

# Circular Economy of Material Recycling Policy: An Analytical Study of selected Non-Ferrous Metals

<sup>\*1</sup>Suri Deepali & <sup>2</sup>Singh Kalpana

<sup>1</sup>PG Student, Amity School of Economics, Amity University, Noida, Uttar Pradesh(India)

<sup>2</sup>Professor, Amity School of Economics, Amity University, Noida, Uttar Pradesh(India)

## ARTICLE DETAILS

### Article History

Published Online: 15 May 2019

### Keywords

AUTOSORT, Circular Economy, Recycling, Scrap, X-Tract.

### \*Corresponding Author

Email: maildeepalisuri[at]gmail.com

## ABSTRACT

*This study has been undertaken to analyze the Circular Economy of Material Recycling Policy. Thus the study aimed at analyzing the market trends in Production & Trade of Aluminium and examining the impact of these factors on Aluminium (Al) Scrap generation using Regression Model & Forecasting & Trend Analysis. The study also investigated the international best practices. To analyze how much scrap is generated by 2025 in future, forecasting has been used. For the very purpose yearly time series data has been arranged. It is observed that Al Scrap Generation is positively affected by Production and Exports of Al and Negatively affected by Imports of Aluminium. The results have overall and individual significance which has been tested through F value, P value and t test and finally the comparative study of Copper and Aluminium has been done.*

## 1. Introduction

The circular economy is more effective way of producing things that humans needs and that don't create so much waste, pollution, exploration and negative impacts. It means rebuilding and regenerating natural capital & designing out waste which increases economic growth and employment which means Growth Within (Webster, 2016). Circular economy as "an industrial system that is restorative or regenerative by intention and design". (Ellen MacArthur Foundation, 2013). Circular economy aims at maintaining the value of products, materials and resources and minimising the generation of waste. (European Union Commission, 2015). Maximising the utilisation of products and materials & Designing out negative externalities such as pollution. (Ellen MacArthur Foundation, 2015). The rationale behind this Material Recycling Policy is that recycling helps to reduce the pollution caused by waste. It conserves raw materials and protects natural habitats for the future. It reduces the need for more landfills. It generates business & economic opportunities & environmental & societal benefits. Developing CE with the objective of promoting Eco Industrial Development (EID) and high rate of economic growth. It strengthens national security.

Present Study mainly focuses upon Material Recycling Policy by exploring the possibility of adapting Circular Economy Mechanism for Non Ferrous Metal (Aluminium) in India.

- To analyse the Market Trend - Production, Consumption & Trade
- To see the impact of factors (Production, trade) on Aluminium scrap generation.
- To analyse the International Best Practices of Metal Recycling which includes Aluminium recycling or Aluminium Scrap Recycling, Copper recycling etc.
- To make a comparative study of Aluminium & Copper.

According to the Green Economy Initiative Report, the main sources are technologies, equipment, infrastructure for fuel-efficient, and waste management, recycling facilities for future growth and development. Aluminium recycling rates are

quite high for most of the applications. Increasing the consumption of aluminium due to government initiatives like, Make in India, Smart Cities etc. Two operations exist for aluminium recycling: remelting or refining. Remelting produces wrought alloys for rolled products & refining Circular economy. Aluminium scrap is used to produce cast alloys. Recovering aluminium from recycling is energy efficient and ecologically sound.

### 1.1 CMR- Century Metal Recycling Plant Visit

CMR – Century Metal Recycling is India's largest producer of Aluminium and Zinc die-casting alloys. The plant deployed technologies such as twin-shaft shredder, eddy current separator, high-capacity melting furnaces with metal circulation pump, de-coater, etc. During the plant visit, they explain about the Material Recycling Policy & the recycling process of Aluminium starting from the collection of Al cans from consumers who throws the Al cans & foil into a recycle bin to when the Al is sorted & cleaned for reprocessing in treatment plant & then goes through a re-melt process & then made into large blocks called ingots & these ingots sent into the mills & made into aluminium products like cans etc. They also explained about the safety measures & about safety equipments, also observed that they give employment to female population. This visit explains & gave a more clear view about how to go about for Material Recycling Policy.

## 2. Methodology

Paper is based on Secondary Data. So far as first & second Objective is concerned, the Quantitative Research Methodology & Analytical Research Methodology has been used, for this the study analysed Trends of Production and Trade using Forecasting analysis from 2012-13 to 2024-25 and also examined the impact of these factors on Aluminium Scrap Generation. For this Multivariate Regression Analysis has been performed on the basis of this model.

**Null hypothesis is  $H_0: \beta_1, \beta_2, \beta_3=0$**

**Alternate Hypothesis is  $H_a: \beta_1, \beta_2, \beta_3 \neq 0$**

Here the null hypothesis indicates that there is no relationship between Independent & dependent variables and Alternative hypothesis represents that there is significant relationship between the variables. As far as concerned the third & fourth Objective, the study used the Qualitative Research Methodology that is Descriptive Research Methodology where through in-depth review of literature, international practices of Aluminium recycling has been analysed & did a comparative analysis between Cu & Al.

**Sources of Data**

For this study secondary data has been collected & some field work was done to gain the better understanding of how the recycling process works. From the website of FICCI Report 2018, Indian Minerals Yearbook 2017 (Metals & Alloys), Ministry of Mines (Govt. of India), data of production, Al Scrap Generation, Exports of Al and Imports of Al has been collected from 2012 to 2016 and further data has been forecasted using forecasting analysis. International best practices has been retrieved from government website of waste recycling and tomra case studies on recycling.

**Factors growth in Future Years which has been forecasted using Trend Analysis:**

**2.1 Data Analysis & Discussion**

**2.1.1 Market Trends**

Paper is based on Secondary Data. As far as concerned with the Objective used the Quantitative Research Methodology, by using the Regression Analysis which determines the relationship between dependent variable (Y) and other changing variables (Independent variables), here by having an impact of Production, Exports of Aluminium, Imports of Aluminium on Aluminium Scrap Generation.

Regression Equation can be represented as:  

$$AI\ Scrap\ Generation(y) = \beta_0 + \beta_1 x_1(Production) + \beta_2 x_2(Exports\ of\ Al) + \beta_3 x_3(Imports\ of\ Al) + \epsilon$$

This multivariable regression equation represents the impact of predictor variables on response variable.  $\beta_0$  represents the Y- Intercept,  $\beta_1, \beta_2, \beta_3$  represents the regression coefficients. Here firstly we did the forecasting of various factors till 2025-26 using trend analysis which is verified by  $R^2$  then perform Multivariate Regression Analysis to see the impact on Aluminium Scrap Generation.

**Graph 1: Production of Al**

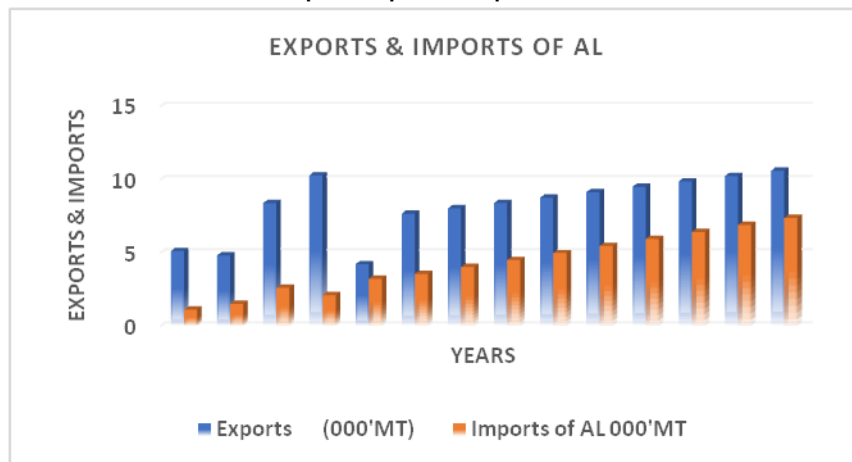


Source: Author's own calculation/Compilation from FICCI Report 2018

This graph represents that the production of Aluminium is continuously increasing throughout from 2017 to 2025 which is forecasted. In terms of primary aluminium production, India ranks fourth & China continued to be the single largest

aluminium producer & major consumers of aluminium. Availability of cheap labour aid in increasing the production efficiency. (FICCI Report, 2018)

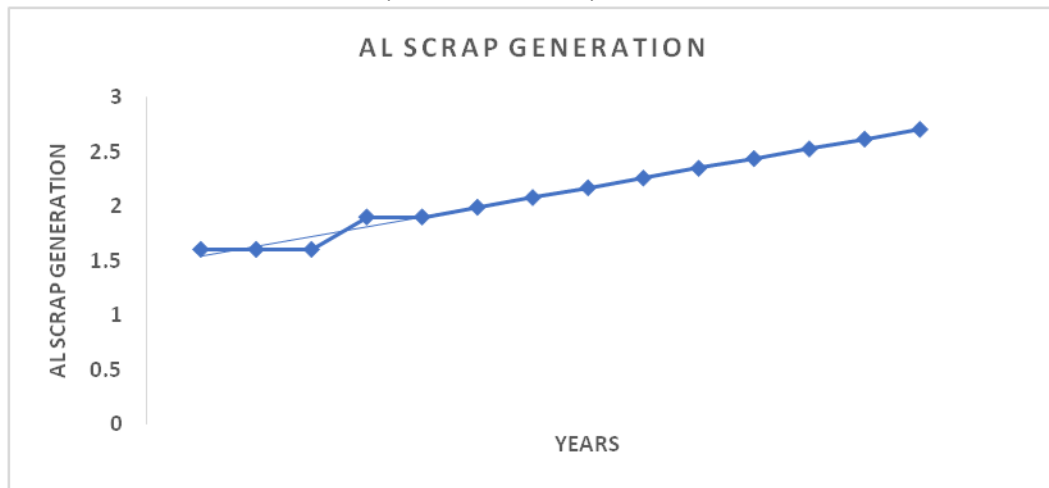
**Graph 2: Exports & Imports of Al**



Source: Author's own calculation/Compilation from FICCI Report

This graph represents the exports and imports of Aluminium. In last five years, India is now a net exporter of base metal rather than importer. ASEAN’s exports of aluminium products to India have risen at a fast pace. The imports of aluminium scrap have increased by almost 200%. (FICCI Report, 2018)

Graph 3: Aluminium Scrap Generation



Source: Author’s own calculation/Compilation from FICCI Report

This graph represents that Al Scrap Generation is continuously increasing which may be due to production of Aluminium.

2.1.2 Results & Discussion of Multivariate Regression

Table 1: Regression Results of Aluminium

Factors	Coefficients	t Stat	P-value
Intercept	0.8513	34.2332	1.07E-11
Production	0.5114	21.0014	1.33E-09
Exports of Al	0.0081	3.3191	0.007758
Imports of Al	-0.1282	-8.7936	5.1E-06

F- Value: It is close to 0 that is 1.68E-15  
Here the alpha is 0.05

Here it represents that Al scrap generation is a **dependent variable** and the production of Al, Exports of Al, Imports of Al are the **independent variables** which indicates the regression equation as:

$$y = 0.8513 + 0.5114x_1 + 0.0081x_2 - 0.1282x_3 + \epsilon \dots\dots\dots(1)$$

y indicates the Al scrap generation, x1 indicates the Production of Al, x2 indicates the Exports of Al and x3 indicates the imports of Al. This regression case is overall significant by testing the significance of F as it is 1.68E-15 which is very small number close to 0, which is less than 0.05 therefore it rejects the Null hypothesis, therefore the overall results are significant.

**Null hypothesis is  $H_0: \beta_1, \beta_2, \beta_3=0$**   
**Alternate Hypothesis is  $H_a: \beta_1, \beta_2, \beta_3 \neq 0$**

Here the null hypothesis indicates that there is no relationship between Independent & dependent variables and Alternative hypothesis represents that there is significant relationship between the variables. This equation (1) represents that Al Scrap Generation is positively related to Production which represents that if production increases which may lead to an increase in Al scrap generation as if production of Al increases which may lead to increase consumption therefore generate more scrap which is available to recycle.

Therefore recycling the scrap metal considered to be as the best option so that we can able to conserve our resources and benefits to our economy and environment as it may lessens the Green House gas Emissions etc. (Suri,2019; Singh,2019)

To check individual significance we consider here P Value and t-test. Here the P Value of production is 1.33E-09 which is very small amount, which is less than 0.05, therefore production has a significant impact on Al Scrap Generation. According to t-test as alpha is 0.05 therefore critical value of t are  $\pm t_{1-\alpha/2, n-2} = \pm t_{0.975, 12} = \pm 2.179$  and the calculated value of t in this case is 21.001 which is much larger therefore it rejects the null hypothesis, therefore the results are significant. Similarly there are significant results for trade impact on Al scrap generation according to p value and t test. As we observe that Exports of Al has a positive impact on Al Scrap generation which shows that if exports increase which means that we are exporting good quality metals for which the scrap generation is later in future years to other countries & the remaining which is left in our country is about to generate its scrap in present year which may increases the scrap generation in present year. Exports has a significant impact on Al Scrap Generation as it has been tested through P Value and t test, according to P value, the P Value of exports is 0.007 which is less than 0.05 therefore it rejects the null hypothesis, it may lead to have

significant result. According to t-test as alpha is 0.05 therefore critical value of t are  $\pm t_{1-\alpha/2, n-2} = \pm t_{0.975, 12} = \pm 2.179$  and the calculated value of t for exports of Al is 3.31 which is larger than critical region therefore rejects the null hypothesis, hence results are significant. Similarly the Imports of Al has a significant impact on Al scrap generation, as if Imports increase which means that we are importing good quality metals which may generate its scrap in future years not in present year, therefore scrap generation is less in current year. P value has a significant impact as p value of imports is less than 0.05, which rejects the null hypothesis. T test also has a significant impact as calculated value of t which is -8.79 which is less than critical value -2.179 at 0.05 level of significance. (Suri,2019; Singh,2019)

Therefore the results have overall and individual significance which has been tested through F value, P value and t test. The main objective to do this trend analysis & regression method is firstly to analyse how much scrap is generated by 2025 in future so that proper recycling methods can be adopted, proper collection mechanism should be there so that it may enhance the value chain which may improve our circular economy. Second objective is to analyse the impact of Production, Imports & Exports of Al on Al scrap generation. It explains Market Trend - Production & Trade and the impact of factors on Aluminium scrap generation, did the trend analysis & forecasting of Al Scrap Generation & its various factors and to show the significance of variables or factors on Al scrap generation, Multivariate Regression analysis has been performed. The results have been observed which shows that the Factors (Production of Al & Exports of Al) has positive impact on Aluminium scrap Generation whereas Imports of Aluminium has negative impact on Al Scrap Generation & by testing through F value the results are overall significant and through P value test and t test the results are individually significant which shows that it has a significant impact on Aluminium Scrap Generation. (Suri,2019; Singh,2019).

### 3. International Best Practices

#### **CENTRO ROTTAMI, ITALY**

Aluminum reusing is huge for the Italian economy, which has been insufficient. Honestly 90% of the aluminum made in the country starts from reusing. Italy has presented an amazing number of X-bar Transmission X-TRACT units which support the arranging and preparing of aluminum for reusing. The Centro Rottami is a principle Italian reusing center. Centro Rottami forms around 300-500 tons of aluminum, 4,000 tons of scrap metal etc. X-TRACT unit is used for better separation of the processed material & optimize the quality of recovered aluminium. Processing begins with a shredding installation because of which three sorts of items are acquired: fluff, mixed shredded metals & shredded scrap metal.

#### **HUNGARY**

New framework, furnished with 10 AUTOSORT units and one X-TRACT unit. Sensor based arranging innovation has been introduced. The plant is intended to meet reusing targets, which require its individuals to reuse half of family and comparative waste by 2020.

**Procedure review :** The Municipal Solid Waste treatment plant involves ten AUTOSORT sensor-based arranging units, which distinguish and recoup significant materials. TOMRA's AUTOSORT units are fueled by weighty and protected FLYING BEAM innovation, which empowers them to give consistent alignment. This implies generously less vacation, more prominent yield dependability contrasted with closest contenders. The AUTOSORT units likewise advantage from DUOLINE innovation, which prompts higher execution, low vitality utilization. At the point when the polymers and aluminum have been isolated from the 80-320 mm part, the two residual streams join. The entire locale has influenced a monster jump from having to send the majority of its MSW to landfill, to having the capacity to process as much as 120,000 tons for every time of MSW material in a best in class framework.

#### **EUROPE**

The "Every Can Counts" programme aims to improve recycling by encouraging people to recycle cans used outside the home (e.g. workplaces, tourist locations, etc.). Every Can Counts programmes operating across 12 European countries (UK, Belgium Greece, Austria, France, Serbia, Romania, Ireland, Spain, Montenegro, Poland, Hungary). It is a 'one stop shop' to help organisations increase recycling and demonstrate their commitment to sustainability. It establishes partnerships between metals industry, local authorities, collection partners and major retail and drinks brands. Europeans use up to 50 billion cans every year. It takes only 60 days for a single aluminium can for the whole procedure that is to be produced, filled, distributed, consumed and recycled into a new can. Encouraging recycling of beverage cans is thus key to achieve the circular economy.

#### **GERMANY & UK**

Reusing of aluminum bundling in Germany achieved its most elevated amount in 2012. 83,500 tons of aluminum bundling was reused, comparing to over 89% of the complete aluminum bundling delivered that year, as indicated by the investigation of CVM Society for Packaging Market Research. "The high rates of reusing demonstrate that we have a magnificently working bundle reusing framework in Germany", says Hans-Jürgen Schmidt, overseeing chief of German Aluminum Packaging Recycling (DAVR). It has been achieved through a yellow bin waste sorting system along with the help of modern technologies such as eddy-current separators. By reusing aluminum, 95 percent of the vitality is moderated which is required for essential creation of raw materials. It is beneficial to climate protection. This compares to the complete lifetime fuel utilization of in excess of 13,000 recently enrolled autos on German streets in 2013 as indicated by information from the Federal Motor Transport Authority (KBA). (Condition Europe Green Capital,2014). Glasgow Recycles is a socio-environment activity given a blended reusing arrangement which was propelled in 2008 and was the primary such venture in the UK. It intends to handle 'far from home' waste and increment reusing rates. The European Green Capital Award is an activity to advance and reward these endeavors. This award is the result of an initiative taken by 15 European cities (Tallinn, Helsinki, Riga, Vilnius, Berlin, Warsaw, Madrid, Ljubljana, Prague, Vienna, Kiel, Kotka,

Dartford, Tartu & Glasgow) and the Association of Estonian cities on 15 May 2006 in Tallinn, Estonia. (Environment Europe Green Capital, 2014)

“Green cities – fit for life”.

**JAPAN**

The aluminum reusing industry is entrenched in business sectors, for example, Europe, China, India, Russia and so on. Japan moved from household essential generation to reusing and it is among the top recyclers of utilized drink can (UBC) on the planet. As per Japan Aluminum Can Recycling Association practically 20.16 billion jars were devoured in Japan. Among them over 17.53 billion units were reused, achieving a reusing extent of 87.4% and engaging the saving of 8.1 billion kWh control. Key factors that have been recognized by the Japan Aluminum Can Recycling Association to clarify the accomplishment of the Japanese can reusing framework that is "Separate Collection" framework. UBC are gathered through general stores and malls and organizations as a feature of their CSR exercises and sold to assets recyclers. Solid help of ACRA to local gatherings ACRA underpins and energizes local gatherings with exhortation and data about reusing. Getting off and destroying framework have been executed for the reusing of trade-in vehicles just as the structure and development. In Europe, aluminum packaging reusing schemes can be characterized into three fundamental classifications: deliberate reclaim frameworks, separate collection schemes, voluntary take back systems, Separate collection of UBC.

**UNITED STATES**

Recycling is significant for the sustainability of a man-made metal like aluminum as it saves both scarce natural resources and energy. Three activities add to the complete aluminum metallic loss to the landfill: downstream separation,

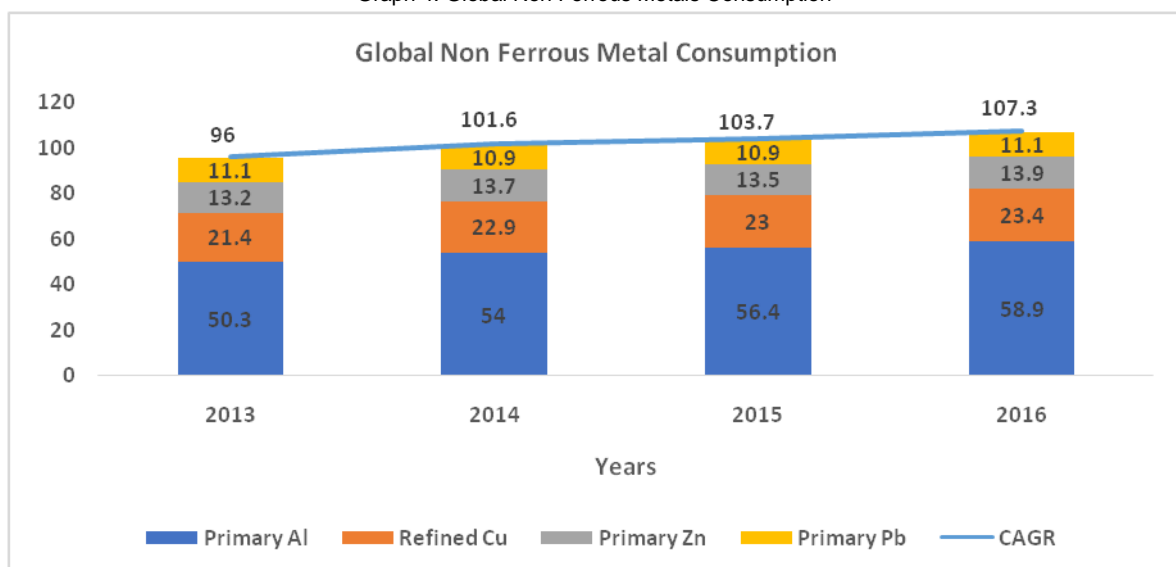
shredding and scrap melting. Aluminum is recovered during the end of-life vehicle (ELV) reusing forms. Eddy Current Separators (ECS) uses the vast scope of electrical conductivities inside the blended metal steam. Sink-float (heavy media, thickness) partition uses the known explicit gravities of water-based slurries to separate non-ferrous metals and plastics with differing densities. X-ray transmission (XRT) is utilized to sort metals. X-ray fluorescence innovation is utilized to decide the chemical composition of unknown scrap metal pieces.

**4. Comparison of Results of Aluminium & Copper**

As the detailed study has already been done in previous paper titled “A study on Non Ferrous Metal: Copper in Circular Economy”, for this refer to the (Appendix), when we compare the results of Al & Cu, we used the Multivariate Regression Analysis, Forecasting & Trend Analysis for both the metals (Al & Cu) as a methodology in our paper, we analysed that the Production, Exports & Imports has a significant impact on Scrap Generation of copper & Aluminium which has been tested through p-value, t-test & f-test. Under Copper Scrap generation we analysed that production & imports has a positive impact on copper scrap generation whereas exports has a negative impact on Copper Scrap Generation & when we analysed the Aluminium Scrap Generation, we saw that Production & Exports has a positive impact on Aluminium Scrap generation & Imports has a negative impact on Aluminium Scrap Generation.

**4.1 Comparative Study Between Copper and Aluminium & Global & Indian Scenario**

Graph 4: Global Non Ferrous Metals Consumption



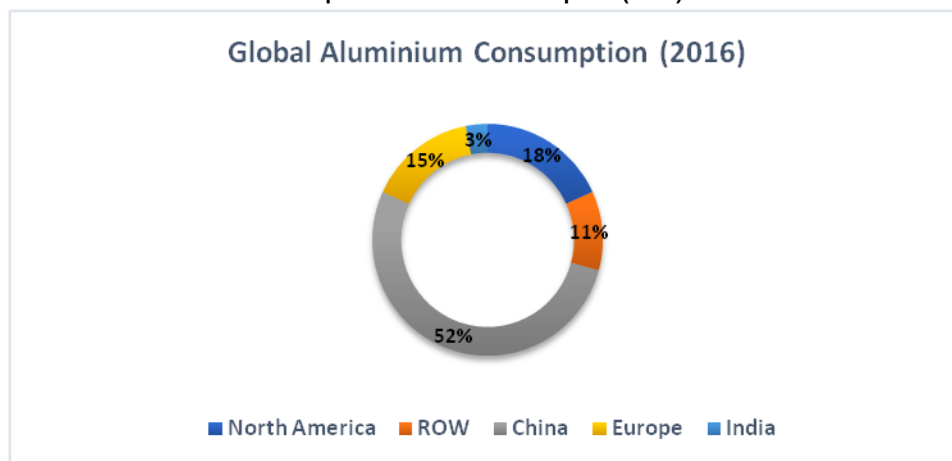
Source: Current IAI Statistics, KPMG Report

It represents that Cu & Al has been majorly consumed globally in various economic activities like Construction etc. The demand of Non Ferrous metals is growing with CAGR of 2.8%. Here the major consumption is of Primary Al as compared to Primary Cu consumption. (KPMG Report, 2017)

**Global Aluminium Consumption**

China is a major consumer of Al for almost 52 per cent of the global consumption. (KPMG Report, 2017)

Graph 5: Global AI consumption (2016)



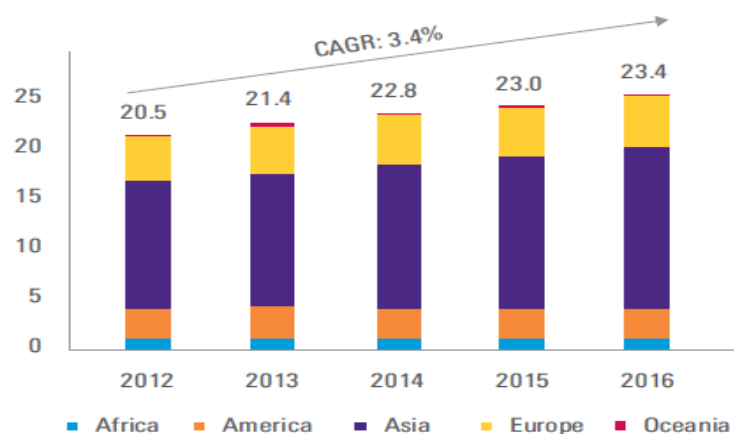
Source: Current IAI Statistics

**Copper Consumption**

Consumption of Cu has shown a growth of 3 per cent from 2012 to 2016. China is considered to be as the largest

consumer of Cu. Growth in Copper consumption was mainly due to spending in infrastructure, electricity networks etc. (KPMG Report, 2017)

Graph 6: Copper Consumption



Source: Current IAI Statistics

**5. Non Ferrous Metals Industry dynamics in India**

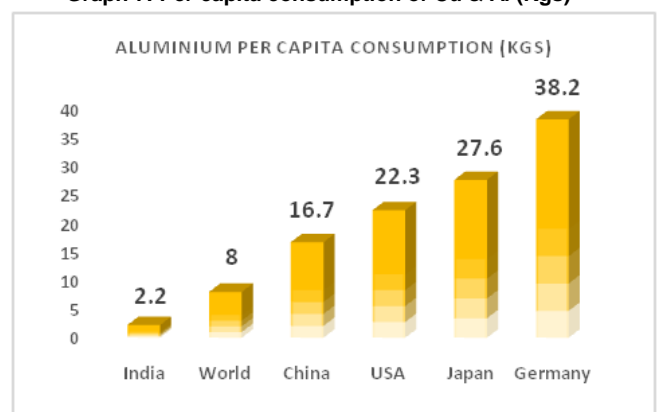
**Aluminium**

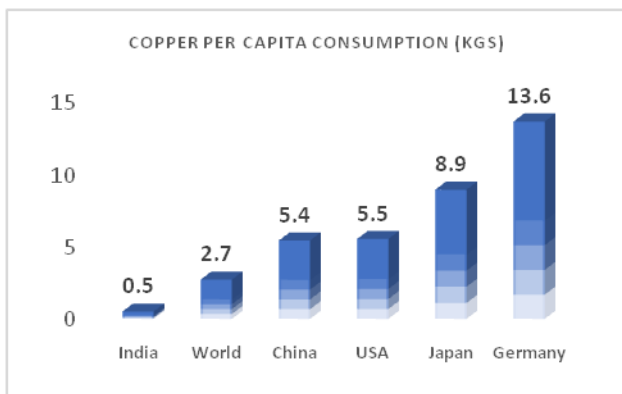
During 2011-12 to 2016-17, the interest for Aluminum demonstrated a CAGR of 5.4 percent because of development in electrical and car divisions which comprises 60-65 percent of the all out utilization of Aluminum. During 2011-12 to 2016-17, limit has expanded from 1.9 million tons for each annum to 4.1 million tons for every annum. As the limit developed at quicker rate opposite interest, trade has ascended at a CAGR of 30 percent during the period that has changed India from being a net shipper to a net exporter of Al.

Copper Demand for essential Copper has developed at a CAGR of 14 percent in the course of recent years because of the development in the electrical part and buyer durables. In spite of the fact that India is a net exporter of Copper, however because of import of downstream items, numerous players in Cu downstream industry faces difficulties, for example, high set up cost, obsolete innovation and so forth. (KPMG Report, 2017)

**Future Potential of Copper and Aluminium**

Graph 7: Per capita consumption of Cu & Al (Kgs)



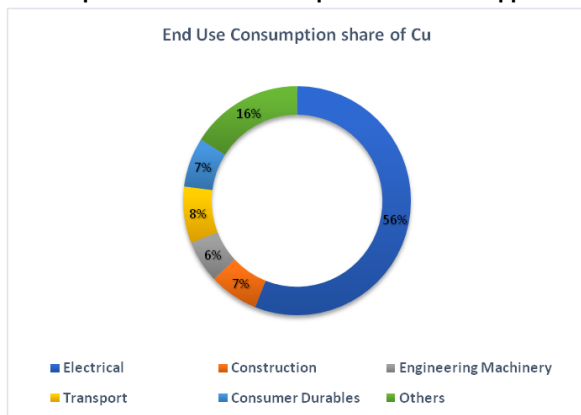


Source: Copper Indian Minerals Yearbook 2012 to 2017 Vol II, KPMG Report

The 'Make in India' activity has given a boost to Investments in significant regions, for example, roadways, control, aeronautics and so on and have an immediate positive effect on the non-ferrous metals. The boost to the Indian assembling segment because of the administration's crusade 'Make in India' is relied upon to give a driving force to non-ferrous metals utilization. solid interest, accessibility of crude Materials gives solid and manageable development potential for the non-ferrous metals industry. Per capita utilization of non-ferrous metals in India is exceptionally low when contrasted with both created and creating economies, thus leading to tremendous growth potential in the years to come. (KPMG Report, 2017)

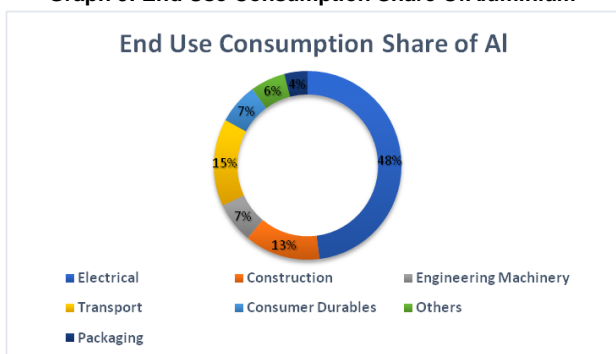
**End Use Consumption share of Non Ferrous Metals**

**Graph 8: End Use Consumption Share Of Copper**



Source: Indian Mineral Yearbook 2015 Vol II, KPMG Report

**Graph 9: End Use Consumption Share Of Aluminium**



Source: Indian Mineral Yearbook 2015 Vol II, KPMG Report

These sectors are transport (automotives), electricals and construction and they are major drivers of consumption led growth.

**6. Policy Prescriptions**

**• Waste Handling Standards**

Introduction of Hygiene & safety standards for waste handling by having a training of waste pickers on collection, segregation, aggregation & transport of each commodity & by Guidelines on each commodity for safe and hygienic handling of each commodity.

**• Recycling Ecosystem**

Promotion of recycling ecosystem& establishes a dedicated national fund to:Promote R&D in recycling technologies, Setting up technology and business facilitation centers & Skilling centers.

**• Curriculum on Recycling**

Developing a pool of recycling professionals like Technical curriculum on recycling under engineering or as an integral component of civil / mechanical / production / chemical / metallurgy&Management curriculum on recycling (circular economy) or as an integral component of general / supply chain management.

**• Regulation of recycling process**

Standardization and compliant recycling processes which includes the harmonization of recycling process for each commodity – optimizing environmental and resource footprint

**• Issues:**

*Waste Generation:*

Low per capita consumption, ,Lack of knowledge in effective disposal, Commodities used beyond useful life, Lack of awareness of using recycled products.

*Waste collection and segregation*

Import duty on scrap, Loss of CENVAT refunds with introduction of GST, Scrap overvalued, leading to higher CSD & IGST

*Processing*

No credit related benefits for setting up recycling plant, Lead recycling plants working under capacity due import restriction of MOEF, Lead recycling without adequate environmental safeguard

*Production*

No quality control in practice for recycled metal, Govt. procurement process favors primary metal. (Suri, 2019; Singh, 2019)

**7. Conclusion**

It explains about the Circular Economy which particularly focuses on Al & Cu. It define its 3R's that is reducing, recycling and reusing. Here the first part explains the Al recycling, its methods, its process & its uses like in Electrical Applications, Aviation, Machinery Equipment, Consumer Durables etc. & about the field/plant visit to CRM-Century Metal Recycling which is situated at Gurugram, Haryana, where we explored their work culture, got a more clear view on Material Recycling Policy. Second part explains about Market

Trend - Production, Trade and the impact of these factors on Aluminium scrap generation. For Al Scrap Generation and other relevant factors, trend analysis and Forecasting has been done. To analyse the significance of variables or various factors on Al scrap generation, Multivariate Regression analysis has been performed, which shows the significant results which has been tested through F test, P Value & t-test. The main objective to do this trend analysis & regression method is firstly to analyse how much scrap is generated by 2025 in future so that proper recycling methods can be adopted, proper collection mechanism should be there so that it may enhance the value chain which may improve our circular economy. Second objective is to analyse the impact of Production, Imports & Exports of Al on Al scrap generation. Third part explains about its international best practices of Al recycling of respective countries like Europe, US, Italy, Germany, UK, Japan which initiated like X-ray Transmission XTRACT units, AUTOSORT units, Every Can counts, end-of-life vehicle (ELV) recycling processes, Eddy-current separation (ECS), used beverage can, X-ray fluorescence technology etc. Fourth part shows the comparative study between Al & Cu, its consumption and their results which impacts Scrap Generation like under Copper Scrap generation we analysed that

production & imports has a positive impact on copper scrap generation whereas exports has a negative impact on Copper Scrap Generation & when we analysed the Aluminium Scrap Generation, we saw that Production & Exports has a positive impact on Aluminium Scrap generation & Imports has a negative impact on Aluminium Scrap Generation. Last part explains the summary & policy prescriptions which recommends to Increase consumer awareness on scrap disposal, Integration of informal waste handlers in recycling value chain by providing Identity cards for authorized waste pickers & Training of waste pickers on collection, segregation, aggregation and transport of each commodity etc.

#### **Acknowledgement**

*I would like to take this opportunity to express my profound gratitude and deep regard to my Research Guide **Dr. Kalpana Singh** for her exemplary guidance, valuable feedback and constant encouragement throughout the duration of the project. Her valuable suggestions were of immense help throughout my research work. Her perceptive criticism kept me working to make this research paper in a much better way. Working under her was an extremely knowledgeable experience for me.*

#### **References**

1. Aluminium Recycling in Germany hits 89%. Available at: <http://ec.europa.eu/environment/europeangreencapital/aluminium-recycling-germany/> [accessed on February 26, 2014].
2. FICCI, Indian Non Ferrous Metals Industry. Available at <http://ficci.in/spdocument/22947/Non-Metal-Report.pdf> [accessed on 2018]
3. Industry Commission. "An Analysis of Steel Scrap Collection". Available at <https://www.pc.gov.au/research/supporting/steel-scrap-collection/steel-scrap-collection.pdf> [accessed on May, 1991]
4. KPMG, Non Ferrous Metal Industry: Building the future. Available at file:///C:/Users/abc/Downloads/Non-ferrous\_metals\_industry\_-\_Building\_the\_future%20-%20KPMG%20(2017)%20(1).pdf [accessed on 2017]
5. Suri D., Singh K. (2019) "A Study of Non Ferrous Metal: Copper in Circular Economy", 525-538
6. Tomra Case studies. Available at <https://www.tomra.com/en/sorting/recycling/case-studies/>
7. Waste Management & Research, Circular economy, permanent materials and limitations to recycling: Where do we stand and what is the way forward?. Available at <https://journals.sagepub.com/doi/full/10.1177/0734242X17724652> [accessed on 2017]
8. When it comes to recycling aluminium, Every Can Counts. Available at <https://circulareconomy.europa.eu/platform/en/good-practices/when-it-comes-recycling-aluminium-every-can-counts>
9. Zafar, S. Methods of Aluminium Recycling. Available at <https://www.ecomena.org/recycling-aluminium/> [accessed on (February 22, 2017).