide. This bauxite ore obtained by excavation is not always pure and treated additionally through crushing and washing etc. to improve its purity. It is composed of about 25% aluminum. It is then dried and ground in special mills where it is mixed with a small amount of water. This process produces thick paste which is collected in special containers and then heated with steam to remove most of the silicon from bauxite. This process leaves behind a white powder called the metallurgical alumina (aluminum oxide) which is composed of about 50% aluminum.

The next process involved is that of electrolytic reduction in which the produced alumina is poured into special reduction cells with molten cryolite at 950 degrees Centigrade. This is done in large production lines and is an energy-intensive process. Electric currents are induced in the mixture at 400kA or above to break the bond between the aluminum and oxygen atoms resulting in liquid aluminum settling at the bottom of the reduction cell.

So, this upstream segment includes all the producers of the raw material from the unwrought mineral, namely the extractors (mining and quarrying) and the primary aluminum smelters.

The product received from a smelter is called the unwrought primary aluminum or unwrought aluminum in terms of Customs Tariff. Primary or unwrought aluminum covers both non-alloyed aluminum containing by weight at least 99% of aluminum and its alloys in which aluminum predominates by weight over other elements. Alloys differ in composition and usage.

Thus, primary aluminum alloys are produced from unwrought not alloyed primary aluminum, which is melted down with the addition of alloying elements necessary for a given alloy.

Secondary aluminum alloys in upstream segment are made from unwrought not alloyed primary aluminum and aluminum scrap. Those alloys are cheaper than primary ones and contain more additional elements which influence their quality and thus determine further usage.

Secondary aluminum in upstream segment is produced by recycling and re-melting aluminum-bearing scrap and/or aluminum-bearing materials. Aluminum scrap is often categorized as:

a) "new" (post-manufacturing), which arises from primary aluminum production or the manufacturing of aluminum semi-fabricated and final products, before the aluminum product is sold to the final user.

b) "old" (post-consumer), which results from the collection and/or treatment of products containing aluminum after use by consumers (e.g. beverage cans, automobiles, wires, and cables).

The secondary production of unwrought aluminum typically employs two different production processes. In the re-melting process, new scraps are used to produce unwrought alloys, usually in the form of extrusion billets and rolling ingots. In the refining process, predominantly old scrap is used to produce casting alloys, mainly for the automotive industry.

The aluminum recycling and re-melting comprise producers of Aluminum alloys (recyclers) from aluminum waste and scrap generated either as a by-product of manufacturing or from recycled goods. These are also included in the upstream segment as they also produce unwrought Aluminum for the downstream transformers.

Unwrought Aluminum is used as a raw material for the production of aluminum semis and then articles. Sectors of the aluminum industry which consume aluminum for further processing are usually named “Downstream”.

B. The Downstream Segment:

In this segment, the output of the unwrought aluminum producers, namely aluminum ingot products, such as slabs, billets, foundry (casting) alloy ingots and re-melt ingots (T-bar, sow or standard ingots), are purchased by downstream operators to produce the semi-finished products (also called “wrought aluminum”, “semis,” or “mill products”) by rolling, extruding, casting and drawing unwrought aluminum into various forms.

The aluminum downstream sector involves a broad group of producers manufacturing highly differentiated outputs like manufacturers of aluminum extrusions, flat-rolled products, and castings, as well as producers of foil, wire, slug, and powder, lacquers and other processing applications. Semi-finished aluminum products are sold to a wide variety of customers using them in manufacturing processes further down the chain. The main markets include packaging, construction and building, engineering, automotive, aerospace, and electrical transmission.

It is important to underline that unwrought aluminum remains the main raw material for all stages of processing through the whole chain. Its value in the final products is at least 60% and more. Other elements of the cost structure are production costs.

1.2 Global Aluminum Industry

Aluminum can serve many areas of application in the economy and is likewise vital to both the industrial and consumer sectors. On the industrial front, aluminum is mainly used in machinery, electrical power transmission equipment, construction and transport. For instance, as a key factor to a vehicle’s energy use is its weight, aluminum can reduce it by 40 percent in comparison with steel, without compromising strength. So, aluminum-intensive vehicle production has been expanding over the past five years.

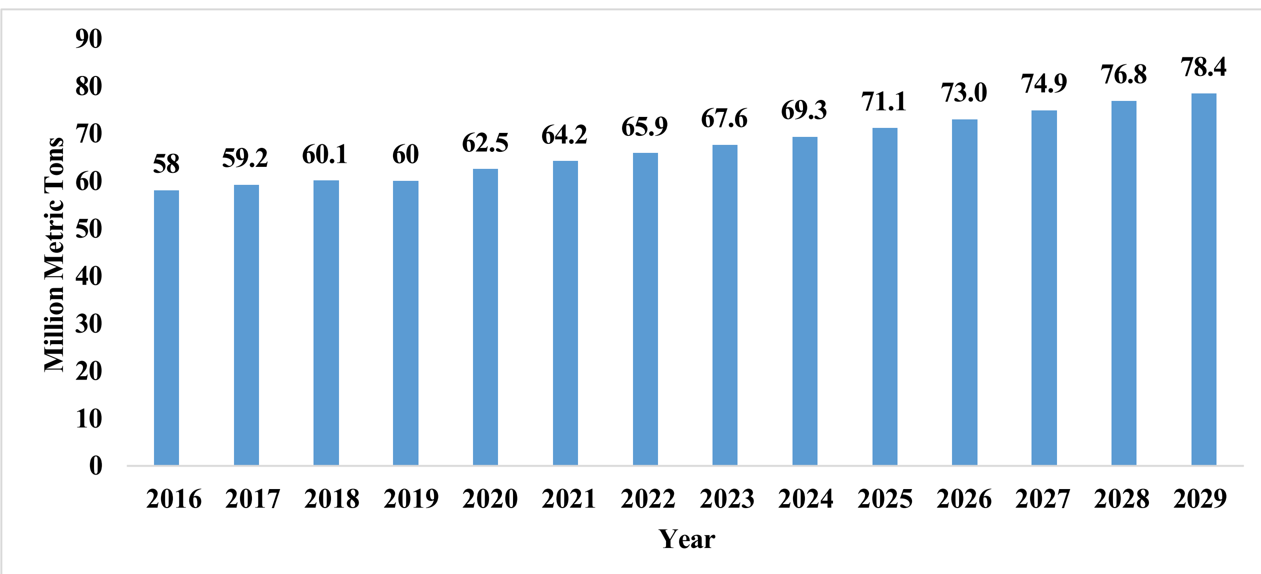
It has an increasing demand in the housing sector as well due to its lightweight property combined with high strength and durability. This metal is used as a substitute for steel and wood in doors, windows and sidings; is also utilized in a variety of retail products including air conditioners, cans, packaging, furniture, etc.

A variety of opportunities for this light metal use in the economy is caused by a favorable combination of its properties. Being light weighted, recyclable and highly versatile material, resistant to aggressive environment material, the areas of aluminum application are almost endless and it plays a pivotal role in human's everyday life. Aluminum is very friendly crystal lattice compared to other metals, so it can be used to develop all sorts of high-tech alloys.

The increase in global consumption is primarily driven by the Chinese economy. China is a major consumer of aluminum accounting for almost 51% of global consumption. The CAGR from 2010 -2022 for China stands alone at 8.9%. While India, the U.S., Europe, Canada, Latin America, Middle East and Rest of Asia, and Rest of the World CAGR from 2010-2020 combined stand at 16.4%.

In China, the demand rose by 8% driven primarily by the transportation, packaging and industrial segments[2]. The global consumption of aluminum is expected to touch around 78 million Metric tons in CY29, as shown in Figure 2.

Figure 2: Global Primary Aluminum Consumption and its Forecast (in million metric tons)



Source: Statista[4]

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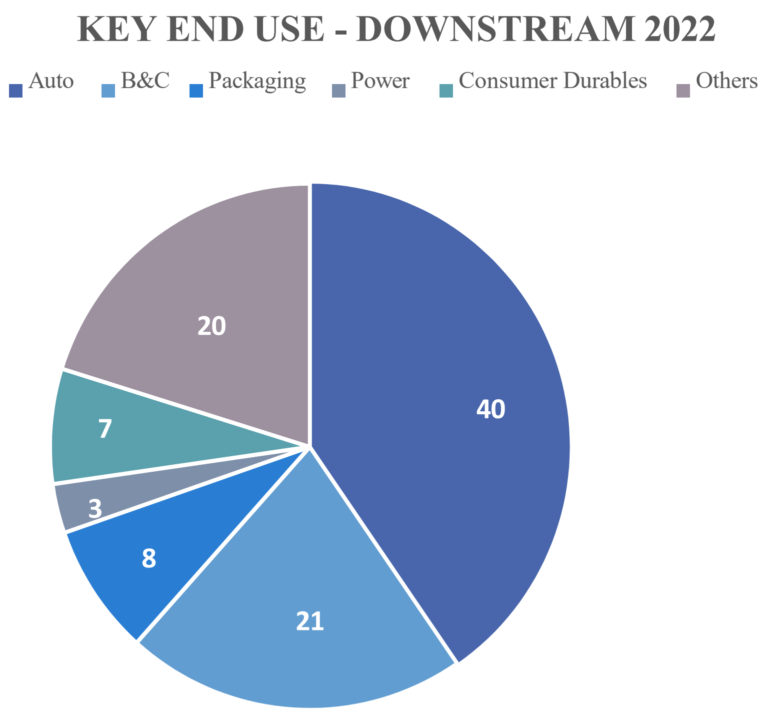
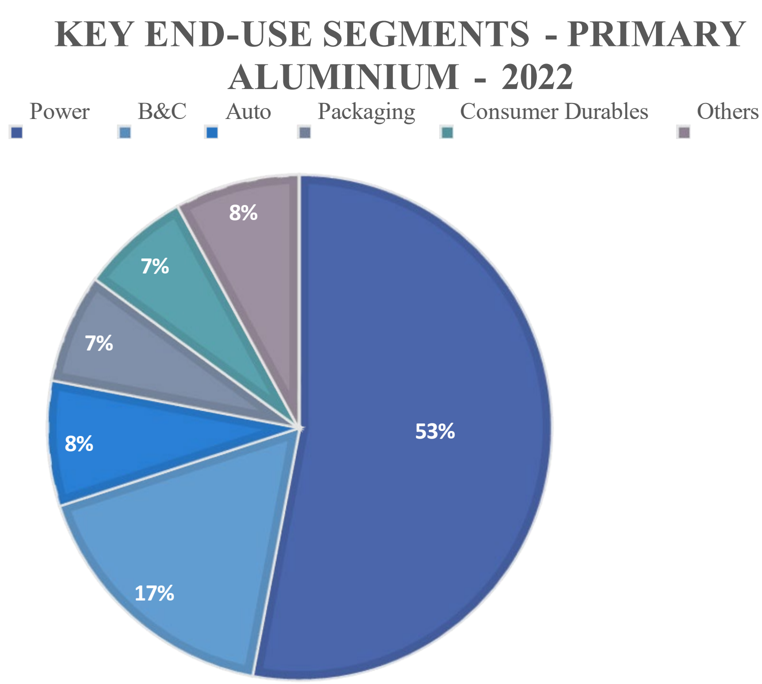
[2]Source: Statista
[3]Source: Statista
[4]2021-2029 is the forecasted consumption.

While the power sector consumes the largest proportion of primary aluminum in India, better cost economics of secondary aluminum and healthy demand for non-ferrous castings from the automotive sector, the largest consumer of secondary aluminum, are the major demand drivers of secondary aluminum in the country.



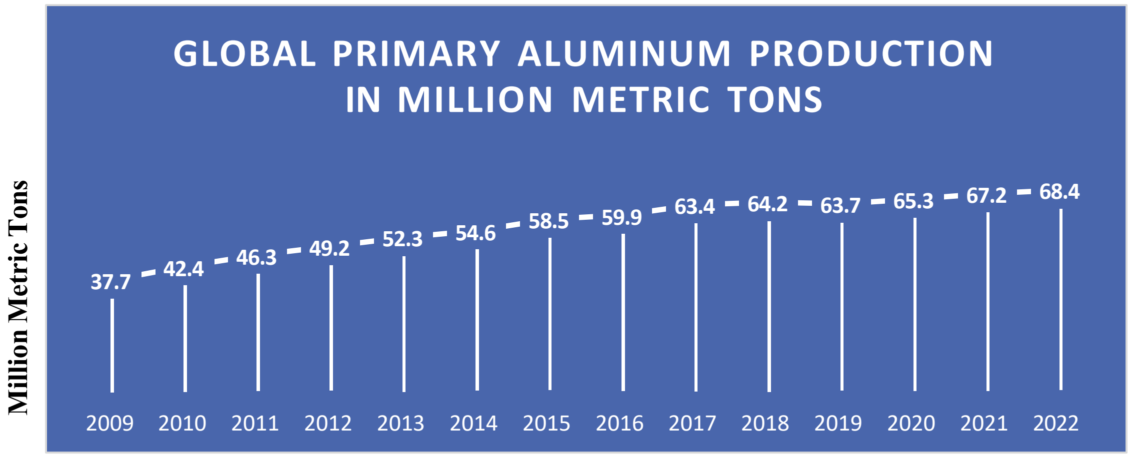


Source:Crisil report (September, 2022

The production of primary aluminum has been on the rise globally since 2009, as shown in Figure 3.

The upward movement of the primary aluminum prices has encouraged the producers of primary aluminum to increase their production. According to International Aluminum Institute, globally about 68.4 million tons of primary aluminum was produced in 2022.

Figure 3: Global Primary Aluminum Production 2009 – 2022 (in million metric tons)



Source: International Aluminum Institute

In Figure 4, a region-wise primary aluminum production is shown, where China alone is able to produce more than fifty percent of primary aluminum.

Figure 4: Unwrought Primary Aluminum Production in 2022 Calendar Year, ktons

Source: International Aluminum Institute

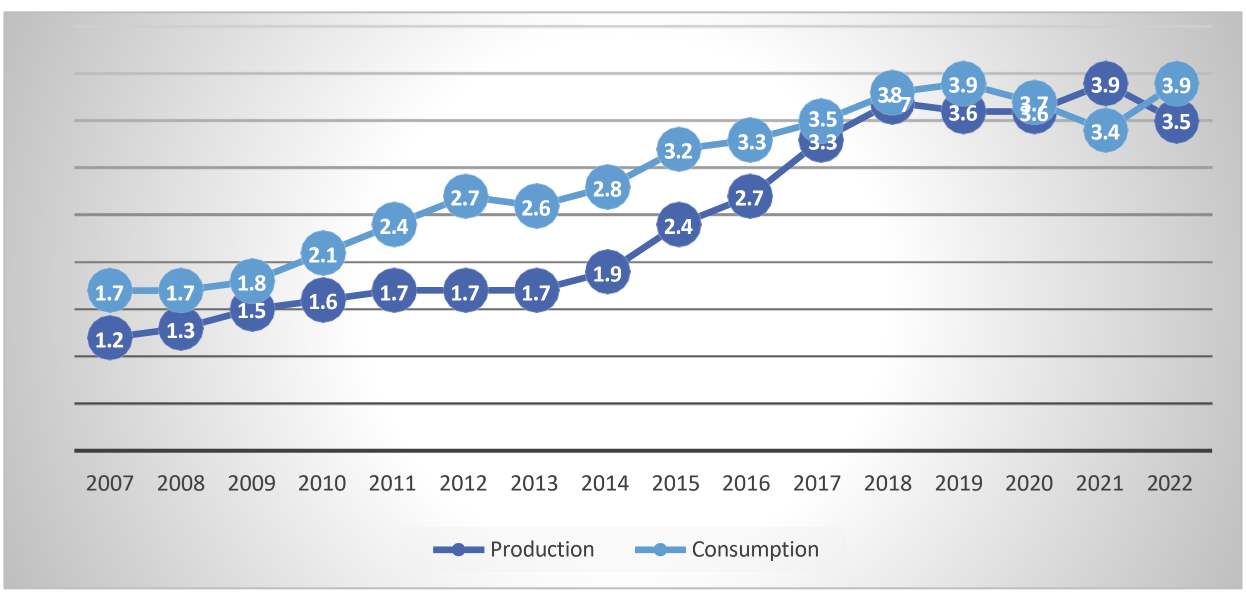
1.3 Indian Aluminum Industry

Aluminum is regarded as a strategic sector for India to move forward. It would support India to boost fuel and cost efficiency, especially in the Transportation, Electrical & Electronics, Building & Construction sector. It will help India to serve its commitment to CO_2 emission norms by adopting electric vehicles, which improves the share of renewable energy to 40% and beyond and promote indigenization in defense equipment, aerospace, and aviation sectors (Niti Aayog).

In Figure 5, the growth pattern of Indian aluminum production and consumption is given. It shows that there is an increase in both production and consumption at a rapid rate. Currently, the aluminum consumption in India is at 2.5 kg per capita which is much below the global average of 11.3 kg per capita (Niti Aayog).

India will need a supplementary annual consumption of 16 million tons to achieve the global average of 11 kg per capita, thus, securing the position of the second-largest consumer in the world (in the absolute terms). This additional consumption can be supported by domestic downstream industry and from qualitative imports. Despite low domestic consumption in comparison to the global consumption, aluminum contributes around 2% to the manufacturing GDP (steel 12%, cement 9%) and this is likely to increase with consumption growth (Niti Aayog). This growth is vital for India's industrial vision of achieving 25% of GDP from manufacturing by 2025 (according to India Brand Equity Foundation) under the "Make in India" initiative.

Figure 5: Indian Total Aluminum Production and Consumption (in million metric tons)



Source: Crisil report

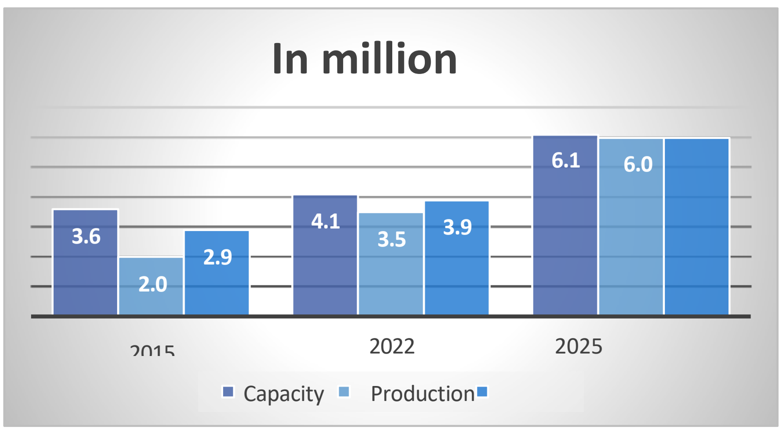
1.3.1 Indian Primary Aluminum Industry

Aluminum Industry is the second most important metallurgical industry in India. Over the course of last four years, India's aluminum production capacity has increased to 4.1 million MT, driven by investment worth Rs 1.2 lakh crore (US$ 18.54 billion) (IBEF, 2019).

In 2019, India was the fourth largest producer of aluminum in the world with a share of around 5.33 percent of the global aluminum output (ibid).

According to Ministry of Mines data, production of aluminum in 2022 (FY 2022-2023) stood at 3.5 million MT, the demand for aluminum has been slightly higher than the production in 2022 because of user industries like power, infrastructure and transportation[5] getting back to pre-covid consumption.

Figure 6: India's Aluminum Capacity, Production & Demand



Source: FICCI report

In 2022 (FY 2022-23), the domestic consumption comprised 3.9 million MT. Aluminum consumption is expected to reach approx. 6.0 million MT in 2025.

The three major players that dominate the primary aluminum market are privately owned Vedanta, Hindalco, and public-sector undertaking National Aluminum Company Limited (NALCO). About 60% of the market share is accounted for Hindalco.

There are 8 aluminum smelting plants in the country:

i) Bharat Aluminum Co. (Balco) which is owned by Vedanta Resources, Korba
ii) Vedanta Resources, Jharsuguda
iii) National Aluminum Co. (Nalco), Angul
iv) Aditya Aluminum (Hindalco Industries Ltd), Lapanga
v) Mahan Aluminum (Hindalco Industries Ltd), Bargawan
vi) Hindustan Aluminum Co. (Hindalco Industries Ltd), Renukoot
vii) Hindalco, Belgaum, Karnataka
viii) Hindalco Industries Ltd, Hirakud

According to India Brand Equity Foundation[7], India has the world's seventh largest reserve base of bauxite, which accounts for about 7 percent of the total world production. Moreover, India had the world's fourth largest coal reserve at 777.31 billion tons in FY22, a 8,55% YoY (according to IBEF).

Coal is the largest energy source in India with coal-fired plants generating 72% of India's electricity. Thus, in India, production is based on coal generation and operates at close to 90% capacity rate[8].

Power is a critical input for Aluminum industry as aluminum production involves the electrolytic reduction of alumina, which is highly energy intensive process that uses electricity. Being an energy-intensive sector, aluminum industry in India entirely relies on coal that contributes to about 30-35 per cent of the metal production cost[9]. Thus, due to a coal-based production process, aluminum produced in India has high carbon footprint.

Major Indian Aluminum manufacturing companies have captive coal-fired power plants that helps them to rationalize power costs to a certain extent in the long-term and serve as a source of energy for manufacturing. Such power plants consume great amounts of coal. For example, Jharsuguda smelter owned by the largest aluminum producer Vedanta Ltd. alone requires 17 million tons of coal a year to generate electricity at its captive power plant, half of which comes from contracts with Coal India. The rest comes from imports and auctions by Coal India.

This coal-based production is one of the major factors responsible for high carbon-dioxide emissions.

Besides abundant bauxite and coal reserves, India ranks fourth in the world in terms of alumina production. That all collectively with other resources and comparatively low labor costs have driven the country to become a net exporter of alumina and bauxite.

As bauxite, alumina and power constitute the major components of the total operating costs, Indian manufacturers of unwrought primary Aluminum enjoy the competitive advantage in terms of natural resources and availability of cheap labor that greatly helps them in growing their production efficiency and lower the cost of Aluminum production.

Particular attention should be given to damage that coal has caused for health and life. Coal-fired power plants in India take the highest toll in the world when it comes to health, according to a

[7]A trust established by the Department of Commerce, Ministry of Commerce and Industry, Government of India
[8]https://economictimes.indiatimes.com/industry/energy/power/india-will-not-be-able-to-achieve-its-renewable-energy-targets-anytime-soon/articleshow/69286279.cms?
[9]NMS: The Aluminum Industry, February, 2018

study of global emission hotspots[10]. About half of all the CO_2 emissions in the country come from burning coal, and coal power plants account for 60% of particulate and 50% of Sulphur dioxide emissions of the entire industrial sector. Deaths and diseases due to air pollution cost India a GDP loss of more than 5%[11] and coal-related pollution constitutes a significant proportion of this.

It is a widely known fact that coal is responsible for 40% of carbon dioxide emissions from fossil fuels. Mining coal wreaks havoc on the environment and on the people who live there. Besides CO_2, which contributes to global warming, burning coal produces pollutants like mercury, sulfur dioxide, which is linked to acid rain, and particulate matter, which causes respiratory illnesses.

Tackling climate change is impossible without reducing Indian dependence on fossil fuels, especially coal.

India is an emerging economy and a signatory of COP-26. This creates a rather difficult situation because India needs to develop yet the use of environment-friendly and climate neutral methods for industrial development. Rather than mining and burning coal to produce exportable primary aluminum, India should use the natural resources judiciously.

India's COP-26 commitments are – as per ministry of environment, forest and climate change:

- Reach 500GWNon-fossil energy capacity by 2030.
- 50 per cent of its energy requirements from renewable energy by 2030.
- Reduction of total projected carbon emissions by one billion tonnes from now to 2030.
- Reduction of the carbon intensity of the economy by 45 per cent by 2030, over 2005 levels.
- Achieving the target of net zero emissions by 2070.

India is one of the major primary aluminum producers and exporters but its downstream is less competitive than it could be and needs the support from the State.

The domestic aluminum industry is struggling to remain globally competitive in the wake of increasing production costs. Amongst the largest producers of aluminum like Canada, Russia, Middle East, Norway and China, India has the highest cost of production. As per OECD, India suffers from high electricity cost as compared to other OECD countries[12].

Power is a critical input for aluminum industry accounting for almost 30-40% of their cost of production. Coal subsidies in China and subsidized power in Middle East as well as various aluminum producing countries gives an edge to them over Indian players.

[10]https://www.thehindubusinessline.com/economy/indias-coal-power-plants-unhealthiest-in-world/article26332557.ece
[11]https://timesofindia.indiatimes.com/blogs/toi-edit-page/india-is-too-poor-to-afford-coal-as-a-primary-source-of-energy-in-the-near-future-and-that-is-aside-from-environmental-costs/
[12]https://energy.economictimes.indiatimes.com/news/power/high-electricity-prices-hurting-indias-exports-oecd/72388803

1.3.2 Indian Downstream Industry

In this segment, the output of the unwrought Aluminum producers, namely aluminum ingot products, such as slabs, billets, foundry (casting) alloy ingots and re-melt ingots (T-bar, sow or standard ingots), are purchased by downstream operators to produce the semi-finished products (also called "wrought aluminum", "semis," or "mill products") by rolling, extruding, casting and drawing unwrought aluminum into various forms.

The aluminum downstream sector involves a broad group of producers manufacturing highly differentiated outputs like manufacturers of aluminum extrusions, flat-rolled products, and castings, as well as producers of foil, wire, slug, and powder, lacquers and other processing applications. Semi-finished aluminum products are sold to a wide variety of customers using them in manufacturing processes further down the chain. The main markets include packaging, construction and building, engineering, automotive, aerospace, and electrical transmission.

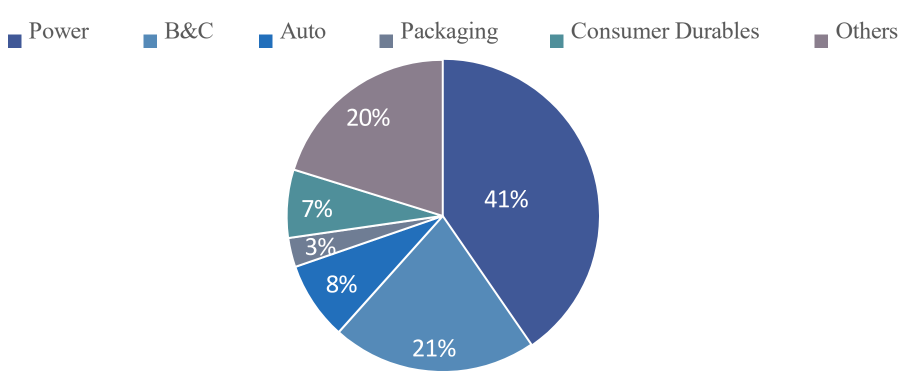
It is important to underline that unwrought aluminum remains the main raw material for all stages of processing through the whole chain. Its value in the final products is at least 60% and more. Other elements of the cost structure are production costs.

India is one of the leading markets for downstream aluminum in the world. This is aided by a vibrant industrial climate in India in transport sector, building and construction sector, electrical and electronics, industrial sector, consumer durables, packaging, and others.

The total aluminum usage in India that includes primary and secondary aluminum stood at around 3.9 million tons in 2022 (according to Crisil Report) where about 2.25 million tons accounted for primary aluminum.

Apart from the downstream production facilities of the major primary producers, the Indian downstream sector also includes producers such as Jindal Aluminum Ltd., Manaksia Aluminum Co. Ltd., Gujarat Foils Ltd., P.G Foils Ltd., Global Aluminum, Banco Aluminum Ltd., Sapa India Ltd., Sacheta Metals, Hind Aluminum etc. The % usage of aluminum in different segments is illustrated below.

Figure 7: India's aluminum consumption in downstream sector-wise



The automotive sector will be the driver of aluminum consumption as India is one of the growing markets in terms of vehicle demand. Automotive Mission Plan (AMP) 20261, released by the Government of India and the Indian Automotive Industry in 2016, targets "a four-fold growth in the automobile sector in India" in 2026 vs. 2016, which will bring India to the top-3 global producers of passenger vehicles and small cars. There are significant import duties on the cars imported into India up to 100%. Such defensive import tariffs push automotive producer should increase local production of vehicles in India. Indian government is considering an option to further increase import duty on auto parts to boost local manufacturing2 , decrease the import and increase the export. The duty reduction in raw alumminium could lead costs reduction by whole value chain and improve competitiveness of Indian final products on external markets.

Automobile Exports Trends[3]

Export of total number of automobiles increased from 4,134,047 in 2020-21 to 5,617,246 in 2021-22, registering a positive growth of 35.9%. India aims to double auto industry size to INR 15 lakh Cr by 2024 end.

Category	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Passenger Vehicles	758,727	748,366	676,192	662,118	404,397	577,875
Commercial Vehicles	108,271	96,865	99,933	60,379	50,334	92,297
Three Wheelers	271,894	381,002	567,683	501,651	393,001	499,730
Two Wheelers	2,340,277	2,815,003	3,280,841	3,519,405	3,282,786	4,443,018

[1] https://www.siam.in/uploads/filemanager/47AUTOMOTIVEMISSIONPLAN.pdf
[2] https://auto.economictimes.indiatimes.com/news/industry/focus-on-localisation-else-govt-will-increase-import-duty-on-auto-parts-nitin-gadkari/81205738?redirect=1
[3] https://www.siam.in/statistics.aspx?mpgid=8&pgidtrail=15

Quadricycles	1,556	1,605	4,400	5,185	3,529	4,326
Grand Total	**3,480,725**	**4,042,841**	**4,629,049**	**4,748,738**	**4,134,047**	**5,617,246**

1.3.2.1 Potential of Aluminum Downstream Sector

Aluminum is considered a strategic sector due to criteria like:

- high linkage effect
- high market potential
- high technological intensity
- high value addition

Non-ferrous metals have a strong output and employment multiplier effect (backward and forward) on other key sectors. Aluminum has forward linkages with such strategic sectors like aviation, defense, auto, electricity, construction, packaging, machinery, marine etc. and backward linkages with mining, chemical industry, power, machinery.

The growth of the aluminum industry can be attributed to its widespread application in major spheres of economic activities including infrastructure, construction, power, packaging, consumer durables and automotive. Some major sectors and their growth plans are listed below:

Key end-use segments and rationale for usage of aluminum:

• Power:

Aluminium is used in overhead conductors of transmission lines, transformer coils, bus bars and foil wraps for power cables, etc. This usage is primarily driven by a favorable strength to weight ratio, better conductivity and lower costs compared with copper. Owing to these properties, the power segment was estimated to account for the highest share of aggregate aluminum volumes (both primary and secondary) at about 30-35% in fiscal 2022. The increase in industrial development, rapid urbanization and infrastructure developments as well as government initiatives for electrification of villages has resulted in healthy growth in the sector. Further growth of aluminum demand will be driven by such government's initiatives as the "Make in India" scheme, "Smart Cities" program, 100% rural electrification. The Government's move towards Aatmanirbhar Bharat is expected to aid the sector through increased focus on enhancing the solar power capacity in India, imposing the basic customs duty with effect from April 2022 on both solar modules/panels and solar cells. If such a move leads to local manufacturing increases, it will stimulate an increase in aluminum demand from solar panels.

Demand from the power segment accounted for 53-55% of total primary aluminum volumes in fiscal 2022.

- Automotive:

Aluminium is extensively utilized in both passenger and commercial vehicle segments due to its intrinsic characteristics and properties. Use of aluminum, instead of steel, enhances performance, safety, fuel efficiency and durability, and also provides many environmental benefits. Aluminium reduces the total weight of vehicles and light-weight vehicles reduce energy consumption and emissions considerably. Within the automotive space, aluminum is used in engine components, gearbox, brake casings, radiators, cylinder heads, transmission housing, wheels, window frames and panels, etc. Aluminium intensity in automobiles manufactured in India is much lower than the global average. Thus, improvement in aluminum demand is expected in the subsequent years, primarily driven by increased intensity of usage within the sector.

EVs could also prompt a shift in the material composition of vehicles. Light weight requirements to improve the efficiency of EVs would mean a greater proportion of plastics and aluminium in them than petrol and diesel vehicles, resulting in an inevitable increase in aluminium demand in this sector.

- Building and construction (B&C):

Aluminium is widely used in building and construction due to its intrinsic properties of lightness and corrosion resistance. It is used for making of windows, door frames, roofing, partitions, false ceilings and other building hardware. Extrusion and aluminium flat rolled products (FRPs) are mainly used in the building and construction sector. Aluminium's light weight lowers the load on any construction, while the metal's strength lends durability. The weight of aluminium structures is one half to two-thirds the weight of steel structures. By weight, aluminium also is lighter than reinforced concrete structures with the same bearing capacity. Its resistance to corrosion protects structures, especially those being built in regions with extreme weather conditions. The share of B&C volumes in total primary and secondary aluminium was 15-17% and 21-22%, respectively, in fiscal 2022. Typically, premium real estate players rely more on primary aluminium for their requirement. The sector witnessed a slowdown for a few months due to unavailability of manpower amid Covid 19. The government's push to build smart cities, coupled with the growing trend of high rises has encouraged a greater concern for environmentally friendly construction where aluminium can fit into potential applications such as fenestration, facades, curtain walling, structural glazings, roofing and cladding.

- Consumer durables:

Aluminium is used in appliances such as refrigerators, washing machines, air conditioners (ACs), etc. The penetration is high in appliances such as ACs and washing machines. Low weight, thermal efficiency, corrosion resistance, and non-reactivity to chemicals favour the use of aluminium in this segment. However, low quality scrap with high lead content and presence of radioactive particles is particularly dangerous in consumer durables and can cause serious problems in electrical equipment. The demand from consumer durables for primary and secondary aluminium volumes is estimated to be 7-8% and 6-7%, respectively, in fiscal 2022.

• Packaging:

The metal is non-toxic, so aluminium foil used to wrap foods does not contaminate them. Aluminium foil offers 100% protection against light, moisture, oxygen and other gases as well as against microorganisms and bacteria. Most common applications within the segment include personal care products, pharmaceuticals, processed foods (soft drink cans), containers and bottle caps. Laminated aluminium pouches (aseptic or retort pouches) are used to pack food products such as biscuits, confectionery, butter, oil, and beverages. Aluminium FRPs have a wide- range of applications in the packaging segment. In India, the penetration of aluminium in the packaging segment is lower than global averages owing to high costs. There could be a potential boom in the packaging sector with growing health consciousness given aluminium's hygienic properties and the boom in pharmaceutical industries. As of fiscal 2022, the demand from the packaging segment for primary and secondary aluminium volumes is estimated to be 8-9% and 8-10%, respectively.

1.3.2.2 Challenge faced by Indian Aluminum Downstream Industry

The capacity of the Indian downstream industries has not been well documented like its primary counterparts. This section will disclose the main issue that influences the development, profitability and competitiveness of the downstream sector.

High cost of unwrought aluminum used in the production of value-added aluminum products:

The price for unwrought aluminum is key for the competitiveness of the Indian aluminum downstream industry. Currently, the main problem that Indian downstream faces is the **over-pricing of the primary aluminum** for the production of value-added products.

Domestic primary producers trade their products in India at import parity taking import duties, namely they include 7.5% as BCD (Basic Custom Duty) as well as 0.75% (10% of the BCD) as social welfare surcharge in the price while selling the primary aluminum to the downstream sector producers. As a result, Indian import tariff provides the primary aluminum producers with additional revenues, while downstream producers overpay for the raw material and carried overspending.

In 2022, downstream aluminum producers in India overpaid the sum in amount of approx. 470 million USD in favor of primary aluminum producers, thereby supported profitable and successful smelters instead of investing to their own production development.

The downstream manufacturers in comparison to smelters produce value added products being under the pressure of buying primary aluminum at import parity prices that is one of the major causes for the decline of their revenues.

The calculation of overpayment is based on a) price on unwrought aluminum at London Metal

Exchange (LME) as the international benchmark; b) local Indian premium; c) import tariff; d) exchange rate of INR/$; e) cost & freight charges and f) amount of aluminum sold in India/year.

With regards to the mentioned criteria, the following data are:

a) The average price in 2022 at London Metal Exchange (LME) was **USD 2703**.
b) Local premium USD 25 which leads to **USD 2728.** *India does not have rating agencies (like Bloomberg) which determine regional premiums, and local produces add USD 20-30 per ton. We took an average USD 25.*
c) Import duty on unwrought aluminum 8.25% (7.5% basic tariff + 0.75% of social welfare surcharge) constituted USD 225 per ton = **USD 2954**
d) C&F charge in USD 36/ Ton resulted in **total price USD 2990**
e) Primary Aluminum Tonnage sold to domestic consumers was ~1.8 million tons.

That means 1.8 million tons multiplied by USD 226 of import duty ~ USD 420 Million.

In 2022, the overpayment amounted to USD 420 million approx.

However, the calculation of the exact amount is not the main thing; it will fluctuate depending on the changing market data. The main principle of importance here is the existence of import tariff on primary aluminum that provides opportunity to raise prices for domestically sold aluminum.

This tendency of gains of the primary producers at the expense of downstream producers is always there and varies yearly depending on the LME.

The majority of the production cost of finished aluminum products produced by the downstream sector is that of the primary aluminum that constitutes up to 60% in production costs of aluminum value added products. Hence, these products become uncompetitive in the domestic as well as the foreign markets.

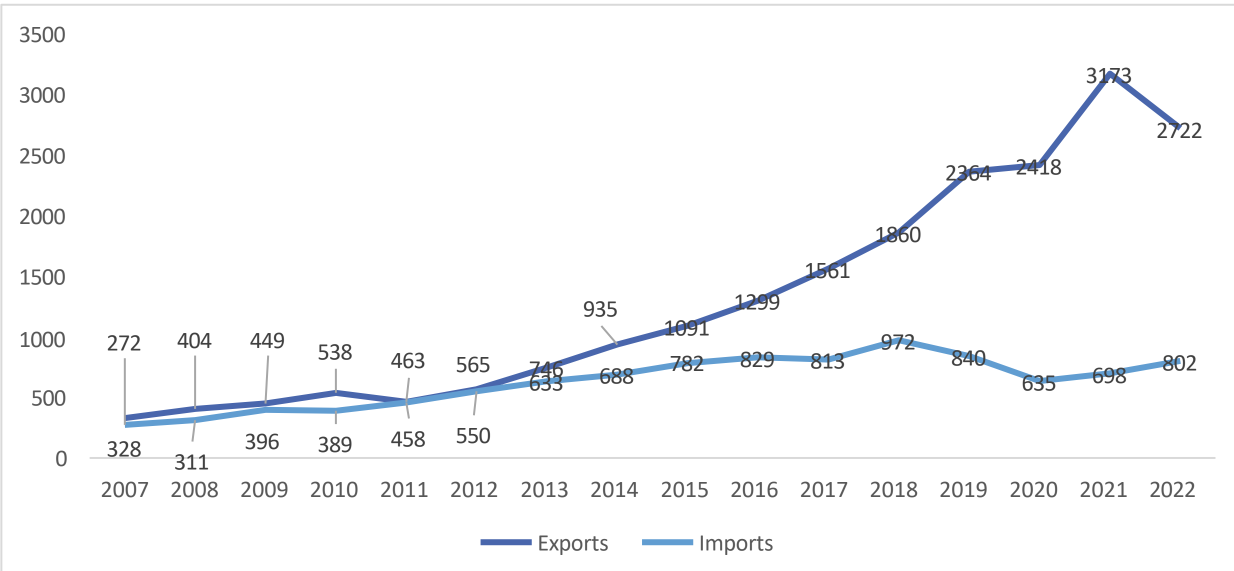
Moreover, downstream sector provides almost 1 million jobs in India and supports urbanization and infrastructure development, while the price disparity eventually threatens lakhs of job in the sector, technological and innovation novelty. Thus, ruining of value adding segments jeopardizes the whole economy.

The only effective solution and way to support the downstream industry is the reduction of raw material price achieved by means of removing import tariffs on primary aluminum.

1.4 Assessment of Trade Structure of Indian Aluminum Industry

India is a net exporter of aluminum and articles thereof[14] where exports and imports both are increasing rapidly from the last decade as shown in Figure 8. Exports have increased at CAGR of 15% and imports have increased at CAGR of 7.5% from 2007 to 2022[15].

Figure 8: India's Trade of Aluminum and Articles Thereof, Thousand Tons (HS:76, excluding 7602)



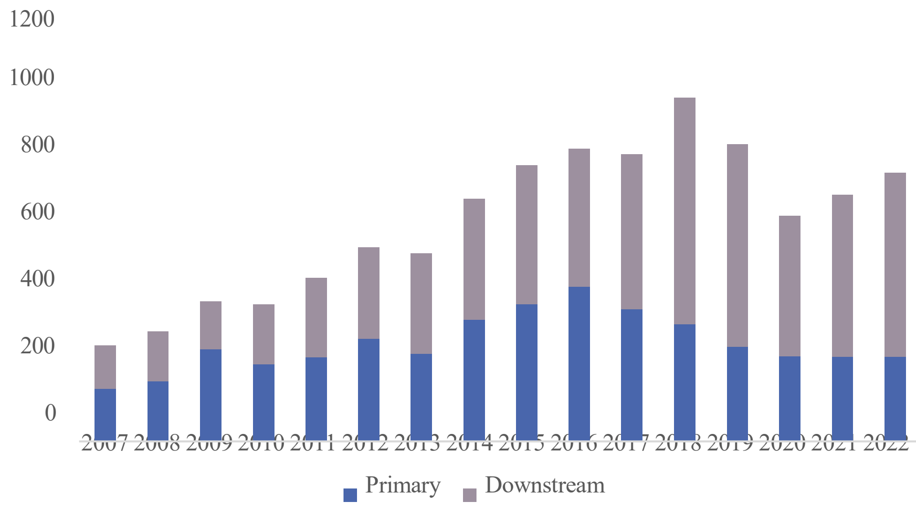
Source: ITC Trade Map, Ministry of commerce and industry of India

As imports are also increasing, it is necessary to specify the group of products that have contributed to this growth. HS codes of 76 group are segregated at 4 digit-level for the analysis, where 7601 is in the category of unwrought primary aluminum sector and HS codes from 7603 to 7616 are in the category of downstream aluminum sector.

We can observe the trend and share of import of primary and downstream sectors in Figure 9. Imports are increasing but the import share of unwrought primary aluminum is decreasing whereas that of the downstream aluminum sector is increasing though there was a slight drop in 2018 but is on the rise again in 2022.

[14]Aluminum waste and scrap (HS:7602) is excluded from the analysis.
[15]Reference period of year 2011 to year 2022 has been taken as Free Trade Agreements with the major trading partners like ASEAN countries, South Korea, and Japan etc. were signed in 2010 and 2011 and to assess the performance post-signing of these FTAs.

Figure 9: Sectoral Share in India's Imports of Aluminum and its products (In **Thousand Tons)**



Source: ITC Trade Map, Ministry of Commerce & Industry of India

According to the Ministry of Commerce & Industry of India and ITC data, imports of the primary aluminum sector which correspond to HS code 7601 were 439 thousand tons in 2016 that decreased to 258 thousand tons in 2022 expressing the drop equaled to - 41%. However, export of primary aluminum from India for the same period has more than doubled (from 1 million tons in 2016 up to 2.6 million tons in 2022).

On the other hand, imports of the downstream aluminum products since 2016 has been steadily growing from 391 thousand tons in 2016 up to 529 thousand tons in 2022, increasing up to 35% despite the decrease in 2020 due to covid-19 lockdowns and disruptions.

It is noteworthy that imports of the primary aluminum decreased and that of downstream sector have experienced increasing trend as the share of downstream aluminum products imports have increased quite fast.

Policies like increase in import duties and introduction of trade measures have not helped. The key reasons are deep and systemic difficulties faced by the downstream sector in India, the main of which is expensive raw material for their production, namely primary unwrought aluminum available in domestic Indian market at a price artificially raised by Indian aluminum smelters that includes the quantum of import duties on primary aluminum in the pricing of the metal.

Solution: Abolishment of import duty on primary aluminum will reduce prices for the Indian downstream, which will then be more competitive, earn more and develop its capacity.

1.5 Country-wise Analysis

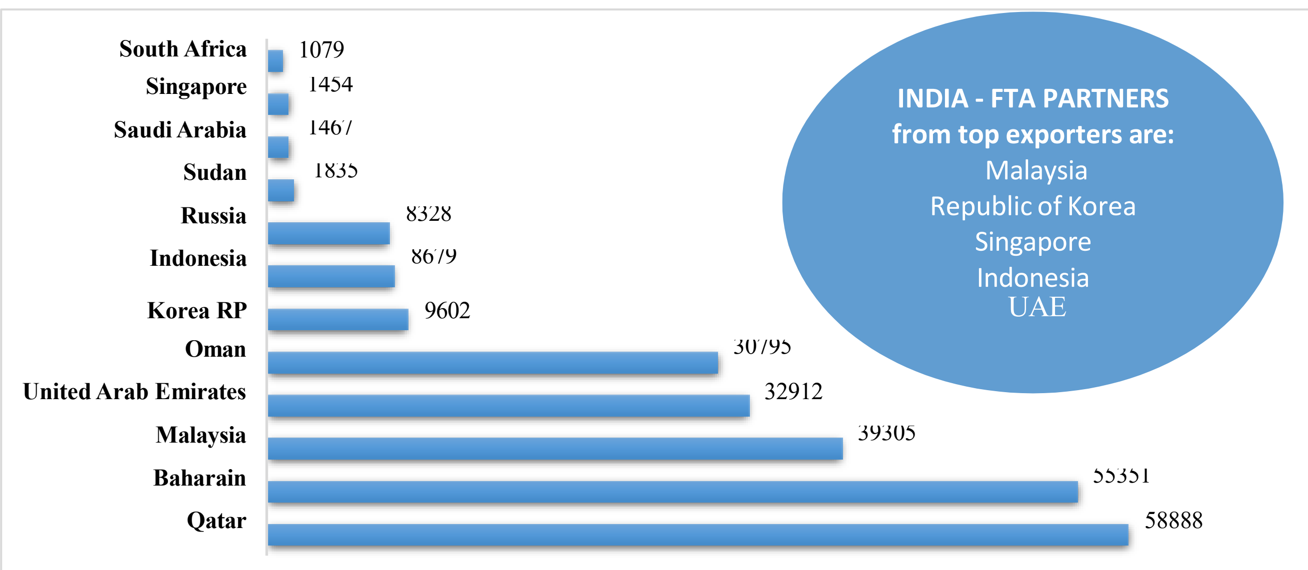
Unwrought primary aluminum is imported from many countries to India. In Figure 10 and Figure 11 the country-wise imported quantity of primary aluminum by India is shown. In 2022 the import structure to India has significantly changed compared to 2021. Currently, the top 5 exporting countries of primary aluminum are Qatar, Bahrain, Malaysia, UAE, Oman and Republic of Korea. Imports from the Russian Federation has decreased and shifted it from the 5th place to the 8th with a share of 3%.

The study has been done from 2011 till 2021 as this constitutes the period of fast changes in aluminum usage, imports and exports of primary aluminum and the dynamics of the trade.

Figure 10 shows that Qatar increased its volumes and supplied the highest volume of primary aluminum to India in 2022. Its share in unwrought primary aluminum imports has increased from 18% in 2011 to 23% in 2022 as well as Bahrain that increased its share from 6% to 21% for the same period.

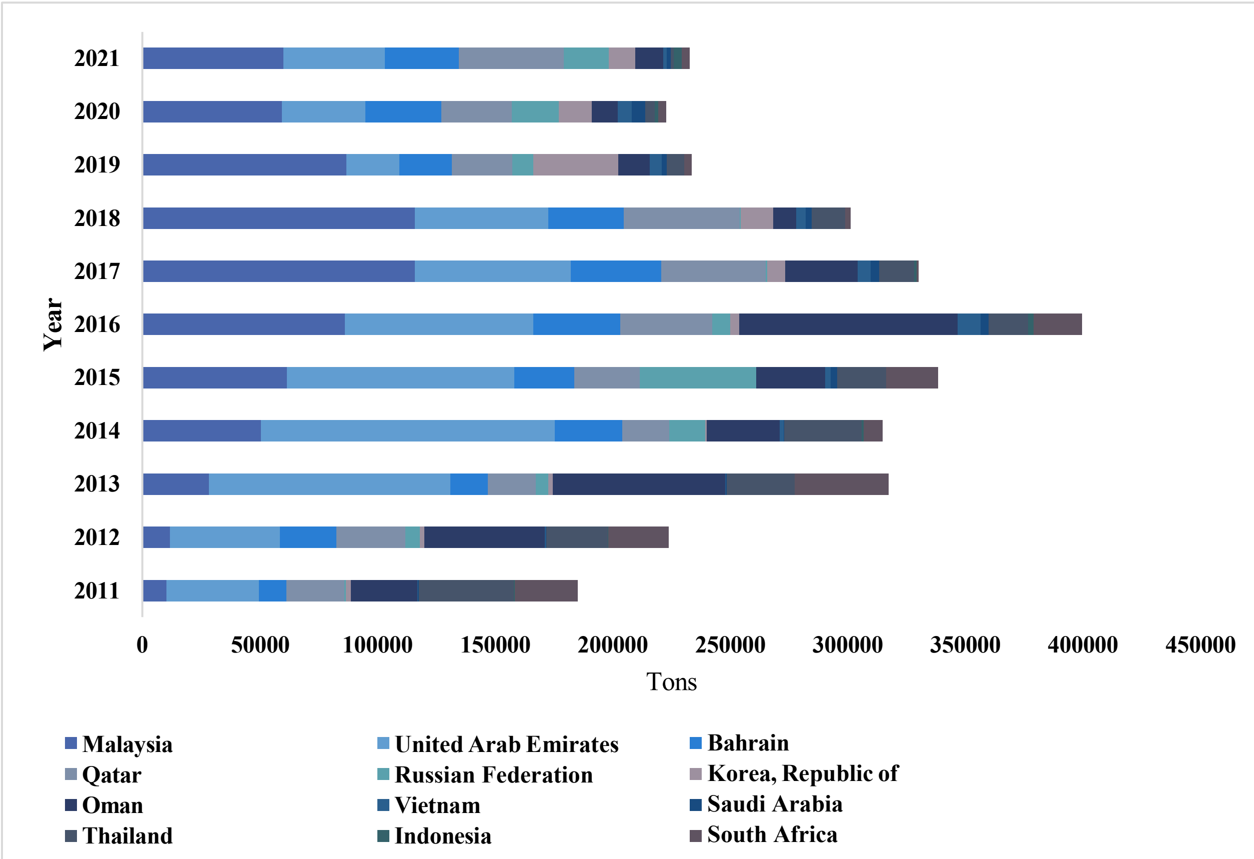
Malaysia was squeezed to the third place with the share of 15% in 2022 though saving the 3rd place among top exporters. UAE and Oman have always been able to hold a good share in India's imports of unwrought aluminum. Russian Federation, on the other hand, has decreased its imports and shifted from the 5th place to the 8th among top exporters with a share of 3% in 2022 compared to 8% in 2021 but still is higher than in 2011 with the share of 0.2%.

Figure 10: Top Exporting Countries of Primary Aluminum to India in 2022 (Tons)



Source: Ministry of commerce and industry trade data

Figure 11: Top Exporting Countries of Primary Aluminum to India in 2021 (Tons)



Source: ITC Trade Map

India's major trading partners are subtly different from the top major exporters of unwrought primary aluminum to the world. In Figure 12 countries mapped with red and beige color are top exporters of primary aluminum in the world, under which Canada, United Arab Emirates (UAE), Russian Federation, India, Australia and Bahrain top the list. Out of these countries, only the UAE, Bahrain and Russia account for a reasonable share in India's imports of primary aluminum. This is explained from geographical point of view, but from economic and ecological perspective, they should be taken into account also. UAE India FTA newly concluded will help in increasing ties with India.

India is among the top exporters of unwrought primary aluminum to the world. However, India's primary aluminum production is costly due to high electricity tariff and partly inefficient thermal generation of power (most of the power plants are coal based and have a high cost per kwh generation). They also have a high carbon footprint.

Figure 12: Major Exporters of Unwrought Aluminum in the World in 2022

Source: ITC Trade Map

There are several countries where the aluminum production is based on hydropower among which are Iceland, Canada and Russia.

The primary aluminum producing country with one of the most effective costs of production among top exporters is the Russian Federation and what is more important than the current market challenges is that the Russian Federation produces aluminum based on clean renewable energy of hydropower stations which reduces the primary aluminum's carbon footprint that remains lower throughout the entire production chain, up to the final product[16]. Due to its geographic position, the Russian smelters are located closer to South-Asian Region including India.

Analysis of Import Tariffs and Effective Rate of Protection ERP) in the Indian Aluminum Industry

1.6 Introduction

The effect of the tariff structure is very important concerning the competitiveness of producing and selling firms. It is expected that high tariff wall on the final products would give protection to the downstream sector and this, in turn, would improve the efficiency of the domestic supply chain. However, since the last 10 years, India has negotiated and implemented different trade agreements (FTAs) in various forms.

Overall, the Most Favorable Nation (MFN) as well as Free Trade Agreement (FTA) tariff rates have come down drastically across the sectors as India is a signatory of World Trade Organization (WTO).

There is an apprehension that a large number of final goods have slipped into the country due to the significant tariff cut under FTAs but duties on intermediate goods are still relatively higher. This anomaly has affected the competitiveness of the final goods producers domestically as they need to compete with cheaper foreign commodities especially from East and Southeast Asia.

It is hypothesized that the situation is further worsened as raw materials, intermediate and final goods are coming from different countries through different trade agreements routes. This may be because tariff reduction schedules have different pace under different FTAs/Comprehensive Economic Partnership Agreements (CEPAs) that has created an uneven situation providing an extra advantage to imported final goods.

This problem is technically described as a situation of 'inversion' of tariff structure. The high excise duties and the pressures of import competition on many of the final goods can stand in the way of correction to this inversion. The current chapter attempts to understand the extent of the inverted duty structure in the Indian aluminum industry through the analysis of tariffs.

1.7 Inverted Duty Structure (IDS) and Effective Rate of Protection (ERP)

An inverted duty structure can make Indian manufactured aluminum goods uncompetitive against finished product imports in the domestic market. Under an inverted duty structure, finished goods are taxed at lower or same rates as raw materials or intermediate products and thereby discourage domestic value addition. There are many manufactures like capital goods, chemicals, electronics, textiles and tires, which are subject to duty inversion. One of the reasons for duty inversion could be regional/bilateral FTAs with countries like Japan, South Korea, ASEAN, etc.

Electronic items like desktops and notebooks have lower duty than their key components, stainless steel products enjoy lower duty under India-Japan CEPA while raw materials have a higher duty, brass products under FTA with some Asian countries have zero duty while raw materials like brass, scraps have positive customs duty, tractors imported from Japan having a concessional duty while

This problem of the inverted duty particularly affects the downstream sector since they are more labor-intensive and have high material to output ratios. For several aluminum product lines, the existing tariff regime results in higher import duty on raw materials/intermediates vis-à-vis that on finished products. This adversely affects domestic manufacturers of finished products denting value addition in industries concerned. However, it is often not recognized that the inverted duty structure is harmful only if it leads to a reduction in the effective rate of protection (ERP) and as such an inverted duty structure does not necessarily imply that the ERP has fallen.

The ERP is an indicative measure of the impact of protection on a nation's domestic producers. It gives the percentage increase in domestic value-added over the free-trade level, an increase made possible by the country's tariff structure. Value added is the difference between the total value of goods produced and the value of imported inputs. In other words, ERP of product is defined as the difference between its value added (per unit of output) at a domestic price, (i.e., inclusive of tariffs on the finished product and the intermediate inputs) and its corresponding value added at world price (i.e., price prevailing under free trade).

When an import-competing industry utilizes intermediate products imported from outside, the precise degree of protection is captured by the ERP accorded to value-added in production, not the nominal rate imposed on the finished product. While the nominal tariff rate is important to the consumers because it indicates how much the price of the final commodity increases due to the tariff, the ERP is provided by the domestic processing of the import-competing goods.

It is difficult to estimate the share of imported components as a percentage of the value of the final good in the absence of a detailed sector-wise input-output table. In absence of this data, we have assumed that there is little change in the share of inputs in final value-added so that we can look, as a first approximation, only at tariff changes on commodities.

In the next section, general tariff rates and preferential tariff rates have been discussed following which the Effective Rate of Protection has been calculated for the Indian aluminum industry for different years.

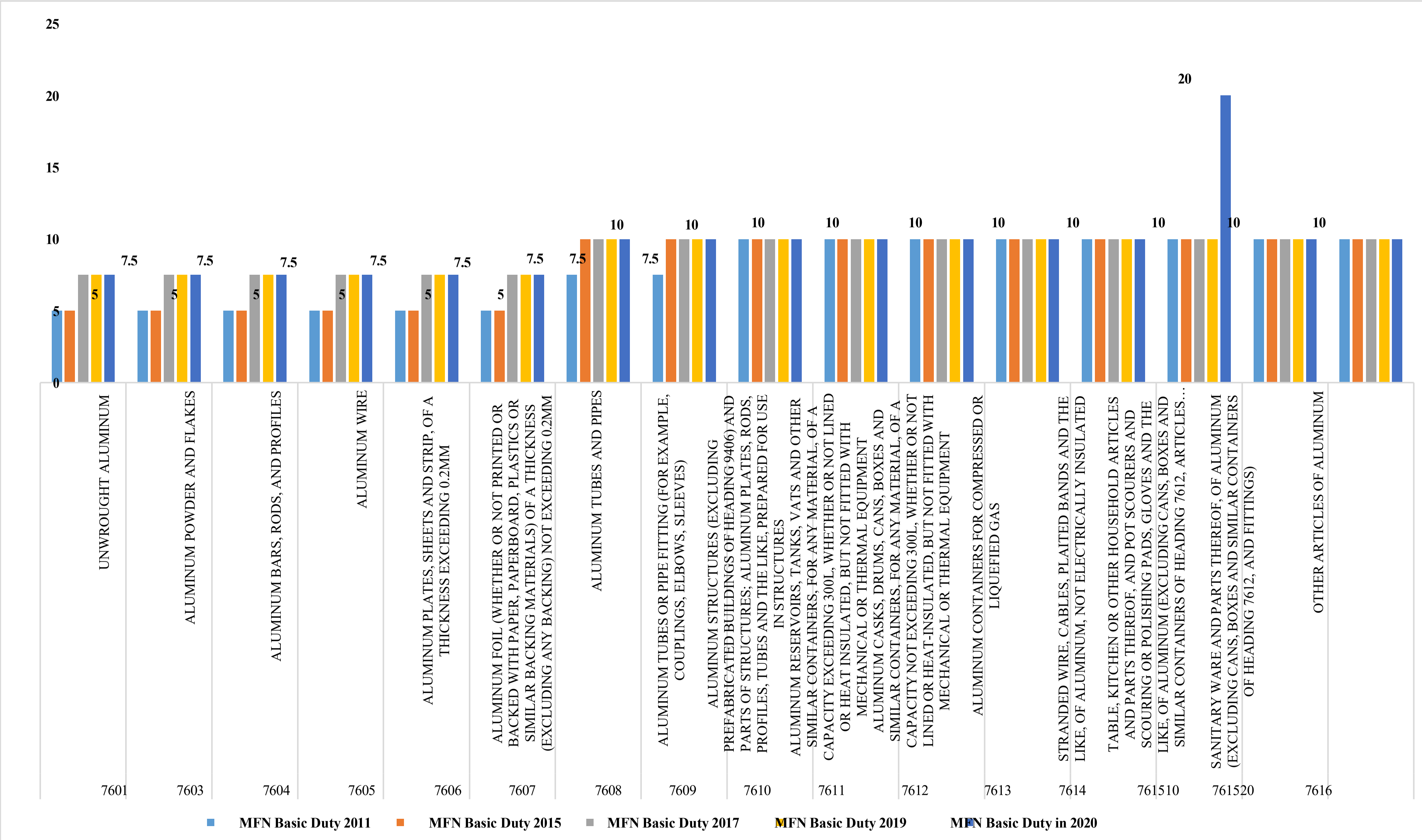
1.7 Indian Tariff Scenario

1.7.1 General Tariff Rates

Basic duties at 4-digit HS code level have been analyzed. For the analysis, five years are taken 2011, 2015, 2017, 2019 and 2020. In 2011 and 2015, primary unwrought aluminum had basic duty of 5% which increased up to 7.5% in 2016 (Indian Budget 2016-2017) and remains at 7.5 % level till 2020. A similar increase in the basic duty was seen for aluminum powder and flakes; bars, rods and profiles; wire; plates, sheets and strip as well as for aluminum foil (HS: 7603 to 7607) in 2016 and remains the same until 2022.

For HS codes 7608 and 7609, 7.5% was basic duty rate in 2011 that was increased up to 10% in 2011 and remains 10% in 2020. For 7610 to 7616, basic duty has been 10% in all the five years and currently remains at the same level except for HS:761510 i.e. table, kitchen or other household articles and parts thereof, and pot scourers and scouring or polishing pads, gloves and the like, of aluminum (excluding cans, boxes and similar containers of heading 7612, articles of the nature of a work implement, spoons, ladles, forks and other articles of heading 8211 to 8215, ornamental articles, fittings and sanitary ware) on which basic duty got increased to 20% in 2020.

Figure 13: Basic Import Tariff Structure of Aluminum and its Products over the years (2011-2015-2017-2019-2022)



Source: Big' s Easy Reference Customs Tariff (Imports) Different Editions written by Arun Goyal, https://www.cbic.gov.in/

Table 1: India's Current Aluminum Import Tariff Structure in 2022

Aluminum Tariff Structure	Basic Duty Rate (%)
From unwrought aluminum (HS: 7601) to foils (HS:7607) excluding aluminum waste and scrap (HS:7602)	7.5
From aluminum tubes and pipes (HS: 7608) to other articles of aluminum (HS:7616) except HS:761510	10
Table, kitchen or other household articles and parts thereof, and pot scourers and scouring or polishing pads, gloves and the like, of aluminum (excluding cans, boxes and similar containers of heading 7612, articles of the nature of a work implement, spoons, ladles, forks and other articles of heading 8211 to 8215, ornamental articles, fittings and sanitary ware) (HS:761510)	20

Source: Big's Easy Reference Customs Tariff (Imports) Different Editions written by Arun Goyal, https://www.cbic.gov.in/

Thus, in general, primary unwrought aluminum has a same or lower basic duty rate as compared to final aluminum products. However, the situation is quite different when we look at the preferential rates as given in the next section.

1.7.2 Preferential Tariff Rates

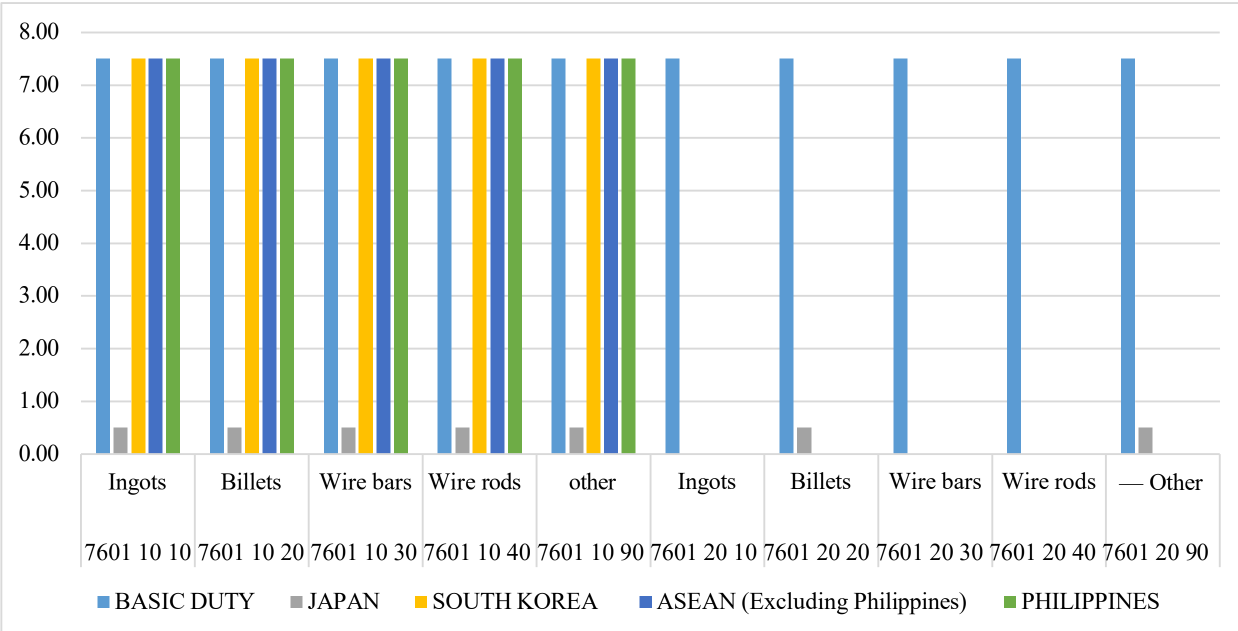
India enjoys few existing FTAs and CEPAs with East and South-East Asia like AIFTA (ASEAN-India FTA) signed in 2011, CEPA with Japan signed in 2011 and CEPA with South Korea signed in 2009.

South Korea and ASEAN (including the Philippines) countries enjoy preferential or zero duties on all aluminum products while exporting to India except for plates, sheets and strip, of non-alloy aluminum, of a thickness of > 0.2 mm, square or rectangular excluding (HS:760611). For Japan also, the preferential rates are very low.

As the duties for unwrought aluminum differ at 8-digit HS Code level, analysis for it is done at 8-digit. Basic tariffs on unwrought aluminum imports with MFN, FTA and CEPA countries for 2020 are provided in Figure 18.

Basic duty is 7.5% but for Japan, it is as low as 0.5% to 0% in some of the cases. For South Korea, ASEAN and Philippines, it is 7.5% for HS codes under 760110 and 0% under 760120.

Figure 14: Primary Aluminum Import Tariffs in 2022: with FTA Partners



Source: Big's Easy Reference Customs Tariff (Imports) Different Editions written by Arun Goyal, https://www.cbic.gov.in/
** Missing bars imply zero duty

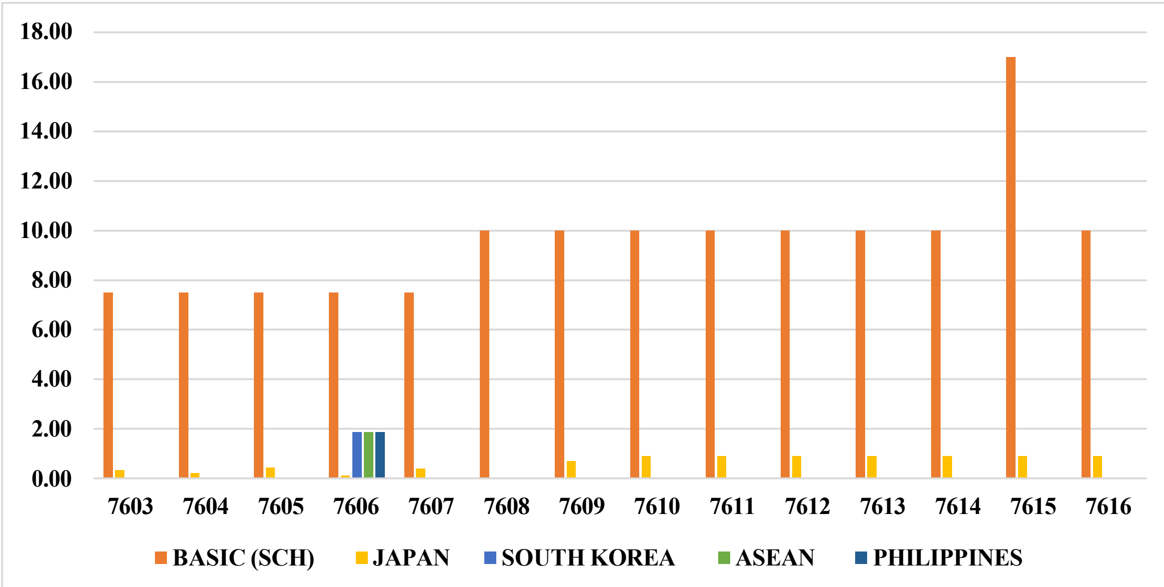
Average basic tariffs on downstream aluminum products with MFN, FTA and CEPA countries for 2022 are provided in Figure 15.

Average Basic duty on tariff lines HS codes 7603-7607 is 7.5%. However, in respect of South Korea, ASEAN and Philippines, the 0% is applied except for aluminum plates, sheets and strip (HS:7606) which faces a duty of 1.88%. Japan also enjoys rather low average duties on these group of products as can be seen in Table 2 below.

The average basic tariff rate on products ranging from HS: 7608 to 7616 is 10% except for 7615 for which it is 17% in 2022. However, the preferential duty which ASEAN, South Korea and Philippines enjoy is 0%.

Japan enjoys a duty of 0% on aluminum tubes and pipes (HS:7608), 0.70% on aluminum tube or pipefittings (HS:7609) and duty of 0.90% on the remaining downstream sector products on an average.

Figure 15: Downstream Aluminum Average Import Tariffs in 2022: with FTA Partners



Source: Big's Easy Reference Customs Tariff (Imports) Different Editions written by Arun Goyal, https://www.cbic.gov.in/

** Missing bars imply zero duty

In Table 2 below, it can be observed that in normal cases, the basic duty on raw materials have same or lower import tariff rates than the final products. This is also true for Japan (except for few products) though the duties are low for both primary and downstream products.

However, in the case of South Korea, ASEAN and Philippines, HS code 760110 is imported at a duty higher than that for the final products. This represents an inverted duty structure with these countries.

Table 2: Import Tariffs on Aluminum and its Products in 2022: Basic Duty and Preferential Duties with Major FTA Partners

	HS CODE	BASIC (SCH)	JAPAN	SOUTH KOREA	ASEAN	PHILIPPINES
Raw Material	7601 10	7.5	0.5	7.5	7.5	7.5
Raw Material	7601 20 10	7.5	0	0	0	0
Raw Material	7601 20 20	7.5	0.5	0	0	0
Raw Material	7601 20 30	7.5	0	0	0	0
Raw Material	7601 20 40	7.5	0	0	0	0
Raw Material	7601 20 90	7.5	0.5	0	0	0

Final Product	7603	7.5	0.33	0	0	0
Final Product	7604	7.5	0.22	0	0	0
Final Product	7605	7.5	0.43	0	0	0
Final Product	7606	7.5	0.13	1.88	1.88	1.88
Final Product	7607	7.5	0.41	0	0	0
Final Product	7608	10	0	0	0	0
Final Product	7609	10	0.7	0	0	0
Final Product	7610	10	0.9	0	0	0
Final Product	7611	10	0.9	0	0	0
Final Product	7612	10	0.9	0	0	0
Final Product	7613	10	0.9	0	0	0
Final Product	7614	10	0.9	0	0	0
Final Product	7615	17	0.9	0	0	0
Final Product	7616	10	0.9	0	0	0

Source: Big's Easy Reference Customs Tariff (Imports) Different Editions written by Arun Goyal, https://www.cbic.gov.in/

Table 3: Imported Quantity of Aluminum Products from Major FTA/ CEPA Partners (Tons)

Country Name	**2011**		**2015**		**2017**	
	Primary	**Downstream**	**Primary**	**Downstream**	**Primary**	**Downstream**
Japan	1456	3896	132	3784	263	2728
Korea, Republic of	2379	26705	0	42053	7693	46896
Malaysia	10180	5515	61573	25523	116093	36478
Thailand	40515	3904	20865	7181	14879	10832
VietNam	338	253	2321	220	5491	222

Total	**54868**	**40273**	**84891**	**78761**	**144419**	**97156**

Country Name	2019		2020		2021	
	Primary	Downstream	Primary	Downstream	Primary	Downstream
Japan	1371	2581	400	1744	336	1795
Korea, Republic of	36061	40707	13904	32326	11,165	52604
Malaysia	86825	81428	59505	42075	60020	30153
Thailand	7552	29249	3917	31983	1159	43,053
VietNam	5100	74	5817	188	1529	219
Total	**136909**	**154039**	**83543**	**108316**	**74209**	**127824**

Source: ITC Trade Map

The 2019 data show that imports of primary unwrought aluminum have more than doubled and that of downstream products have more than tripled during the last few years from the major FTA/CEPA countries given in Table 3. The supplies of downstream products have increased from 40273 Tons in 2011 to 127824 Tons in 2021. Year 2020 has seen a decline in both primary and downstream aluminum import as a result of the coronavirus pandemic.

Significant increase of imports has happened in the primary aluminum due to imports from Malaysia and South Korea. In the case of downstream products, the imports are rising significantly from Malaysia, South Korea and Thailand. However, in the complete basket of downstream products import into India, countries with FTA do not account for a major share.

1.8 ERP Calculations for Indian Aluminum Industry

The Effective Rate of Protection (ERP) is calculated for final products by taking into account the tariff rate of raw material i.e. primary aluminum and its share in the production process which is 60% as derived from Supply-Use table of India.

In Table 4 below, it can be observed that the ERP for the final products under FTAs is less than under Basic duty without FTA. ERP has declined a lot from 2011 to 2020 under the Free Trade Agreements, in fact reaching a negative rate under FTAs with ASEAN (inclusive of Philippines) and South Korea.

ERP for our final goods industries under Basic (SCH) increased in 2015 on account of increase in basic customs tariff of aluminum tubes and pipes (excluding hollow profiles) (HS:7608) and aluminum tube or pipe fittings "e.g., couplings, elbows, sleeves” (HS:7609) from 7.5% to 10% and in 2020 on account of increase in basic customs tariff of table, kitchen or other household articles and parts thereof, and pot scourers and scouring or polishing pads, gloves and the like, of aluminum (HS:761510) from 10% to 20%.

Table 4: ERP Calculation for Final Products (HS:7603 to HS:7616) (%)

Based on Tariffs	2011	2015	2017	2019	2020	2021	2022
Basic Duty	12.05	12.26	11.14	11.14	13.30	13.30	13.30
India-Japan CEPA	11.98	7.59	4.21	2.11	1.03	1.03	1.03
India-ASEAN (Excluding Philippines) FTA	11.24	-3.03	-5.65	-5.65	-5.65	-5.65	-5.65
Philippines (Part of ASEAN)	11.55	3.29	-4.17	-5.65	-5.65	-5.65	-5.65
India-South Korea CEPA	12.00	1.05	-5.65	-5.65	-5.65	-5.65	-5.65

Source: Authors' Calculations, Supply-Use Table

This implies that imports from ASEAN and South Korea are particularly affecting the domestic downstream industry. The situation is linked to the existing problems in the sector, which leads to the incapacity of national companies to provide the required amount and quality of production. Many reasons exist for that as mentioned below:

- Firstly, a significant part of the current capacity is not assisted by modern machinery/technologies that makes it difficult to increase the output of products that comply with the standards of the market quality.
- Secondly, a stable system of product distribution is lacking due to economic recession in general and low solvent demand, as well as due to lack of widespread information, meaning that the end consumer and the producer simply never 'connect'.
- Thirdly, a high production cost, lowers the competitive edge of the Indian products compared to deliveries from China, for example, coming into India via FTA countries.
- Weak domestic downstream sector loses competitiveness on the home market in comparison with imported products and cannot compete on external markets with equivalents produced in more favorable economic conditions.

1.9 Future of the Indian Aluminum Industry

"Non-competitive energy costs and acute coal shortage for the industry have adversely hit the sustainability of the whole aluminum industry[4]", Rahul Sharma, co-chairman of FICCI Committee on Mining and Minerals, said in a press statement.

India's electric power sector is highly inefficient today. State-owned distribution utilities and power plants have long-term contracts that lock them into transacting with each other; existing markets for day-ahead and real-time electricity trading are tiny and often illiquid. The creative tenders in early 2020 (i.e., 1.2 GW of renewable energy projects with storage that could reliably meet power demand during morning and evening hours and another tender for 400 MW of "round-the-clock" renewable energy) are just the first steps for India to continue its transition to renewable energy. Large and efficient markets will be required by India to efficiently integrate huge quantities of renewable energy and harness conventional power plants to operate flexibly and compensate for intermittent renewable sources of power. India will need to invest in beefing up the transmission grid to prepare for an influx of new renewable energy capacity over the coming years[5].

Over the last decade, India's government had the luxury of focusing mostly on adding solar and wind energy capacity as fast as possible. The next phase will require deep structural reforms to create a cleaner, more flexible, and more efficient power system which will be a very long and expensive process.

Keeping these things in mind, it would be essential to increase the production of aluminum using an adequate, reliable, viable, environment-friendly and efficient source of import for the primary unwrought aluminum.

As mentioned earlier, even though countries all around the globe have aluminum smelters, only some of them produce primary aluminum with low-carbon footprint. Russia is one of the world largest producer of low carbon aluminum that majorly relies on hydropower generation and permanently focuses its efforts on improving the lowest aluminum carbon footprint through enhancing new top-notch technologies. Due to the hydro-based electricity that is used for electrolytic reduction of alumina, the primary aluminum and value added aluminum products from Russian aluminum companies are unique from an environmentally friendly production viewpoint. Every shipment of Russian low carbon aluminum comes with a traceable, verified carbon-footprint statement from the smelter of origin, which implies that customers can be guaranteed that the product contains less than 4 tons CO2 per ton of aluminum (direct and indirect energy emissions from aluminum smelters), which is 4 to 5 times lower than the CO2 footprint of aluminum produced from a coal-based smelter.

Currently India and Russia are engaged in discussions concerning a Free Trade Agreement (FTA) between India and the Eurasian Economic Union (EAEU), which consists of 5 more countries with Russia among its members. Such FTA will provide excellent opportunities for Indian aluminum downstream to get access to the high quality, low-carbon aluminum and significantly increase the competitiveness of Indian value-added aluminum products both domestically and abroad.

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4 https://www.ndtv.com/business/union-budget-2019-aluminum-producers-seek-import-duty-hike-2054223

5 https://www.aspeninstitute.org/blog-posts/the-next-phase-of-indias-renewable-energy-transition/

1.10 Scenario Building to get High Quality Primary Aluminum

India needs high-quality primary aluminum to help its downstream sector which is overpaying the domestic primary producers for a primary unwrought aluminum with high carbon footprint and hence, unable to compete with the imported aluminum products or access foreign markets. Low carbon primary aluminum can be imported by India at reasonable prices and then downstream sector will be able to produce good quality finished aluminum products competitive in the domestic as well as foreign markets. This is required for improving the performance of the Indian downstream aluminum sector.

We have performed a partial equilibrium model using SMART Analysis available under WITS to assess the impact of a tariff change on the imports of India by estimating new values for imports under the new tariff regime. It will help us to know the Trade Effect i.e., the change in bilateral flows which are split into creation, diversion, and price effects. Trade creation is calculated in SMART as the direct increase in imports attributable to a tariff reduction. Further, the model uses finite supply/export elasticity leading to the generation of price effect. This indirectly indicates how much the exporting country can increase the price in the importing country.

Russia has been taken as an example for the simulation studies due to the focus on increasing trade with Russia by the GOI, and also the low carbon footprint alloyed aluminum available from the far-east region of Russia.

Table 5 below contains the simulation results with three different scenarios of tariff reduction of unwrought aluminum to 5%, 2.5% and 0%. It is observed that imports rise from Russia as a partner in FTA with India. If tariffs reduce by 2.5% for Russia, imports of primary unwrought aluminum will increase by 9.25% and trade creation effect is more than trade diversion effect as 46.83 thousand USD is higher than 27.795 thousand USD. If tariffs reduce by 5% for Russia, imports of primary unwrought aluminum will increase by 18.5% and trade creation effect is more than trade diversion effect. And if tariffs reduce to 0% for Russia, imports of primary unwrought aluminum will increase by 27.75% and trade creation effect is more than trade diversion effect.

Table 5: Impact of Tariff Reduction of Unwrought Aluminum Imports by India from Russia

Partner Name	Product Code	Imports at Present Rate in 1000 USD	Imports at New Rate in 1000 USD	Imports Change in 1000 USD	Imports Change (%)	Price Effect	Trade Creation Effect in 1000 USD	Trade Diversion Effect in 1000 USD
	Reduction in tariffs from 7.5% to 5%							
Russian Federation	**7601**	839.011	916.625	77.614	9.25	1.493	46.834	27.795
Russian Federation	**760110**	691.477	761.235	69.758	10.09	1.342	44.364	22.711
Russian Federation	**760120**	147.534	155.39	7.856	5.32	0.151	2.47	5.084
	Reduction in tariffs from 7.5% to 2.5%							
Russian Federation	**7601**	839.011	994.212	155.201	18.5	2.985	93.667	55.564
Russian Federation	**760110**	691.477	830.989	139.512	20.18	2.683	88.728	45.418

Russian Federation	**760120**	147.534	163.223	15.689	10.63	0.302	4.939	10.146
	Reduction in tariffs from 7.5% to 0%							
Russian Federation	**7601**	839.011	1071.829	232.818	27.75	4.477	140.501	83.363
Russian Federation	**760110**	691.477	900.748	209.27	30.26	4.024	133.091	68.13
Russian Federation	**760120**	147.534	171.081	23.548	15.96	0.453	7.409	15.233

**Substitution Elasticity: 1.5 by default implying substitution among the exporting countries with respect to relative price change; Supply Elasticity: 50 i.e., finite export supply elasticity

Source: World Integrated Trade Solution (WITS) SMART Analysis

Chapter 2
Decarbonizing the Aluminum Industry: Short Term and Long-Term Goals

2.0 Introduction:

Aluminum is the most abundant and versatile metal important for both industrial and household products. It is one of the essential sectors for countries to modernize as the metal is lightweight, durable and infinitely recyclable. According to International Energy Agency (IEA), global aluminum demand is projected to grow at an average annual rate of 1.2% representing a 15% growth by 2030 as compared to 2020. This growth in demand is particularly due to factors such as increasing population, GDP growth as well as increased demand for specific aluminum-based materials including light weight vehicles, renewable energy technology and greater use in consumer goods packaging.

After the Paris climate agreement in 2015, about 192 nations of the world pledged to reduce their greenhouse gas emissions to keep global warming to 1.5 degree Celsius and below 2 degrees Celsius in the 21st century. India being a signatory of the Paris agreement has already taken action to cut down it's emissions and achieve net zero by 2070. Decarbonization of heavy Industries could be a crucial step towards the transition to a net zero economy. In this regard, aluminum plays a critical role in achieving a sustainable economy. Aluminum can reduce energy costs and carbon emissions in several applications for example coated aluminum roofs can reflect up to 95 percent of sunlight, intensely growing structure's energy efficiency (Roof India, 2020). In many advanced countries, aluminum is gradually substituting wood and steel in the building sector. Also, because of the increasing shift towards electric vehicles due to the low carbon initiatives, there is a growing demand for aluminum because of its light weight properties in making vehicles, renewable energy technology and in consumer goods packaging.

2.1 Aluminum Production Value Chain:

To understand the impact of decarbonization, let us see the aluminum production value chain again. The value chain involved in the aluminum industry comprises of various stages starting from the extraction of mineral raw materials to the production of intermediate and semi-finished products and final goods. It can be divided into 2 main segments:

2.1.1 The Upstream Segment:

The activities in this segment begin from the mining of bauxite ore which is an aluminum rich mineral in the form of aluminum hydroxide. This bauxite ore obtained by excavation is not always pure and treated additionally through crushing and washing etc to improve its purity. It is composed of about 25% aluminum. It is then dried and ground in special mills where a small amount of water is mixed into it. As a result of this process, a thick paste is produced which is collected in special containers and heated with steam to separate most of the silicon from bauxite. This procedure leaves behind a white powder called the metallurgical alumina (aluminum oxide) which is composed of about 50 percent aluminum and is popularly named as the Bayer process. The next process involved is that of electrolytic reduction of alumina. Figure 16 below describes the Bayer process of processing the aluminum ore (bauxite) into alumina.

Alumina is then processed to aluminum via the Hall-Heroult method using the electrolysis process. One of the most energy-intensive step in primary aluminum production is the process of electrolysis. The molten aluminum that is produced via the Hall Heroult process is cast into ingots, which are transported to foundries and other plants where it is transformed into alloys or final products.

Figure 16: Alumina Production (Bayer Process)

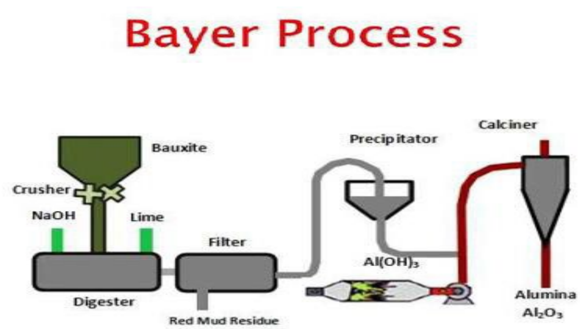
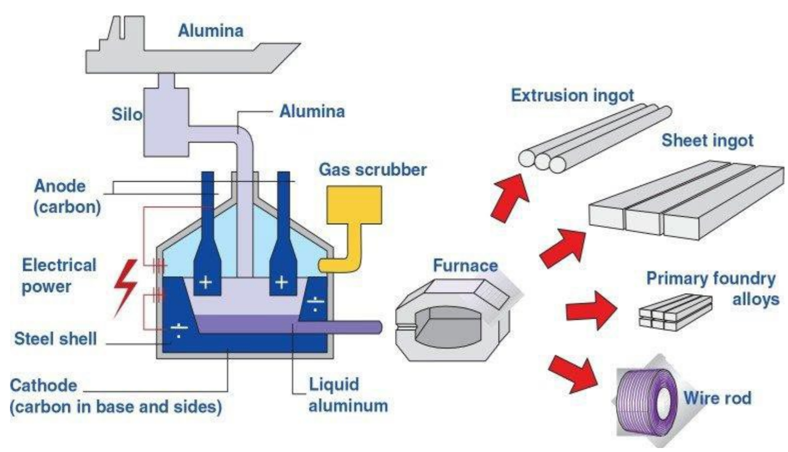


Figure 17: Aluminum Production (Hall Heroult Process)



Therefore, the upstream segment includes all the producers of the raw material from the unwrought mineral, namely the extractors (mining and quarrying) and the primary aluminum smelters. The product received from the smelter is called the unwrought primary aluminum. Thus, primary aluminum alloys are produced from unwrought not alloyed primary aluminum.

Downstream Segment: In this segment, the output of the unwrought aluminum producers, namely aluminum ingot products, such as slabs, billets, foundry alloy ingots and re-melt ingots are purchased by downstream operators to produce the semi-finished products called the wrought aluminum by rolling, extruding, casting and drawing unwrought aluminum into various forms.

2.1.2 The Downstream Segment

The aluminum downstream sector involves a broad group of producers manufacturing highly differentiated outputs like manufacturers of aluminum extrusions, flat-rolled products, and castings, as well as producers of foil, wire, slug and powder, lacquers and other processing applications.

It is important to note that unwrought aluminum remains the main raw material for all stages of processing through the whole chain. It's value in the final product is at least 60 percent and more.

Aluminum production is one of the most carbon intensive industries due to the high levels of electricity required for aluminum smelting. It is to note that primary production process of aluminum accounts for more than 90 percent of the aluminum industry's emissions, despite primary aluminum contributing to less than 70 percent of global supply. The production of alumina, an intermediate product in aluminum production, is also a highly energy-intensive process. Around, one third of aluminum is produced from recycled scrap (referred to as secondary production) (International Energy Agency, 2020). However, primary aluminum production is about 20 times more energy intensive as processing recycled aluminum (U.S DOE 2017). Therefore, in this study we would restrict the scope of Co2 emissions from primary aluminum production.

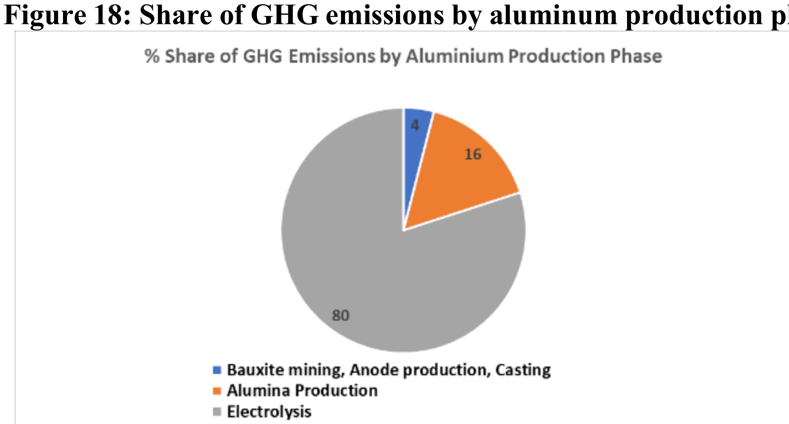
2.2 Global Emissions from Aluminum Production

Aluminum production generates CO2 emissions as:

1) Direct process emissions referred to as Scope 1 emissions where CO2 emissions are generated as a result of aluminum electrolysis, emissions from combustion of fuel used onsite mainly in alumina production and oxidation of the carbon anode to generate heat and electricity.

2) Indirect emissions (Scope 2) include those related to the use of electricity, heat or steam generated offsite, as well as other emissions arising during the production lifecycle such as from other inputs or raw materials, product end-use, transportation of goods to the market and waste disposal. Figure18 below shows the relative GHG emissions (based on tons of CO2e) from each phase of aluminum production supply chain.

Figure 18: Share of GHG emissions by aluminum production phase.

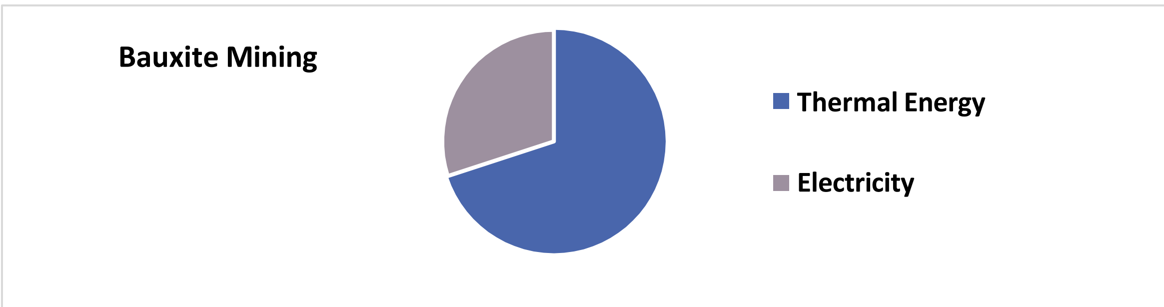


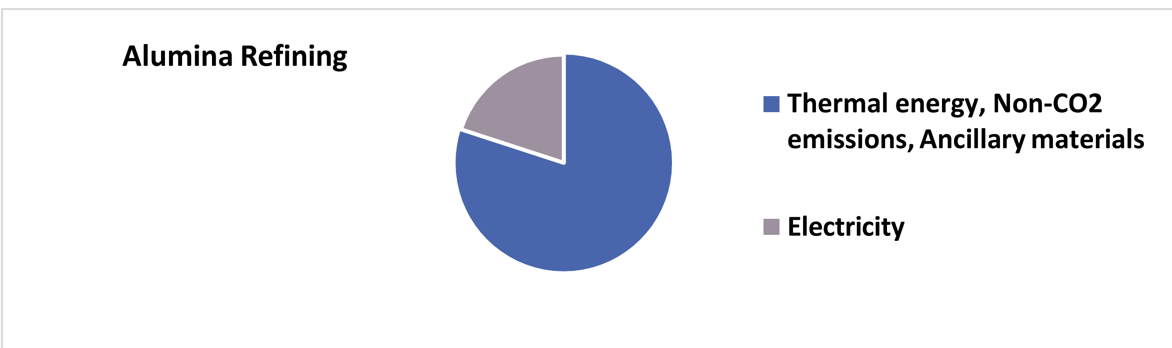
Source: International Aluminum Institute 2021a

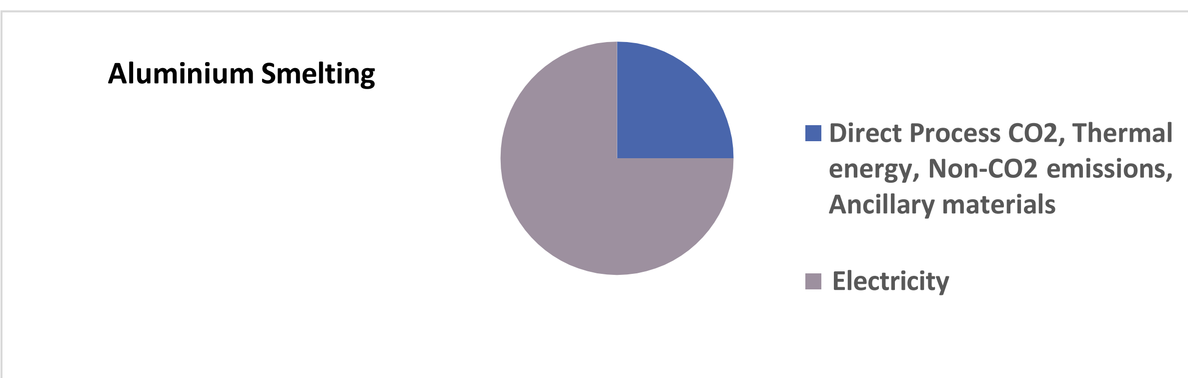
It can be seen that alumina production and electrolysis account for 96% of GHG emissions from aluminum production. Within the electrolysis phase, electricity based emissions account for about 81 percent of GHG emissions for global average production.

If we further look at the composition of total emissions into scope 1 and scope 2 in each phase of primary aluminum production (Fig 19) below:

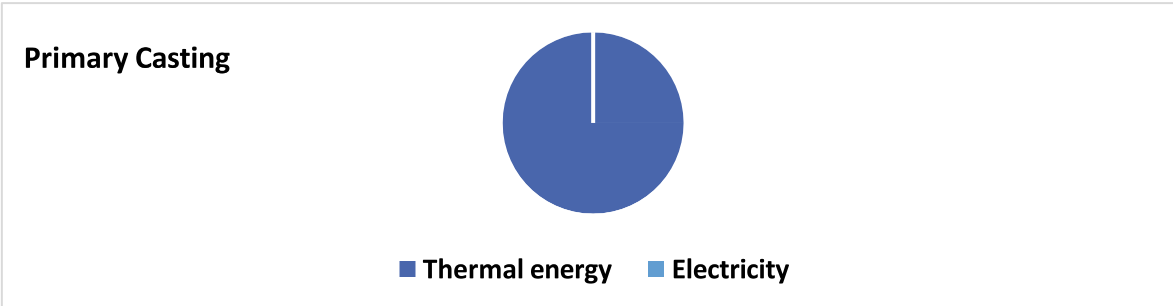
Figure 19: shows the scope 1 and scope 2 emissions in each phase of primary **aluminum production**

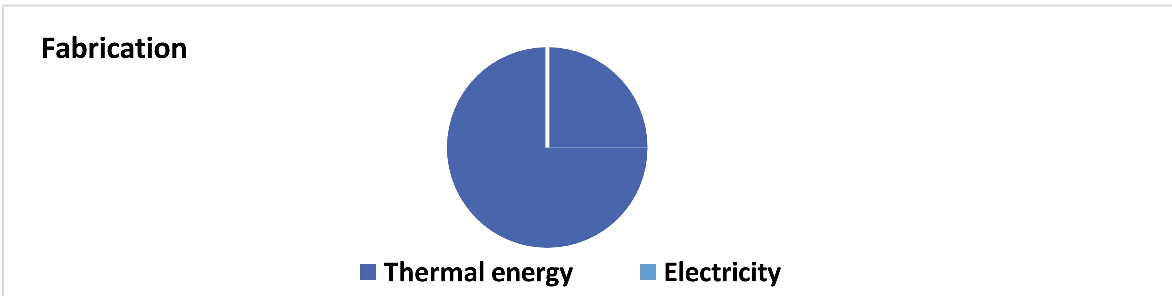






Scope 1 Emissions
Scope 2 Emissions





Scope 1 Emissions
Scope 2 Emissions

Source: World Economic Forum, 2020

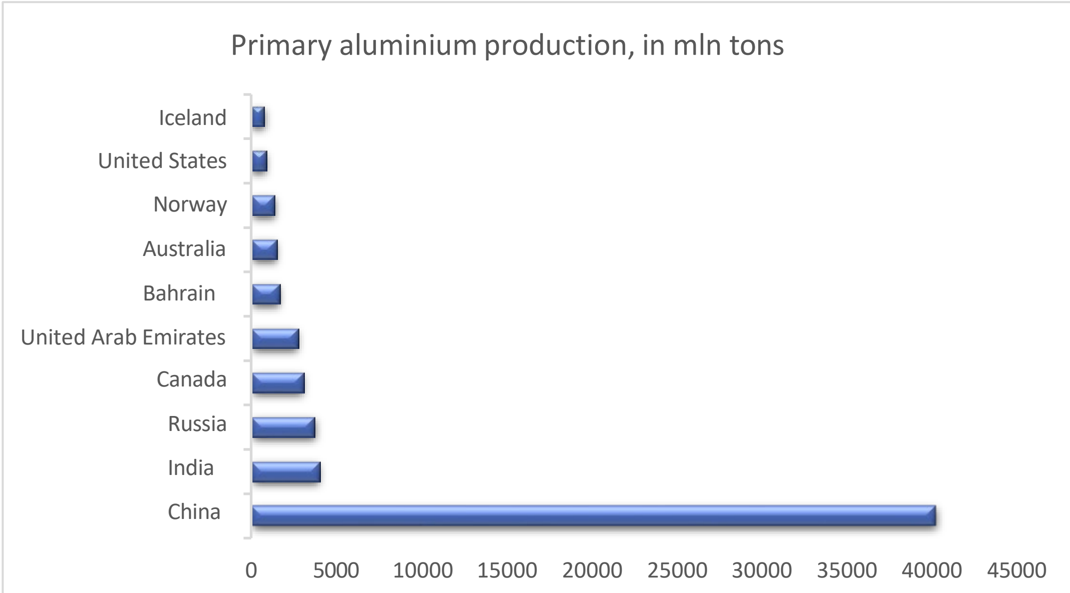
About 77 percent of aluminum sector CO2 emissions are generated in the smelting process, of which around 64 percent are due to electricity usage (World Economic Forum, 2020).

Therefore, because of aluminum production high reliance on electricity, the sector's ability to decarbonize is heavily dependent on the electricity generation technology that varies widely across countries. In North America, Europe, and Russia, aluminum is typically made with hydro power, and is thus relatively low in emissions. Conversely, aluminum from China and India uses electricity from coal power. The aluminum that results is extremely carbon intense.

2.3 Global Primary Aluminum Production

World Aluminum production has increased from 42.4 million metric tons in 2010 to 68.4 million metric tons in 2022 (according to IAI). China accounted for 58 percent of global aluminum production in 2022 followed by India (6%), Russia (5%) and Canada (4%) (US Geological Survey's report on aluminum).

Figure 20. Top 10 Aluminium producing countries in 2022



Source: US Geological Survey[6]

Fig 20 shows the top 10 aluminum producing countries of the world. In 2022 these 10 countries contributed towards 86 percent of global aluminum production

Table 6: Top 10 Aluminum and articles thereof (HS 76) Exporting Countries in 2022

Country	Net Exports (USD)
China	42109007
Germany	21117541
United States of America	14511112
Canada	14138192
India	10248810
Italy	10104316
Russian Federation	9963571
United Arab Emirates	9521415
Netherlands	7858063
Malaysia	7447085

Table 7: Top 10 Importers of Aluminum and articles thereof (HS 76) in 2022

Country	Net Imports (USD)
United States of America	36664809
Germany	26699244
China	11685868

6 https://pubs.usgs.gov/periodicals/mcs2023/mcs2023-aluminum.pdf

Mexico	11640040
Italy	11499605
Japan	10649970
Korea	9753227
France	9655612
Netherlands	9136001
Türkiye	7683146

Source: ITC data

According to ITC Trade map data, US, Germany, China, Mexico and Japan were the top five importers (Table 7) and China, Germany, United States of America, Canada, and India were the top five exporters of aluminum in 2022 (Table 6). The significant global trade of such a carbon intensive commodity has substantial implications for the embodied carbon in traded aluminum. Our national and international carbon accounting and climate policies do not account for this carbon embodied in traded aluminum.

2.4 Global Aluminum Industry's CO2 Emissions

The global aluminum industry accounts for around 3 percent of the world's 9.4 Gt of direct industrial CO2 emissions in 2021(International Energy Agency, 2021). The table below depicts the total energy related CO2 emissions from the top 10 aluminum producing countries in 2021. China alone is responsible for about 67 percent of global energy related CO2 emissions, due to the high CO2 intensity of aluminum production.

Total energy related CO2 emissions from aluminum production in 2021

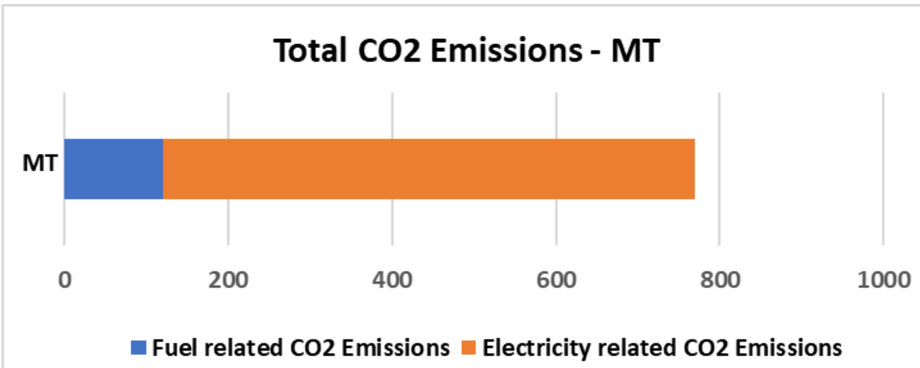
Table 8: Total energy-related CO2 emissions from aluminum production in top 10 aluminum producing countries in 2021

Country	Energy related CO2 emissions from primary aluminum production (MT)	%
India	56	8.25%
Russia	26	3.83%
Australia	20	2.95%
UAE	20	2.95%
Bahrain	18	2.65%
USA	10	1.47%
Canada	8	1.18%
Norway	6	0.88%
Iceland	3	0.44%
New Zealand	1	0.15%
Rest of the world	**511**	**75.26%**

Source: World Economic Forum, 2021

Further, it is discussed previously that electricity-based emissions account for about 81 percent of global GHG emissions during the electrolysis phase and 19 percent comes from fuel use. Due to the high reliance of aluminum production on electricity, decarbonization efforts becomes heavily dependent on the type of power available to the aluminum smelters worldwide. Also, given the carbon neutrality goals in many countries, alumina production should also be oriented towards lower carbon fuels.

Fig 21: Total CO2 emissions from global aluminum production by energy Source



Source: Hasanbeigi et al., Global Efficiency Intelligence, 2021

Different countries have different fuel vs electricity mix, for e.g., countries like Iceland and Norway, Russia use electricity derived from renewable sources such as hydro, wind and it is called zero emissions electricity, used for aluminum production while other countries like India use carbon intensive fuels for electricity used in the electrolysis phase and alumina production.

Table 9: Emission Aluminum producing countries' data of the world (high intensive and **low intensive in terms of scope 1 and scope 2 emissions)**

Countries	CO2eq/ton (Scope 1 and Scope 2)	Scope 1	Scope 2
South Africa, USA, India, China	**58.23**	**33.19**	**25.04**
Turkey, Iran, Egypt, Bahrain, UAE	**42.38**	**21.94**	**20.44**
Russia	**2.55**	**2.19**	**0.36**
Canada	**2.07**	**1.92**	**0.15**
Iceland	**1.78**	**1.64**	**0.14**
Norway	**2.15**	**1.88**	**0.27**

Source: Independent analytical agencies estimations

2.5 Factors contributing to differences in energy and CO2 emission intensity in different countries:

After having discussed the contribution of different aluminum producing countries towards CO2 emissions, it is evident that the energy and CO2 emissions intensity varies from country to country. The following factors are responsible for these differences:

a) The fuel mix used for alumina production: The production of alumina requires different fuels and the share of different fuels influences the energy intensity as different fuels have different carbon intensity e.g. in Canada, the natural gas is mainly utilized towards alumina production which helps in lowering the CO2 emission intensity relative to production in India and China, which mainly uses coal.

b) The electricity production CO2 emissions factor: In addition to the share of fuels used directly for alumina production, the fuel mix for power generation to produce electricity used in aluminum industry in each country is an important factor when we compare the CO2 emissions of the aluminum industry in different countries. For e.g. countries like Norway and Iceland as well as Russia, utilize hydropower to produce electricity which generates near-zero direct CO2 emissions. As discussed previously, nearly 81 percent of emissions from aluminum production are associated with electricity use, the most important measure to decarbonize aluminum industry is decarbonization of the electricity used in aluminum production.

c) Captive power used for aluminum production: As electricity constitutes a major input in aluminum production, many aluminum smelters have on-site “captive” power plants. Some aluminum producing countries uses more captive power while others use more grid electricity. According to IEA 2020a, aluminum smelters in Europe tend to use electricity drawn from grid whereas aluminum smelters in Asia rely almost 100 percent on ‘captive power. Depending on the type of fuel used to generate electricity at the captive power stations, the share of captive power vs grid electricity used in a given location, the CO2 emission intensity of aluminum production varies from country to country.

d) Environmental Regulations: Environmental regulations and policies vary from country to country. For e.g. European Union has implemented Carbon Border adjustment mechanism to limit carbon leakage and incentivize stronger emission measures in other countries. In addition, many countries have set the net zero emission target by 2070 which in turn would motivate them to decarbonize in coming future.

2.7 Pathways to Decarbonization:

Achieving a low carbon economy to attain climate neutrality is crucial in todays' scenario. The global aluminum industry that processes bauxite to aluminum ingot, has a challenge to reduce the CO_2 emissions and the greenhouse effect that these emissions may have on global warming and climate change. As already discussed, there are two main sources of these emissions, one emerging directly from production processes, and other emerging indirectly from the electricity that is used to power it. The emissions are increasing because of the growing demand for aluminum and the limited supply of electrical energy generated from renewables. Many countries are taking a responsible approach to the impact of global warming and taking actions to minimize their national footprint. Meanwhile, the public and governments rightfully demand reductions of greenhouse gas emissions, thus requiring strong actions from the aluminum industry in the coming years. While indirect emissions due to electricity consumption represent the greatest opportunity to reduce its carbon footprint and are responsible for about 60 percent of its sectoral emissions, the industry also needs to consider how to address its direct emissions, constituting around 30-35 percent of its emissions.

Aluminum Industry accounts for about 275 Mt of direct CO2 emissions in 2021 and the number increases to 1.1 Gt of CO2, if indirect emissions from electricity consumption are included in it. Despite the efforts, the past few years has seen only a slight decline in the average direct CO2 intensity of aluminum. However, if we consider the net zero scenario targets then emission intensity would decline only at about 3.5% annually to 2030 which are far less than the targets needed to attain net zero by 2070, therefore, aluminum emissions are not on track and there is an urgent need to initiate and expedite the decarbonization of this sector (International Energy Agency, 2022).

It has been discussed before that over 90 percent of aluminum production's direct CO2 emissions come from aluminum refining and aluminum smelting, the remaining arise from recycled production, anode production and casting. It is proposed that by deploying and adopting near zero emissions technology, direct emissions can be considerably reduced. Also, by increasing the share of recycled production from post-consumer scrap, reliance on refining and smelting can be reduced which in turn could reduce direct emissions (IEA).

There are two major sources of direct emissions in the aluminum sector: 1) consumption of carbon anodes during aluminum smelting; 2) generation of thermal energy for high-temperature processes.

1. Presently, carbon anodes are used during aluminum primary smelting that release carbon- dioxide as a part of the electrolysis process. However, these carbon anodes could be replaced by inert anodes that release oxygen as they decay. Commercialization and early deployment of this technology has a potential to get on track with the net zero scenario and is critical for the next few years. RUSAL's Krasnoyarsk plant in Russia produced primary aluminum at industrial scale using inert anodes for the first time in April 2021 while Elysis, a joint venture between Alcoa and Rio Tinto in Quebec, Canada, successfully deployed this technology in November, 2021.

2. Carbon capture and storage (CCS) technology is another method for reducing aluminum smelting emissions (direct emissions). This technology prevents large quantities of carbon- dioxide from being released in the atmosphere from the use of fossil fuels. The three main steps involved in CCS are capture (separation of CO2 from other gases produced at industrial processes), Transport (the separated CO2 is compressed and transported via pipeline to an appropriate site for geological storage and Storage (where CO2 is injected into deep underground rock formations). This technology is highly successful in reducing Co2 emissions. Two firms – Alvance Aluminum Dunkerque in France, and Norwegian company Norsk Hydro – have recently announced that they are exploring options to use CCS for aluminum, with Norsk Hydro setting a goal of using CCS on a commercial scale by 2030.

3. Another important technology to decarbonize the aluminum sector is switching to alternative fuels such as bioenergy and hydrogen for high temperature processes. Hydrogen is considered the "Swiss army knife" of renewable energy solutions, as it can be used across many sectors such as electricity, fuel and thermal energy, for a broad range of purposes. The use of hydrogen as a fuel source to produce high temperature heat or industrial use, such as in alumina refining, is now being explored today.

4. Since aluminum production greatly relies on electricity, efforts to decarbonize electricity generation will be necessary to reduce the subsector's indirect emissions. In addition to decarbonizing electric grids, much of the electricity for aluminum is generated on site, meaning that the industry must also take measures to either switch away from fossil fuels, or reduce its emissions through technology such as CCS.

5. Another cost effective way to reduce the sector's indirect emissions is by sourcing electricity from renewable energy sources, such as hydro, solar, and wind power. Hydropower is considered the best option for decarbonizing aluminum because of its storage capacity.

6. Trade can also play an increasingly important role in decarbonization. If the government could facilitate renewable energy to be traded freely across borders, then the process of decarbonization can be expedited and made cost effective too. For e.g. Canada is the United States' largest partner for energy and electricity trade, with bilateral energy flows reaching $119 billion in 2019. In the United States, states like New York and Minnesota are increasingly using Canadian hydropower to help achieve clean energy goals.

7. Recycling available scrap metal is also necessary to decarbonize aluminum. Approximately, 30 percent of total aluminum demand could be met through recycled scrap, with the potential to increase to 39 percent by 2050, even as demand is projected to grow. The current trend on the circular economy and environmentally friendly technologies should stimulate the consumers to increase the raw materials with high recyclability and low carbon footprint. Relatively attractive prices will make them more "material of the choice" for the consumers. Aluminium is a circular material, capable of being recycled over-and-over again without losing its original properties. The benefits of increased

aluminium recycling are significant. As the aluminium scrap prices are directly depend on the primary and other aluminium products prices, the abolishment or reduction of import duty on primary aluminium in India will realize in the lower scrap prices and create the right incentives to promote aluminium consumption and circular business models worldwide.

2.8 Lessons from Foreign Aluminum Industries

Several countries around the world have introduced policies addressing CO2 emissions as a whole. Some of the efforts by various countries are discussed below:

- **China** – Approximately, 60 percent of global aluminum production and consumption is accounted by China. Due to the high reliance on coal-based production process, 12.7 tons of carbon is emitted per ton of aluminum produced in China, versus a global average of 10.3 tons, according to the latest figures, which cover the 2005 to 2019 period. This is why decarbonizing the power supply for Chinese primary aluminum production is critical. However, in the very recent years, China has been steadily deploying the best available aluminum production technology, going from one of the most energy-intensive aluminum producers to one of the least. With China's potential for energy intensity improvements essentially fully exploited, global energy efficiency in primary production has been modest in recent years. In this regard, the following initiatives are promoting decarbonization in the Aluminum Industry particularly their electricity supply.

a) Reallocation of primary aluminum production capacity to areas with abundant renewables:

Southwest China has plenty of hydropower resources and an energy cost advantage. Hence, primary aluminum capacity is being transferred to this region to exploit these advantages.

b) Adjusting captive/grid power proportions

We estimate the proportion of captive power in China's aluminum sector will fall from 60 - 70% in 2020 to 20% in 2060. In the short term, captive power will remain dominant, but it will be gradually replaced by grid power over time, except for a small number of provinces that are likely to retain captive coal-fired power plants.

c) The decarbonization of captive power plants

Captive renewable power technology is undergoing research and development, with only a few ongoing pilot projects in China's aluminum sector. From 2026-2030, the total number of captive coal-fired power plants in China will gradually decrease. During this time, captive renewables will be introduced and used at a small scale.

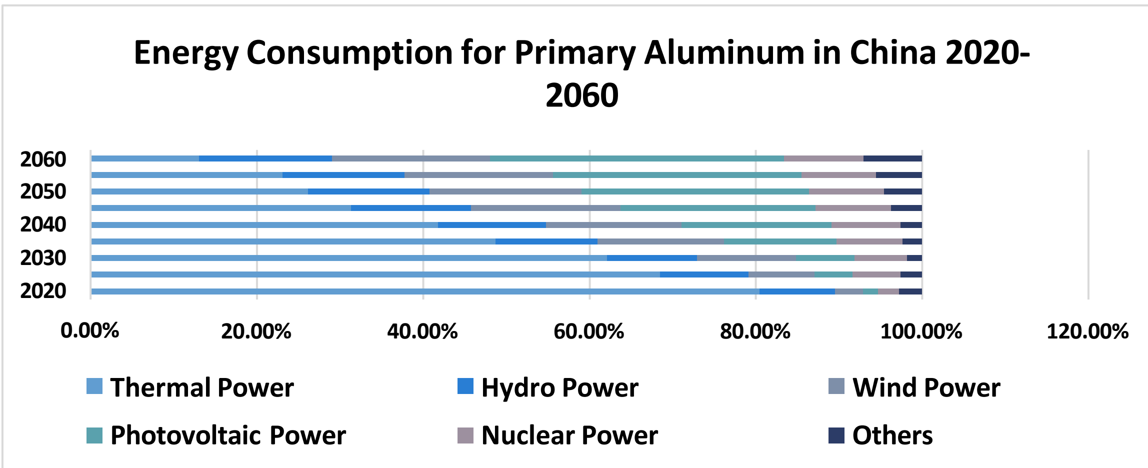
d) The decarbonization of grid-tied power plants

The installed capacity of renewable energy and nuclear power in China is set to increase significantly, accounting for 82.9% of all energy by 2060. Hydropower, photovoltaic, and wind power will remain the main sources of renewable energy power generation, while nuclear power will account for a relatively small proportion.

e) The rise of renewables in China

It is predicted that combining the four initiatives mentioned above, carbon emissions for China's aluminum sector will reach a peak of 506 million tons per year by 2028. After 2040, emissions will decrease at an average rate of 2.4% annually. By 2045, our analysis shows that renewable energy will become the main energy source for primary aluminum production in China, with photovoltaic power accounting for the largest proportion.

Fig 22: Energy consumption for primary aluminum in China 2020-2060.



Source: Accenture in-house modelling

It is evident from the figure that renewable energy is expected to become the main energy source for primary aluminum production by 2045 in China.

Canada: Canada's innovation on zero-carbon aluminum smelting is an initiative that could help in achieving carbon neutrality goals. It has recently invested in ELYSIS process developed by Alcoa and Rio Tinto that replaces the carbon anodes used in traditional aluminum smelting with inert anodes eliminating the direct carbon emissions from aluminum smelter and reducing operation cost.

As per International Energy Agency, the ELYSIS technology once fully developed and adopted at Canadian aluminum smelters, would eliminate a considerable amount (around 7 million tons a year) of carbon emissions that represents 1% of Canada's overall greenhouse gas emissions. As Canada, North American and global manufacturers transition toward green supply chains, this investment will leverage Canada's reputation. The investment in ELYSIS technology strengthens local manufacturing capabilities, integrating local workers and supply chains in the shift toward a greener and more resilient aluminum industry in Canada.

Iceland: It uses renewable energy to generate electricity that is used to produce aluminum and has ten times less CO2 emissions as compared to that produced in coal generated aluminum smelters in China. Furthermore, carbon emissions per produced ton from aluminum smelters in Iceland have been reduced by 75% since 1990, and now carbon emissions from aluminum production are lowest in Iceland compared to other countries. Hence, it is important that the global aluminum market demand is in part met with environmentally friendly aluminum produced in Iceland.

The new technology namely Iceland's zero-emissions Arctus Metals- could reduce Iceland's emissions by 30 percent—and illustrate the important role advanced aluminum manufacturing and R&D can play in future decarbonization.

Russia: The Aluminum smelter used in Russia is one of the greenest in the world. RUSAL, a leading global aluminum producer in Russia, opens the first phase of the world's most advanced low-carbon aluminum production plant. More than 90% of electricity for aluminium production is provided by clean and renewable hydroelectric power, which allows the company to produce low carbon footprint products. The aluminum smelter in Russia operates on clean energy from Siberian hydroelectric power plants, which together with modern gas cleaning equipment and a closed water circulation system, has a low-level impact on the environment. Full scope CO2 emissions will be one of the lowest in the industry. The carbon footprint of aluminium production is 5 times lower than the industry's average and amounted to 2.3 CO2e per tn Al.

European Union: The European Union is using trade as a tool to decarbonize. It is in the process of developing and implementing a carbon border adjustment mechanism (CBAM), while the United States has stated that it is considering such a mechanism. Under CBAM, there will be an import levy on EU imports of electricity, cement, aluminum, fertilizer as well as iron and steel products depending on the carbon emission content of their production. The CBAM will equalize the price of carbon between domestic products and imports and ensure that the EU's climate objectives are not undermined by production moving to countries with less ambitious policies. The tax imposed on imported goods from countries with less strict climate polices will sur adaptation of cleaner technologies.

2.9 Challenges in the path towards Decarbonization:

Although there are ranges of new technologies for decarbonization, but the best-suited technologies change based on each countries operating environment including policy, geography and role in the aluminum supply chain. The speed at which these technologies can be evolved is dependent on the regulatory and investment environment and would require a strong policy response with partnerships across industries, investors and stakeholders.

The path to decarbonization will be affected by the speed at which the broader aluminum industry can adopt these new technologies. For e.g., Inert anode technology is not yet commercially available. In addition, the operational requirements of inert anodes are still unknown. Some research suggests that the use of inert anodes results in higher electricity demand, which would increase indirect emissions if the process were reliant on fossil fuel-based energy sources. Also, end-of-life requirements for inert anodes also need to be understood. As they are not consumed by electrolysis, there will need to be adequate infrastructure to dispose of or recycle waste. Furthermore, while the operational carbon footprint of aluminum smelters will decrease, there will still be emissions tied to inert anode production and transportation.

Moreover, most of these new technologies require high capital investments. The greatest barrier to scaling CCUS is the high capital cost for capture technology and the installation of the vast infrastructure needed for widespread use. This transportation and storage infrastructure requires comprehensive planning and development in the near term, as it can take years to approve and build. Also, the greatest barrier to the growth of green hydrogen is the high cost, which is significantly affected by access to low-cost renewable energy. Beyond production costs, hydrogen requires extensive infrastructure for transportation and storage, which needs local, national and international collaboration between governments and industry.

This suggests that there is no single solution to address primary aluminum sectoral direct and indirect emissions, thus, there is a need for collaborative research, design and development. E.g Partner with start-ups or research institutions to provide avenues for pilot studies to demonstrate breakthrough technologies in an industrial context. Partner with other industries that are investing in scaling up technologies such as CCUS or hydrogen to share information, explore the application of commercially available technologies within the aluminum industry. But all these efforts seem to take a sufficient long period of time to materialize. Thus, aluminum industry must also focus on exploring short term ways to decarbonize.

2.10 Decarbonization of Aluminum Industry in India:

Aluminum is regarded as a strategic sector for India to move towards a sustainable economy. It could play an increasingly crucial role to help India to serve its commitment to CO2 emission norms by adopting electric vehicles, which improves the share of renewable energy to 40% and beyond and promote indigenization in defense equipment, aerospace and aviation sectors (Niti Aayog). It could also support India to boost fuel and cost efficiency, especially in the transportation, electrical & electronics, building and construction sector.

The three major players that dominate the primary aluminum market are privately owned Vedanta, Hindalco and public sector undertaking National Aluminum Company Limited (NALCO). About 80 percent of market share is accounted for Hindalco and Vedanta.

Power is a critical input for aluminum industry as aluminum production involves the electrolytic reduction of alumina, which is highly energy intensive process that uses electricity. Being an energy-intensive sector, aluminum industry in India entirely relies on coal that contributes to about 30-35 percent of the metal production cost. This coal-based production is one of the major factors responsible for high carbon-dioxide emissions.

The average intensity of CO2 emissions from Indian aluminum production is 48% higher than the global average. It is a widely known fact that coal is responsible for 40 percent of carbon-dioxide emissions from fossil fuels. Mining of coal is very hazardous for the environment and for the health of the people who live there. Besides, CO2, which contributes to global warming, burning coal produces pollutants like mercury, Sulphur dioxide, which are linked to acid rain, and particulate matter, that causes serious respiratory illnesses.

Tackling climate change and achieving net zero is impossible without reducing Indian dependence on fossil fuels, especially coal. India, being a signatory of Paris agreement, needs to develop the use of environment friendly and climate neutral methods for Industrial development.

2.11 Pathways/strategies to decarbonize the aluminum sector in India:

Based on the discussion so far, there are two key learnings to be understood in terms of energy consumption and carbon intensity of aluminum as a sector.

One is that aluminum making is an energy intensive process: The electrolysis process in aluminum smelter is very energy intensive. In India, in absence of hydro power linkage and or gas availability, all smelters are dependent on captive thermal powerplants. Second, aluminum is infinitely recyclable and light-weighted metal. Recyclability of aluminum means, the recycled metal consumes 95% less energy to produce as compared to primary metal. Its light weight offers opportunity to reduce energy consumption and carbon footprint in other sectors. For example, it offers reduction in vehicular GHG emissions, very useful in building & construction and to replace plastic packaging for food, pharmaceuticals. Aluminum not only delivers significant energy and CO2 savings in the use phase and has the potential to be produced in a carbon neutral way.

Therefore, the decarbonization efforts in India has focused on the following strategies so far:

1. Reducing energy consumption and changing energy mix: It can be achieved in the following ways:

a) Technology driven growth: Investments in latest technology that can provide a significant reduction in energy requirement or could change the energy mix could play an important role in decarbonization. For e.g., recently Hindalco has invested in AP60 technology-based aluminum smelters that have led to significant reduction in energy requirement and about 17 percent reduction in GHG emissions from FY15 base.

b) Energy efficiency improvement of existing facilities through specific improvement projects. The national mission on enhanced energy efficiency (NMEEE) has been assigned the task of promoting energy efficiency through creating and sustainability markets for energy efficiency (NAPCC, 2008). Perform, Achieve and Trade (PAT) is an initiative under NMEEE to improve the energy efficiency of the high energy intensive industrial units through target setting and tradable energy saving certificates. The first cycle of PAT scheme covered eight industrial sectors, including aluminum and had a compliance period from April 2012 to March 2015. So, far seven cycles have been notified. The VII cycle has been notified in October 2021 for the period 2022-23 to 2024-25 with overall energy saving target of 6.627 MTOE. PAT is similar to the cap-and-trade scheme i.e. cap and trade in energy intensity. Literature suggests that PAT scheme has been successful in bringing about a decline in the energy intensity of heavy industries in India (Oak and Bansal, 2022).

2. Future growth focus in downstream and use of recycled aluminum: **C**losed-loop Aluminum recycling system allows us to take back a much of our customer's scrap as possible, turning it back into the same product again thus supports in developing circular economy. Hindalco, through subsidiary Novelis has invested heavily in developing Aluminum recycling and leads global aluminum recycling with **60%** of its products coming from recycled Aluminum.

2.12 Way Forward:

As discussed in the section on challenges in the path towards decarbonization, it is discussed that investments in new technology such as inert anode, CCUS, green hydrogen etc would require high capital cost and vast infrastructure. Moreover, the speed at which these technologies can be evolved is dependent on the regulatory and investment environment in each country. India, being a developing country and with a host of regulatory and environmental procedures for adopting any new technology, this option could be viable in the long run. Also, schemes such as PAT, although successful but are not free from limitations. In such a scenario with an increasing ambition to reduce greenhouse gas emissions by 2030, India should also explore short term ways to decarbonize.

In this regard, India could use trade as a tool to spur decarbonization. One such tool could be reducing the import tariffs on primary aluminum with low carbon footprint that could reduce the price of raw material and thus could raise the competitiveness of downstream aluminum sector. It could also encourage the import of low carbon primary aluminum from countries like Canada, Norway, Russia and Iceland that could be used to produce the finished goods domestically and in turn, promote export of green aluminum value added products globally. The next chapter would explore the viability of this option in the short run by using empirical data and fitting an appropriate econometric model.

Chapter 3

Trade, Tariffs and Border Adjustments: An analysis of the impact of import tariffs, energy intensity on revenues of downstream aluminum sector in India

3.0 Indian Downstream Aluminum Industry

India is one of the leading markets for downstream aluminum in the world. The key beneficial and versatile properties of aluminum include its lightweight and high strength to weight ratio and great flexibility for efficient formability into complex shapes using modern design features. It is also durable and infinitely recyclable. Aluminum could play a key role in contributing to a sustainable economy as a significant proportion of the products arising from the finished articles using aluminum are energy saving, and thus reducing the carbon dioxide emission that would otherwise arise from them.
The most common uses of aluminum include:

- Building and Construction
- Transportation
- Electrical and Electronics (power transition lines and consumer electronics)
- Consumer durables (packaging)
- Industrial

Currently, aluminum has one of the fastest growing demands among metals in the world. Specifically, the demand is driven by a transport sector that needs to improve fuel efficiency and reduce energy use and emissions through lighter cars, trucks and trains. The advances in aluminum technology have made possible an expansion in aircraft capabilities and size coupled with safe air travel. Furthermore, aluminum is a key to zero-energy buildings, solar applications and packaging that preserves food and drinks and requires less energy to transport. Thus, aluminum plays a central role in the success of emerging green sectors such as renewable energy and electric vehicles which will see increased intensity of aluminum consumption. This may eventually create an exponential rise in demand for cost effective aluminum – moving from 4 MTPA at present to 10 MTPA by 2030 (Soumya Garnaik, TOI, 31st Jan, 2023). Of course, considering the net-zero emissions targets, wherein greening the electricity sector is what the nation is striving for, aluminum will indisputably play a pivotal role in such scenario.

The aluminum downstream sector involves a broad group of producers manufacturing highly differentiated outputs like manufacturers of aluminum extrusions, flat rolled products and castings, as well as producers of foil, wire, slug and powder, lacquers and other processing applications. Semi-finished aluminum products are sold to a wide variety of customers using them in manufacturing processes further down the chain.

3.1 Challenges faced by Indian downstream aluminum Industry

It is important to highlight that unwrought aluminum (primary aluminum) remains the main raw material for all stages of processing through the whole chain. Its value in the final products is at least 60 percent and more. Apart from the downstream production facilities of the major primary producers, the Indian downstream also includes producers such as Jindal Aluminum Ltd, Global Aluminum, Century Extrusions, Banco aluminum, Balaji Aluminum Extrusions, Maan Aluminum and Alom Extrusions Ltd and others.

As already discussed in chapter 1, the price of unwrought aluminum is key for the competitiveness of the Indian aluminum downstream industry. Currently, the main problem that Indian downstream faces is the overpricing of the primary aluminum to produce value-added products.

Domestic primary producers trade their products in India at import parity taking import duties such as 7.5% as BCD (Basic custom duty) as well as 0.75% (10% of the BCD) as social welfare surcharge in the price while selling the primary aluminum to the downstream sector producers. As a result, Indian import tariff provides the primary aluminum producers with additional revenues, while downstream producers overpay for the raw material and carried overspending.

It is discussed in chapter 1 that in 2022, downstream aluminum producers in India overpaid the sum in amount of approx. 420 million USD in favor of primary aluminum producers, thereby supported profitable and successful smelters instead of investing to their own production equipment.

The downstream manufacturers in comparison to smelters produce value added products but are under the pressure of buying primary aluminum at import parity prices. It is argued that import tariffs on primary aluminum does not contribute to Indian budget but secures additional revenues to aluminum smelters.

Primary aluminum constitutes around 60% in the production cost of finished aluminum products produced by the downstream sector. Hence, overpricing the primary aluminum makes secondary products uncompetitive in the domestic as well as the foreign markets.

Moreover, downstream sector is a major provider of employment (around 1 million jobs) in India and supports urbanization and infrastructure development. Non-Competitiveness of this sector eventually threatens millions of jobs in the sector, technological and innovation novelty. Thus, ruining of value-added segment jeopardizes the whole economy.

Chapter 1 discusses the trade structure of Indian aluminum industry and highlights that the import share of primary unwrought aluminum is decreasing whereas that of the downstream aluminum sector is increasing since 2016. And that the downstream producers face high cost of raw materials particularly due to rise in import tariffs on primary aluminum are major challenges for the Indian downstream aluminum sector. The condition is further worsened with the downstream sector seems to be grappling with an inverted duty structure, where the imports of its critical raw material are taxed at a higher rate than the imports of competing finished goods.

It seems that that rising imports of downstream aluminum products, high cost of raw materials particularly due to rise in import tariffs on primary aluminum are major challenges for the Indian downstream aluminum sector. The condition is further worsened with the downstream sector seems to be grappling with an inverted duty structure, where the imports of its critical raw material are taxed at a higher rate than the imports of competing finished goods.

Although aluminum production is energy intensive, we must acknowledge the fact that the sector has done extremely well in reducing the specific energy consumption (SEC) by 1 to 1.5% per year over the last decade. Schemes like Perform, Achieve and Trade (PAT) has been successful in reducing the SEC of some of the large aluminum producers in India. Therefore, it is pertinent to note that this sector is very proactive in upholding India’s quest for decarbonization while also ensuring its economic growth.

Thus, we need to nurture and promote this sector by removing the fiscal challenges faced by the downstream sector and increasing its competitiveness. One of the effective solutions could be the reduction in the raw material price achieved by means of removing import tariffs on primary aluminum. This could help in increasing the revenues of the downstream sector, make it more competitive and develop its capacity.

Moreover, as discussed in chapter 2, regarding an ambitious target of achieving net zero carbon emissions by 2070 and the Nationally Determined Contribution (NDC) goals by 2030, aluminum will indisputably play a pivotal role. As the effects of climate change intensify, countries have taken it upon themselves to use trade as a tool to ignite greater international action on climate change. The European Union’s recently proposed Carbon Border Adjustment Mechanism (CBAM) seeks to limit carbon leakage and encourage a race to the top when it comes to environmental standards and emissions reductions. Under the proposed CBAM, beginning in October 2023, importers of non-EU aluminum will need to report both their direct and indirect emissions, making the decarbonization of aluminum an increasingly urgent matter for the industry. It is argued that a significant share of India's exports to the European Union are likely to be impacted by CBAM, and Indian goods will run the risk of becoming less competitive in the EU market.

To drive decarbonization in energy intensive sectors like aluminum in India, a range of long term decarbonization pathways have been explored and discussed in chapter 2. However, in the absence of any short-term policies towards decarbonization, it seems that reducing the import tariffs on primary aluminum could serve two-fold objectives:

a) It could reduce the price of raw material and thus could raise the competitiveness of downstream aluminum sector.
b) It could also encourage the import of low carbon primary aluminum from countries like Canada, Norway, Russia and Iceland that could be used to produce the finished goods domestically and in turn, promote export of green aluminum globally. In the changing global scenario and increasing demand for green products globally (particularly in the presence of EU CBAM), this could be seen as an efficient policy measure to make Indian products competitive as well as sustainable.
c) Revenues is the major yard stick for any sector and industrial landscape and therefore, this study would like to analyze the impact of economic factors such as import tariffs on primary aluminum, energy intensity in aluminum production on the revenues of the downstream sector.

3.2 Energy Intensity of Aluminum Industry in India

Energy intensity is a measure of the efficiency with which energy is utilized and thus can be treated as a proxy for energy efficiency (United Nations Sustainable Development Goals, 2018). Energy Intensity is defined as the energy consumed to produce a unit of output (Bu et al., 2019; Alam et al., 2019; Energy Statistics, Government of India, 2017; Office of Energy Efficiency and Renewable energy, U.S Department of Energy).

As discussed in chapter 2, primary aluminum production is a highly energy intensive process and India relies entirely on coal-based energy that contributes to about 30-35 percent of the metal production cost. This coal-based production is one of the major factors responsible for high carbon-dioxide emissions. Thus, decarbonization efforts in India could focus on energy efficiency improvements in existing facilities. Improvements in energy efficiency could be attained by either technological improvement such as adopting inert anode technology, CCUS, green hydrogen or by switching to power produced by renewable sources such as wind and hydro energy.

Although investments in new technology is a costly and long-term process, but such investments could lead to improvement in energy efficiency in primary aluminum production in the long run and thus could improve the competitiveness of the downstream sector. Considering, the climate targets of India in terms of net zero emissions by 2070 and increasing global demand for green aluminum products, it is important to understand the impact of energy intensity on the revenues of the downstream sector.

Data Source: *We use firm level data in India's aluminum sector on 10 largest MSME firms for 9 years (2014-22). The data has been taken from Prowess IQ database; the largest available firm level time series data set on financial variables of Indian firms. This dataset is a product of the Centre for Monitoring Indian Economy Pvt Ltd. (CMIE) and includes all companies traded on the National Stock Exchange and the Bombay Stock Exchange,* *thousands of unlisted public limited companies, and hundreds of private limited companies. The database is built from Annual Reports, quarterly financial statements, Stock Exchange feeds, and other reliable sources. We have considered data for 10 MSME firms that constitutes the highest market share and for which power and fuel expenditure data was available. Our sample comprised of 90 observations which represented 10 largest downstream aluminum firms over 9 years (2014-22).*

3.3 Econometric Methodology and Model Specification

We use a dynamic panel model and estimate it using an Arellano Bond Estimation to analyze the impact of import tariffs on primary aluminum, energy intensity, size etc. on the revenues of the downstream aluminum sector.

We now define the variables used in our regression:

- Dependent Variable: Growth rate of sales measures a firm's ability to generate revenue through sales over a fixed period of time. It is treated as a dependent variable in our analysis. Data on sales of the downstream MSMEs are taken from Prowess IQ database.

- Independent Variables: Import tariffs on primary aluminum: Basic custom duty in percentage has been taken as a proxy for import tariffs. This data has been collected from the official government reports of the Ministry of Commerce, Government of India.

- Energy Intensity: Energy intensity is a measure of efficiency with which energy is utilized and thus can be treated as a proxy for energy efficiency (United Nations Sustainable Development Goals, 2018). Energy intensity is defined as the energy consumed to produce a unit of output (Energy statistics, Government of India, 2017). Due to lack of availability of data in physical units and consistent with prior literature, we use the ratio of power and fuel expenditure to total sales (in Rs million) as an indicator of energy intensity. Power and Fuel expenditure is defined as the cost of consumption of energy for carrying out the business of a company (Prowess IQ database).

- Per unit capital investment: Evidence from prior literature highlights the importance of employing new technologies in energy efficiency improvements (Erdem, 2012;Goldar, 2011). Therefore, we have included per unit capital investment as an explanatory variable. It indicates the pace of new investment and is measured as a change in gross fixed assets between periods t and t-1 as a proportion of total sales (Oak and Bansal 2022). The rationale for incorporating this variable is that often new technologies are embodied in new capital investment. New technologies are likely to be more productive and could lead to an increased in growth rate of sales.

- Size: Evidence from Indian manufacturing sector suggests that often large sized firms have more resources to invest in better technologies and can earn more revenues as compared to small sized firms (Goldar, 2011). Therefore, we use gross fixed assets as a proxy for the size variable.

Econometric model: Following Pablo et al. 2011, Judsen and Owen, 1996, we would use a dynamic panel data model to estimate the impact of various economic variables on the growth rate of sales of downstream aluminum firms.

Dynamic panel models are linear regression models that allow the dependent variable to depend on its value from the previous time period, thus making the model dynamic. This generalization results in an auto regressive model which is described below:

$y_{it} = \beta_0 + \beta_x X_{it} + \emptyset y_{i,t-1} + \epsilon_{it}$

The model is dynamic because the equation for time t includes an element from the previous time period, the lagged response $y_{i,t-1}$.

Here, y_{it} is the growth rate of sales of firm i in year t.

$y_{i,t-1}$ is the growth rate of sales of firm i in year t-1.

X_{it} are the independent variables namely import tariffs on primary aluminum, energy intensity, size, per unit capital investment.

In the dynamic AR model, the dependent variable depends on its value from the previous time period in a way that is not explained by the regressors X_{it}.

Alternatively, $\emptyset$ is the degree to which change (or shock) affects the system. If we are considering sales of a firm, suppose a policy change in 2018 which is not represented by X_{it} resulted in much higher sales for that year. Then the higher sales are represented in the AR model by a large positive residual for the year 2018. This effect of policy would not vanish in 2019. Therefore, we include lagged growth rate of sales in our model so that growth of sales in 2019 depend on those for 2018. The results of our econometric model are described in the table below.

Our model was estimated using Arellano and Bond GMM estimator.

3.4 Results:

Arellano-bond dynamic panel data model Estimation Results: Please refer to the annexure.

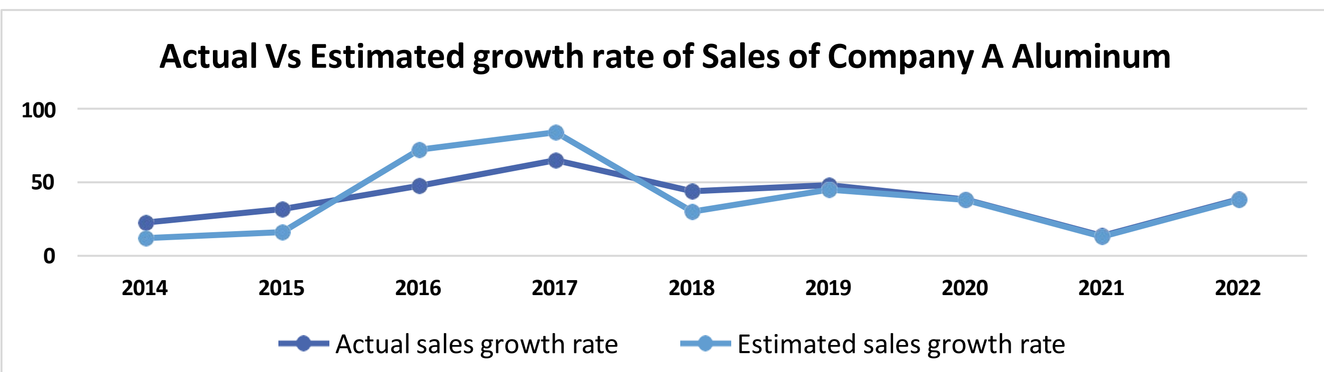
3.5 Interpretation:

It is clearly evident from the table (in Annexure) that the coefficient of import tariffs and energy intensity are negative and significantly impact the growth rates. This suggests that a reduction in import tariffs on primary aluminum would lead to an increase in growth rate of sales of secondary aluminum firms. This could be because a reduction in the import tariffs on primary aluminum could reduce the price of raw material used to develop secondary aluminum and in turn, increase their revenues. Also, a reduction in import tariffs could also promote import of primary aluminum with low carbon footprint from countries like Iceland, Norway, Russia, Canada which could be utilized and processed to make finished goods. This could enhance the competitiveness of the downstream aluminum sector by increasing their revenues/ profitability and making final aluminum production sustainable.

The coefficient on energy intensity is negative and significant at 1 percent. This suggests that a reduction in power and fuel expenditure as a ratio of sales would lead to a reduction in energy intensity which in turn could enhance energy efficiency and ultimately the growth rate of sales of downstream aluminum firms. This in turn could suggest the policy makers regarding policy options to lower the power and fuel expenditure either by investing in new technologies (inert anode, CCUS, green hydrogen etc.) or by switching to electricity generated through renewable energy which could improve the competitiveness and sustainability of downstream aluminum in India.

While the coefficient of size is positive and significant, the coefficient of per unit capital investment is insignificant. This suggests that large size firms generate more revenues as compared to small sized firms which is as expected.

Figure 23: Actual VS Estimated Growth rate of Sales:



Using the coefficients from the dynamic panel data model, this study computed the estimated sales growth rate and compared it with actual sales growth rate. It finds that the model fits the data quite well which is evident from the figure.

3.6 Predictions:

From the results government-imposed import tariffs on primary aluminum significantly impacts the growth rate of sales of downstream aluminum firms. Our study also sheds light on the significance of energy intensity in impacting the sales growth rate. To further examine the impact of import tariffs and energy intensity on the revenues/sales of downstream sector, we have attempted to project the growth paths under 3 different scenarios using the values of coefficients estimated in dynamic panel model.

3.6.1 Scenario I: Base Scenario

The base scenario is the estimated sales growth rate using estimated coefficients from the dynamic panel model and actual data on import tariffs, energy intensity and other variables. This acts as a benchmark for comparing other scenarios.

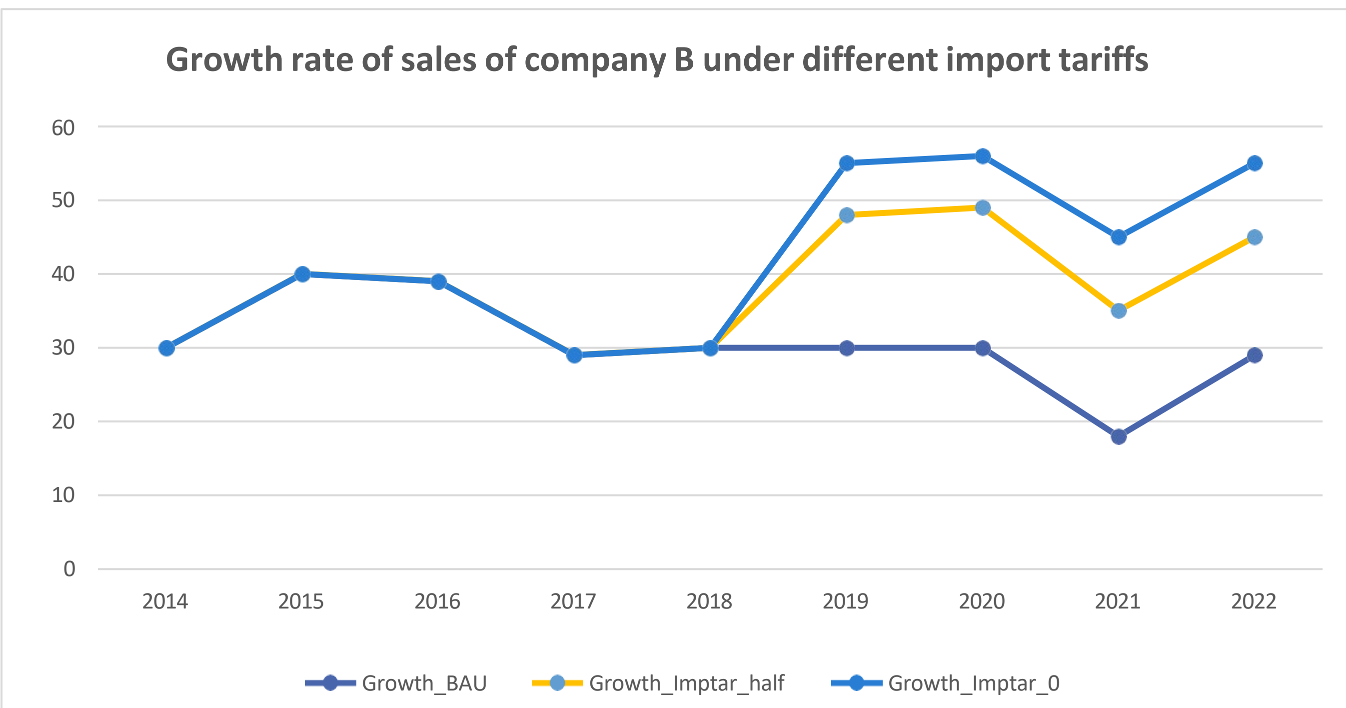
3.6.1.1 Scenario II: Import Tariffs reduced to half.

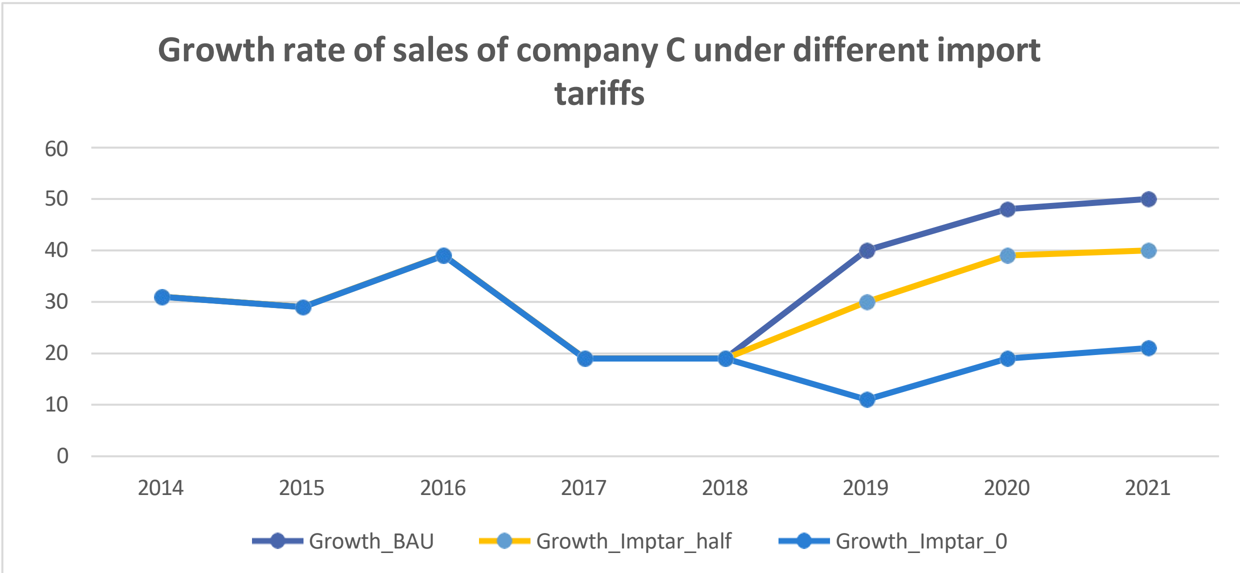
Looking at the data on import tariffs on primary aluminum, we find that the government has consistently increased the import duty from 5 to 7.5 in 2016 and further to 8.25 in 2019. However, since the focus of this paper is to analyze the impact of import tariffs on sales growth rate, the second scenario traces the growth path if the government instead of increasing, would have decreased the import tariffs from 5 to 2.5 in 2018.

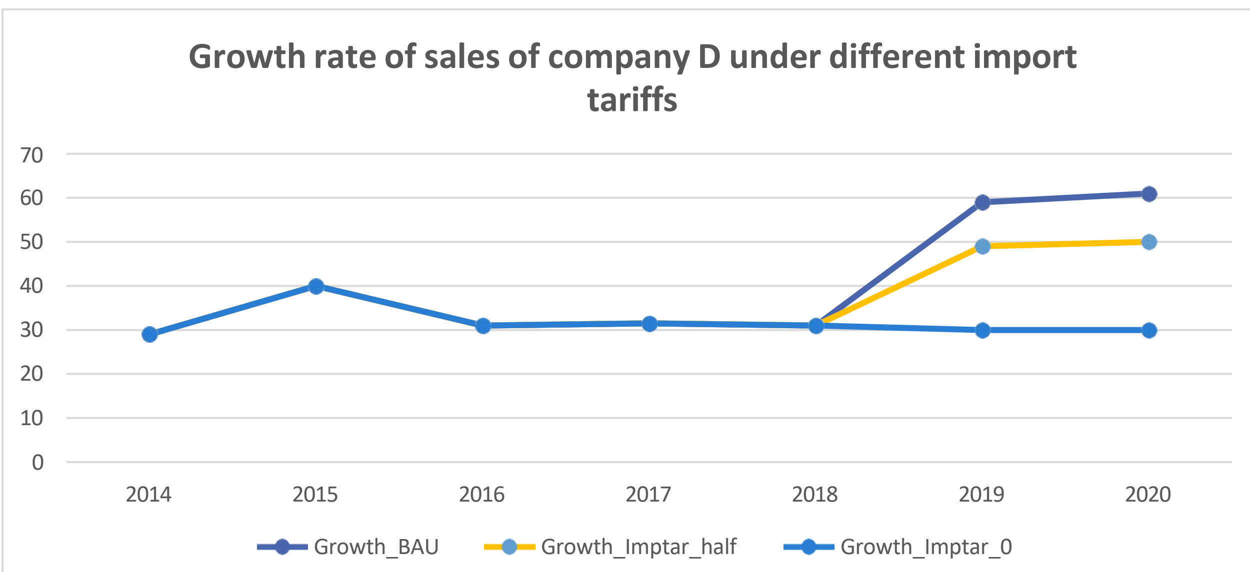
3.6.1.2 Scenario III: Import Tariffs reduced to zero.

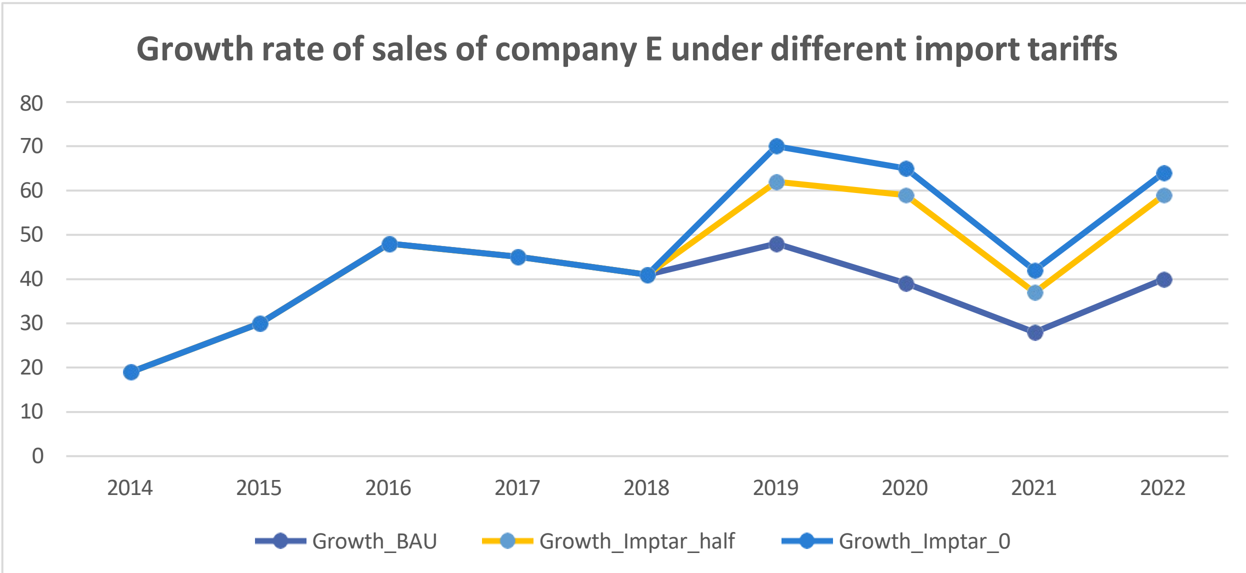
Scenario III: Another interesting scenario would be to trace the growth rate of sales path had the government removed the import tariffs at all i.e. Import tariffs at 0 percent from 2018 onwards.

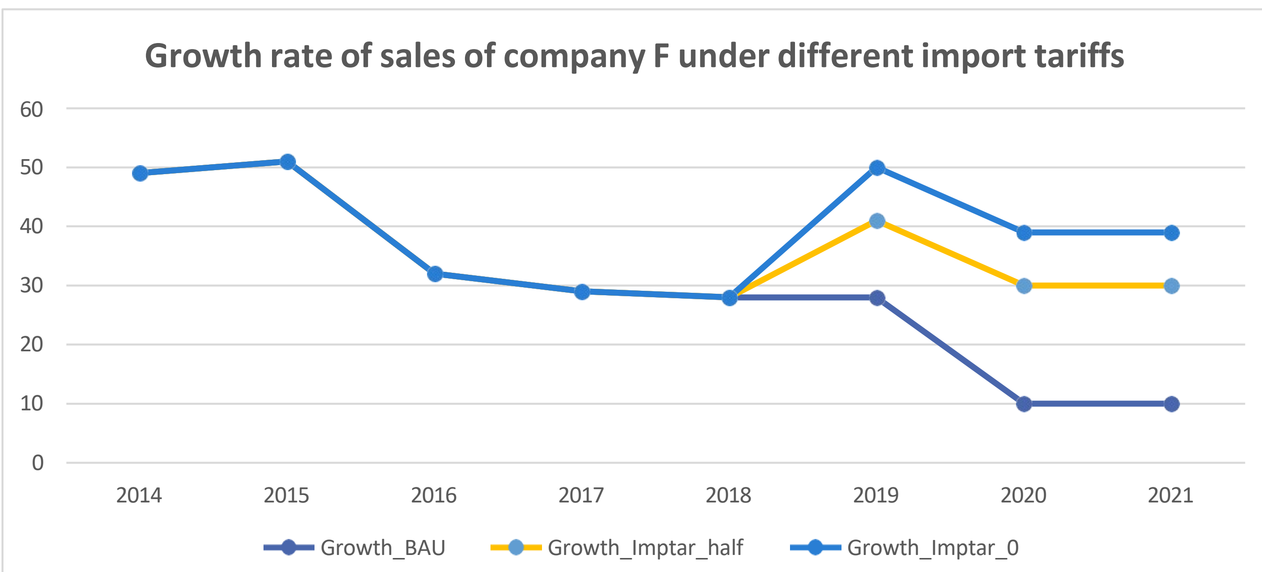
Figure 24: Actual VS Estimated Growth rate of Sales

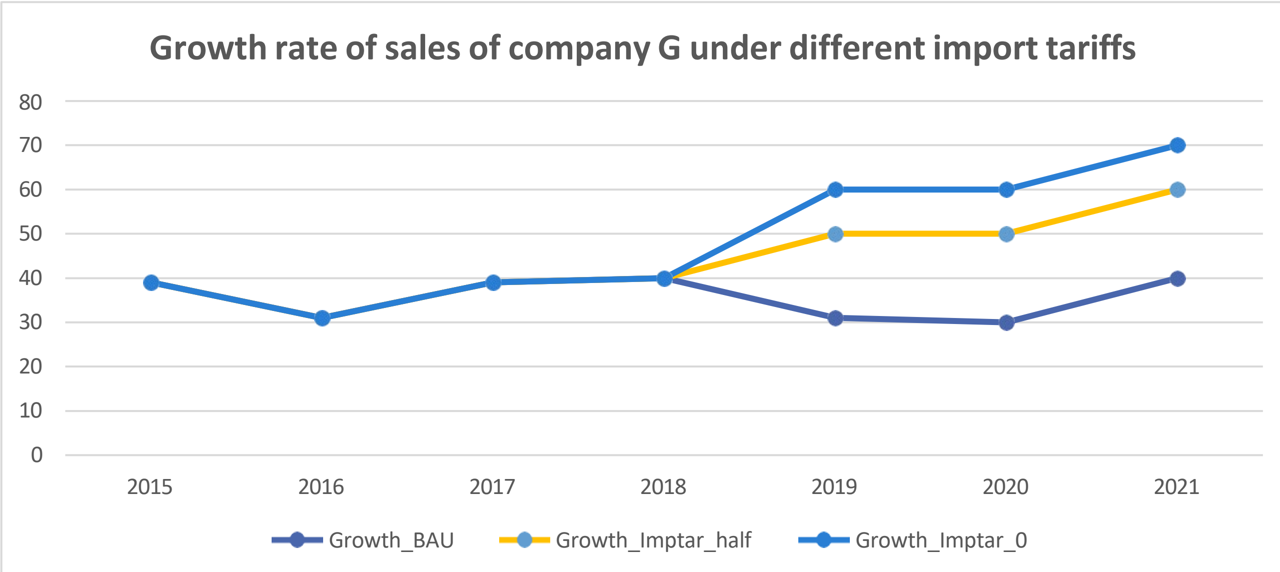



Growth rate of sales of company C under different import tariffs
60
50
40
30
20
10
0
2014
2015
2016
2017
2018
2019
2020
2021
Growth_BAU
Growth_Imptar_half
Growth_Imptar_0


Growth rate of sales of company D under different import tariffs
70
60
50
40
30
20
10
0
2014
2015
2016
2017
2018
2019
2020
Growth_BAU
Growth_Imptar_half
Growth_Imptar_0


Growth rate of sales of company E under different import tariffs
80
70
60
50
40
30
20
10
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
Growth_BAU
Growth_Imptar_half
Growth_Imptar_0


Growth rate of sales of company F under different import tariffs
60
50
40
30
20
10
0
2014
2015
2016
2017
2018
2019
2020
2021
Growth_BAU
Growth_Imptar_half
Growth_Imptar_0



From the figures, it is evident that the red line lies above the blue line and green line is even above the red line. This suggests that if the government would have reduced the import tariffs to half in 2018, then it could have led to an increase in growth rate of sales. Further, if the import tariffs would have reduced to zero percent in 2018, it could have led to further increase in the sales growth rate of downstream aluminum firms.

3.7 Energy Intensity Scenarios:

Another interesting analysis covered in this study is regarding the different energy intensity scenarios. From the results, energy intensity is negatively related to revenues. It is postulated in the literature and also discussed in chapter 2 that by investing in new technologies such as inert anodes, green hydrogen etc., it is possible to reduce the direct emissions and thus, could reduce the power and fuel expenditure which in turn could reduce the energy intensity and increase the revenues of the downstream aluminum sector. Alternatively, switching to alternative sources of energy i.e. from coal based to hydro/solar, we could reduce the indirect emissions and thus energy intensity and increase the revenues of the downstream sector.

Therefore, different energy intensity scenarios would quantify the change in revenues of the downstream aluminum sector as a result of a reduction in energy intensity.

3.7.1 Scenario I: Base scenario

The base scenario is the estimated sales growth rate using estimated coefficients from the dynamic panel model and actual data on import tariffs, energy intensity and other variables. This acts as a benchmark for comparing other scenarios.

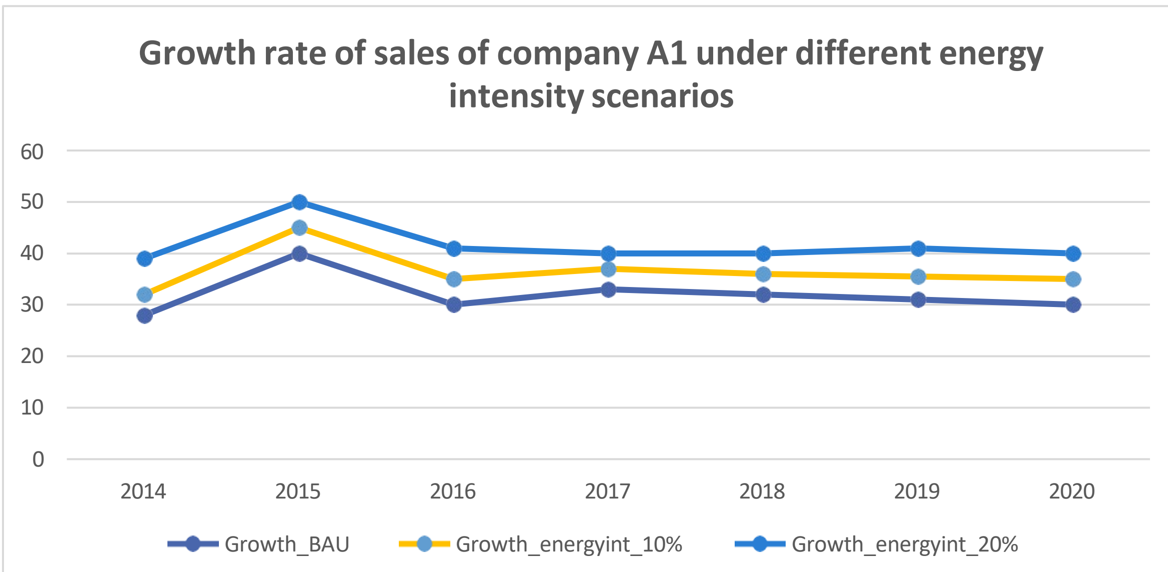
3.7.2 Scenario 2: Energy intensity reduced by 10%

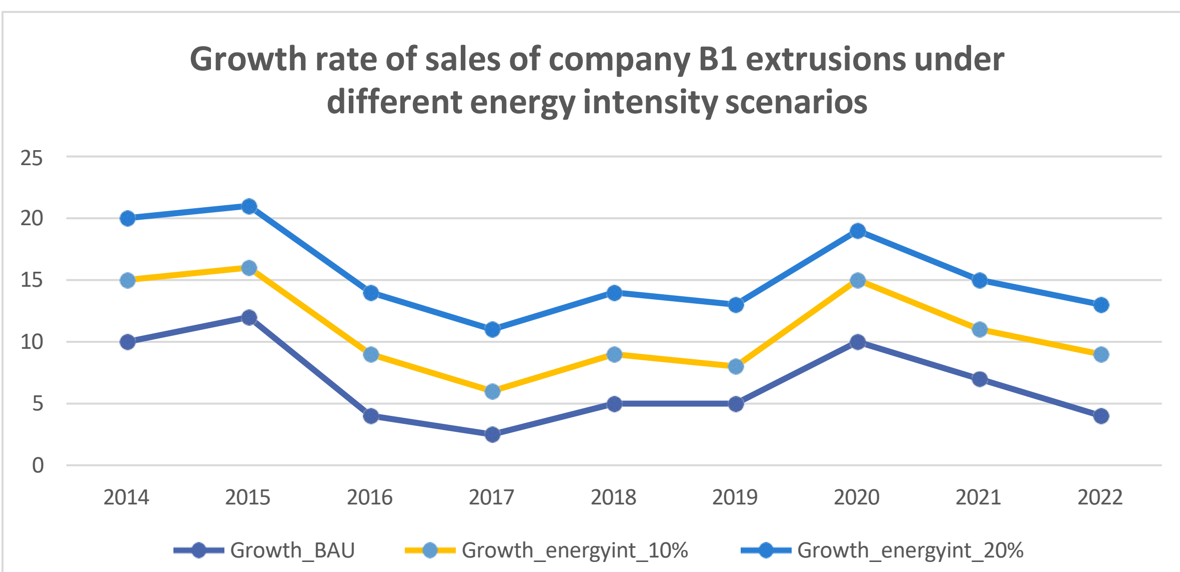
This scenario traces the growth path of sales if the energy intensity is reduced by 10 percent either due to reduction in direct or indirect emissions.

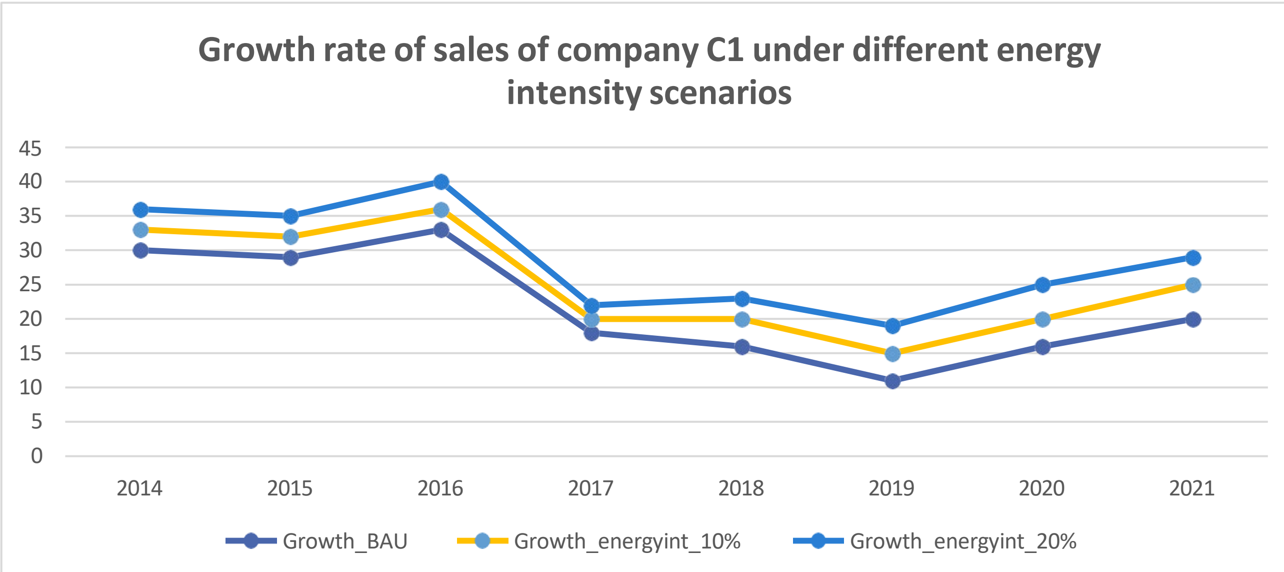
3.7.3 Scenario 3: Energy intensity reduced by 20%

This scenario traces the growth path of sales if the energy intensity is reduced by 20 percent either due to reduction in direct or indirect emissions.

Figure 25: Actual VS Estimated Growth rate of Sales

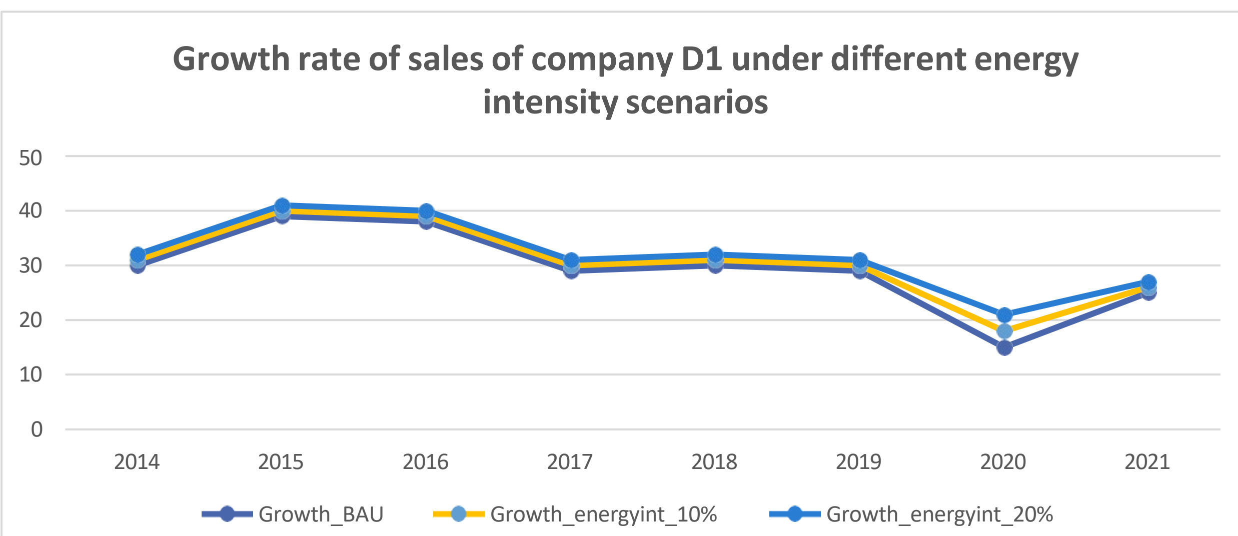


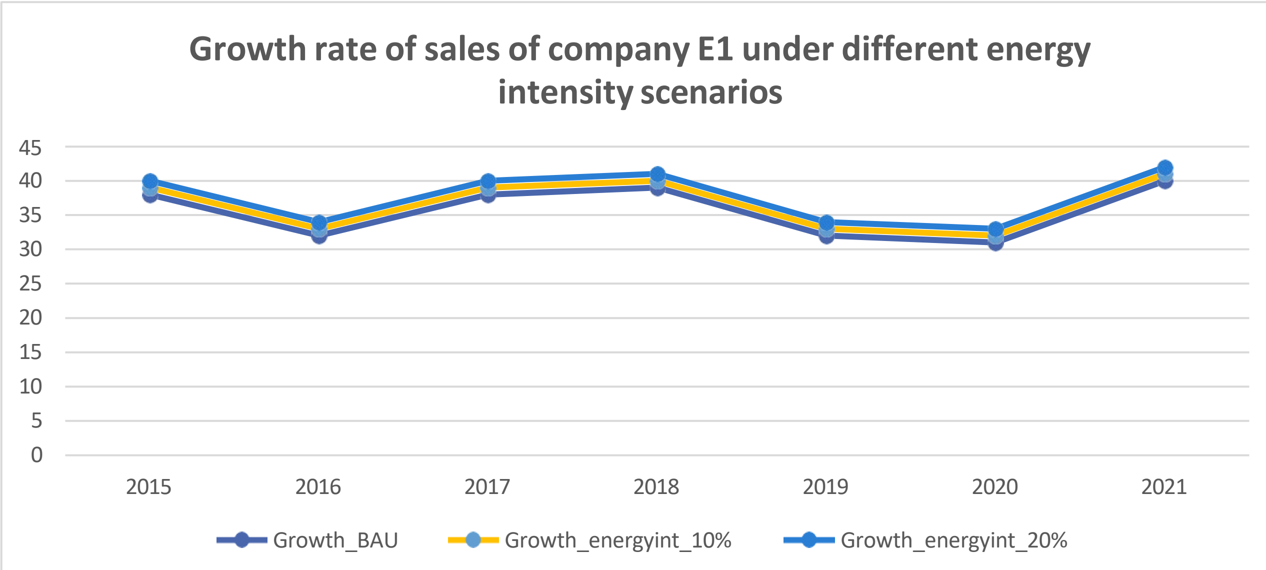




The above figure depicts three alternative scenarios. The blue line depicts the business-as-usual scenario. Whereas the red line depicts the growth rates had there been a 10 percent decline in energy intensity. It clearly suggests that it would lead to an increase in the revenues of downstream aluminum firms (Since, red line lies above the blue line for all three firms). The green line depicts the growth rates had there been a 20 percent decline in energy intensity. The figures above clearly suggest that a reduction in energy intensity to 20 percent would further add to the revenues of downstream aluminum firms.

Figure 26: Actual VS Estimated Growth rate of Sales





3.8 Conclusion and Policy Significance

Using a panel data on 10 aluminum firms from 2014-2022 and utilizing an Arellano bond estimation on dynamic panel model, this study analyzes the effect of various economic factors such as import tariffs on primary aluminum, energy intensity, per unit capital investment etc. on the revenues of the secondary downstream aluminum firms in India. It further quantifies the growth rate of sales revenue under different import tariffs and energy intensity scenarios. It finds that both import tariffs on primary aluminum and energy intensity are negatively and significantly impacting the growth rate of sales of different aluminum firms.

It further quantifies and traces the growth path under different import tariff scenarios: one where the import tariffs decreased from 5 percent to 2.5 percent and second where import tariffs reduced to 0 percent. It finds that a reduction in import tariffs led to a significant increase in growth rate of sales. This in turn suggests that a reduction in import tariff on primary aluminum could serve a twofold purpose: One it could lead to an increase in the revenues of secondary aluminum firms and promote their exports, thus, could raise its competitiveness. Also, as discussed in chapter 2 that in the absence of any short-term measure to decarbonize the aluminum sector in India, a reduction in import tariffs could promote the import of green unwrought/primary aluminum from countries such as Canada, Iceland, Russia, Norway, which could then be further processed in India to make semi-finished and finished secondary products. This in turn, could further improve the competitiveness of secondary products in the global market. In the changing global scenario and increasing demand for green products globally (particularly in the presence of EU CBAM), this could be seen as an efficient policy measure to make Indian products competitive as well as sustainable.

This study also analyzes the impact of energy intensity (which is measured as the ratio of power and fuel expenditure to total sales) on the revenues of the downstream aluminum firms. It finds a negative and significant relation between energy intensity and growth rate of sales of secondary aluminum firms in India. This suggest that a reduction in power and fuel expenditure in India may be due to investments in new technology to decarbonize or due to switching to energy from renewable source such as hydro, wind etc. could reduce the energy intensity in the production of aluminum and thus could raise the growth rate of sales of secondary aluminum firms and make them globally competitive.

It also traces the growth path under different energy intensity scenarios. One is the growth path with a 10 percent reduction in energy intensity from the base scenario, second is the growth path with a 20 percent reduction in energy intensity from the base scenario. It finds that under both scenarios the growth rate of sales revenue of secondary firms increased. This in turn informs the policy makers to frame policies that could lead to a switch from coal-based energy intensive aluminum production process to a production process based on renewable energy such as wind, hydro etc. This could particularly help in reducing the indirect emissions in aluminum production. Alternatively, India could invest in new technologies such as inert anode, green hydrogen, CCUS that could reduce its direct emissions in primary aluminum production.

However, considering the Nationally determined goals of 2030 and net zero by 2070, and in the absence of short-term measures to decarbonize (discussed in chapter 2), reducing the import tariffs on primary aluminum could play a vital role for enhancing the competitiveness and sustainability of secondary aluminum in India.

Chapter 4

Impact of CBAM on Indian downstream aluminum sector

4.0 Background and Introduction:

Energy use in industry is considered as a major contributor towards **global greenhouse gas (GHG) emissions**. Therefore, **decarbonization** of heavy industry could have an immediate impact on reducing GHG emissions and slowing climate change.

As the effect of ***climate change*** is intensifying, various countries and industries are seeking new ways to decarbonize to meet emission targets and reduce energy costs.

In this regard, the European Union institutions have recently adopted the ambitious target of reaching **climate neutrality by 2050.**

Applying a "**Carbon Border Adjustment Mechanism (CBAM)**" is one approach put forward by European Commission.

4.1 What is Carbon Border Adjustment Mechanism (CBAM)

- The CBAM is a climate measure that should prevent the risk of carbon leakage and support the EU's increased ambition on climate mitigation, while ensuring World Trade Organization (WTO) compatibility. The CBAM is implemented to create a level playing field between EU and foreign producers.
- Under CBAM, there will be an import levy on EU imports of electricity, cement, aluminum, fertilizer, hydrogen as well as iron and steel products depending on the carbon emission content of their production.
- Aluminum products included in the CBAM:

  Unwrought aluminum (HS Customs codes: 7601 10, 7601 20);
  Downstream products: aluminum powders and flakes, extrusion, wire rod, flat rolled products, foil, tubes and pipes, tube or pipe fittings, structures, containers, cables and other articles of aluminum (customs codes 7603-7616, excl. 7615).
- The CBAM will equalize the price of carbon between domestic products and imports and ensure that the **EU's climate objectives are not undermined by** production moving to countries with less ambitious policies. The CBAM will apply to imported goods from countries with less strict climate policies will spur adaptation of cleaner technologies.
  - India's aluminum exports to European Union countries will face extra scrutiny under the Carbon Border Adjustment Mechanism (CBAM) starting from October 1, 2023 through reporting obligations on embedded emissions in the imported to the EU goods.
  - From January 1, 2026, the CBAM Regulation[7] will require importers of certain energy-intensive goods including unwrought aluminium and aluminium products

[7] https://www.europarl.europa.eu/doceo/document/TA-9-2023-0100_EN.html

to pay a levy on carbon embedded in their imports that corresponds to the price of emissions allowances under the EU Emissions Trading System ("EU ETS").

- This will be a disruption in the negative sense towards the exports of downstream aluminum products from India. The total share of the world-wide exports of Aluminum and its products thereof to EU is 27.7%. The value of these exports is about 2.7 billion USD and all the products in this category will be impacted by CBAM. Total volume of downstream products exported to EU under CBAM is about 76 thousand tons in 2022.

EU imports of aluminium products from India, tn		
Product	**CN code**	**2022**
Aluminium bars, rods and profiles	7604	19 119
Aluminium wire	7605	14 364
Other articles of aluminium	7616	13 614
Aluminium plates, sheets and strip, of a thickness exceeding 0,2 mm	7606	11 945
Aluminium foil (whether or not printed or backed with paper, paper-board, plastics or similar backing materials) of a thickness (excluding any backing) not exceeding 0,2 mm	7607	8 374
Stranded wire, cables, plaited bands and the like, of aluminium, not electrically insulated	7614	5 094
Aluminium tubes and pipes	7608	1 048
Aluminium powders &flakes	7603	749
Aluminium casks, drums, cans, boxes and similar containers (including rigid or collapsible tubular containers), for any material (other than compressed or liquefied gas), of a capacity not exceeding 300 litres, whether or not lined or heat-insulated, but not fitted with mechanical or thermal equipment	7612	715
Aluminium structures (excluding prefabricated buildings of heading 9406) and parts of structures (for example, bridges and bridge-sections, towers, lattice masts, roofs, roofing frameworks, doors and windows and their frames and thresholds for doors, balustrades, pillars and columns); aluminium plates, rods, profiles, tubes and the like, prepared for use in structures	7610	536
Aluminium tube or pipe fittings (for example, couplings, elbows, sleeves)	7609	184
Aluminium containers for compressed or liquefied gas	7613	6
Aluminium reservoirs, tanks, vats and similar containers, for any material (other than compressed or liquefied gas), of a capacity exceeding 300 litres, whether or not lined or heat-insulated, but not fitted with mechanical or thermal equipment	7611	0
Total		**75 748**

4.2 What is the EU Emissions Trading System (EU ETS)?

To be fully compliant with the WTO rules, the CBAM mirror the current EU ETS to make all market participants, both in the EU and outside, be equally treated**.**

Emissions Trading System (EU ETS) it is a cap-and-trade market-based tool for reducing greenhouse gas emissions operating since 2005 in the EU. The system covers about 10,000 stationary installations (power stations, oil refineries, iron, steel, aluminum, cement, paper, glass, and civil aviation) the EU, Iceland, Liechtenstein and Norway, this represents around 38% of the EU's total emissions.

The ETS system operates through the EU Allowances (EUA). The EU-ETS sets a cap on the quantity of greenhouse gas emissions (mainly carbon dioxide) each installation can release. Each participating firm gets a limited number of annual EUAs.

At the end of each compliance cycle, all EU-ETS participants must calculate and balance enough EUAs to cover all their emissions of that cycle. If their emissions exceed the EUA allowance provided free of charge, they must buy EUAs through auction at ETS. Firms that have reduced their emissions have surplus EUAs. The system allows the market to determine a carbon price, and that price drives investment decisions and spurs market innovation.

The firms are expected to achieve lower emissions by investing in better technologies, fossil fuel alternatives, and energy efficiency.

4.3 How Carbon Border tax will be calculated

The price of the CBAM payments should be calculated based on actual emissions of exporters including India to the EU. To cover the emissions embedded in the exports to the EU, EU importers buy CBAM certificates, calculated as a weekly average auction price of emissions allowances under the existing EU ETS. The current free allowances will be deducted from such embedded emissions until they are fully phased out.

In case when actual direct emissions cannot be adequately determined by the EU importer (authorized CBAM declarant), default values will be used:

1. Default values based on average emissions intensity of India for aluminum, increased by a mark- up;
2. Default values based on X (for example 10%) of the worst performing installations in the EU for aluminum. Using default values will also increase the CBAM payments for Indian exporters.

Below we propose the CBAM extra costs estimations for downstream exporters in India to the EU based on the assumptions that 1) indirect emissions are included in the CBAM for aluminum 2) reduction of free allowances will lead to an increase of EU ETS prices and CBAM payments, up to 150 EUR/t.

Current benchmark EU ETS (smelters)[8]: tCO_2/ t Al	1.464
India, tCO_2/t Al (Scope 1 &2)	16.8
India, Emissions over ETS benchmark (Scope 1&2)	15.3 (16.8-1.464)
ETS Allowance Price, EUR/t	**150**
CBAM costs, EUR/t	2 295
Total export of India's downstream products to the EU in 2022, t	75 748
Total overpayment, EUR	173 841 660
Total overpayment, USD	183 055 268

India's downstream producers when exporting to the EU **will face 183 mln USD of extra CBAM costs that translates to 47% import duty rate.** In case India implements internal carbon market and put a price on carbon, then it will be deducted from the CBAM price. However, in practice on the initial stages of the carbon markets' functioning, the price is very low to offset CBAM costs.

Based on the 2022 level of Scope 1&2 CO_2 emissions the CBAM **price on India's aluminum products would be about 2 400 USD/t** and it will further increase with free allowances are phased out.

It should be noted that emissions from the downstream production have to be added to the emissions generated by smelters used in above calculations that will further increase the CBAM payments. Extra costs resulting from CBAM would undermine the development of India's downstream sector and their competitiveness on the EU market will be at risk.

India's downstream needs green solutions to stay competitive in the internal and external markets and access to duty-free low-carbon raw aluminum will contribute to the quality and reputation of India's brands in the global market in the category of green goods.

[8] https://climate.ec.europa.eu/system/files/2021-10/policy_ets_allowances_bm_curve_factsheets_en.pdf

CONCLUSION AND WAY FORWARD:

Aluminum is the future of numerous sectors like transportation, construction, power etc. There is an upsurge in production, consumption and demand of India's aluminum within India and outside because of its unique properties like circularity, durability and lightweight, etc. The demand for aluminum is going to rise in India to support India's industrial vision of achieving 25% of GDP from manufacturing by 2025 under the "Make in India" initiative and as a result of increasing urbanization, development of industrial corridors, rural electrification, smart city projects, housing for all, and various other infrastructural projects.

An aluminum sector can be looked at from two perspectives i.e., primary aluminum and downstream aluminum. In India, there are 3 major producers of primary aluminum, who enjoy the plentiful source of bauxite, availability of cheap labor and access to their captive power plants along with coal abundance which helps in growing the production efficiency. For primary aluminum production, 90% of the production capacity depends on coal which is the cause of high carbon-dioxide emissions.

Internationally, coal-based production is regarded as the environment's foe and the production process is also highly cost-ineffective. Coal is responsible for 40% of carbon dioxide emissions from fossil fuels globally. It negatively affects the global competitiveness of Indian Aluminum producers, whose products entail a high carbon footprint, the characteristic which increasingly influences the customer's choice.

On the other hand, more than 60% of the value addition takes place at the downstream sector level and the sector accounts for the major share in the Indian aluminum industry's output and employment. The aluminum downstream sector involves a broad group of producers manufacturing highly differentiated outputs like manufacturers of aluminum extrusions, flat rolled products and castings, as well as producers of foil, wire, slug and powder, lacquers and other processing applications. Semi-finished aluminum products are sold to a wide variety of customers using them in manufacturing processes further down the chain. However, it has been continuously suffering from the increase in the costs of the main raw material i.e., the unwrought aluminum, whose value has been increasing, concurrently decreasing the competitiveness of the sector.

In-spite of high costs and issues concerning environment, India enjoys the status of net exporter of unwrought aluminum and aluminum items, whose exports have increased. Imports of value added products have also risen sharply, but the import share of unwrought primary aluminum decreased whereas the downstream aluminum sector increased, starting from 2014 and especially post 2016. It is observed that the Indian domestic downstream industry is losing its market share steadily due to rising imports of aluminum products. There has been an increase in import duty on unwrought aluminum which negatively impacts the Indian downstream sector.

The effect of tariff structure is crucial for the competitiveness of Indian firms. Since last 10 years, India has negotiated and implemented different trade agreements in various forms. As a result, a large number of finished aluminum goods have slipped into the country due to the significant tariff cut under FTAs but duties on intermediate goods are still relatively higher. Even, the Effective Rate of Protection has declined a lot from 2011 to 2022 under the Free Trade Agreements and has reached a negative rate under FTAs with ASEAN (inclusive of Philippines) and South Korea. This situation of inverted duty structure has affected the competitiveness of the final goods producers as they need to compete with cheaper foreign commodities.

This study also shows through an econometric model (dynamic panel data model) the relation between the revenues of a downstream aluminum producer and import tariffs, energy intensity, capital investment, and size. It shows that the downstream companies can grow in revenues significantly with a reduction in tariffs on the primary aluminum.

Primary production process of aluminum accounts for more than 90 percent of the aluminum industry's emissions. Usage of primary aluminum with high carbon footprint jeopardizes entry of Indian aluminum products to the EU and other markets in the perspective of Carbon Border Adjustment Tax. The study concludes that the effective tariff on the exports of the Indian downstream aluminum products will be to the tune of 47% due **carbon border adjustment tax.** Keep in mind that the domestic downstream MSMEs already buy primary aluminum at an **import-parity price that is inflated by 8.25% due the customs duty.**

The aluminum industry accounts for about 275Mt direct CO2 emissions in 2021 and it increases to 1.1 Gt of CO2, if indirect emissions from electricity consumption are included in it.

This study discusses a series of new technologies for decarbonization such as inert anodes, carbon capture and storage (CCUS), green hydrogen etc. But there are challenges in the path towards decarbonization e.g., these new technologies would require high capital cost and vast infrastructure. Moreover, the speed at which these technologies can be evolved is dependent on the regulatory and investment environment in each country. All these options could be viable in the long run for a country like India with a host of regulatory and environmental procedures for adopting any new technology.

This study also analyzes **the impact of energy intensity (which is measured as the ratio of power and fuel expenditure to total sales) on the revenues of the downstream aluminum firms**. **It finds a negative and significant relation between energy intensity and growth rate of sales of downstream aluminum firms in India.** This suggest that a reduction in power and fuel expenditure in India in part due to investments in new technology to decarbonize or due to switching to energy from renewable sources such as hydro, wind etc. could reduce the energy intensity in the production of aluminum and thus could raise the growth rate of sales of downstream aluminum firms and make them globally competitive.

In a highly competitive environment where countries like EU are coming up with Carbon border adjustment mechanism in 2023, there is an increasing pressure on India to reduce its GHG emissions by 2030, it should explore short term ways to decarbonize. In this regard, for the short –term goals India could use trade as a tool to spur decarbonization.

As mentioned earlier, the price for unwrought aluminium is key for the competitiveness of the Indian aluminium downstream industry. Currently, the main problem that Indian downstream faces is the over-pricing of the primary aluminium due to import parity prices (read high import tariffs) for the production of value-added products.

In the absence of any short-term policies towards decarbonization, one such tool could be reducing the import tariffs on primary aluminum and total abolishment of tariffs on aluminum with low carbon footprint that could reduce the price of raw material and thus could raise the competitiveness of downstream aluminum sector. It could also encourage the import of low carbon primary aluminum from countries like Canada, Norway, Russia and Iceland that could be used to produce the finished goods domestically and in turn, promote export of green aluminum value added products globally.

In the changing global scenario and increasing demand for green products globally (particularly in the presence of the EU CBAM), this could be seen as an efficient policy measure to make Indian products competitive as well as sustainable.

By doing this, the government will keep the prices of the inputs to the downstream sector in control, help in increasing the revenues of the downstream sector, allow to rise its competitiveness at local and export markets, including in the EU, and will protect millions of jobs, providing the possibilities for technological and innovation development as well as stimulate the capacity increase.

Time is of the essence and the government should act fast.

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Annexure:

Results
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Arellano-bond dynamic panel data model Estimation Results Table:

Dependent Variable: Growth rate of Sales	Coefficient	Standard Error	P Value
Independent Variables			
l.salesgrowth	-.1917	.1446714	0.185
Energyintensity	-.5707***	.1689414	0.001
l.importtariff	-3.30724***	1.441372	0.022
Perunitcapinvest	-.0628169	.0838394	0.454
Size	.0017651 *	.0012198	0.148

Number of obs = 53

Wald chi2(5) = 16.11

Prob > chi2 = 0.0065

Instruments for differenced Equation: GMM-type: L(2/.).salesgrowth_n

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