Crisil Intelligence

Industry chapter – metal recycling

Final report

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by S&P Global

Crisil
Intelligence

Contents

1 Global macroeconomic overview

1.1 GDP growth

Global GDP growth, after averaging 3.8% annually between 2000 and 2019, contracted to 2.7% in 2020 as the Covid-19 pandemic disrupted economic activity. However, the contraction was considerably lower than that estimated by the International Monetary Fund (IMF), with a strong rebound in manufacturing, shift to new ways of working, and fiscal and policy support arresting a further slide.

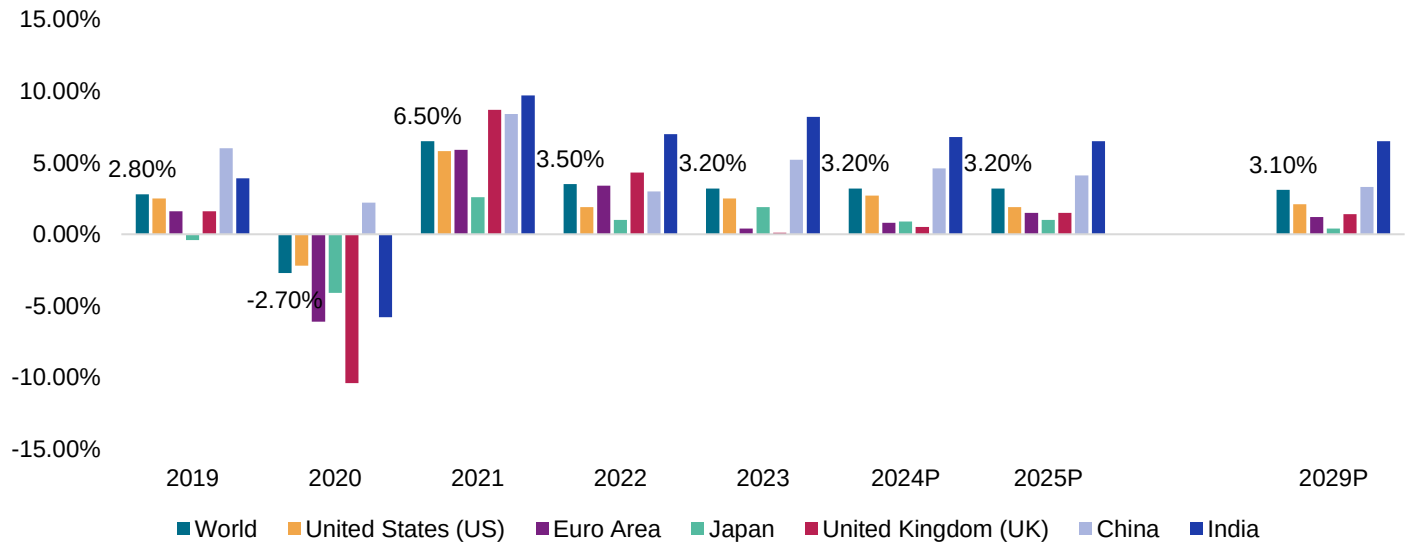
In 2021, growth rebounded to 6.5%, led by vaccine-powered normalisation and continued fiscal support. However, in 2022 and 2023, it slowed to 3.5% and 3.2%, respectively, owing to challenges such as supply-constraint-driven high inflation, tightening financial conditions, long-term effects of the pandemic and geopolitical uncertainties.

The pace of global growth is projected to continue to trend below the historical annual average of 3.8% (2000 to 2019) this year and the next, on account of restrictive monetary policies and withdrawal of fiscal support1.

Five-year historical data and growth forecast

The IMF has projected on-year global GDP growth of 3.2% for 2024 as well as 2025, considering the current geopolitical uncertainties, increasing geoeconomic fragmentation, tighter inflation-tackling monetary policies and fiscal support withdrawal amid high debt and extreme weather conditions.

Economic review and outlook



P: Projected (years mentioned on the horizontal axis correspond to the calendar years)

Note: Unless mentioned otherwise, the years correspond to calendar years throughout the report.

Source: Crisil Intelligence, IMF, World Bank, S&P Global

[1] IMF – World Economic Outlook April 2024

Real GDP (on-year growth)	2019	2020	2021	2022	2023	2024P	2025P	2029P
World	**2.80%**	**-2.70%**	**6.50%**	**3.50%**	**3.20%**	**3.20%**	**3.20%**	**3.10%**
Key countries								
United States (US)	2.50%	-2.20%	5.80%	1.90%	2.50%	2.70%	1.90%	2.10%
Euro area	1.60%	-6.10%	5.90%	3.40%	0.40%	0.80%	1.50%	1.20%
Japan	-0.40%	-4.10%	2.60%	1.00%	1.90%	0.90%	1.00%	0.40%
United Kingdom (UK)	1.60%	-10.40%	8.70%	4.30%	0.10%	0.50%	1.50%	1.40%
China	6.00%	2.20%	8.40%	3.00%	5.20%	4.60%	4.10%	3.30%
India	3.90%	-5.80%	9.70%	7.00%	8.20%	6.80%	6.50%	6.70%
Key emerging and developing regions								
Emerging and developing Asia	5.2%	-0.50%	7.70%	4.4%	5.60%	5.20%	4.90%	4.50%
Middle east and central Asia	1.70%	-2.40%	4.50%	5.30%	2.00%	2.80%	4.20%	3.70%
Emerging and developing Europe	2.50%	-1.60%	7.50%	1.20%	3.20%	3.10%	2.80%	2.60%
Latin America and the Caribbean	0.20%	-7.0%	7.30%	4.20%	2.30%	2.00%	2.50%	2.40%
Sub-Saharan Africa	3.20%	-1.60%	4.70%	4.00%	3.40%	3.80%	4.00%	4.30%

P: Projected (years mentioned on the horizontal axis correspond to the calendar years for the world and countries except India; for India year 2019 refers to fiscal 2020 and so on)

Source: Crisil Intelligence, industry, IMF

However, the GDP trajectory has varied for key economies, as detailed out below:

US

The country's GDP, which expanded from 1.9% in 2022 to only 2.5% in 2023, would have been higher if not for high inflation and, consequently, the raising of higher interest rates by the US Federal Reserve (Fed) to cool the print, which impacted spending. The economy is expected to continue to grow at a relatively benign 2.7% in 2024 and thereafter slow to 1.9% in 2025[2] with a slowdown in wage growth, continued fall in disposable incomes and accumulated savings and the Fed's tight monetary policy. However, the growth forecasts have been buoyed by stronger-than-expected core goods consumption, which has improved financial conditions.

Euro area

While the pace of growth slowdown in this region was less pronounced than in the US in 2023, it was only a marginal 0.4% because of lower policy rates vs the US and NextGenerationEU bonds supporting economic activity. The slowdown in 2023 was due to spillover effect from geopolitical issues in Europe, with some economies more affected, and tighter financial conditions. The prices of gas, which is the key source for electricity and heating, rose owing to constrained availability amid high demand, leading to increased manufacturing expenses. That said, in 2024, the IMF expects GDP growth to increase to 0.8% before rising to 1.5% in 2025. But key economies in the region are expected to post diverging trends. Germany's economy is expected to contract faster than expected, whereas France and Spain are expected to see some recovery, helped by tourism.

[2] All forecasts are by the IMF unless otherwise stated

Japan

Pent-up demand, surge in inbound tourism and accommodative policies, as well as rebound in auto exports pushed up the country's growth rate to 1.9% in 2023. However, in 2024, a negative shift in the terms of trade (ratio of export to import prices) from higher energy import prices, as well as lower consumption, as price inflation outpaced wage growth, is expected to crimp economic growth rate to just 0.9%, which is expected to rise slightly to 1% in 2024 as domestic demand stabilises.

UK

Growth declined from 4.3% in 2022 to 0.1% in 2023, reflecting tighter monetary policies to curb stubbornly high inflation and lingering impact of the terms-of-trade shock from high energy prices. That said, growth was somewhat supported by a fiscal package announced in September 2022. In 2024, though, the GDP growth is expected to remain at 0.5%.

China

In 2021, China's GDP grew 8.4% on-year, recovering strongly from the previous year's on-year growth of 2.2%, on the back of pent-up domestic demand and strong growth in exports owing to slowdown in global industrial activities. China will continue to contain its macroeconomic stimulus following a property-driven downturn, and is, therefore, expected to see 4.60% economic growth this year and 4.10% the next.

India

India has solidified its position as the world's fastest-growing major economy, with ambitious plans to achieve high middle-income status by 2047[3]. After a pandemic-induced 5.8% contraction in 2020, India's GDP bounced back, growing 9.7%, 7.0% and 8.2% on-year in 2021, 2022 and 2023, respectively. The growth trend is expected to sustain over the next 5 years, with the IMF projecting an annual rate of 6-7%.

[3] https://www.worldbank.org/en/country/india/overview

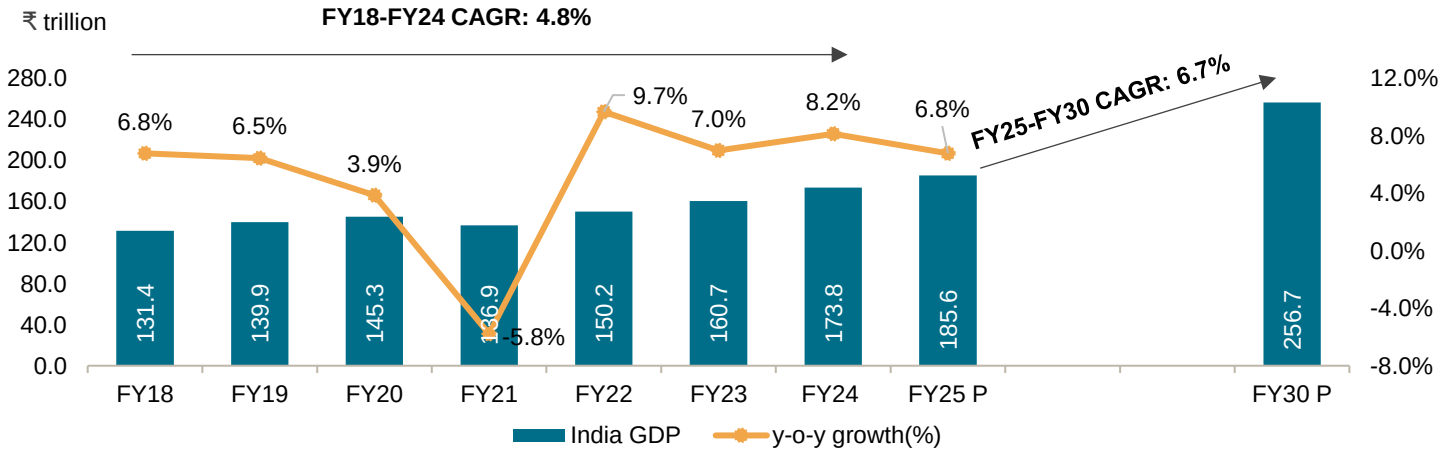
2 Indian macroeconomic overview

2.1 GDP trends and composition by sectors

India's economy has demonstrated resilience in recent years, with its gross domestic product (GDP) registering a CAGR of 4.8% between fiscals 2018 and 2024, reaching a total value of ₹173.8 trillion[4]. This growth trajectory is based on the revised GDP calculation methodology, which was introduced by the Ministry of Statistics and Programme Implementation in 2015, with a change in the base year from fiscal 2005 to fiscal 2012.

Notwithstanding the pandemic-induced lockdowns, which led to a decline in GDP growth to 5.8% in fiscal 2021, the post-pandemic scenario has been marked by a strong recovery. In fiscal 2022, the economy bounced back, recording a robust 9.7% year-on-year growth, driven primarily by the manufacturing and construction sectors. This upswing is a testament to the Indian economy's ability to adapt and respond to challenges, and bodes well for its future growth prospects

India's GDP trend



P: Projected

Source: Central Statistical Office (CSO), Crisil Intelligence

India's real GDP grew 8.2% on-year in FY 2024, compared to 7.0% in the previous fiscal. The growth is estimated to have been stronger in the first half compared to the second. Despite weak agricultural growth, overall GDP growth is seen as robust, indicating that the resilience of non-agricultural sectors more than offset the agricultural slowdown.

[4] Statistics from provisional estimates of national income 2022-23 and quarterly estimates of gross domestic product for the fourth quarter (Q4) of 2022-23

2.2 Performance of key macroeconomic indicators

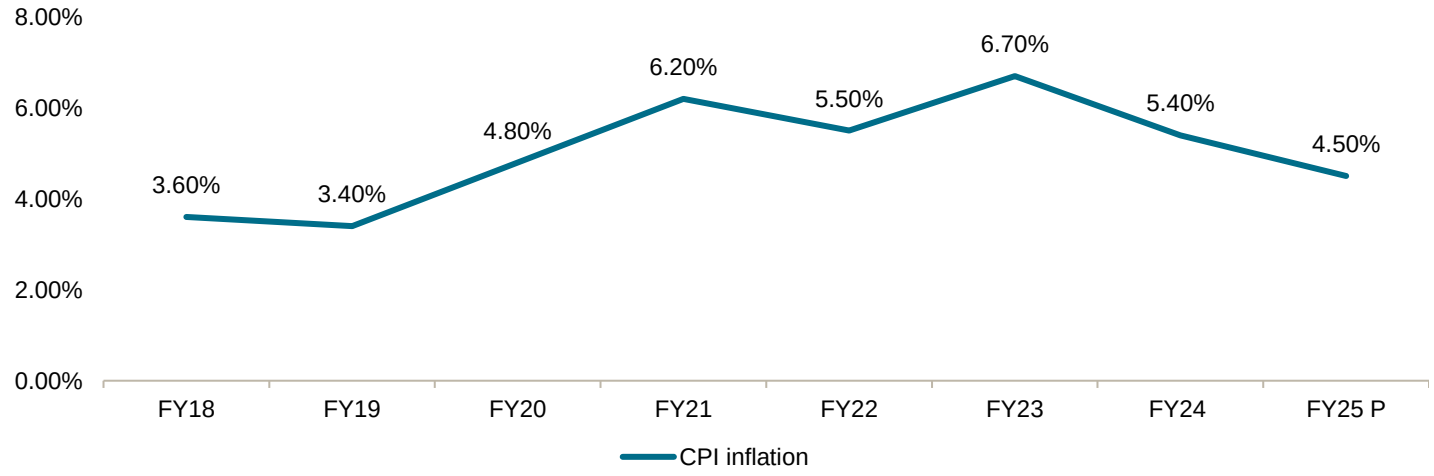
Consumer Price Index inflation trend

India's macroeconomic performance has been marked by a notable trend in consumer price index (CPI) - based inflation. Between fiscals 2018 and 2022, CPI inflation averaged around 4.7%. However, it witnessed a significant uptick in fiscal 2023, rising to 6.7% primarily driven by surging food prices before moderating to an average of 5.4% in fiscal 2024.

Despite low core and fuel inflation numbers, food inflation has continued to exert upward pressure on CPI inflation, keeping it above the Reserve Bank of India's (RBI's) medium-level target of 4%. As of March 2024, food inflation remained elevated at 8.5%, largely due to strong inflation in food grains, meat, and fish, as well as a slower pace of deflation in edible oils.

Looking ahead, CPI inflation is expected to moderate further to 4.5% on average in fiscal 2025 on the back of a potential dip in food inflation led by a favourable monsoon and a high base effect.

CPI inflation trend



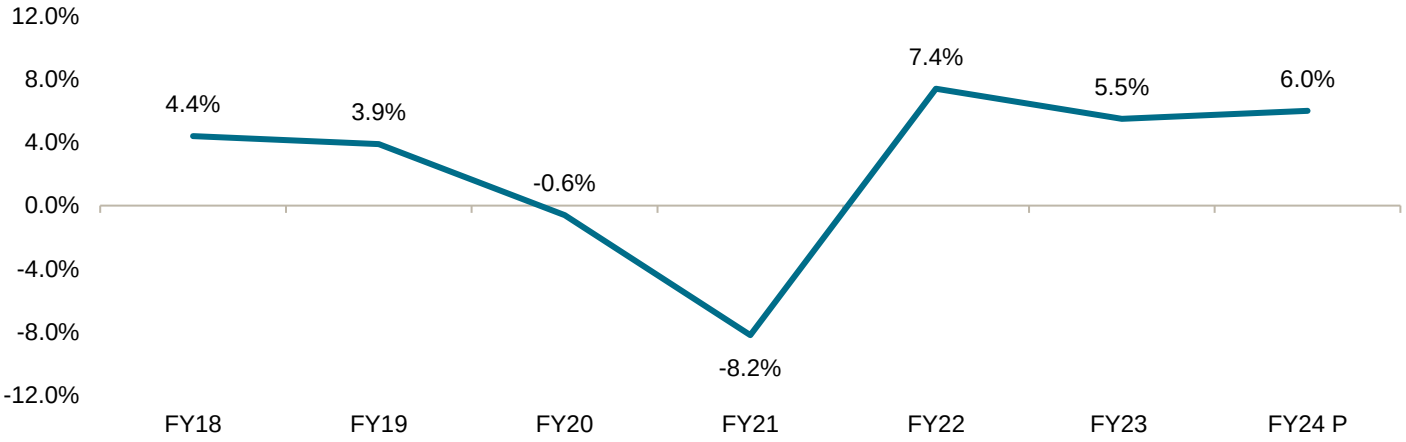
P: Projected

Source: NSO, the Ministry of Industry and Commerce, Crisil Intelligence

Index of Industrial Production (IIP) growth trend

After averaging a modest 2.6% between fiscals 2018 and 2023, the IIP surged to 6.0% in fiscal 2024. This significant uptick was primarily driven by a strong pickup in the sectors related to manufacturing of electrical equipment and basic metals. Additionally, an uptick in the consumer durables sector also contributed to the IIP growth, underscoring the resilience of India's industrial sector

IIP growth trend



Source: NSO, the Ministry of Industry and Commerce, Crisil Intelligence

Increasing per capita income

In fiscal 2023, per capita income (or per capita gross national income or GNI) is estimated to have grown by 5.7%, followed by a further 7.2% increase in fiscal 2024. This upward trajectory is expected to continue, with the International Monetary Fund (IMF) estimating a 5.4% CAGR in India's per capita income (at constant prices) over 2024 to 2028. As disposable income increases, it typically has a positive correlation with demand for housing units, as it enhances affordability and ultimately boosts housing demand. This trend is likely to have a positive impact on the overall economy, particularly the housing sector.

Per capita income trend

Per capita GNI	Level in FY24 (₹ '000)		Growth at constant prices (%)									
	Current prices	Constant prices	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24
	169.49	99.4	6.2	6.7	6.9	5.5	5.3	2.5	-8.9	9.3	5.7	7.2

Source: MoSPI, IMF, Crisil Intelligence Research

Per capita income trend – Comparison with other major economies

Sr. no.	Country	GNI per capita (2023) in US$	GNI per capita (2022) in US$
1	India	2,540	2,400
2	United States	80,300	76,590
3	Germany	53,970	54,030
4	Japan	39,030	42,550
5	United Kingdom	47,800	48,640
6	China	13,400	12,890
7	Brazil	9,070	8,240
8	Sri Lanka	3,540	3,620
9	South Korea	35,490	36,160
10	Singapore	70,590	66,970

Source: Macrotrends, Crisil Intelligence Research

2.3 Key government schemes for end-use industries

The metals recycling industry in India has gained significant momentum due to a series of government initiatives aimed at fostering sustainable industrial practices, boosting domestic manufacturing, and enhancing raw material security. These schemes cover a broad spectrum of end-use industries such as infrastructure, automotive, electronics, and energy, all of which are key consumers of recycled metals. The government's focus on creating a circular economy and reducing dependency on imported materials has positioned metal recycling as a critical component in India's growth strategy.

Policies such as the Production Linked Incentive (PLI) Scheme, National Infrastructure Pipeline (NIP), and Make in India are focused on bolstering domestic manufacturing and infrastructure development, creating significant demand for recycled metals such as steel, copper, and aluminium. These initiatives align with the broader goal of fostering a circular economy and ensuring resource efficiency in key end-use industries such as electronics, automotive, and construction.

To further support the recycling ecosystem, the Steel Scrap Recycling Policy, Non-Ferrous Metal Scrap Recycling Framework and the Vehicle Scrappage Policy provide a structured approach to recycling ferrous, non-ferrous metals, and End of Life vehicles.

The transition to cleaner energy and transportation is driven by schemes like the Green Hydrogen Mission, Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) India, and the National Electric Mobility Mission Plan (NEMMP), which have increased the demand for metals such as copper and aluminium used in electric vehicles and renewable energy technologies. Coupled with the Smart Cities Mission, which focuses on sustainable urban development, these initiatives create a strong growth trajectory for metals recycling by driving demand for environmentally friendly materials.

The overarching framework of initiatives such as the Make in India, National Resource Efficiency Policy, Circular Economy Action Plan, and the Atmanirbhar Bharat Abhiyan highlights the government's commitment to resource conservation and self-reliance. These policies ensure that the demand for recycled metals remains robust, allowing companies to expand their operations and play a pivotal role in India's shift towards sustainability across various industries.

Key Government Schemes for End-Use Industries

Sr. no.	Policy	Details	Outlay	Current Status
1	PLI scheme for 14 key sectors	Aimed at boosting domestic manufacturing across multiple sectors.	₹1.97 lakh crore	It had registered investments of over ₹1.03 lakh crore till November 2023 and disbursed ₹4,415 crore of incentives.
2	National Infrastructure Pipeline	Aims to provide world-class infrastructure across the country and improve the quality of life for all citizens.	₹108.88 lakh crore	1,965 projects under development out of 10,232 projects covering 61 sub sectors
3	Green Hydrogen Mission	To make India the Global Hub for production, usage and export of Green Hydrogen and its derivatives.	₹19,744 crore	• GAIL Limited has started India's maiden project of blending Hydrogen in City Gas Distribution grid in Indore (Madhya Pradesh) • NTPC Limited has initiated the blending of Green Hydrogen up to 8% in PNG Network at NTPC Surat (Gujarat). • Hydrogen based Fuel-Cell Electric Vehicle (FCEV) Buses in Greater Noida (Uttar Pradesh) and Leh by NTPC.

Sr. no.	Policy	Details	Outlay	Current Status
				• Oil India Limited has developed a 60-kW capacity hydrogen fuel cell bus, which is a hybrid of an electric drive and a fuel cell.
4	FAME India (Faster Adoption and Manufacturing of Hybrid and Electric Vehicles) Phase II	Aims to accelerate the shift to electric mobility.	Phase II: ₹11,500 crore	Govt has incentivised 11.53 lakh EVs with subsidies worth ₹5,228 crore under FAME II scheme
5	Smart Cities Mission (SCM)	Aims to enhance the quality of life in 100 selected cities by providing efficient services, robust infrastructure, and a sustainable environment	₹48,000 crore	90% of the total projects have been completed; ₹46,787 crore to 100 Smart Cities under the SCM has been released, of which over 90% has been utilized.

Source: Crisil Intelligence

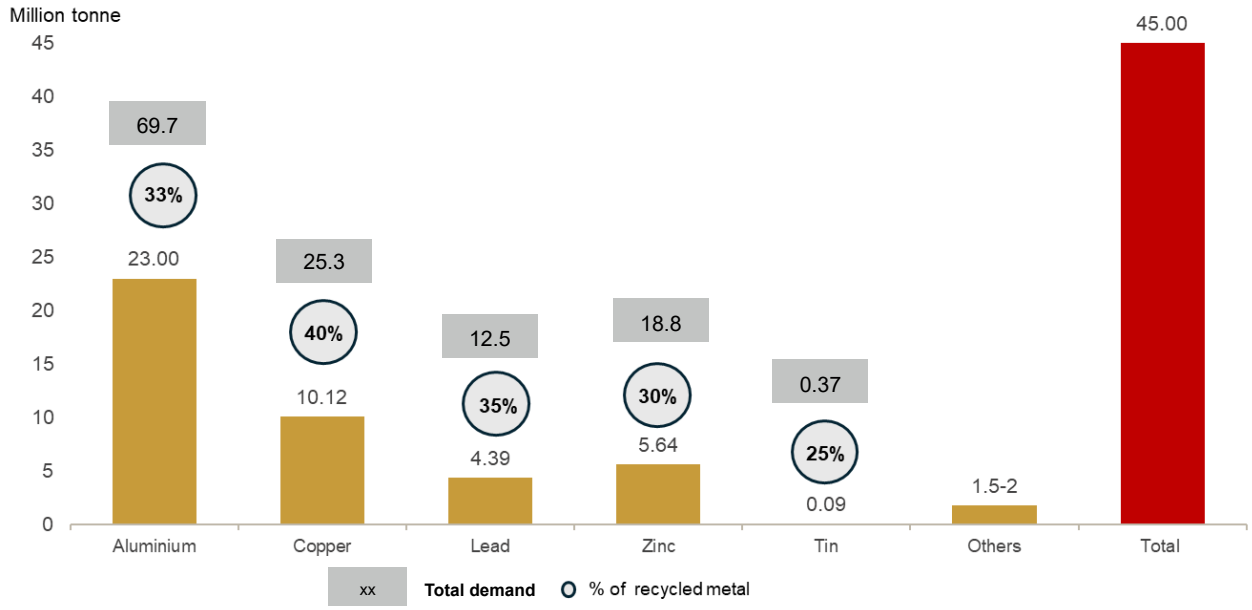
3 Global recycling market

3.1 Overview of the global non-ferrous metals recycling market

Currently estimated at 45 million tonne, the global non-ferrous metals recycling market is a vital arm of the metal recycling industry. It mainly encompasses metals such as aluminium, copper, lead and zinc.

The promising growth shown by the industry in recent years is driven by sustainable practices, environmental regulations and a strong demand from multiple sectors, particularly automotive, construction and electronics.

Global non-ferrous metals recycling market size (2023)



Source: International Wrought Copper Council, International Lead and Zinc Study Group, Bureau of International Recycling, USGS, International Tin Association, Crisil Intelligence

Aluminium

- Aluminium recycling has a significant positive impact on the environment. One tonne of aluminium recycled can save up to 8 tonne of bauxite, 14,000 kWh of energy, 40 barrels (6,300 litre) of oil and 7.6 cubic metre of landfill space
- The aluminium recycling process consumes up to 95% less energy than producing aluminium from virgin raw material
- The recycling of one aluminium can is sufficient to power a 100-watt bulb for almost four hours, highlighting the energy efficiency of the recycling process
- Aluminium drink cans account for almost 100% of recycling rate in some countries, demonstrating the success of its recycling efforts

Copper

- Copper has a high recycling value, with premium-grade scrap holding at least 95% of the value of primary metal from newly mined ore

- Recycling copper is an energy-efficient process and saves up to 85% of the energy used in its primary production
- Replacing the primary production method with copper scrap reduces carbon dioxide (CO2) emissions by ~65%, making recycling a more environmentally friendly option

Lead

- The lead industry has a high recycling rate, with 50% of the lead produced and used each year having been used before in other products.
- From 1960 to 2022, the total usage of refined lead stood at 422.1 million tonne, with 47% attributable to the recycling industry
- According to the International Lead Association, 80% of modern lead is used in the production of batteries, of which more than 99% are recycled
- Using secondary lead instead of ore reduces CO2 emissions by 99%

Tin

- Primary production of tin requires 99% more energy than secondary production
- In the use of refined tin, solder accounts for almost half of the total, following by others, including chemicals, tinplate, lead-acid batteries and copper alloys. The use of recycled tin as a proportion of total tin use is ~32%

Zinc

- According to the International Zinc Association, 60% of total zinc production is still in use, while the global end-of-life recycling rate for zinc is ~45%
- Secondary zinc production is more energy-efficient and uses 76% less energy than primary production
- Old zinc scrap mainly comprises die-cast parts, brass objects, end-of-life vehicles, household appliances, old air-conditioning ducts, obsolete highway barriers and street lighting, which reflect the diverse sources of recyclable zinc materials

3.2 Geographical analysis

North America: The North American market is well-established, with the United States (US) and Canada as key players. The region has a mature recycling infrastructure, aided by technological advancements and sustainability regulations. Aluminum recycling is particularly strong in the US owing to its widespread use in the packaging, construction and automotive sectors. North America has the world’s highest Recycling Input Rate (RIR) with 57 per cent of the metal produced in the region originating from scrap.

Europe: Europe leads in regulatory support for metal recycling, promoting an advanced recycling ecosystem across the European Union (EU). The EU Green Deal and various waste management frameworks encourage high recycling rates for non-ferrous metals, especially in automotive and industrial manufacturing. Europe has the highest Recycling Efficiency Rate (RER) in the world, recovering 81 per cent of aluminium scrap available in the region.

Asia: Asia leads the global market for non-ferrous metal recycling, with China, Japan and India driving substantial growth, owing to expanding industrial and infrastructure development. Rapid urbanisation and industrialisation, coupled with significant demand for metals such as aluminium and copper in the construction, electronics and automotive sectors, have bolstered recycling efforts. India's recycling market is growing, especially with governmental support for sustainable

development and resource efficiency. In addition, investments in recycling infrastructure and advancements in technology contribute to higher recycling rates across the region.

South America: Led by Brazil and Chile, the South American market mainly focuses on copper recycling owing to its vast mining resources. However, the region is gradually diversifying into the recycling of other non-ferrous metals to meet growing local demand and support global supply chains.

Rest of the world: Other regions, including parts of Africa and the Middle East, are increasingly recognising the economic benefits of recycling but face infrastructure challenges. Investments and partnerships from global recycling firms are helping to foster growth in these regions.

The non-ferrous metals recycling industry thus holds a promising future as global environmental and industrial requirements converge, driving demand for sustainable solutions and increasing recycling capacity worldwide.

3.3 Key growth drivers

The global non-ferrous metals recycling market is experiencing significant shifts, driven by rapid urbanisation, technological advancements and regulatory support. Key dynamics and growth drivers are as follows:

Environmental benefits and regulatory support: Recycling non-ferrous metals significantly reduces greenhouse gas emissions, conserves natural resources and limits energy consumption. Governments in developed countries (e.g., Canada, the US and United Kingdom) have implemented systems to streamline collection, separation and sorting of scrap metal. For instance, Canada collaborates with provincial governments to enhance metal reuse and recycling initiatives, which directly benefits the recycling industry. Similarly, a global supplier of non-ferrous metals, Aurubis AG's acquisition of recycling company Metallo Group, is aimed at expanding the diversity of recycling services offered.

Economic benefits: The recycling of non-ferrous metals presents a compelling economic proposition, driven by the retention of value and versatility of these metals across various industries. Notably, recycling non-ferrous metals is significantly more cost-effective than extracting virgin materials, with aluminium recycling, for instance, saving up to 95% of the energy required for primary production. This not only reduces costs but also leads to substantial emissions savings. Furthermore, the non-ferrous metals recycling industry has a profound impact on the overall economy, as evidenced by the United States, where the recycling of approximately 130 million tons of material per year generates a staggering $117 billion in annual economic activity and supports over 500,000 jobs, according to the Institute of Scrap Recycling Industries.

Demand from key end use industries: Robust demand from various industries is driving the growth of non-ferrous metals recycling. Key sectors contributing to this trend include:

- ***Automotive:*** The rapid adoption of electric vehicles is boosting demand for recycled aluminum and copper, essential for battery components and lightweight vehicle designs.
- ***Construction:*** As the largest sector in 2023, construction is driving demand for recycled metals, particularly aluminium and copper, as countries are investing more in housing and infrastructure. Urbanization and disaster recovery efforts are further boosting this trend. In response, companies such as Nucor Corporation and Aurubis AG are expanding their product lines and making strategic acquisitions to capitalize on this growing demand and diversify their metal recycling offerings.
- ***Consumer Goods:*** Growing awareness and regulatory pressures are promoting the use of recycled metals in electronics and home appliances, further fueling demand.

Resource Scarcity: The growing scarcity of critical metals such as copper, zinc, and nickel is underscoring the importance of recycling. Fortunately, advances in technology now enable high-purity recovery of these metals, allowing the companies to meet demand without depleting natural reserves further. This is particularly significant in countries like India, where per capita copper consumption is expected to increase from the current level of 0.6 kg to 1.0 kg by 2025[5], with recycling poised to play a crucial role in fulfilling this growing demand.

Technological innovations: Technological advancements in sorting and separation methods are driving greater efficiency in non-ferrous metal recycling. With improved precision, companies can extract valuable metals from complex waste streams. For e.g., Finland's Kuusakoski, a leading recycling company, recently invested 25 M€ to enhance its recycling and processing capabilities[6] to meet the growing demand for recycled aluminium.

Circular economy initiatives: Countries across Europe, North America and Asia-Pacific are implementing circular economy policies, pushing industries to adopt recycled material to enhance recycling rates and foster innovations in recycling technology.

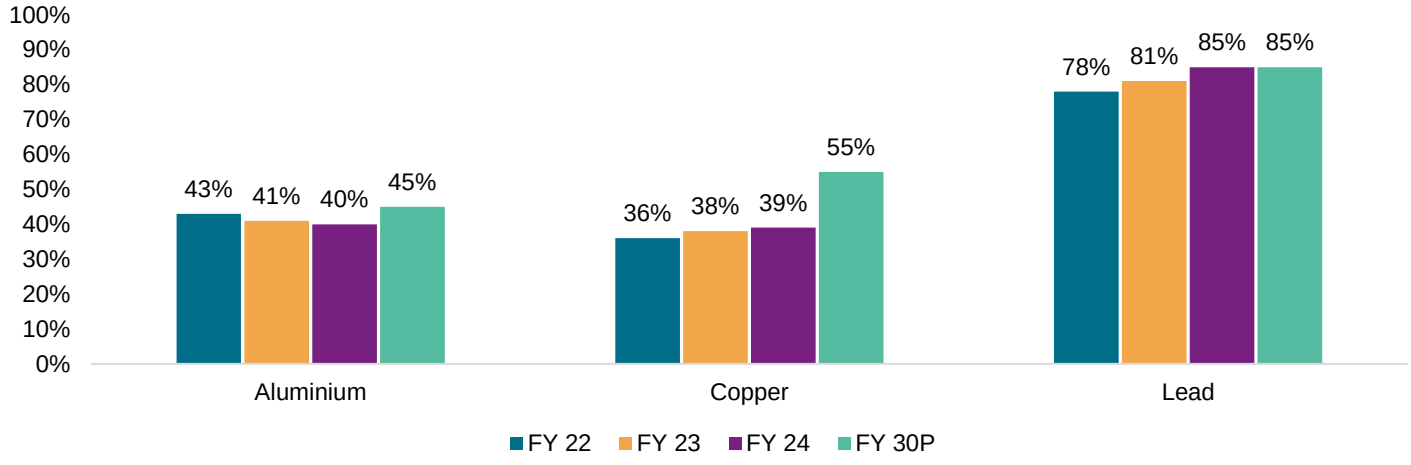
[5] https://mines.gov.in/webportal/copper
[6] https://www.kuusakoski.com/en/global/news/2023/kuusakoski-invests-25-m-to-meet-increasing-demand-for-pure-recycled-metal-products/

4 Overview of metal recycling in India

4.1 Metals recycling rate in India

Metal recycling in India is poised to undergo a significant transformation, driven by the government's commitment to reducing industrial waste and promoting sustainable practices.

Historic & Projected rate of recycled content (%)



Source: Crisil Intelligence

4.2 Existing stance of Government of India on recycling and need of the hour

India's metals recycling rates may appear high, but a closer look reveals a concerning reality. Most of the remelted copper is used to produce rods and billets, primarily for the electrical and electronics segment. However, the country's recycling process is largely focused on direct melting of scrap, resulting in variable copper purity due to the use of diverse scrap types. This approach raises quality concerns, particularly regarding tramp elements in conductor applications.

In contrast, leading economies like China, the EU, and Japan have a much higher share of secondary smelting and refining of scrap, with rates of 32%, 30%, and 16%, respectively[7]. India's reliance on direct melting of scrap results in copper rods or billets that often fail to meet national standards. Poor-quality wires and cables are a leading cause of building fires and electrocutions in India.

A study by ICA India found that 26% of building wire samples across India failed to meet conductor test standards, with all failures attributed to products from local brands of non-listed companies. This underscores the urgent need for investment in secondary smelting and refining of scrap processing in India to align with ETP copper standards.

In response to these concerns, to increase the share of secondary smelting and refining of scrap in India (now at a mere 1%), the government has mandated that all new products made from non-ferrous metals must contain a minimum of 5% recycled content starting from the financial year 2028. This requirement is a part of a detailed roadmap towards reducing

[7] https://www.business-standard.com/content/press-releases-ani/india-s-copper-story-critically-dependent-on-the-quality-of-scrap-processing-124031500502_1.html

industrial waste, with the target progressively increasing to 10% in FY29. By FY31, the government has set a target of achieving at least 10% recycled content for aluminium products, 20% for copper and 25% for zinc[8].

The government has not notified its recycling target for other non-ferrous metals such as lead and tin.

Government mandate - Rate of recycled content (in %)

Metal	FY 2028	FY 2029	FY 2031
Aluminium	5%	10%	10%
Copper	5%	10%	20%
Zinc	5%	10%	25%

Source: MoEFCC

The three non-ferrous metals – copper, zinc, and aluminium – are highly valued for their unique properties, making them essential for various applications. As the demand for energy-transition metals surges, significant investments in recycling will be necessary to alleviate the primary metal supply constraint, a major barrier in energy transition.

The need for metal recycling is pressing, as the industry is a significant contributor to greenhouse gas emissions. Steel and aluminium, in particular, together account for nearly 10% of global emissions. However, recycling offers a promising solution, with secondary aluminium production resulting in a carbon footprint 5-25 times lower than primary production, and scrap-based steel production reducing emissions by about 50%.

The Indian government's latest directive, the Hazardous and Other Wastes (Management and Transboundary Movement) Second Amendment Rules, 2024, is a significant step towards promoting metal recycling in the country. Effective from April 1, 2025, these regulations not only require non-ferrous metal producers to incorporate a specified percentage of recycled content in their products, but also introduce an extended producer responsibility (EPR) framework to ensure the environmentally sound management of scrap metals, with EPR certificates allowing producers to trade and meet their recycling targets.

The EPR framework has the potential to inspire new business models, enabling companies to reap both economic and environmental benefits. Proper implementation of these regulations should reduce the country's dependence on primary resources, mitigate the environmental impacts of mining and create new opportunities within the recycling industry, generating employment and advancing India's fight against climate change.

4.3 Supportive policy/regulatory provisions on metal recycling

The Government of India has been emphasising the importance of metal recycling as part of its broader push for sustainability, resource efficiency and a circular economy. Below is an overview of the key supportive policies for metal recycling in India:

Sr. no.	Policy	Ministry	Details	Current Status	Focus Metals
1	Extended Producer Responsibility (EPR) framework for non-ferrous metals (2024)	MoEF&CC	Producers of non-ferrous metals to get registered with the Central Pollution Control Board (CPCB) and fulfil their EPR obligations by ensuring the collection, recycling, or refurbishing of their products.	NA	Non-ferrous metals such as Copper, Aluminium, Zinc, lead, Tin etc.

[8] https://www.policycircle.org/policy/non-ferrous-metal-recycling-in-india/

Sr. no.	Policy	Ministry	Details	Current Status	Focus Metals
2	Vehicle Scrappage policy (2021)	Ministry of Road Transport & Highways	Aims to phase out old and unfit vehicles, promoting a safer and more environmental friendly transportation system. Under this policy, commercial vehicles and private vehicles older than 15 and 20 years, respectively, will be scrapped if they fail the mandatory fitness test, thereby being classified as End-of-Life Vehicles (ELVs).	• There are a total of 123 registered vehicle scrapping facilities, out of which 65 are Operational and 58 have been classified as "Approved Only" • As of March 31st, 2024, the number of medium and heavy commercial vehicles (M&HCVs) older than 15 years was ~1.1 million units • As per ICRA, an additional 5.7 lakh vehicles are projected to cross the 15-year age threshold in FY 25 & FY 26 • As of Aug 31st, 2024, the registered vehicle scrapping facilities (RVSFs) received 44,803 private scrap applications and 41,432 govt. scrap applications	Steel, Aluminium, Copper, Lead, Tin, Zinc
3	National Non-ferrous metal scrap recycling framework (2020)	Ministry of Mines	Aims to reduce scrap imports and promote a more efficient mineral value chain. The framework's objectives include creating economic wealth and jobs, increasing GDP contribution, and establishing a formal, organized recycling ecosystem with energy-efficient processes.	• The Centre has come out with a detailed roadmap mandating that all new products made from non-ferrous metals will have to contain a minimum of 5% recycled content beginning FY 28.	Non-ferrous metals such as Copper, Aluminium, Zinc, lead, Tin etc.
4	National Resource Efficiency Policy (2019)	MoEF&CC	The Draft National Resource Efficiency Policy is guided by the principles of (i) reduction in primary resource consumption to 'sustainable' levels, in keeping with achieving the Sustainable Development Goals and staying within the planetary boundaries, (ii) creation of higher value with less material through resource efficient and circular approaches, (iii) waste minimization, (iv) material security, and creation of employment opportunities and business models beneficial to the cause of environment protection and restoration.	NA	

Sr. no.	Policy	Ministry	Details	Current Status	Focus Metals
5	Steel Scrap Recycling policy (2019)	Ministry of Steel	The policy seeks to establish an environmentally sound management system for ferrous scrap, ensuring high-quality scrap for quality steel production, reducing import dependency, and decongesting cities from end-of-life vehicles. It also promotes the 6Rs principles of Reduce, Reuse, Recycle, Recover, Redesign, and Remanufacture through authorized centers, while ensuring compliance with Hazardous and Other Wastes Management Rules, 2016.	• In FY 24, the share of scrap metal in steel production was ~25%, with ferrous scrap consumption of 29 MT. • India aims to increase the share of scrap metal in steel production to 50% by 2047. The government will rely on green steel to reduce pollution from the steel industry.	Steel
6	Standard operating procedure (SOP) for the recycling of lead scrap/used lead-acid batteries (2024)	MoEF&CC	The SOP aims to regulate the import, transport, and recycling of lead-bearing waste while minimising environmental and health risks.	N/A	Lead

Source: Crisil Intelligence

4.4 Highlights of metals recycling initiatives by the state governments

Several state governments in India are taking proactive steps to promote metals recycling and circular economy practices. Some notable initiatives include:

Maharashtra: The state is setting up four circular economy parks in Aurangabad, Ratnagiri, Pune, and Nagpur, catering to various industries. The parks will feature specialized units for shipbreaking, e-waste and auto parts, steel scrap, and multipurpose recycling.

Gujarat: Building on its success in setting up specialized recycling zones like Alang-Sosiya for shipbreaking, Gujarat is expanding its efforts to incorporate other metal recycling activities.

Tamil Nadu: The Tamil Nadu Pollution Control Board has licensed four e-waste processing facilities and 38 waste dismantlers in the state. Additionally, a large battery recycling plant is planned at State Industries Promotion Corporation of Tamil Nadu's (SIPCOT's) future mobility park in Krishnagiri, which will recycle used batteries, electrical and rare earth magnets. Pondy Oxides & Chemicals Limited has also signed an MoU with the state government to invest in state-of-the-art recycling and manufacturing plants for non-ferrous metals, lithium-ion batteries, and other materials.

Delhi: The Delhi government has introduced an incentive scheme offering a 10-20% tax rebate to buyers of new vehicles who scrap their old ones.

Karnataka: The state's Transport Department plans to implement a vehicle scrapping policy, establishing scrapping facilities in Bengaluru Rural, Tumakuru, and Koppal.

Rajasthan: The state is taking a significant step towards circular economy by setting up India's first integrated waste recycling park (WRP) in Tholai, Jaipur. This park will process a diverse range of waste streams, including plastic waste, e-waste, hazardous waste, waste from PV panels and storage batteries, metal scrap, and end-of-life (EOL) vehicles, making it a comprehensive recycling hub.

4.5 Challenges/threats faced by metals recycling industry in India

The metals recycling industry in India faces various challenges from the fronts of regulations and policies, supply chain, infrastructure, economy, environment, trade, etc. Some of the challenges or threats are listed as below:

Challenges/threats with respect to regulations and policy adherence:

1. A threat of rise in stringent regulations on scrap imports with respect to quality adherence and increase in import duties might lead to increase in raw material costs for the domestic metals recycling industry
2. India, as of now, lacks a well-defined generic policy for metals recycling, which leads to inconsistencies in implementations

Challenges/threats with respect to supply chain:

1. The metals recycling industry, throughout its value chain, is unorganized which leads to high inefficiencies and low quality control
2. India’s metals recycling industry has a fragmented collection network which leads to difficulties in scrap availability

Challenges/threats with respect to infrastructure gaps:

1. Most of the recyclers lack access to modern machineries and thus use outdated recycling methods, leading to lower metal recovery rates and high waste generation
2. Since metals recycling is already a highly energy intensive process, the lack of modern technology further increases energy costs and thus operational costs

Challenges/threats with respect to market risks:

1. Fluctuations in global metal prices (such as the likes of aluminium which are tracked on London Metal Exchange) impacts the profitability of recyclers in general.

Challenges/threats with respect to environmental and social concerns:

1. Most of the recyclers do not follow proper environmental protocols, which leads to pollution and other health hazards
2. Poor management of hazardous materials produced as by products of metals recycling can lead to environmental damage

5 Copper recycling industry in India

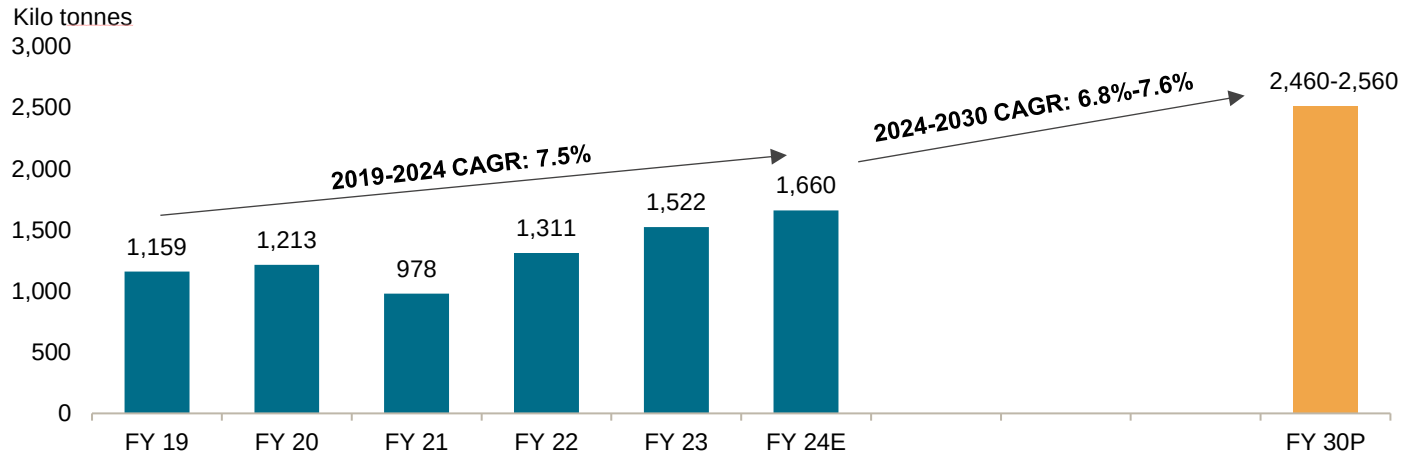
5.1 Review and outlook of the Indian recycled copper market

As India embarks on an economic growth sprint, its infrastructure-enhancement efforts are gaining remarkable momentum. This rapid progress underscores the critical role of copper in industrialisation, particularly electrification, a key driver of the global energy transition. With the significance of copper increasing worldwide, its steady supply is essential for India's burgeoning infrastructure, spanning building construction, transportation networks and power grids. Moreover, copper is a vital component in new clean-energy technologies such as electric vehicles, electrical motors, wind turbines, solar panels and battery storage, which are crucial to India's envisioned economic, industrial and sustainable growth.

The overall copper demand in India has witnessed significant growth, surging from 1,159 kilo tonnes (kT) in FY19 to 1,522 kT in FY23, registering a 7.05% CAGR. It is estimated at 1,660 kT in FY24, a growth of 9.1% from FY 23. Further, it is projected to clock a CAGR of 6.8-7.6% to reach 2,460-2,560 kT by FY30.

The global copper demand in 2023 reached 25.3 million tonnes. India’s copper demand in FY 24 is estimated at 1,660 KT, representing approximately 6.6% of global demand.

Overall copper demand 2019-2030 (kilo tonnes)



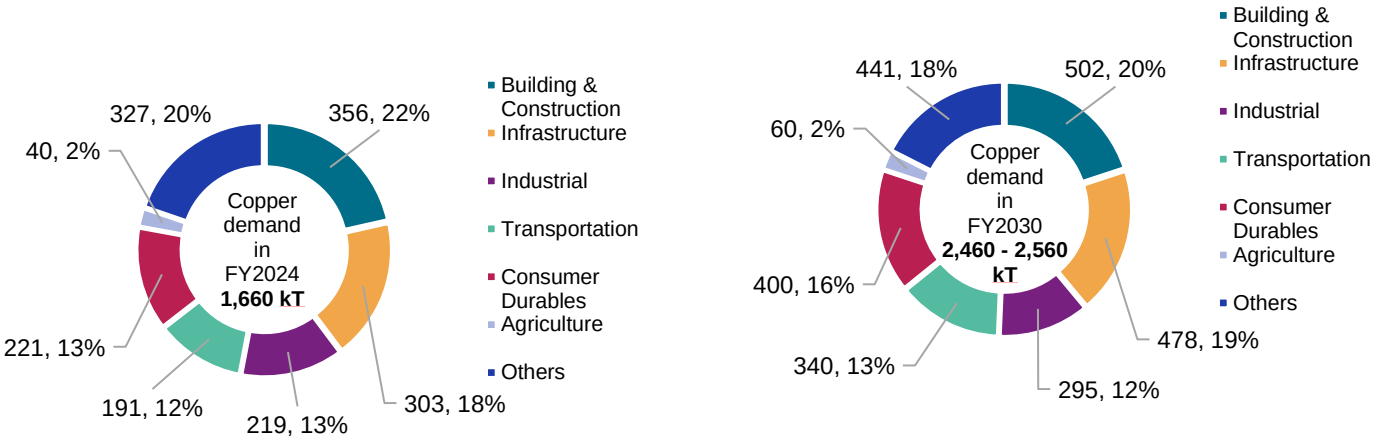
E: Estimated, P: Projected
Source: Industry, ICA India, Crisil Intelligence

Overall copper demand – end-use sectors

Copper and copper-alloy products are used in end-use sectors such as building and construction, infrastructure, industrial, transportation, consumer durables and agriculture.

In FY23, the transportation sector emerged as the fastest growing segment, with a 34% increase in copper demand, driven primarily by the growth in automobiles and railway modernisation. The industrial and infrastructure products sectors followed closely, with a 14% growth each, while consumer durables, such as room air conditioners, laptops, and phones, continued to exhibit strong demand growth of 13%.

Looking ahead, this growth is expected to be driven by the increasing demand for copper-intensive products, such as electrical wiring, plumbing and Heating, Ventilation, and Air Conditioning (HVAC) systems, in the construction of residential and commercial buildings.

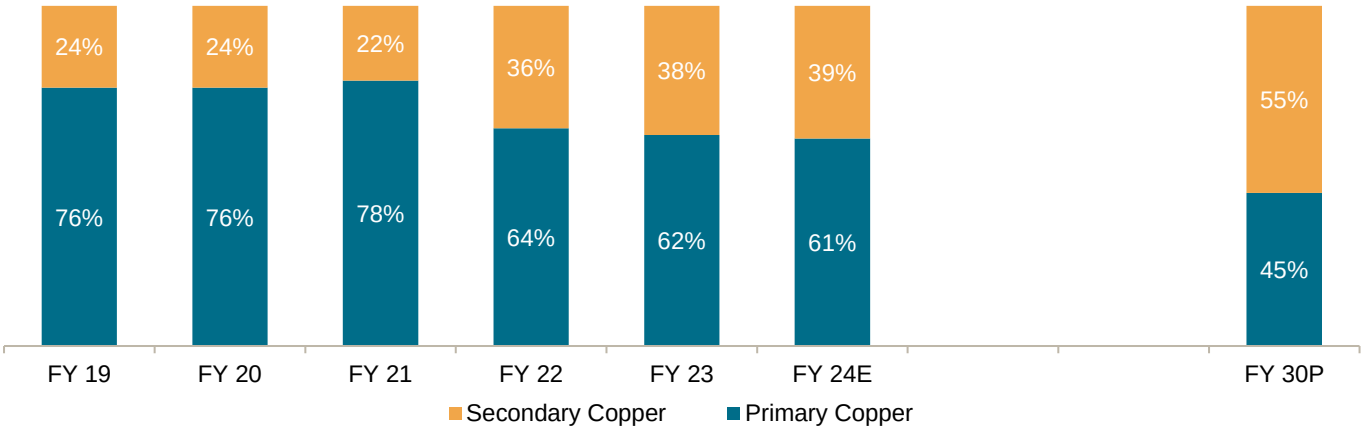


Source: Industry, Crisil Intelligence

Secondary copper industry

The secondary copper industry in India has witnessed significant growth in recent years, driven by increasing demand and a shift towards sustainable practices. The share of secondary copper increased from 24% in FY19 to 38% in FY23. It is estimated at 39% in FY24. Further, it is projected to grow to 55% by 2030.

Share of secondary copper industry (2019-2030)



E: Estimated, P: Projected
Source: ICA India, Crisil Intelligence

Between FY19 and FY24E, the demand for secondary copper increased from 278.2 kT to 645.0 kT, registering an ~18% CAGR.

Old and new scrap copper is generated from various sources, including used electric motors, cable wires, household utensils and cutlery, ship breaking, radiators, turning shavings, copper smelters and the fabrication industry[9]. India has a

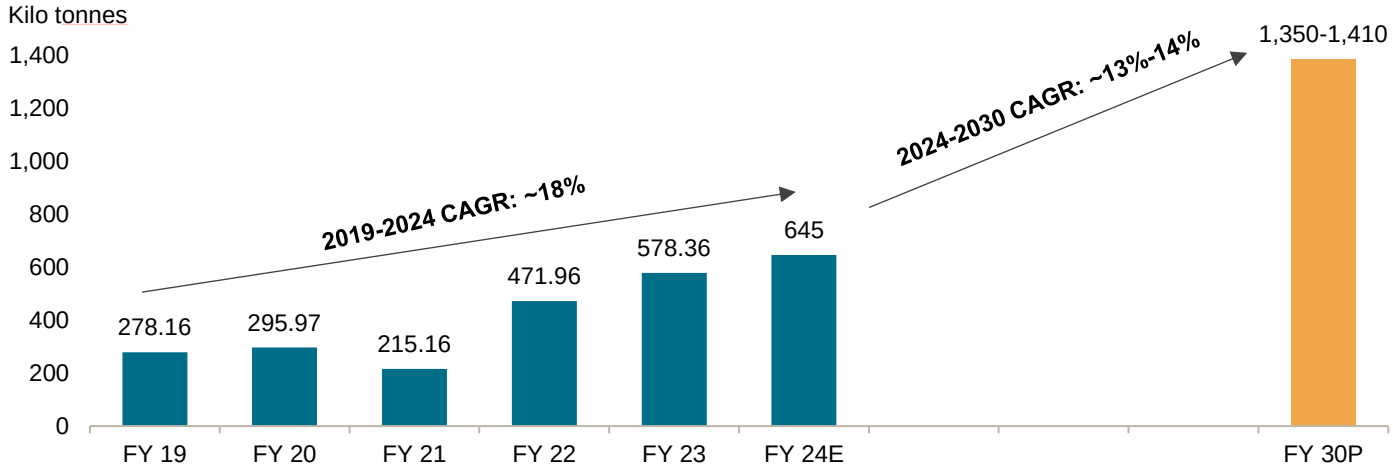
[9] Indian Bureau of Mines

high collection efficiency of end-of-life (old) copper scrap, with minimal copper loss during the direct remelting process for semis production, leading to high recycling rates.

However, the recycling process in India needs to focus on refining high-grade scrap and smelting & refining low-grade scrap to eliminate impurities. Currently, India primarily relies on direct melting of scrap, resulting in variable copper purity due to the use of diverse scrap types. Traditional methods are employed to reduce impurities, producing copper rods or billets that are non-compliant with national standards[10].

Looking forward, the share of secondary copper is expected to grow to ~55% by 2030, clocking 13-14% CAGR to reach 1,350-1,410 kT by 2030. Considering the government's ambitious recycling targets, which aim to increase the recycled content in copper products to at least 20% by 2031, the share of refined secondary copper is projected to be ~500 kT (~36% of the total secondary copper demand) by 2030[11].

Secondary copper demand 2019-2030 (kilo tonnes)



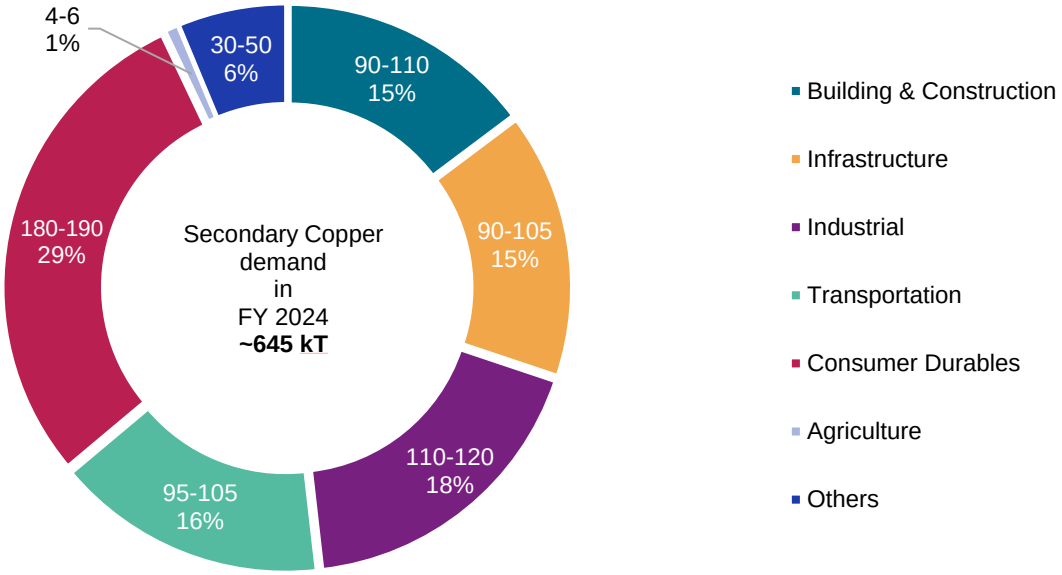
E: Estimated, P: Projected

Source: Industry, ICA India, Crisil Intelligence

[10] https://www.business-standard.com/content/press-releases-ani/india-s-copper-story-critically-dependent-on-the-quality-of-scrap-processing-124031500502_1.html

[11] https://recyclinginternational.com/commodities/non-ferrous-metals-recycling/india-copper-products-to-contain-20-recycled-content-by-2031/58264/

Secondary copper: Demand (in kT) and % share across end-use industries



Source: Industry, Crisil Intelligence

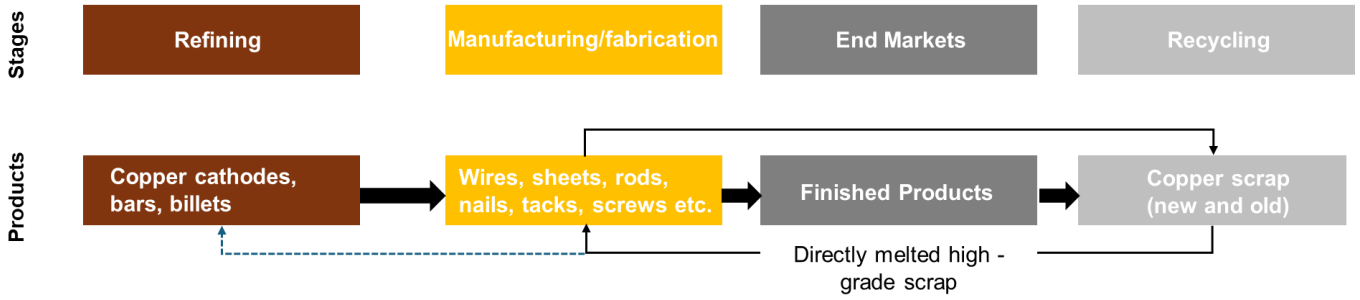
The breakdown of secondary copper usage varies by sector, depending on the nature of copper applications, quality requirements and adoption of recycling technologies.

Sr. no.	End use industry	Application	Share of Secondary Copper (as a % of the Overall copper demand in the sector)
1	Building & Construction	Electrical Wiring, Plumbing and other structural applications. However, use of secondary copper is moderate due to the high-quality standards required in certain applications such as wiring, which must adhere to safety norms.	25-30%
2	Transportation	Higher demand due to rise of EVs, which rely on copper for wiring, motors and batteries.	50-55%
3	Consumer Durables	Higher demand in this sector due to cost efficiencies and suitability of secondary copper in Appliances and electronics such as ACs, Laptops, Mobile Phones etc.	80-85%
4	Industrial	Increasing adoption of secondary copper in manufacturing and machinery production, especially in motors, transformers, and industrial machinery.	50-55%
5	Infrastructure	Infrastructure projects, particularly in power transmission, telecommunications, and public works, are gradually incorporating secondary copper, although quality standards often necessitate primary copper in some areas.	30-35%
6	Agriculture	Lower secondary copper usage in Irrigation systems, pest control devices, and machinery due to specific performance requirements in the agricultural equipment and systems that demand higher-purity copper.	10-15%
7	Other Sectors	Other sectors include healthcare and medical equipment, defense and aerospace, telecommunications, energy and renewables.	10-15%

Source: Industry, Crisil Intelligence

5.2 Structure of copper recycling industry in India

Secondary copper value chain



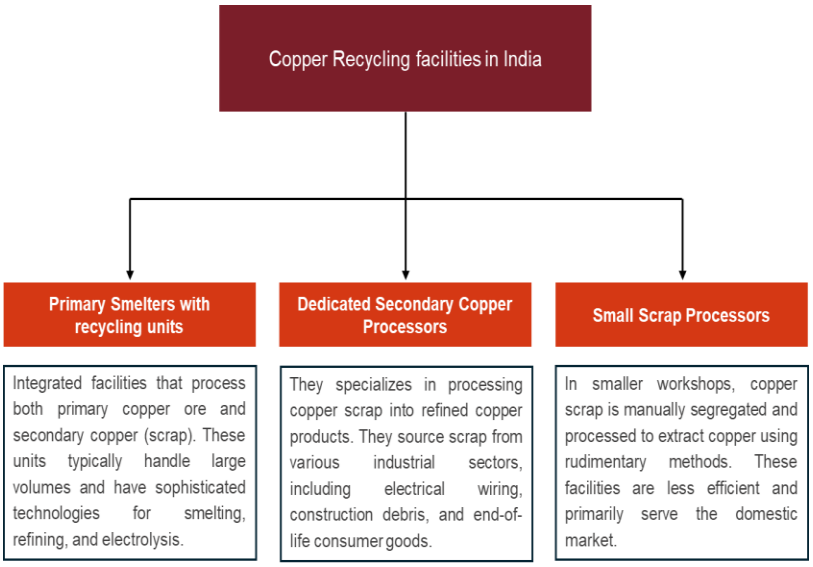
Source: Industry, Crisil Intelligence

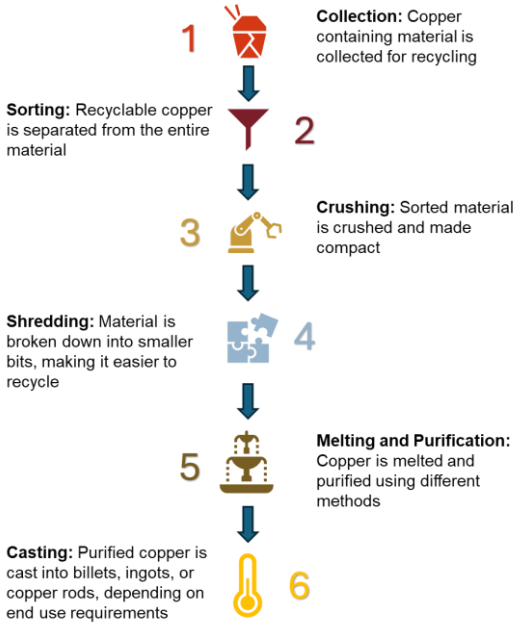
During semi-fabrication, copper and scrap are converted into wires/rods, tubes, sheets and strips for use down the value chain. These semis are then transformed into finished products that can be used directly by consumers and businesses. Semis made from refined cathode (through smelting) and remelted copper (through scrap) are mostly used for electrical applications in India. The major end use products are as below:

Sr. no.	Product type	Raw material	Manufactured by
1	Copper rods	Directly melted copper scrap	Matod, Rajnandini, JMW
2	Copper and copper alloy tubes and pipes	Cathode and scrap	Mehta Tubes, Mercure Metals, Global Copper, Mandev Tubes, ABC Tube
3	Copper and copper alloy rolled products	Refined Cathode: 50%, Scrap: 50%	Agarwal Metal, Rashtriya Metal, Bhagyanagar India

Source: ICA India

Copper recycling facilities in India and key steps involved in recycling





Source: Industry, Crisil Intelligence

Copper recycling in India typically involves several stages, each aimed at recovering the maximum amount of pure copper from scrap. The process can be summarised as follows:

- **Collection and sorting**: The recycling process starts with the collection of copper-containing scrap sourced from industrial waste, construction and demolition debris, electrical appliances and consumer goods. The scrap is then sorted based on copper content and quality. High-purity copper scrap (such as copper wires) is segregated for direct recycling, while lower-grade scrap undergoes further processing.
- **Crushing and shredding**: The collected scrap is shredded into smaller pieces to facilitate easier handling and processing. Granulation helps separate metallic copper from non-metallic materials such as plastics, insulation and rubber. In modern recycling plants, automated sorting and shredding technologies are used to enhance efficiency.
- **Melting and purification**: The shredded copper is then melted in furnaces. Molten copper is purified through processes such as electrolysis or fire refining, depending on the desired level of purity. In the fire refining process, impurities are removed by oxidation, while electrolysis involves using an electrolytic cell to obtain high-purity copper.
- **Casting and production of recycled copper**: After refining, the purified copper is cast into billets, ingots or copper rods, depending on end use requirements. These products can be used by diverse industries for manufacturing wires, tubes and other copper components. Recycled copper is often indistinguishable from copper produced from virgin ore, making it a highly valuable resource.

Copper industry players and level of integration

Supply of secondary copper by companies

Production in FY23	Used by	Quantity	Players
Scrap used: 574 kT (Domestic: 400 kT, net imports: 174 kT)	Remelters of copper and copper alloys for other applications	260 kT	Registered: 221 Unregistered: 800
	Fire rod manufacturers for electrical applications	314 kT	

Source: ICA India

5.3 Recycling practices

India's copper recycling industry is a vital component of the circular economy, utilizing established practices to recover copper from diverse waste streams. Key practices include:

1. **Collection and Segregation**:
   Copper scrap is systematically collected from industrial waste, end-of-life products, and manufacturing residues. Scrap dealers and collection centers play a critical role in segregating scrap based on quality and source.

2. **Role of Informal Sector**:
   Small-scale scrap dealers and informal recyclers form the backbone of the recycling ecosystem. They gather and initially process scrap from households, businesses, and industrial units before channeling it to larger recyclers.

3. **Industrial Recycling**:
   Large-scale recyclers use advanced facilities to handle substantial volumes of scrap, including:

   - Industrial production waste

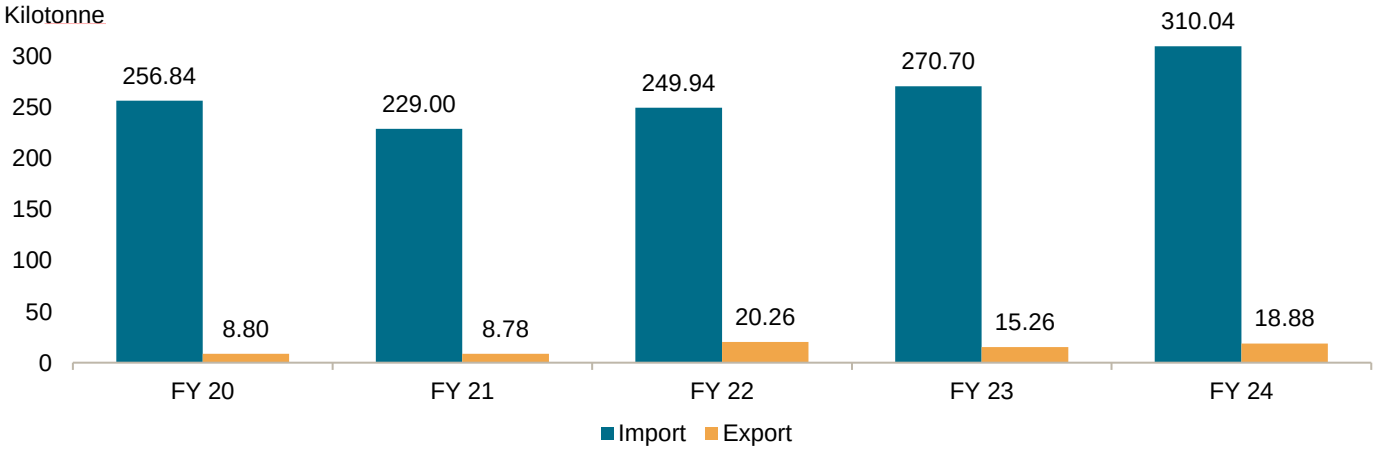
- End-of-life electrical and electronic equipment (e-waste)
- Construction and demolition waste
- Automotive components

4. **Source-Specific Recovery**:
   Specialized recovery practices are employed across key sectors:
   - **Automotive**: Copper recovery through authorized dismantling centers
   - **Electronics**: E-waste collection and recycling channels
   - **Construction**: Recycling copper from demolition waste
   - **Manufacturing**: Direct recycling of industrial by-products
5. **Classification and Grading**:
   Copper scrap is graded according to industry standards to determine the recycling process and end-use applications.
6. **Integration with Manufacturing**:
   Many manufacturers operate closed-loop recycling systems to process production scrap and end-of-life

5.4 Trade (import / export) assessment of recycled copper market

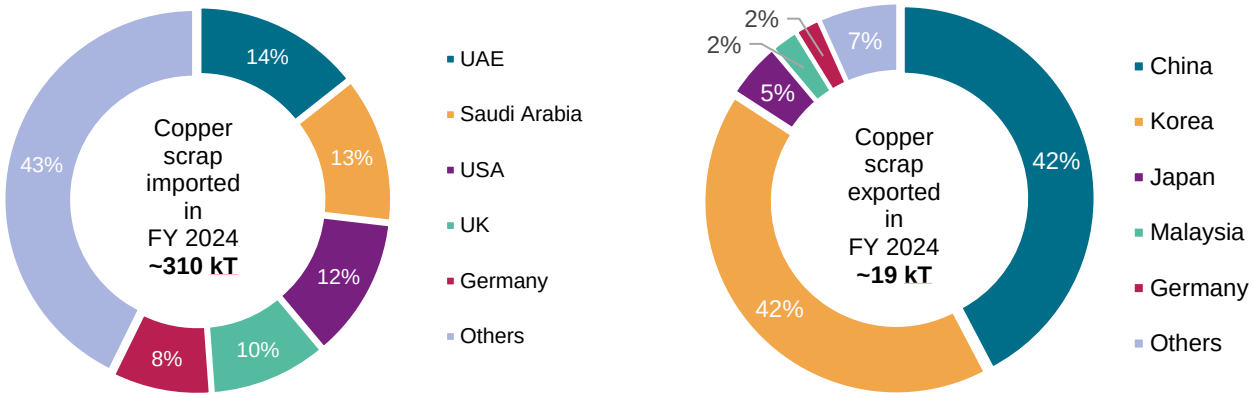
Recycled (secondary) copper plays a crucial role in meeting India's copper needs. In FY 2024, the import of copper scrap stood at 310 kT—a 14.5% increase over FY 2023. This growth highlights the country's reliance on foreign sources to supplement domestic copper scrap supply.

Import/export of copper waste and scrap (HS Code: 740400) – FY 2020-FY 2024



Source: Ministry of Commerce and Industry, Crisil Intelligence

Import/export countries



Source: Ministry of Commerce and Industry, Crisil Intelligence

Over the past five years, India's copper scrap imports have been dominated by a few key countries. In FY 2024, the UAE, Saudi Arabia and the US emerged as the top import sources, accounting for 44.5 kT, 38.8 kT and 37.3 kT respectively, of copper scrap imports. The other major import countries in FY 2024 included Kuwait, Belgium, Sweden, Australia and Netherlands. In contrast, in FY 2020, India's primary import partners were the US, Germany and Saudi Arabia. The most commonly imported types of copper scrap are druid, berry, brass honey and birch. These cater to demand from electrical, electronics and construction industries.

On the export front, India's copper scrap shipments have primarily catered to China, Republic of Korea and Japan. In FY 2024, these countries received 8 kT, 7.9 kT and 0.9 kT respectively, of India's copper scrap exports. Notably, in FY 2020, the top three export destinations were China, Hong Kong and Republic of Korea.

5.5 Advantages of using recycled copper

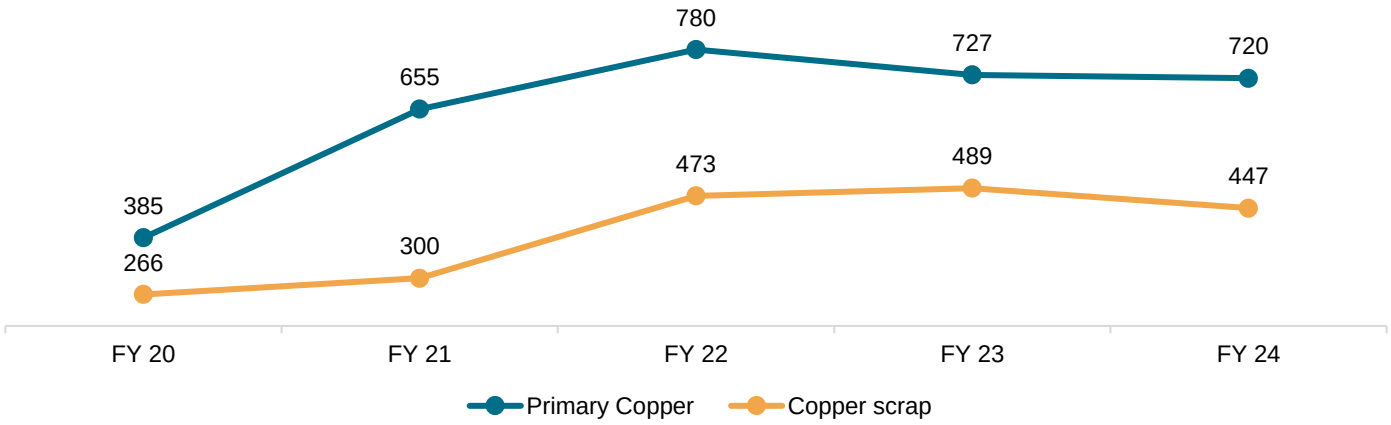
Recycled copper offers several advantages over virgin copper—essentially environmental, energy and economic benefits. Copper recycling produces fewer carbon emissions, less air pollution and supports jobs in the scrap metal recycling sector. It also uses up to 85% less energy than mined virgin copper, making it a more sustainable option.

Recycled copper offers the same standards of performance as virgin copper, and its unique ability to be recycled infinitely without losing its properties makes it ideal for a circular economy. The development of metal recycling infrastructure also drives the recovery of other important metals, reducing demand for virgin metals across industries.

- In order to extract copper from copper ore, the energy required is approximately **100 GJ/tonne**. Recycling copper uses much less energy, about **10 GJ/tonne**; that's only **10%** of the energy needed for extraction.
- According to the ICA India, India can **reduce energy costs by over 75%** by using recycled copper instead of natural resources.
- Recycling copper is **cheaper than mining** and extracting new copper, with recycled copper worth up to **90% of the cost of the original copper**.

Source: ICA India, Copper Recycling and Sustainability, Copper Development Institute

Primary copper & copper scrap: Price trend (Rs/Kg)



Source: IBM, Ministry of commerce and industry, Crisil Intelligence

5.6 Raw material availability in metal recycling

Major sources of copper scrap

1. Waste-Printed Circuit Boards

In India, Waste-Printed Circuit Boards (WPCBs) are one of the significant sources of copper scrap. They are generated in sizeable quantities, with an estimated ~113 kT of WPCBs produced in the country.

Most WPCBs—essentially 80-85%—come from the information and communications technology sector. This is not surprising given the rapid growth of the technology industry in India and the subsequent increase in electronic waste. The estimated copper content in WPCBs is significant at 21-23 kT.

Major cities such as Hyderabad, Bengaluru, Chennai, Delhi and Gurugram account for ~25.9 kT of WPCBs. The copper content in these WPCBs is substantial at 10-12%. Notably, PCBs used in information and communications technology equipment have even higher copper content, typically 18-23%.

- Moradabad is one of the largest hubs for informal WPCB recyclers; typically, the informal sector is concentrated in and around large cities across the country
- Scrap dealers from New Delhi, Mumbai, Kolkata, Bengaluru and Chennai trade WPCBs with players in the informal segment

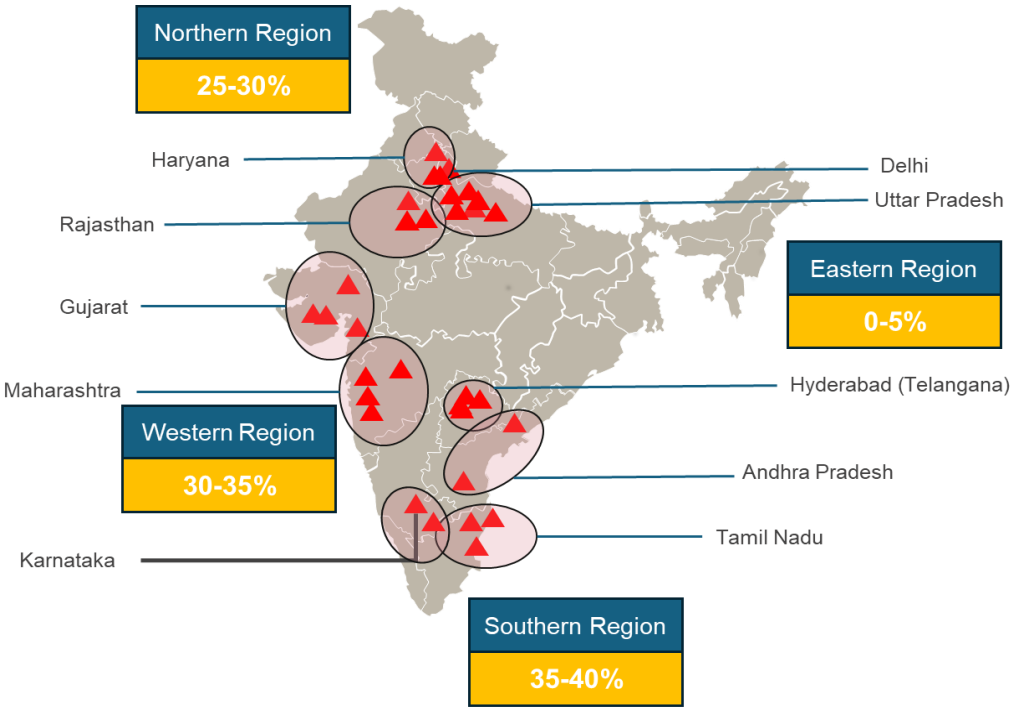
Copper recycled from WPCBs is in high demand across industries. Key end-users are manufacturers of copper alloys such as brass and bronze. Brass manufacturers producing artefacts, locks and hinges, too, are significant consumers of recycled copper. Similarly, bronze manufacturers catering to the artefact industry and the bushing industry rely on recycled copper as a critical raw material. Additionally, the automobile industry is another major consumer of recycled copper, which is used in applications such as radiators, bearings and electrical systems.

2. ICW (insulated copper wires)/ druid scrap

In addition to WPCBs, another significant source of copper scrap are Insulated Copper Wires (ICW)—also known as druid scrap. India imports ~60kT of ICW scrap per year.

Most of these imports, around 70-75%, come from three key regions: the Middle East, the UK, and the US. The estimated copper content in these total imports is significant, ranging from 28-29 kT. This imported ICW scrap provides a valuable source of recyclable copper, which can be used to meet the growing demand for copper in various industries.

WPCB and ICW recycling clusters are concentrated in and around large cities



Source: Industry, Crisil Intelligence

3. Construction and demolition sites

At construction and demolition sites, copper scrap includes copper from the wiring used in buildings, pipes and fittings and brass from door handles and frames. The most common types are as below:

- Electrical wires (ISRI Code BARLEY or BERRY, #1 copper wire)
- HVAC components (ISRI Code CANDY or CLIFF, copper solids and tubings)
- Insulated copper wire (ISRI Code DRUID or DROID)
- Sheet copper, gutters, downspouts, roofing (ISRI Code DREAM, light copper)
- Valves, machinery parts (ISRI Code EBONY, red brass)
- Old motors, generators (ISRI Code BIRCH, copper wire)

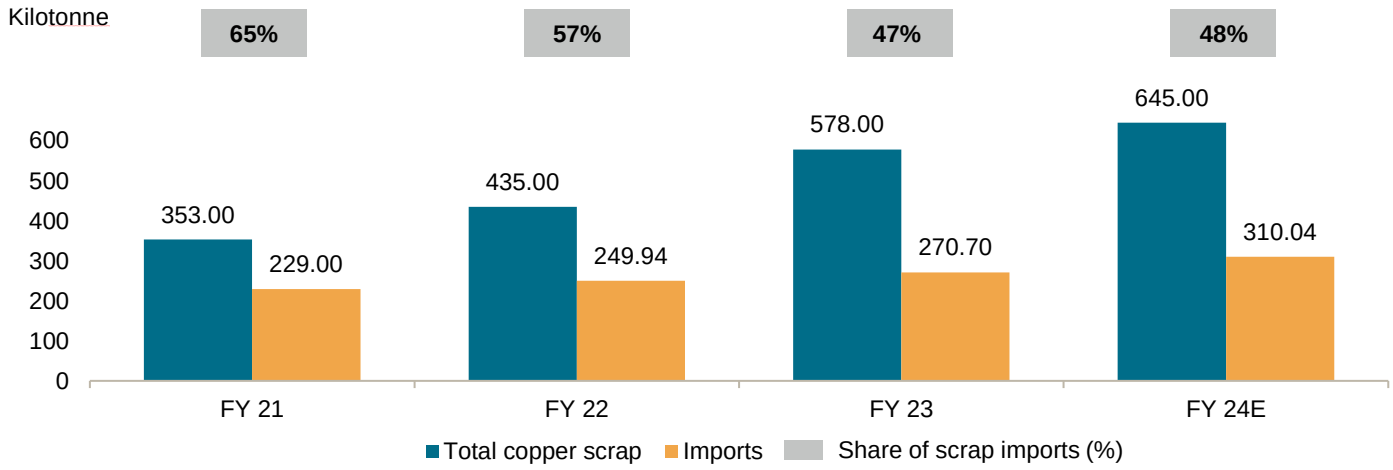
4. Others

There are significant sources of copper scrap in addition to WPCB and ICW. Electrical contractors, for instance, generate excess copper wires from various electrical appliances, which can be collected and recycled. HVAC contractors and plumbers also contribute to copper scrap generation through excess copper tubing used in construction and HVAC systems. End-of-Life Vehicles are another key source, with copper wiring, electric motors and wiring harnesses being recovered and sold to recycling plants. Further, electric rewinders, auto parts, municipal solid waste and shooting ranges are some more sources of copper scrap. These diverse sources thus provide a substantial amount of copper scrap for recycling and reuse.

Import dependency – share of scrap imports (2021-2024)

The country's reliance on copper scrap imports has reduced significantly over the past two years. In FY 2021, scrap accounted for 65% of total copper imports but its share dropped to 47% in FY 2023, indicating a notable shift towards greater self-sufficiency.

Based on recent trends, it is estimated that the share of scrap imports in FY 2024 will remain consistent with FY 2023 levels, with the total volume reaching ~310 kT.



E: Estimated

Source: Ministry of Commerce and Industry, ICA India, Crisil Intelligence

6 Aluminium recycling industry in India

6.1 Review and outlook

India—the world's second-largest producer of aluminium after China—with a production of ~4.2 million tonne[12] in fiscal 2024, plays a vital role in the global aluminium supply chain.

The global aluminium demand in 2023 reached 69.7 million tonnes. India's aluminium demand in FY 24 is estimated at 4.8 million tonne, representing approximately 6.9% of global demand.

The Indian aluminum market demonstrates robust growth potential, driven by increasing demand across end-use industries, including automotive, construction, packaging, and electricals. Total aluminum demand (primary and secondary) in India reached 4.8 million tonnes in FY 2024. Following a decline due to COVID-19 restrictions - from 3.9 million tonnes in FY 2019 to 3.4 million tonnes in FY 2021 - demand rebounded strongly, growing on-year at rates of 17.6%, 10%, and 9.1% to reach 4.0 million tonnes, 4.4 million tonnes, and 4.8 million tonnes in FY 2022, 2023 and 2024 respectively.

India's per capita Aluminium consumption is only about 3.1 kg compared to the world average of 12 kg and China's per capita consumption of 31.7 kg[13].

Per capita Aluminium consumption (Kg)

Source: Industry, Crisil Intelligence

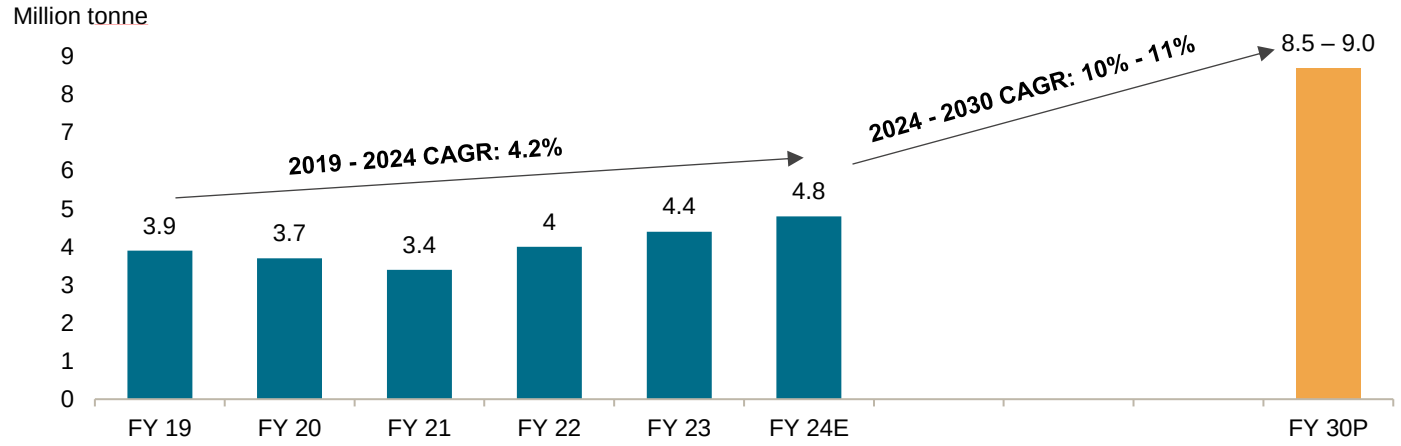
This presents a huge opportunity for Indian aluminium industry to grow across various end-use segments. Further, it is projected to clock a CAGR of 10-11% to reach 8.5 – 9.0 million tonne by FY30.

The rise in demand is supported by the replacement of other non-ferrous or ferrous metals with aluminium in key end-use industries, owing to its superior technical properties such as an optimum strength-to-weight ratio, low melting point, corrosion resistance, better electrical and thermal conductivity, and better recyclability.

[12] NALCO Annual Report 2023-24
[13] NALCO Annual Report 2023-24

Demand growth drivers include projected high GDP growth and government initiatives such as Make in India, 100% rural electrification, Housing for All, Smart Cities, the National Infrastructure Pipeline of ₹100 lakh crore, renewable energy and FAME (Faster Adoption and Manufacturing of Hybrid and Electric Vehicles) scheme.

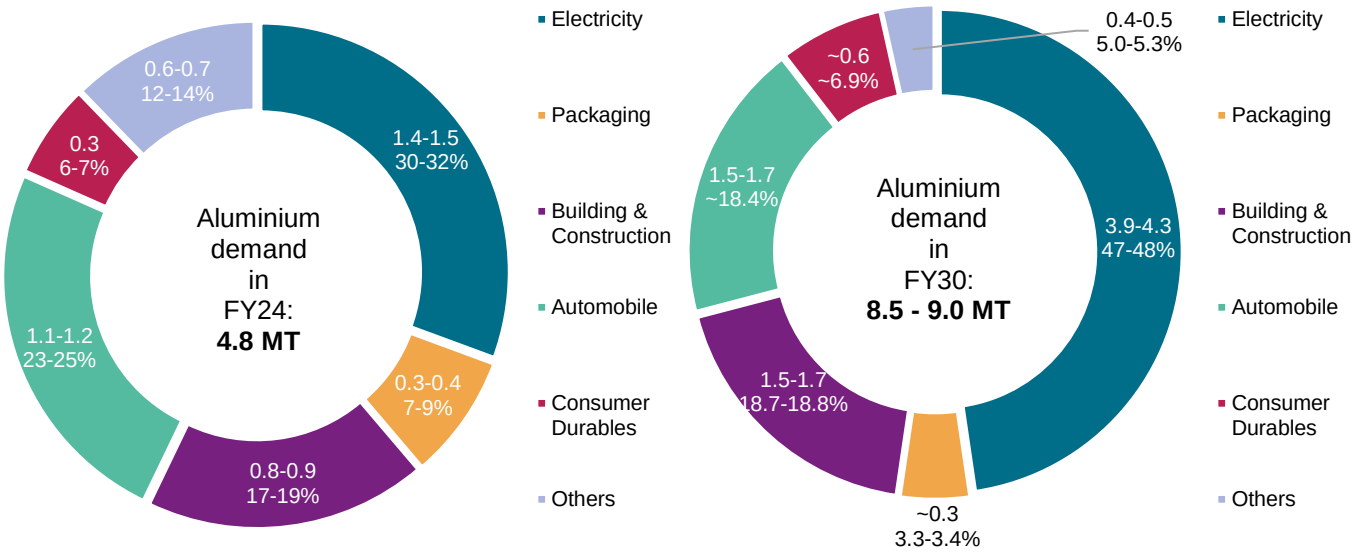
Aluminium demand on the rise



E: Estimated, P: Projected
Source: Industry, Crisil Intelligence

Demand by end-use sectors

Aluminium is a recyclable environment-friendly metal having a host of applications in a number of diverse sectors - electricity, building and construction (B&C), automotive, packaging and consumer durables.



Source: Industry, Crisil Intelligence

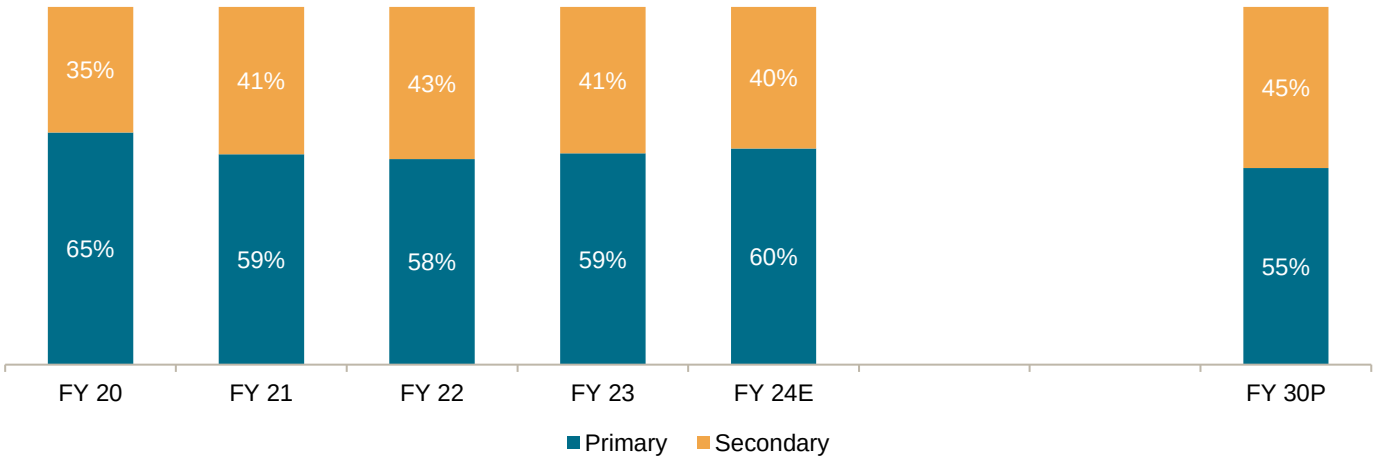
6.2 Secondary aluminium industry

The secondary aluminium (recycled) industry in India is driven by the cost advantages of recycled aluminium and healthy demand from the automobile sector, its largest consumer. The automobile sector's growing demand for non-ferrous

castings, coupled with increasing environmental concerns and a shift towards recyclable materials, is fueling growth of the secondary aluminium market.

In addition to the auto sector, growing demand from packaging, consumer durables, and construction sectors is also driving the growth of secondary aluminium. As a result, the share of secondary aluminium in the overall aluminium market is increasing, rising from 35% in fiscal 2020 to 40% in fiscal 2024. This trend is expected to continue, with secondary aluminium's share projected to grow to 45% by fiscal 2030.

Share of secondary aluminium



E: Estimated, P: Projected
Source: Industry, Crisil Intelligence

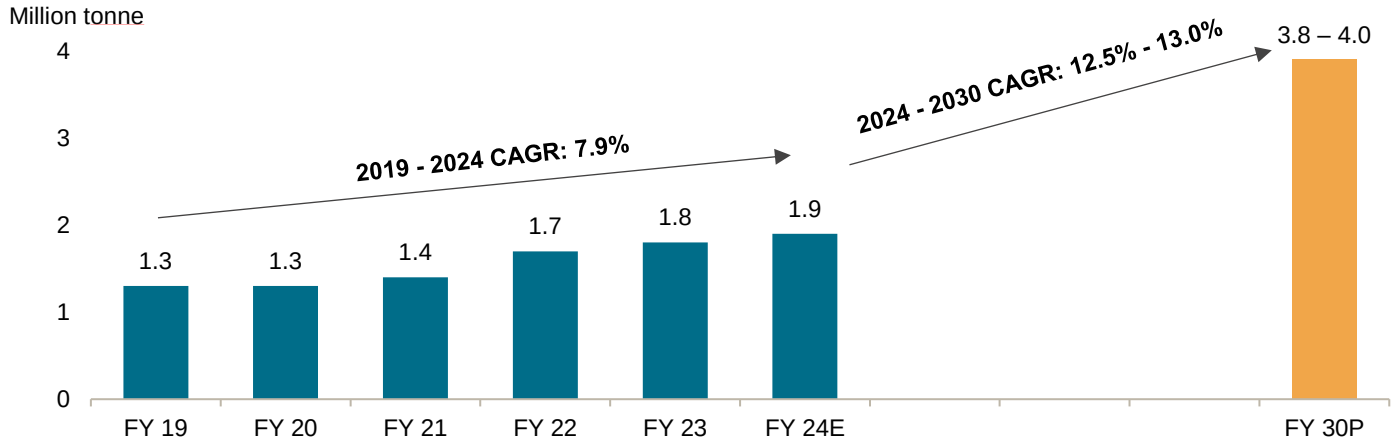
The demand for secondary aluminium in India has experienced a remarkable surge, with a CAGR of approximately 8% from FY 2019 to FY 2024. In FY 2024, the demand for secondary aluminium reached 1.9 million tonnes, driven by robust automobile production and construction activities.

Between fiscal 2019 and fiscal 2021, the demand for secondary aluminium grew marginally by ~2% CAGR reach 1.36 MT in fiscal 2021 owing to weak manufacturing activity resulting from pandemic induced lockdowns. Between fiscal 2021 and fiscal 2023, the demand for secondary aluminium grew by ~14% CAGR due to a weak base in the preceding years, revived automobile production along with other demand segment shifting to secondary aluminium amid sharp rise in primary aluminium prices.

The share of secondary aluminium is projected to increase at a CAGR of 12.5 - 13% to 3.8-4.0 million tonne by fiscal 2030, driven by improved domestic scrap collection and expansion in domestic production capacity.

However, the share increase is expected to be capped by the fall in exports of primary aluminium during the period, prompting domestic players to divert their local production along with shortage of scrap metal in the short term.

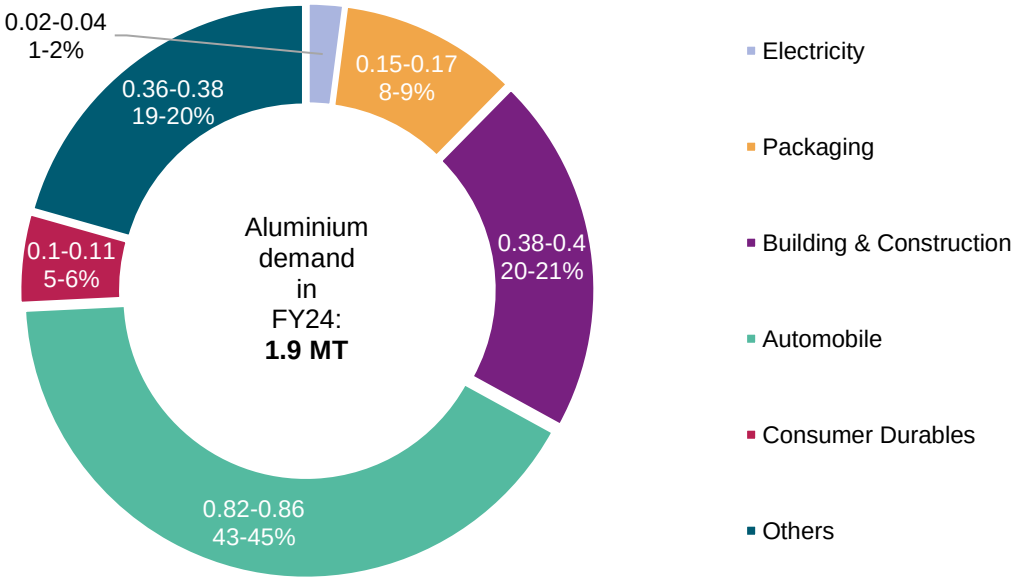
Demand for secondary aluminium



E: Estimated, P: Projected

Source: Industry, Crisil Intelligence

Secondary aluminium: Demand and % share across end-use industries



Source: Industry, Crisil Intelligence

Industry-wise use of secondary aluminium

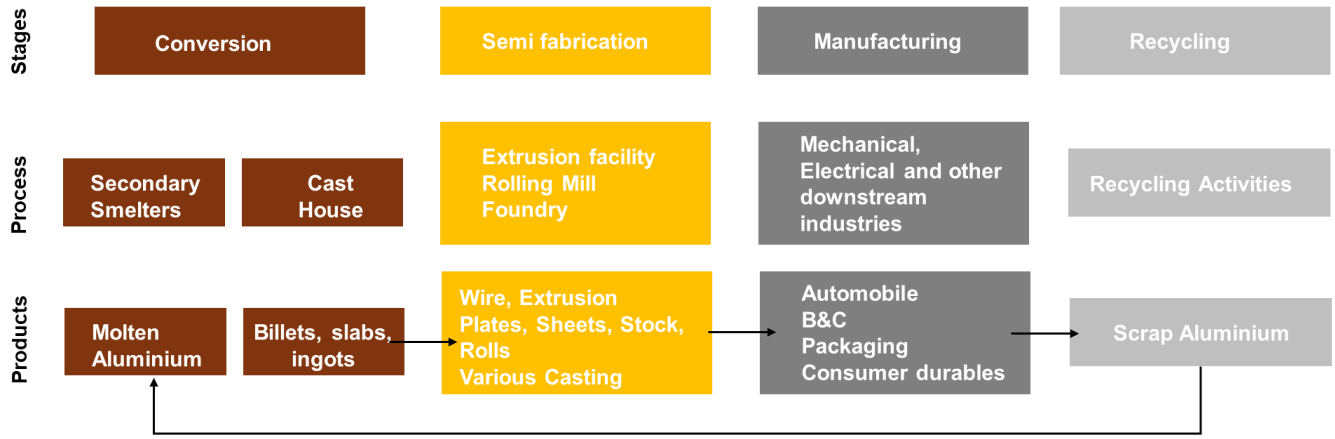
Sr. no.	End-use industry	Application	Share of secondary aluminium (%)
1	Automobile	• The superior molecular properties of secondary aluminium make it an ideal choice for casting applications, accounting for a significant share of the total casting requirement • The automobile sector's demand is driven by the government's stringent vehicular emission norms, which necessitate reduced vehicle curb weight • Electric vehicles have a higher aluminium intensity than traditional internal combustion engine vehicles, leading to increased demand for secondary aluminium	43 - 45%

Sr. no.	End-use industry	Application	Share of secondary aluminium (%)
2	Building & Construction	• Aluminium's intrinsic properties of lightness and corrosion resistance make it a popular choice in Building & Construction applications • It is extensively used in the manufacture of various building components, including windows, door frames, roofing, partitions, false ceilings and other building hardware, with extrusion and aluminium flat rolled products (FRPs) being the primary forms used in this sector • The growing demand for aluminium in B&C is driven by the increasing adoption of secondary aluminium, which offers significant cost advantages	20 – 21%
3	Packaging	• 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 are widely used in the packaging segment	8 – 9%
4	Consumer durables	• Aluminium is a preferred material in the manufacture of various household appliances, including refrigerators, washing machines and air conditioners (ACs) • The penetration of aluminium is particularly high in ACs and washing machines owing to its low weight, thermal efficiency, corrosion resistance and non-reactivity to chemicals • Despite its advantages, the demand for secondary aluminium is relatively low in the appliances sector, as the use of low quality scrap can pose significant risks, including serious problems in electrical equipment, making quality control a top priority in consumer durables	5 - 6%
5	Electricity	• Aluminium is primarily used in overhead conductors of transmission lines, transformer coils, bus bars and foil wraps for power cables • The power segment's share in secondary aluminium has been negligible over the years as it uses more of primary aluminium	1 - 2%
6	Others	• Defence, aerospace, machinery and equipment	19 - 20%

Source: Industry, Crisil Intelligence

6.3 Structure of aluminium recycling industry in India

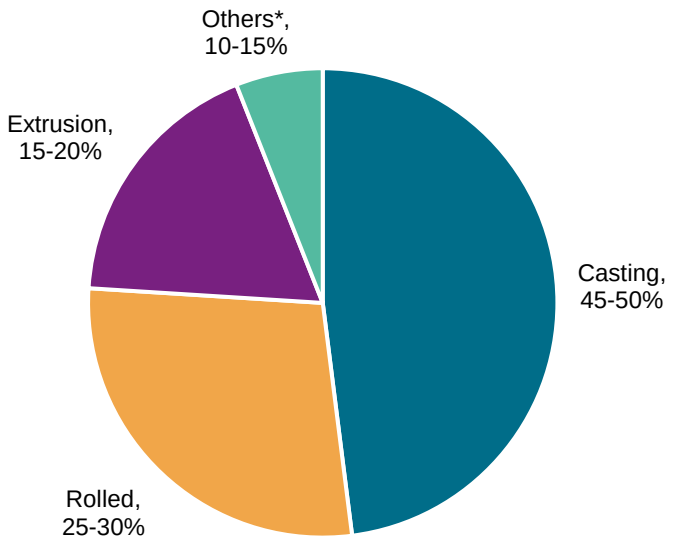
Value chain of secondary aluminium



Source: Industry, Crisil Intelligence

Aluminium is used in various semi-fabricated forms, produced from ingots, slabs and billets through processes such as rolling, extruding, drawing, casting and forging.

Product-wise secondary aluminium usage: FY24 (1.90 million tonne)



*Others: Drawing, powders and pastes among others

Source: Industry, Crisil Intelligence

Rolling: Aluminium ingots or slabs are compressed between rollers to produce flat products such as sheets (used in packaging and automotive applications), plates (used in aerospace and construction), and thin foils (used in food and pharmaceutical packaging).

Extruding: Aluminum billets are heated and forced through a die to create long products with uniform cross-sections, such as profiles (used in construction and transportation), rods, and tubes (used in piping, frames, and heat exchangers).

Casting: Molten aluminum is poured into molds to produce near-net-shape components like engine blocks, wheels, or structural parts, commonly used in automotive and aerospace sectors.

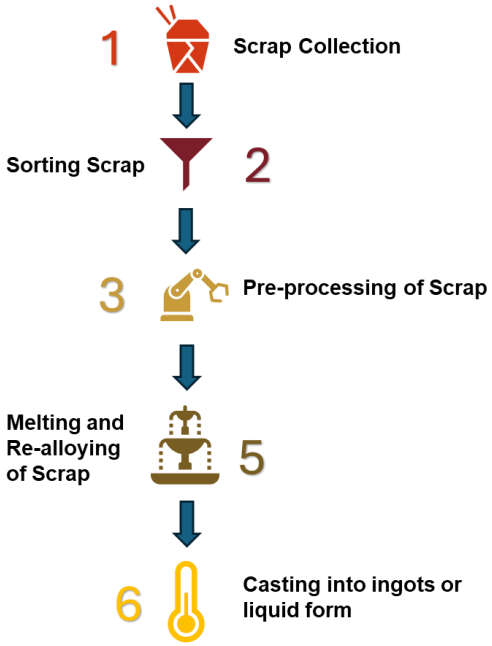
In fiscal 2024, the total secondary aluminium demand of approximately 1.90 million tonne comprised various product forms, with casting products accounting for the largest share of 45-50%. The bulk of the casting volumes were consumed in the automotive segment, primarily for manufacturing engine blocks, transmission systems and other components.

Extrusions, with their application in the building and construction (B&C) segment, accounted for 15-20% of total secondary aluminium volumes. Around 90% of the B&C segment's aluminium consumption was in the form of extrusions.

Rolled products, which find maximum application in the automotive and packaging segments (accounting for 85-90% of total rolling volumes) and some in the construction segment, accounted for 25-30% of overall secondary aluminium demand in fiscal 2024.

Other forms of the metal include drawn products, such as aluminium wires and tubes, and powder and paste forms. Aluminium powder is used in inks and explosives, while the paste is used in paints and to provide a metallic finish to automobiles.

Aluminium recycling facilities and key steps involved



Source: Industry, Crisil Intelligence

Aluminium recycling in India involves a multi-stage process aimed at recovering the maximum amount of pure metal from scrap. The process can be summarised as follows:

1. **Collection of scrap**, which is classified into two categories:

   New scrap: New scrap is surplus material that arises during the manufacturing and fabrication of aluminium products, up to the point where they are sold to the final consumer. For example, off cuts of aluminium sheets or extrusions are considered new scrap. Sometimes, this new scrap can be safely recycled by aluminium smelters as its composition is known.

Old scrap: Old scrap is material that has been used and discarded by the consumer. For example, used beverage cans, window frames, electrical cabling and car cylinder heads are all considered old scrap. Aluminium smelters are unable to safely accept this old scrap as its composition is usually unknown and it can be contaminated.

Scrap aluminium is also collected from the community — from households, scrap merchants and local and regional authorities, among others.

2. **Scrap sorting:** The collected scrap is sorted into coated (painted or lacquered) and uncoated aluminium. Non-aluminium materials such as paper, plastic and other contaminants are removed during this stage.
3. **Pre-processing of scrap:** The sorted aluminium is crushed into bales to reduce freight, storage and handling costs. The pre-processing stage involves segregating scrap by alloy grade, cleaning and removing impurities such as chemicals, oil and paints. Large and bulky pieces of scrap are shredded and coatings are removed in high-tech plants.
4. **Melting and re-alloying of scrap:** Uncoated scrap is loaded directly into a large furnace called a remelter, where it is melted at high temperatures. If the scrap is coated, it is processed through a gas-fired rotary furnace to remove the coating and then transferred to the remelter.

   While recyclers can remove most impurities through cleaning, sorting and segregation, some such as iron or steel remain and are removed separately from the bottom of the furnace during the melting process. After the scrap is melted, recyclers carry out the re-alloying process based on specifications such as tolerance levels and proportions of various alloying elements. Quality control measures such as tensile strength testing, spectrometric analysis and microscopic testing help ensure that the final product meets the required specifications. As the required configuration varies client-wise, alloy manufacturers typically install furnaces with small capacities (5-10 tonne/ batch), enabling them to switch grades at any time during production.

5. **Casting into ingots or liquid form**: This is the last stage in the value chain. Molten aluminium may be kept in its liquid state or cast into large slabs called ingots or billets. In some cases, alloying elements are added to liquid aluminium to produce the desired form for a specific product type.

   Alloy metal is also increasingly being supplied in the molten stage to the final consumer (typically auto component manufacturers), owing to several operational advantages for manufacturers and consumers. This is because eliminating the re-melting process reduces power and fuel consumption, lowering other operational costs.

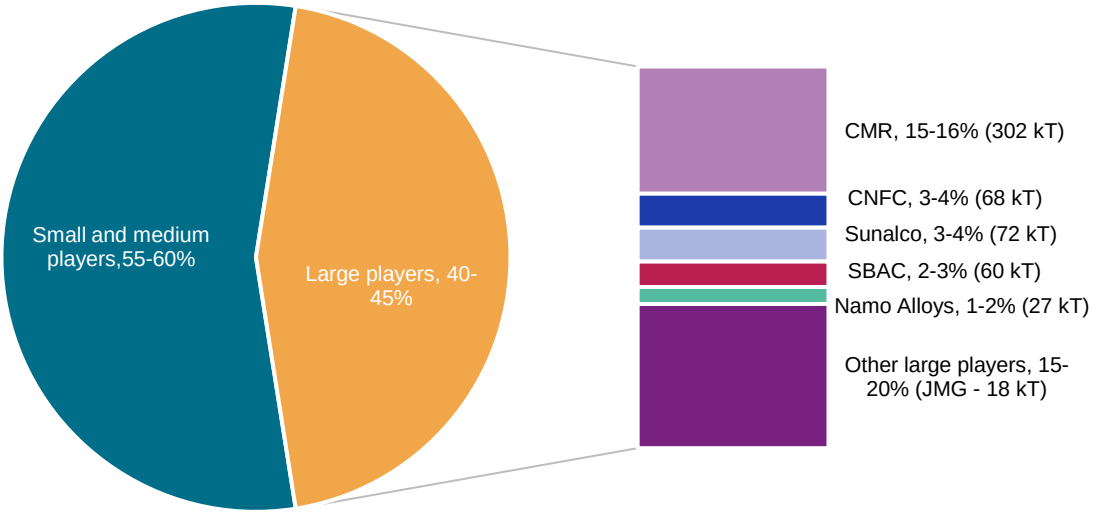
Secondary aluminium Industry players and the level of integration

The aluminium scrap recovery industry can be broadly segmented into two categories: small and medium players, and large entities.

Currently, there is only one recycling unit of Hindalco in the organised sector at Taloja with 25 KT annual capacity. Although the plant was facing challenges in availability of scrap, production has improved and the plant is now operating at 80% of the rated capacity as against 60% earlier. Hindalco is planning to set up a 93KTPA greenfield recycling unit at Mundra[14].

[14] Indian Bureau of Mines

Small and medium players have more cumulative capacity than large players



Note: Note: i) CMR – Century Metal Recycling, CNFC – Century NF Casting, SBAC – Shree Balaji Alumnicast; JMG: Jain Metal Group
ii) Large players are defined as known players with an annual capacity of 40K tonne or above
iii) Share is calculated based on estimated installed capacity for fiscal 2024
Source: Industry, company websites, Crisil Intelligence

The aluminium recycling market is predominantly dependent on small and medium players, which commanded 55-60% of the aggregate supply estimated for fiscal 2024, while large players accounted for the rest. Better economies of scale, steady order books, large client pools, mechanised operations, technological advancements and better productivity are some of the characteristics of large players.

A key differentiator between large and small players is their geographical presence. Large players tend to have plants at multiple sites, whereas small and medium players typically operate from a single location. This diversified presence allows large players to hedge against the risk of demand volatility in any region or cluster.

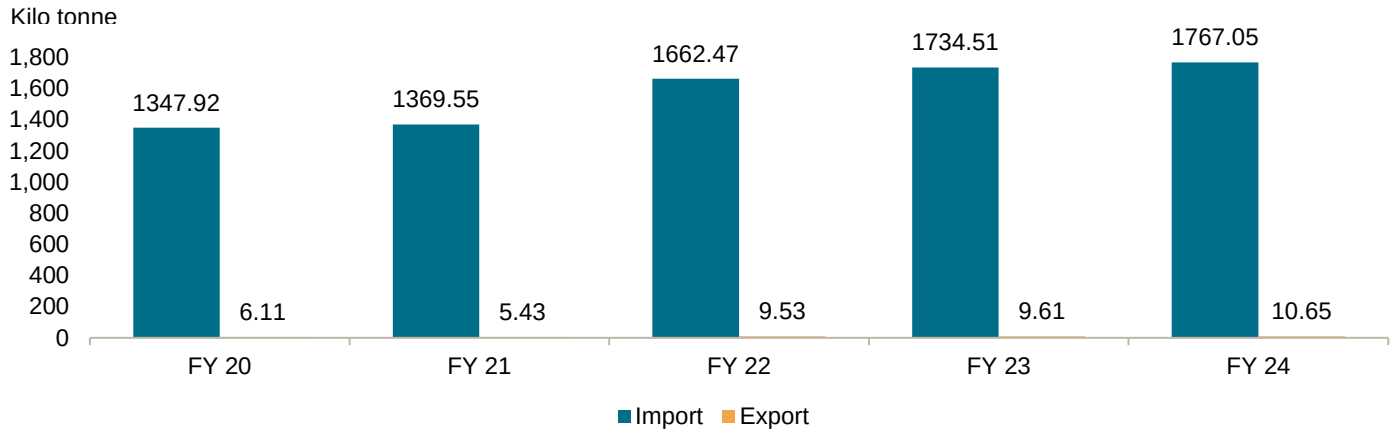
Many larger players, such as CMR, CNFC, SBAC, and Sunalco, have a significant presence in key auto clusters, which enables them to capitalise on the growing demand for aluminium in the automotive sector.

6.4 Trade assessment of aluminium waste and scrap

India's imports of aluminium waste and scrap have been rising steadily, from approximately 1,350 KT in fiscal 2020 to around 1,770 KT in fiscal 2024, at a CAGR of 7%. This significant growth indicates increasing demand for recycled aluminium in the country.

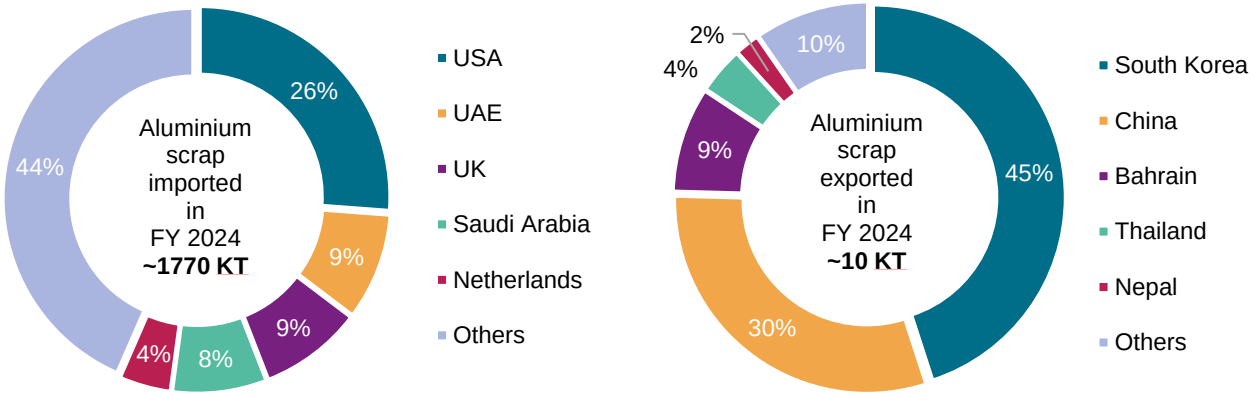
Aluminium scrap exports have also increased from around 6 KT in fiscal 2020 to ~11 KT in fiscal 2024.

Import/Export trend of aluminium waste and scrap (HS Code: 760200) for the past five years



Source: Ministry of Commerce and Industry, Crisil Intelligence

Trade partners



Source: Ministry of Commerce and Industry, Crisil Intelligence

Over the past five years, India's aluminium scrap imports have been dominated by a few key countries. In fiscal 2024, the US, UAE and the UK were the top import sources, accounting for 462.7 KT, 161.1 KT and 155.4 KT, respectively, of aluminium scrap imports. In fiscal 2020, too, India's primary import partners were the US, UK and UAE. The major types of aluminium scrap imported are taint tabor, tale and tense.

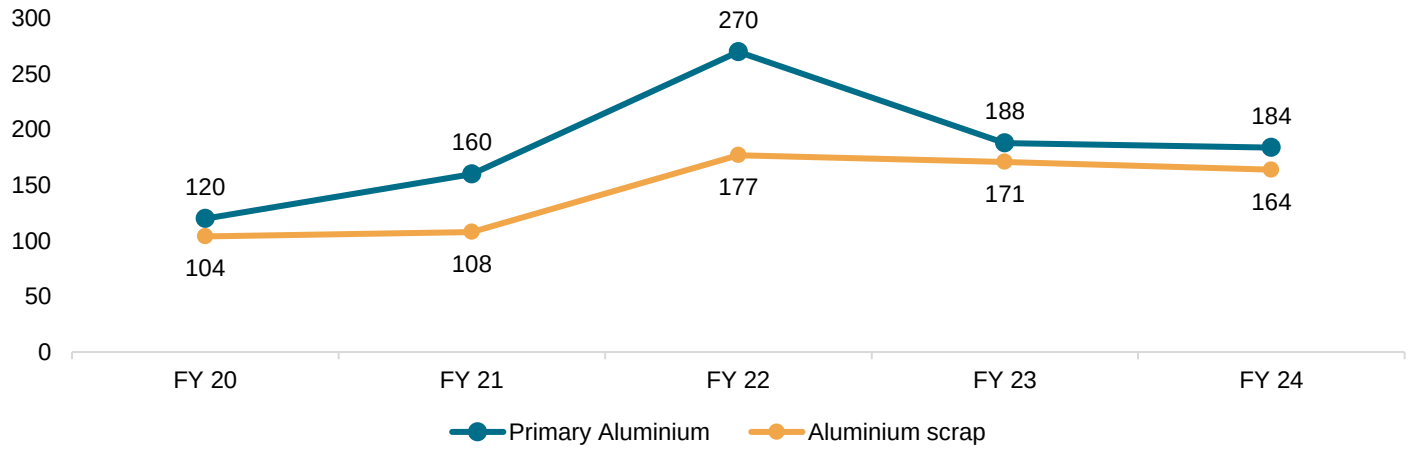
On the export front, aluminium scrap shipments have primarily catered to South Korea, China and Bahrain. In fiscal 2024, India exported 4.8 KT, 3.2 KT and 0.9 KT, respectively, to these countries. In fiscal 2020, the top three export destinations were South Korea, USA and Canada.

6.5 Advantages of recycled aluminium

- **Lower capital intensity:** Manufacturing aluminium through the primary route involves bauxite mining and refining, and smelting of alumina, among other processes. These activities are capital and energy intensive. Setting up a greenfield refinery and smelter of a minimum economic size (typically a refinery of 1 million tonne and a smelter of ~0.5 million tonne) with a captive power plant requires an investment of ₹22,000-24,000 crore. As against this, the recycled route involves sorting and segregating scrap, melting, re-alloying and casting into ingots. Setting up a fully mechanised recycling unit of 1 million tonne capacity would typically involve an investment of ₹1,500-2,000 crore.

Low cost of production compared to primary aluminium: A major advantage of recycling is the lower production costs than the primary route, owing to significantly lower energy requirements (~90-95% of energy savings in case of secondary aluminium production as per International Aluminium Institute). Also, aluminium scrap already contains the required alloyed elements, reducing alloying costs. As a result, there is a notable price difference between secondary and primary aluminium ingots.

Primary Aluminium & Aluminium scrap: Price trend (Rs/kg)



Source: IBM, Ministry of commerce and industry, Crisil Intelligence

- **Perpetual recyclability:** Aluminium is 100% recyclable, irrespective of the number of times it is recycled. The other key advantage of secondary aluminium is the pre-existence of desired properties, as it is pre-alloyed specific to the end-use requirement when in scrap form.
- **Scrap availability:** Aluminium scrap is estimated to be abundant globally, which further increases recycling of the metal for key end-use products.
- **Environment-friendly option:** Manufacturing primary aluminium consumes significant natural resources. As per industry estimates, every tonne of aluminium manufactured through the primary route consumes 4-6 tonne of bauxite, 1-1.5 tonne of limestone, 20-22 cubic metre of water and ~14,000 Kwh of power. As against this, manufacturing 1 tonne aluminium through the recycled route consumes scrap as a key raw material (saving natural resources) and only 5-7% of the total energy required for primary aluminium.

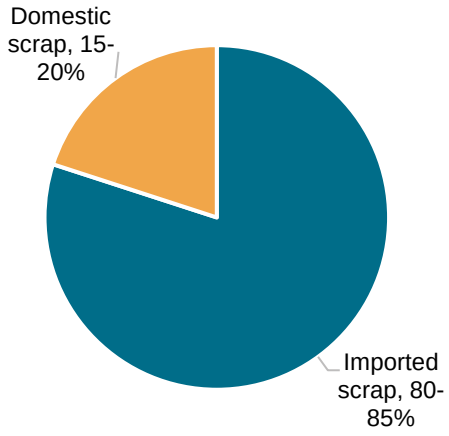
Furthermore, as per the Bureau of International Recycling, each tonne of aluminium ingot manufactured through the primary route emits ~3,830 kg of CO_2 compared with ~290 kg of CO_2 for aluminium manufactured through scrap recycling. Primary aluminium production through refineries generates ~ 2-2.5 tonne of solid waste for every tonne of aluminium produced, unlike secondary aluminium production, where solid and liquid discharge is close to negligible.

6.6 Raw material availability in aluminium recycling

Imported scrap dominates recycling industry

India is heavily dependent on imports for aluminium scrap. In fiscal 2024, 80-85% of the total demand for the material was met through imports. The high share of imports is largely because the country lacks an efficient ecosystem for scrap collection and processing facilities, such as scrap yards. Also, a large chunk of scrap collected domestically is used by small and mid-sized players for utensil making.

Domestic versus imported scrap (fiscal 2024)



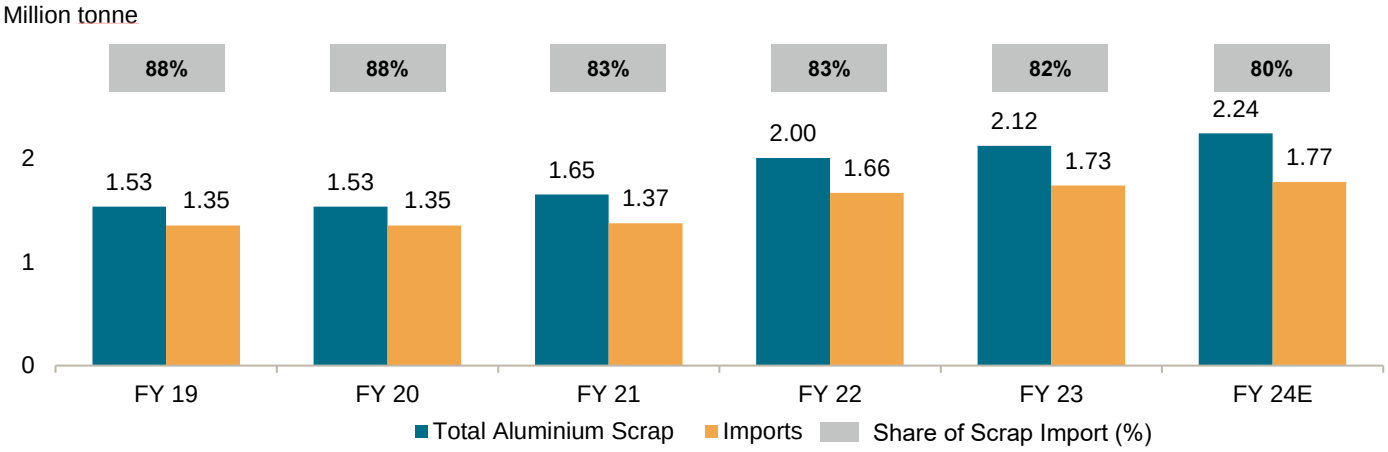
Source: DGFT, Industry, Crisil Intelligence

Import dependency – share of scrap imports (2019-2024)

Scrap imports increased by 2.3% on-year during FY 2024 owing to increasing demand for secondary aluminium. However, the growth has been limited owing to improving domestic scrap collection and lower primary aluminium prices which allowed end users to meet their demand with primary aluminium. In FY 2019, aluminium scrap imports accounted for 85-90% of total scrap used.

On the supply side, India is heavily reliant on scrap imports which has increased at 5.5% CAGR between FY 2019 and FY 2024 to reach 1.77 million tonne owing to low domestic scrap collection. Based on recent trends, it is estimated that the share of scrap imports in FY 2024 will remain consistent at 80-85% with the FY 2023 levels.

Import dependency – Share of scrap imports (2019-2024)



E: Estimated
Note: Recovery factor of 85% has been considered to estimate total aluminium scrap
Source: Ministry of Commerce and Industry, Crisil Intelligence

Recycled aluminium demand is largely concentrated in and around auto clusters

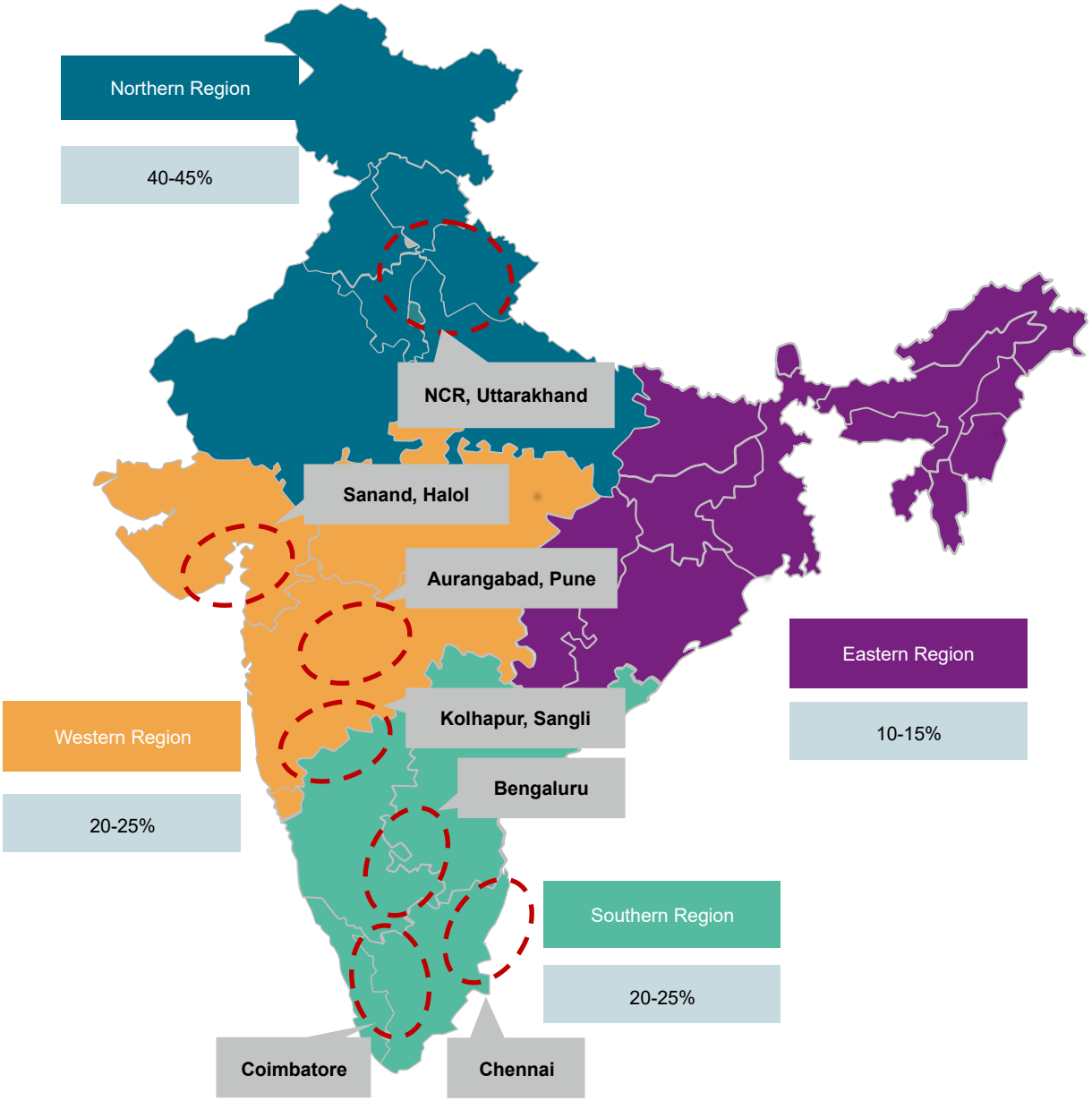
Of the total estimated demand for secondary aluminium of ~1.90 million tonne in fiscal 2024, ~40-45% was concentrated in the northern region, followed by the southern and western regions. This was primarily because of the key auto

hubs/clusters in the NCR, which house units of original equipment manufacturers such as Maruti Suzuki, Hero MotoCorp, Bajaj Auto and Tata Motors.

The western and southern regions accounted for 20-25% of the demand for secondary aluminium each, with auto clusters located in Chennai, Coimbatore and Pune, coupled with a significant presence of extruders in these regions.

The eastern region, which has no major auto component hubs, had the lowest share of 10-15% during the fiscal. De-ox (deoxidiser) and utensils are key end-users in the eastern belt. With newer OEMs being set up in the region, demand for secondary aluminium is expected to increase.

Aluminium recycling clusters in India (fiscal 2024)



Source: Industry, Crisil Intelligence

7 Lead Recycling Industry in India

7.1 Indian recycled lead market review and outlook

The Indian lead market has witnessed steady growth in recent years, driven by increasing demand from the lead acid battery industry. Demand for lead in India grew from 1.20 million tonne to 1.37 million tonne between FY 2019 and FY 2024, logging a CAGR of 2.7%.

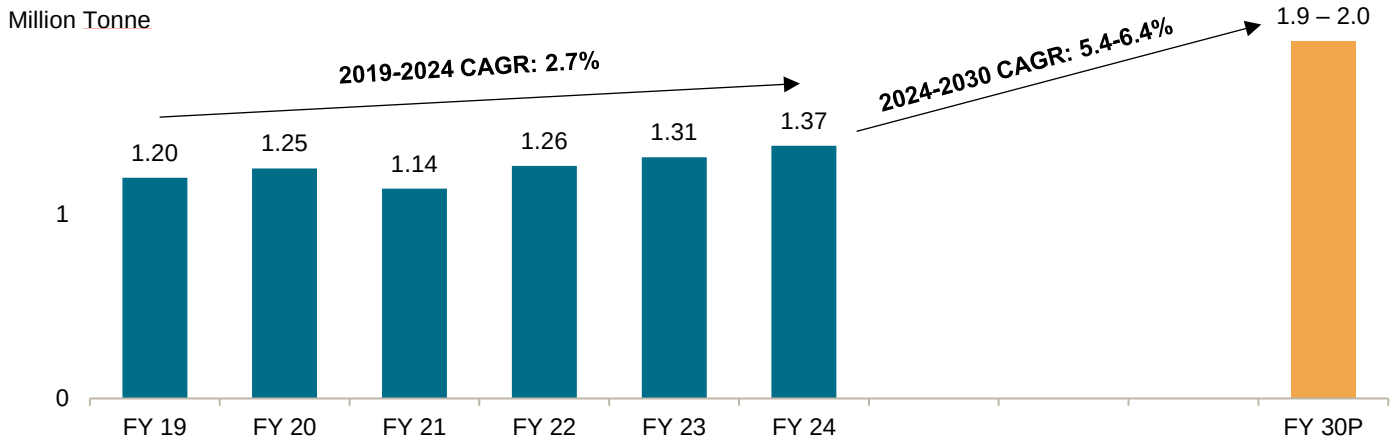
India is expected to remain an attractive market for lead, with demand projected to grow at an average 6.4% until 2031[15]. The overall demand is anticipated to log a CAGR of 5.4-6.4%, reaching 1.9-2.0 million tonne by FY 2030.

The lead acid battery industry, comprising both original equipment manufacturer (OEM) and replacement markets, is the primary driver of demand. Additionally, industrial sectors such as telecom, home Uninterruptible Power Supply (UPS) and commercial power backup are also aiding demand. The emerging opportunity of energy storage for electricity generated from photovoltaic (PV) cells is expected to further drive demand given India's ambitious plan to aggressively expand solar PV capacity by 2030.

The domestic battery manufacturing industry is also witnessing growth, with major players expanding their lead acid battery manufacturing capabilities to cater to sustained demand. The industrial battery segment, which caters to data centres, financial institutions and the telecom industry, is experiencing strong growth on the back of a digitalisation surge in the country that has driven up demand for reliable power backup solutions.

The global lead demand in 2023 reached 12.5 million tonnes. India’s lead demand in FY 24 stood at 1.37 million tonnes, representing approximately 11% of global demand.

Overall growth in lead demand (2019-2030)



P: Projected

Source: Industry, Crisil Intelligence

Overall Lead Demand - End Use Sectors

The lead acid battery industry is the largest end user of both primary and secondary lead. A small portion of lead is utilised in cable sheathing and PVC stabilisers.

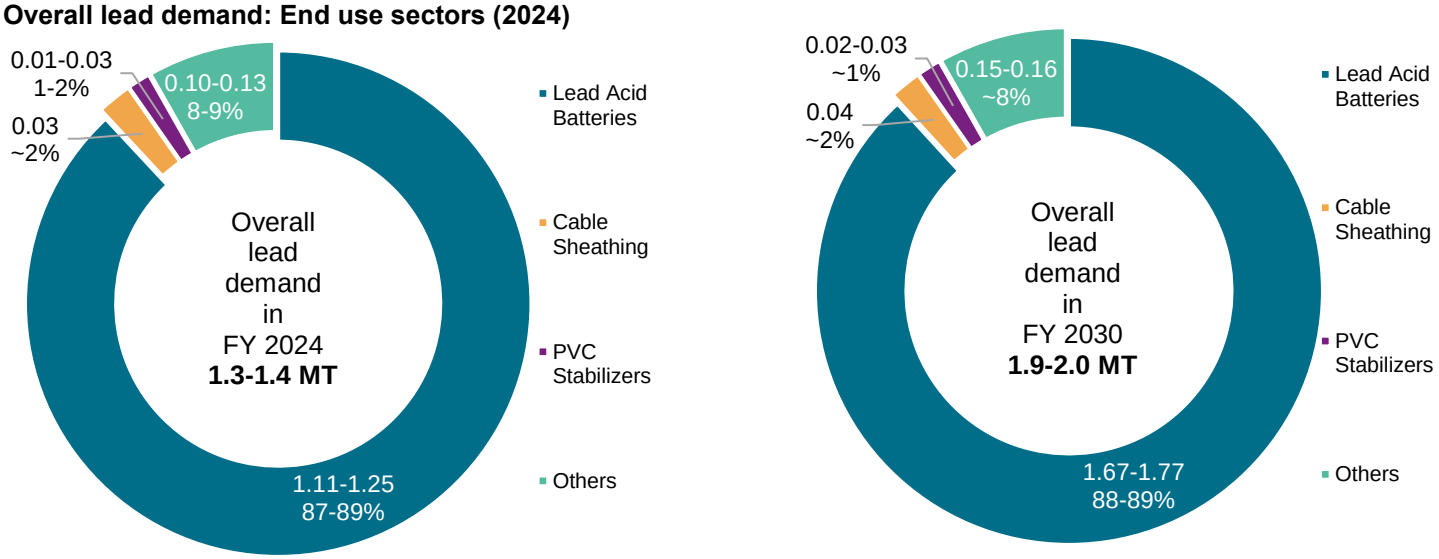
[15] HZL Annual Report

The auto industry (OEM and replacement segments) is a significant driver of demand, followed by non-auto sectors such as telecom, UPS/inverter (home and office), solar, traction and submarine. These industries rely heavily on lead acid batteries to power their operations.

In the auto segment, primary lead is used in compact Valve-Regulated Lead-Acid (VRLA) batteries for two-wheelers, exports and high-end domestic models, driven primarily by OEM demand. Additionally, primary lead finds applications in critical equipment such as submarine and naval ships, where reliability and performance are paramount.

In the non-auto segment, primary lead is used in VRLA batteries for high-end applications in telecom, industrial UPS, railways and traction segments, where reliable power backup is essential.

Overall lead demand: End use sectors (2024)



Source: Industry, Crisil Intelligence

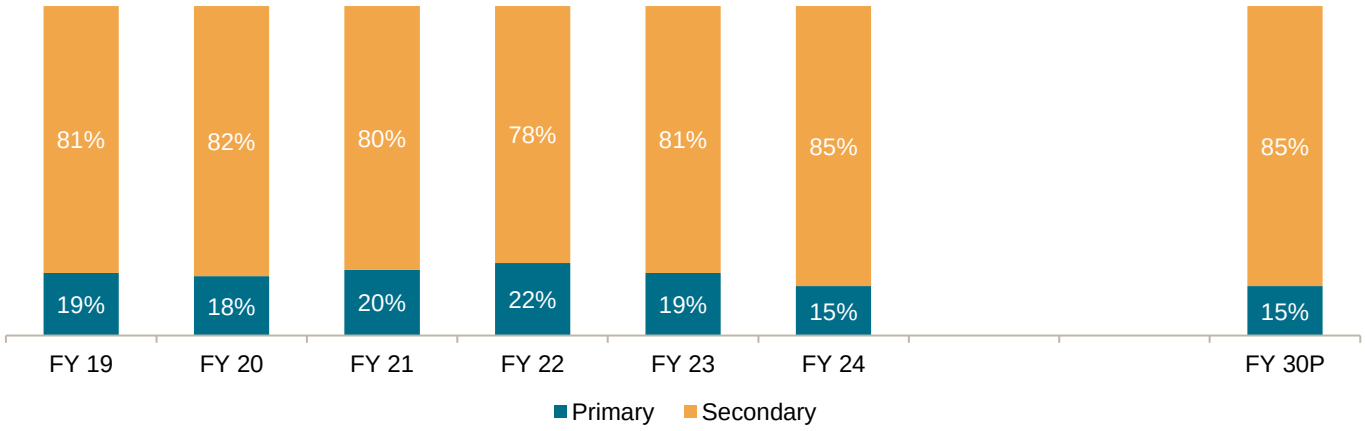
7.2 Secondary Lead Industry

Lead is one of the most highly recycled metals, with the ability to be re-melted multiple times without losing its properties. A significant portion of lead production in India, i.e. 85-90%, comes from recycling. Most of the lead consumed in the country, i.e. over 80%, is used in the manufacturing of batteries.

The recyclability of lead is a significant advantage—it can be redeployed in applications such as batteries, cable sheathing and radiation shielding without compromising its properties. India has a thriving lead recycling industry, but given the health risks involved, the Central Pollution Control Board issues licences to lead reprocessors to ensure environmental norms are followed.

The share of secondary lead in the market has been increasing steadily, rising from around 80% in FY 2019 to approximately 85% in FY 2024. Growth is expected to remain ~85% in FY 2030 as the industry is likely to experience a shift, with smaller, unorganised recyclers exiting the market due to stringent regulations, creating opportunities for larger secondary players and driving demand for primary lead.

Secondary Lead Industry (2019-2030)



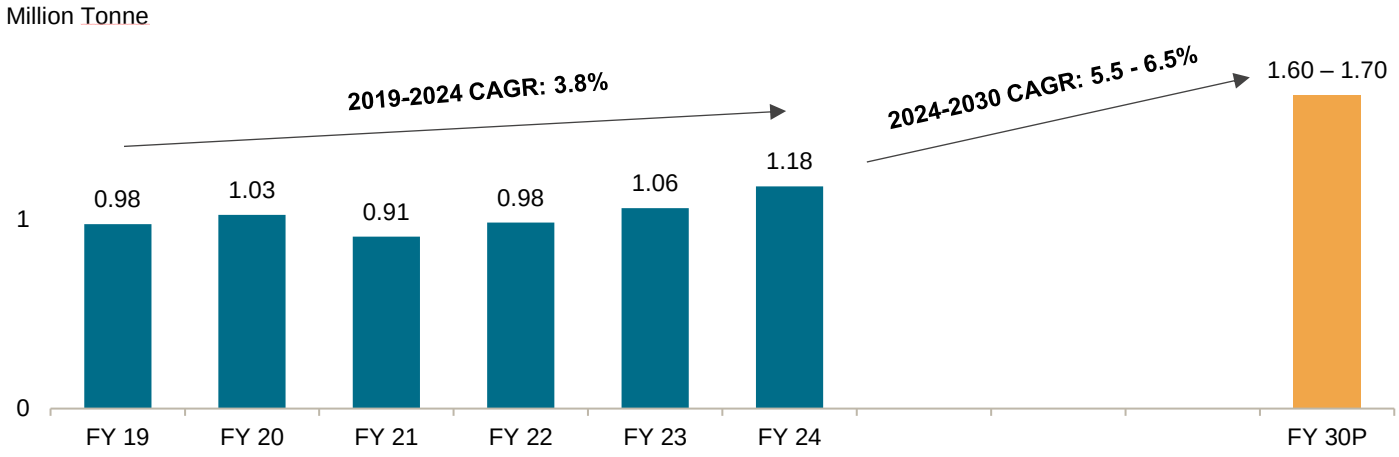
P: Projected

Source: Industry, Crisil Intelligence

Demand for secondary lead has experienced steady growth, increasing from 0.98 million tonne in FY 2019 to 1.18 million tonne in FY 2024—a CAGR of 3.8%. Although demand declined to 0.91 million tonne in FY 2021 due to COVID-related restrictions, it rebounded strongly in subsequent years, growing 8% in FY 2022 as well as FY 2023 and 11% in FY 2024.

This upward trend is expected to continue in the years to come, with demand for lead logging a CAGR of 5.5-6.5% to reach 1.6-1.7 million tonne by 2030. The growth is expected to be driven by factors such as an expanding automotive market, emerging export opportunities and increasing demand for lead as a raw material.

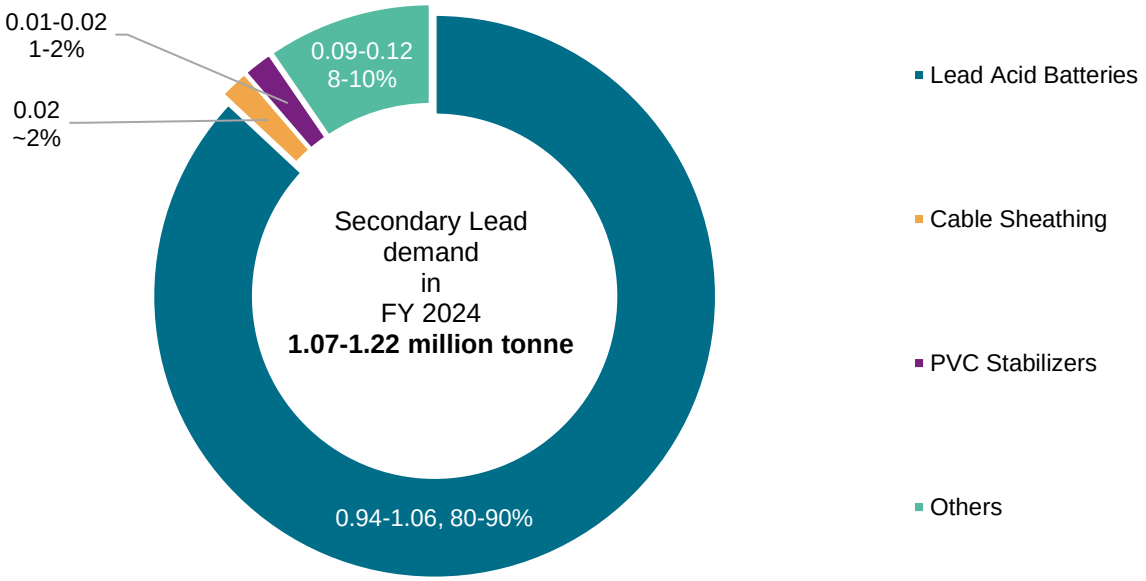
Secondary Lead Demand (2019-2030)



P: Projected

Source: Industry, Crisil Intelligence

Secondary Lead



Source: Industry, Crisil Intelligence

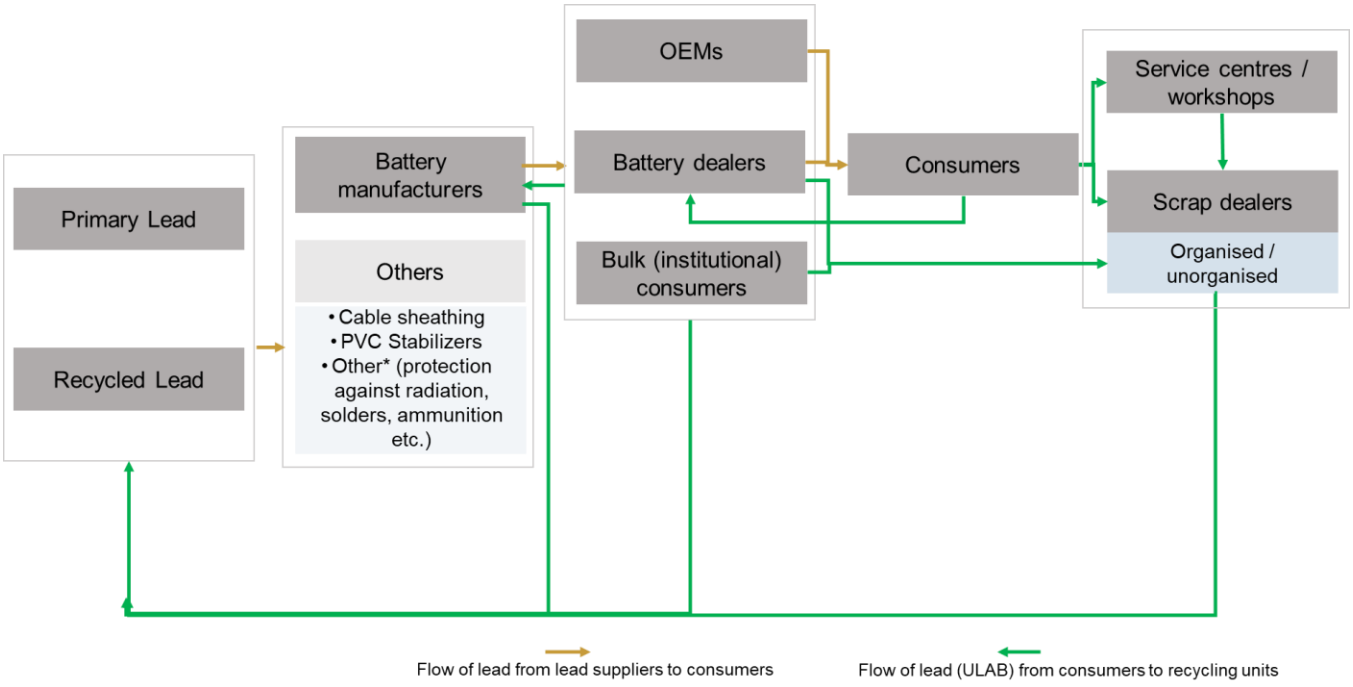
The sector-wise breakdown of secondary lead usage is as follows:

Sr. no.	End use industry	Applications	Share of Secondary Lead (%)
1	Lead Acid Batteries	More than 80% of the lead consumed in the country goes into manufacturing lead batteries. Storage battery scrap is the main source of secondary lead	80-90%
2	Cable Sheathing	Lead sheathing plays a crucial role in providing a chemical and corrosion barrier, as well as water resistance, in high-voltage transmission lines. Its primary application is in the HV-EHV segment, where it ensures the reliable transmission of power over long distances. With an average lifespan of 25-30 years, lead sheathing is a durable and long-lasting solution. Moreover, lead used in cable sheathing is fully recyclable. It retains its properties even after recycling, making it a sustainable choice	~2%
3	PVC Stabilisers	Lead-based stabilisers are widely used in a variety of PVC products, such as recyclable pipes and fittings, profiles, sheets, conduits and cables. These products are designed to have a long service life and fabrication duration, ensuring durability and reliability. The production of lead-based stabilisers relies on yellow lead (litharge), a key raw material	1-2%
4	Others	Applications include lead pipes, bricks for radiation screening at nuclear plants, rolled and extruded products, ammunition and protection against radiation such as X-rays	8-10%

Source: Industry, Crisil Intelligence

7.3 Structure of lead recycling industry in India

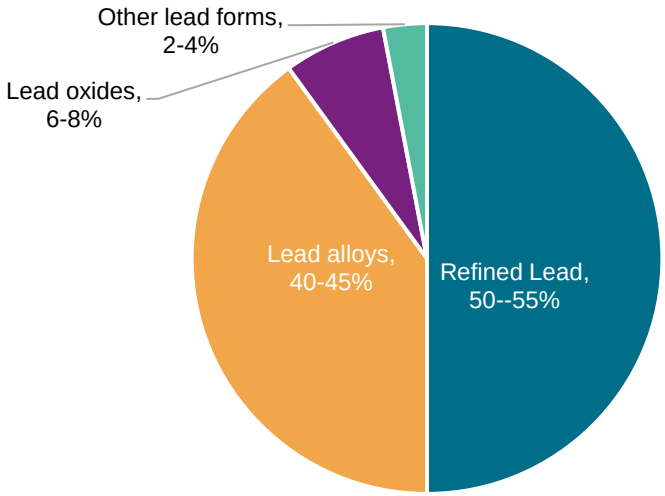
Value Chain of Secondary lead



Source: Industry, Crisil Intelligence

The key products supplied by lead manufacturers are refined lead and lead alloys, followed by lead oxides and other forms of lead such as lead sheets, plates, pipes, wire, powder, bricks, wools, etc.

Lead: Product-wise breakup in fiscal 2024

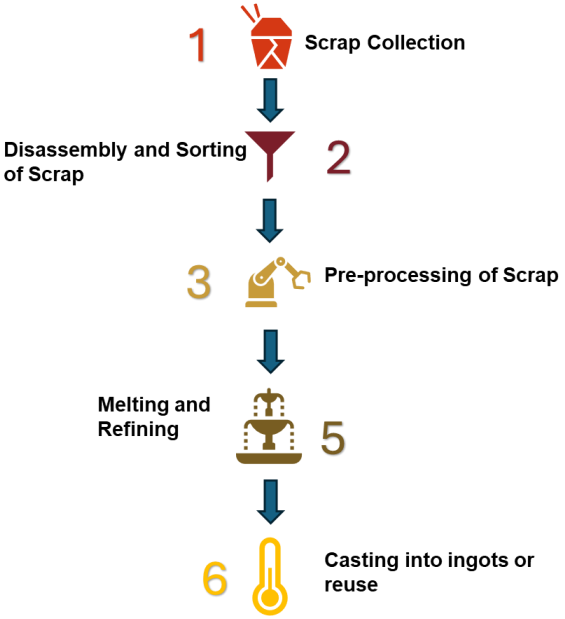


Source: Industry, Crisil Intelligence

1. **Refined lead (50-55% of total demand):** Refined lead accounts for the largest share of the market, with the lion's share being used to manufacture lead acid batteries. Other applications of refined lead include ammunition, galvanising, cable sheathing, etc.

2. **Lead alloys (40-45% of total demand):** Lead alloys comprise a significant portion of the demand, with a wide range of applications in lead acid batteries, solders and other industries. Some of the commonly used lead alloys include lead calcium, lead antimony selenium, lead antimony, lead copper, and lead tin.
3. **Lead oxides (6-8% of total demand):** Lead oxides account for a smaller but still significant share of the market, with applications in lead acid batteries, electroplating anodes, sulphuric acid tank liners, and more.
4. **Other forms of lead (2-4% of total demand):** This category includes other forms of lead, such as lead sheets, plates, pipes, wire, powder, bricks, wools, and others, which account for a relatively small share of the market.

Lead recycling facilities in India and key steps involved in recycling



Source: Industry, Crisil Intelligence

The recycling of lead, especially from lead acid batteries (LAB), involves a comprehensive multi-stage process designed to recover valuable lead components while minimising environmental impact.

Collection of scrap: The lead recycling process begins with the collection of used LABs from various sources such as vehicle repair shops, recycling centres, and household collection initiatives. These batteries are transported to dedicated recycling facilities where they undergo systematic processing to recover the lead and other reusable components.

Disassembly and sorting: At the recycling facility, the LABs are either manually disassembled or processed through an automatic battery breaker. In manual disassembly, the tops of the batteries are cut off using a battery cutting machine (BCM). This machine is installed in an acid-proof segregation area, ensuring the components are safely collected. The plastic cases, polypropylene (PP) separators and lead plates are segregated here. The plastic cases and PP separators are washed using treated water from the effluent treatment plant, with the wash water flowing into the plant for further treatment. When an automatic battery breaker is used, the entire drained battery is crushed, and its components—washed plastic parts, lead metal, and lead paste—are separated.

Pre-processing of scrap: Following segregation, the lead plates, lead metal and lead paste are sent to a furnace for smelting. During smelting, the lead is heated at high temperatures to remove impurities and convert it into molten form. This molten lead is poured into moulds to form ingots, known as re-melted lead (RML). After washing, the plastic cases

and PP separators are stored in a covered area before being sold to authorised recyclers. This stage ensures the efficient reuse of both lead and plastic components.

Melting and refining of lead: The molten lead produced in the smelting furnace is subjected to further refining in specialised pots. This refining process ensures impurities are removed, yielding high-purity lead that meets industrial standards. Emissions from the smelting furnaces and refining pots are controlled using an air pollution control system, ensuring minimal environmental impact.

Casting into ingots or reuse: After refining, the lead is cast into ingots, which can then be reused in the production of new LABs or other lead-based products. This refined lead ensures the recycled material is of high quality and suitable for various industrial applications. Additionally, the sulphuric acid electrolyte from the battery is neutralised and treated for safe disposal or repurposed for other industrial uses, while the remaining components, such as plastic, are sold to authorised recyclers or repurposed into new products.

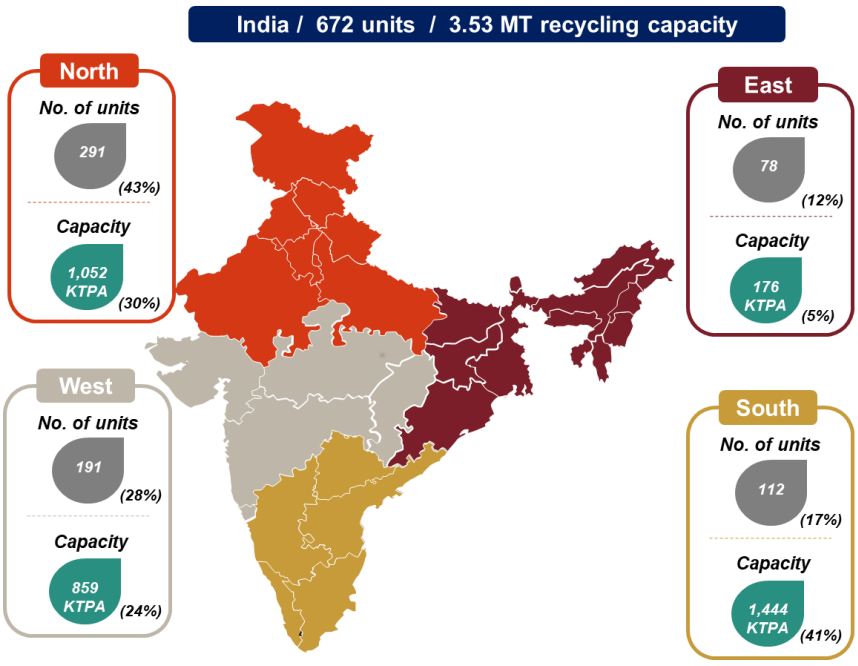
7.4 Secondary lead industry players and level of integration

The Indian secondary lead industry comprises a large number of players, with 672 units registered with the Central Pollution Control Board (CPCB) as lead recycling units. These units have a combined production capacity of 3.53 million tonne per annum, processing used LABs and lead wastes/scraps.

In addition to these registered units, the CPCB has also developed an online web-based application, Batteries (Importer) Registration Management, to facilitate the registration and renewal of registration for the import of new LABs[16].

However, a significant portion of the secondary lead demand, estimated to be 30-35%, is still met by unregistered recyclers. This highlights the need to promote organised and sustainable recycling practices in the Indian lead industry, ensuring all players operate in an environmentally responsible and compliant manner.

Some 70% of the total capacity is held by recyclers in the north and south. The detailed breakup is given below:



Source: CPCB, Crisil Intelligence

[16] Indian Bureau of Mines, CPCB

Some of the key Indian lead recycling companies are Gravita India, Jain Metal Group, Chloride Metal Ltd, APL Metals Ltd., Bindal Smelting, and Pondy Oxides & Chemical Ltd.

7.5 Raw material availability in lead recycling

Scrap lead is a diverse and abundant resource, originating from various sources and possessing distinct characteristics. The availability of lead scrap for recycling is ensured by a range of sources, including:

- **Lead acid batteries**: Used in automotive, industrial and stationary applications, LABs serve as a primary source of lead scrap
- **Industrial scrap**: Manufacturing residues such as trimmings, offcuts and rejected parts from processes such as casting, machining and fabrication contribute to the availability of industrial scrap lead
- **Construction and demolition waste**: Lead scrap is generated from construction and demolition activities in the form of lead pipes, roofing materials and lead-based paints removed from structures
- **Electronic scrap**: Discarded devices such as batteries, circuit boards and cathode ray tubes contain lead components that can be recycled
- **Miscellaneous sources**: Other types of lead scrap include lead weights, ammunition and miscellaneous consumer products containing lead

The diversity of these sources ensures a steady supply of lead scrap for recycling, supporting the growth of the lead recycling industry.

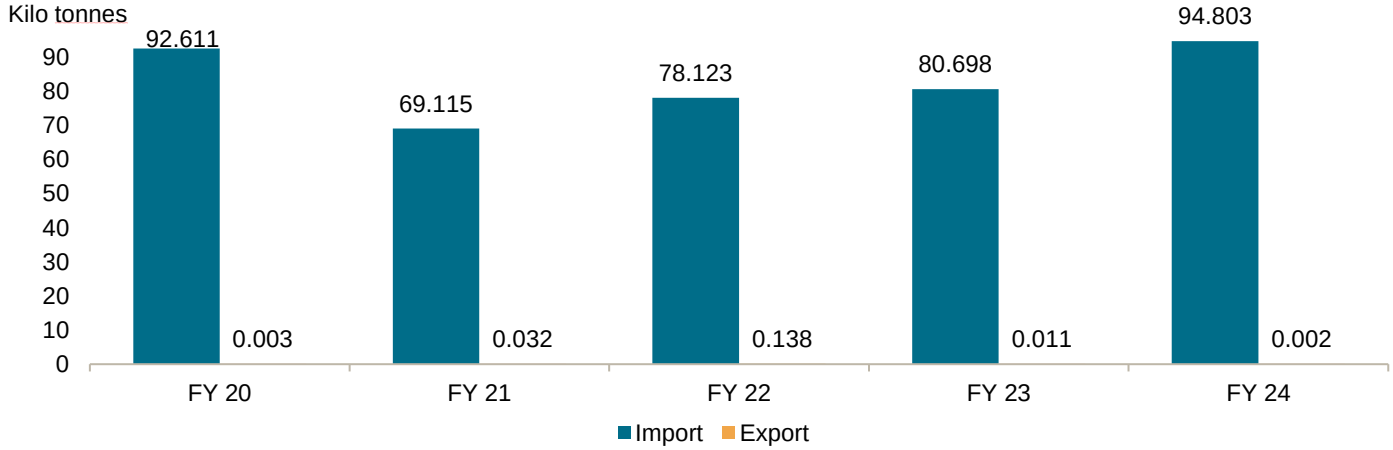
7.6 Trade (import / export) assessment of lead waste and scrap

India's imports of lead waste and scrap have remained steady over the past few years, with a slight increase from ~93 KT in fiscal 2020 to ~95 KT in fiscal 2024. The imported lead scrap includes a range of materials, such as LABs, cable coverings, pipes, sheets, and lead-coated metals. Additionally, soldering product waste and dross may also be recovered for their small lead content.

Most of the old scrap recycled as secondary lead raw material comes from the automobile sector, with battery scrap accounting for ~80%. Used LABs are one of the largest sources of secondary lead production globally, including in India.

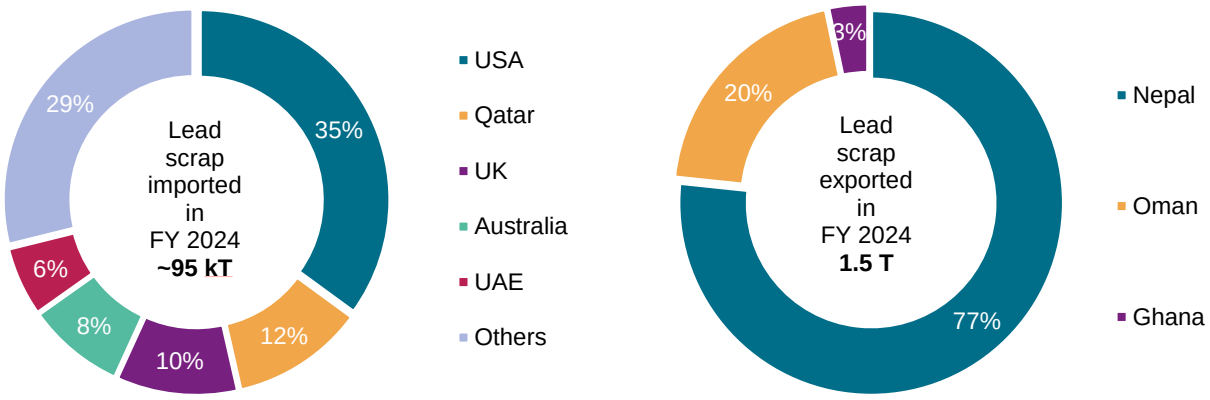
In terms of exports, India's shipments of lead waste and scrap have declined over the period, from 2.9 tonne to just 1.5 tonne.

Import/export trend of lead waste and scrap (HS Code: 780200) for the past five years



Source: Ministry of Commerce and Industry, Crisil Intelligence

Import/export countries



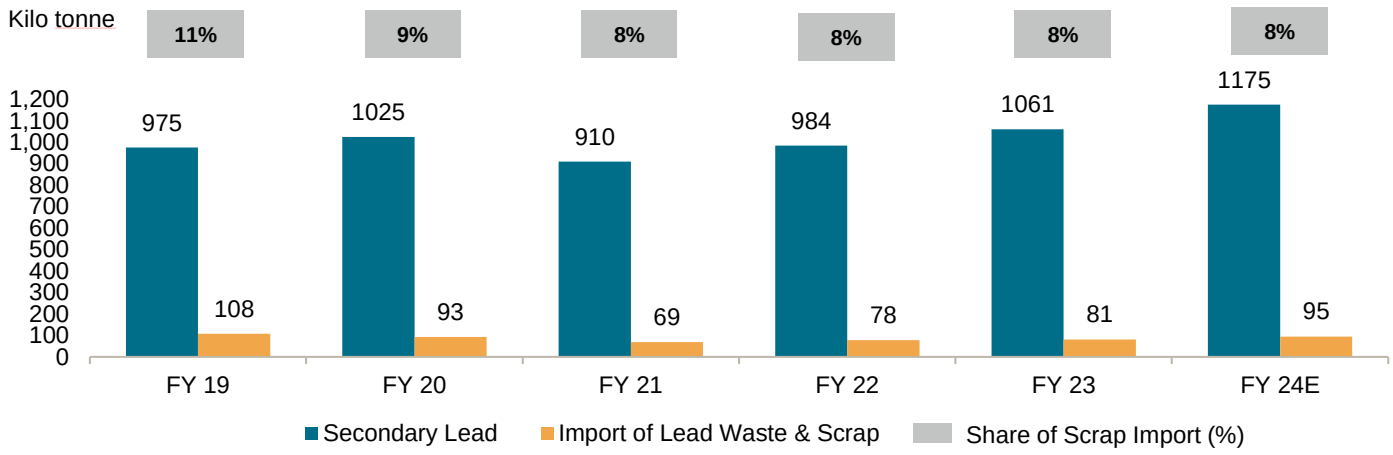
Source: Ministry of Commerce and Industry, Crisil Intelligence

Over the past five years, India's lead scrap imports have been dominated by a few key countries. In fiscal 2024, the US, Qatar and the UK emerged as the top import sources, accounting for 33.2 KT, 10.8 KT and 9.8 KT respectively, of lead scrap imports. Other import countries include Malaysia, Japan, Thailand, Canada, Spain, Libya and Kuwait. Notably, in fiscal 2020, India's primary import partners were the US, the UK and Australia.

On the export front, India's lead scrap shipments have primarily catered to Nepal, Oman, and Ghana. In fiscal 2024, these countries received 1.15 T, 0.3 T and 0.05 T respectively, of India's lead scrap exports. In fiscal 2020, Nepal and the UAE were the only export destinations.

Import dependency – share of scrap imports (2019-2024)

India's import dependency on lead waste and scrap has remained relatively stable over the past few years. In fiscal 2024, lead waste and scrap imports accounted for 8-10% of the country's total secondary lead production. This is a slight decrease from fiscal 2019, when lead scrap imports made up 11-13% of total secondary lead production.



E: Estimated

Source: Ministry of Commerce and Industry, Crisil Intelligence Research

7.7 Advantages of using recycled lead

The use of recycled lead offers numerous environmental and economic benefits, making it a more sustainable and attractive option compared with extracting lead from ore. The key advantages of using recycled lead are:

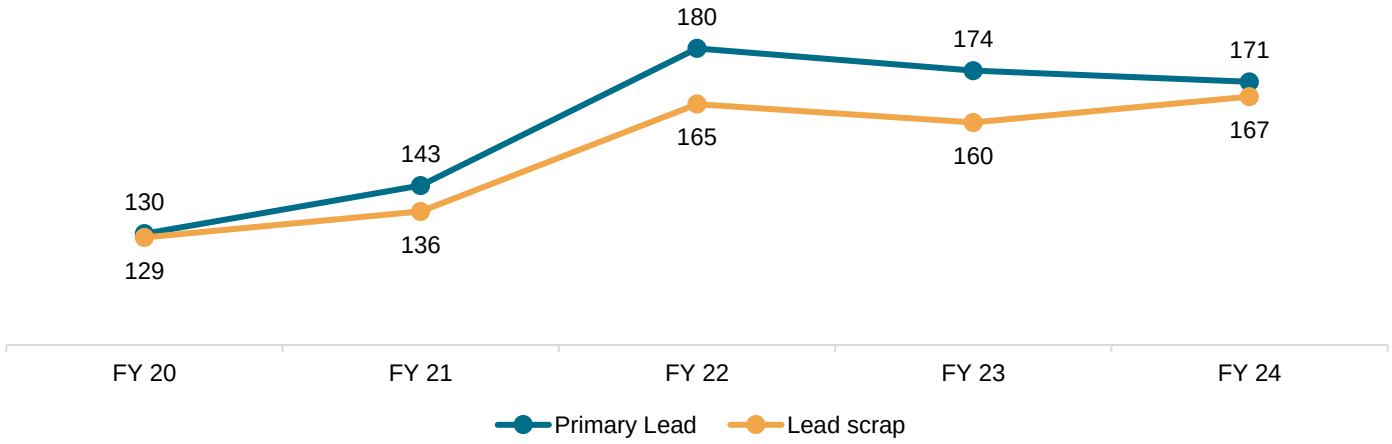
Energy efficiency: Producing secondary lead requires significantly less energy than extracting lead from ore, resulting in energy savings and a reduced environmental footprint associated with mining. In fact, producing lead through the secondary route requires only about one-third of the energy needed to extract it from its ores.

Waste management and environmental protection: Recycling lead batteries prevents hazardous waste from entering landfills and reduces the risks of soil and water contamination. In India, the recycling of lead-acid batteries is crucial for waste management, with recycled batteries accounting for 50-60% of the country's total lead supply.

Job creation and economic opportunities: The lead recycling industry in India provides both direct and indirect employment opportunities, from collection to processing. This sector supports jobs and encourages small-scale recycling enterprises, aligning with India's focus on creating economic opportunities within green sectors.

Cost-effectiveness: Recyclable lead-based batteries are 50-75% less expensive than lithium-ion batteries, offering strong reliability and low or near-zero maintenance costs. This makes recycled lead a more cost-effective option for various industries and applications. Notably, recycled lead is ~5% cheaper compared to its primary counterparts.

Primary lead & Lead scrap: Price trend (Rs/kg)



Source: IBM, Ministry of commerce and industry, Crisil Intelligence

8 Gold refining industry

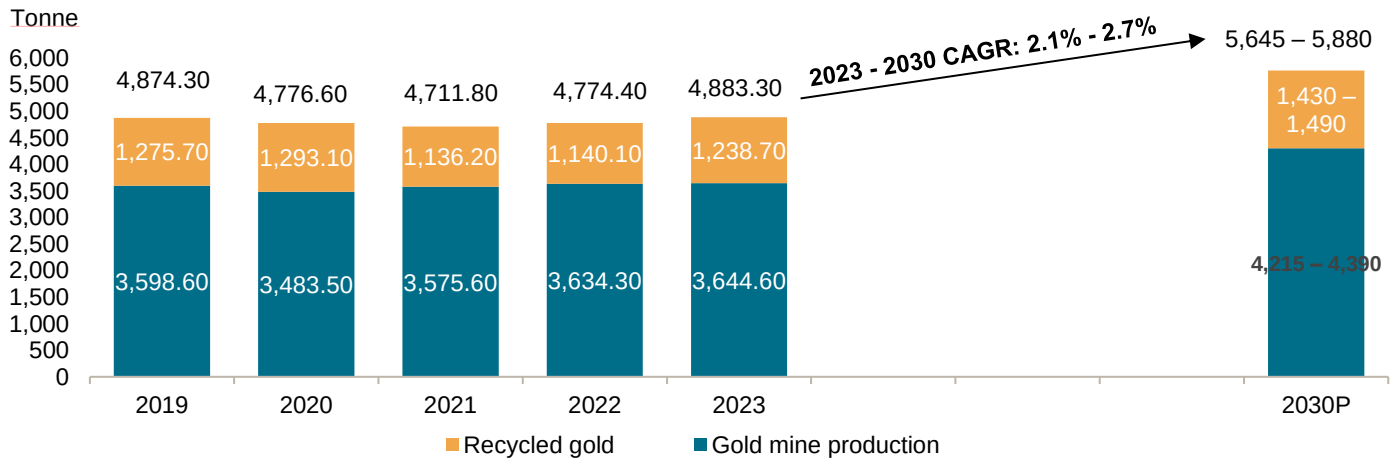
8.1.1 Overview of the global gold refining industry

The global gold refining industry saw robust demand in 2023, driven by strong purchases from global central banks and steady jewellery consumption. As per the World Gold Council, total global gold demand increased 3% year-on-year to 4,899 tonne. Jewellery demand grew modestly, particularly in China, which saw a 10% rise after Covid-19 restrictions eased. Meanwhile, demand in India weakened due to currency depreciation. Together, China and India accounted for 57% of global jewellery consumption. Demand for gold in industrial and technological applications fell 3%, reflecting broader economic challenges.

In 2023, overall supply of gold grew 3.6% from the 2021 level, mainly due to an increase in recycled gold. Supply of recycled gold rose 9% year-on-year to 1,238.70 tonnes, and global mine production increased slightly to 3,644.60 tonne. Despite high gold prices and increased exploration spending, significant obstacles such as rising construction costs and lengthy environmental permitting processes have hindered production growth. Between 2023 and 2030, overall gold supply is projected to increase at a CAGR of 2.1-2.7% to 5,645-5,880 tonne.

The global gold refining market size in 2023 reached 4883.3 tonnes. Gold refined in India in FY 2024 stood at 910 tonne (793 tonnes of imported gold dore and 117 tonnes of recycled gold), representing approximately 19% of global market size.

Global gold refining market size (mine production and recycled gold)



P: Projected

Source: World Gold Council, Crisil Intelligence

Gold mine production by regions (2023)

Sr. no.	Region	Gold mine production (2023)	% share of total production
1	Central & South America	520.3	14.3%
2	Oceania	341.2	9.4%
3	Europe	25.4	0.7%
4	Africa	884.0	24.3%

Sr. no.	Region	Gold mine production (2023)	% share of total production
5	North America	485.2	13.3%
6	Asia	611.7	16.8%
7	CIS	553.2	15.2%
8	Others	223.6	6.1%
	Total	**3644.6**	

Source: World Gold Council, Crisil Intelligence

Key drivers

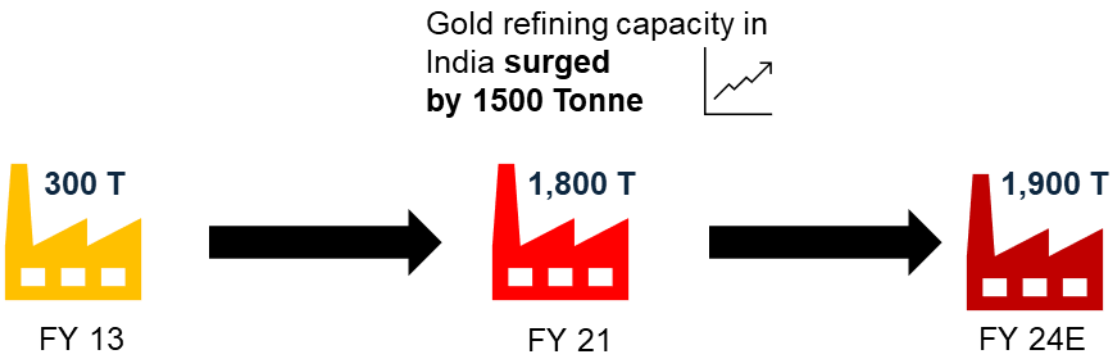
- **Technological advancements:** Innovation in automation and digitisation is revolutionising the gold refining process, making it faster, more efficient and cost-effective. New technologies allow for enhanced precision in refining, enabling companies to minimise resource use while improving overall yield. Automation systems are reducing labour costs and streamlining operations, making it possible to refine gold with fewer inputs and improved energy efficiency.
- **Rising demand in emerging markets:** Countries like India and China have seen a surge in gold consumption, particularly for jewellery and investment purposes. This has spurred the expansion of gold refining and processing activities in these regions, driving industry growth. Refineries are increasingly setting up operations closer to these high-demand markets, creating new opportunities for growth and tapping into the burgeoning middle-class consumer segments.
- **Focus on sustainability:** Environmental concerns are prompting refineries to invest in technologies that reduce carbon emissions and minimise waste. Moreover, the focus on ethical sourcing, such as avoiding conflict minerals and ensuring human rights within supply chains, is becoming critical owing to growing public scrutiny.
- **Government Policies and Trade Regulations:** Favourable policies and regulations in major gold producing countries support the growth of the gold refining market, ensuring compliance with environmental and safety standards.

8.2 Overview of the Indian gold refining industry

India’s gold refining industry has undergone substantial growth in recent years, driven by multiple factors, including policy changes and increased demand for refined gold. Historically, India has only recycled a small portion of its vast gold stock, contributing around 8% to the global gold scrap supply. In addition to formal recycling channels, the country’s informal sector plays a significant role, processing an estimated 300 to 500 tonne of gold annually.

Several macroeconomic changes, such as the implementation of the goods and services tax, the Covid-19 pandemic and other market dynamics, have enhanced profitability, particularly for smaller refineries. The imposition of customs duties on gold has made the domestic refining sector more attractive for local players, further spurring growth.

As per the World Gold Council, India’s gold refining industry has expanded significantly, with the number of formal refineries increasing from under five in 2013 to 33 by 2021. This has substantially raised organised gold refining capacity which grew at CAGR of ~25% from just 300 tonne per annum in 2013 to 1,800 tonne per annum by 2021. In FY 2024, India’s gold refining capacity was estimated to be 1,900 tonne per annum.

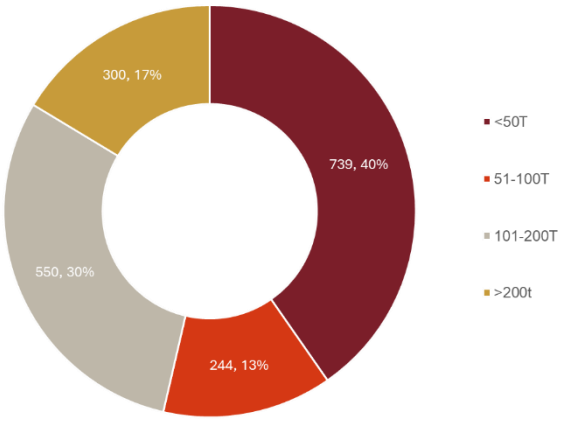


E: Estimated

Source: World Gold Council, Crisil Intelligence

Despite the expansion, most of these refineries have an annual capacity of less than 50 tonne, indicating room for further consolidation and scale-up in the sector.

India's gold refineries by capacity (as of January 2022)



Source: World Gold Council, Crisil Intelligence

Gold refineries in India (as of January 2022)

Sr. no.	Name	Capacity (tonne)	Location
1	MMTC-PAMP India Pvt Ltd	300	Haryana
2	CGR Metalloys Pvt Ltd	150	Kerala
3	JBL Refineries	150	Uttarakhand
4	Augmont Enterprises Pvt Ltd	140	Uttarakhand
5	Sovereign Metals Ltd	110	Gujarat
6	Narondas Manordas	100	Maharashtra
7	Others (including Kundan Care Products Ltd, MD Overseas Pvt Ltd etc.)	883	Uttarakhand, Haryana, Rajasthan, etc.
	Total	**1,833**	

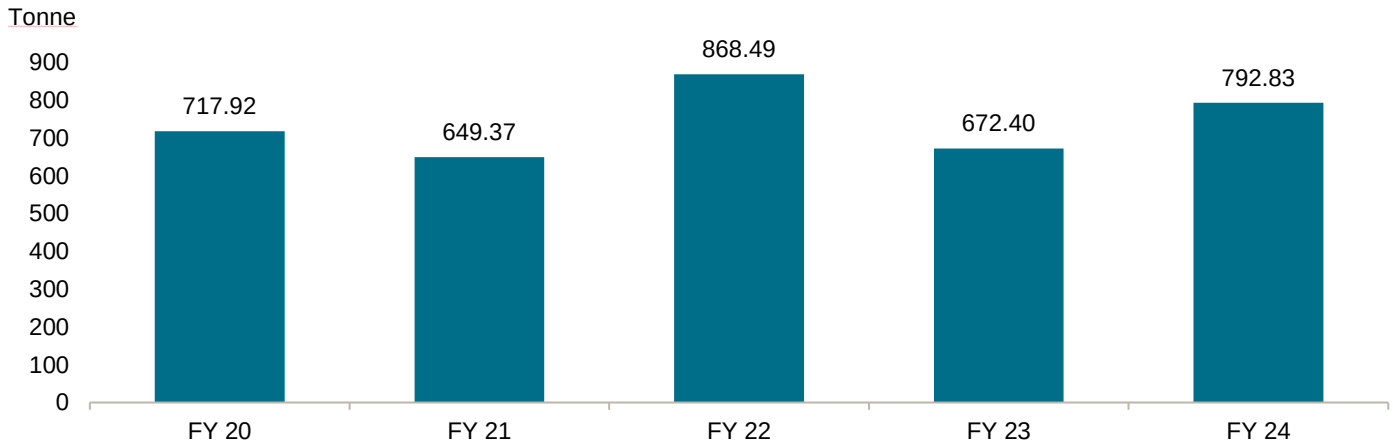
Source: Metals Focus, World Gold Council

According to the Ministry of Commerce and Industry, India's import of 'Other unwrought forms of gold' has exhibited a significant upward trend, increasing from approximately 718 tonnes in fiscal 2020 to around 793 tonnes in fiscal 2024. A

key driver of this growth has been the rising import of gold doré (unrefined gold), which has been steadily increasing over the years. Although the pandemic caused a temporary dip in gold doré imports in 2020 and 2021, the industry quickly recovered, with imports rebounding to 868 tonnes in 2022. However, in fiscal 2023, gold doré imports declined to 672 tonnes, largely due to a surge in gold loans against jewellery and the exchange of old gold jewellery for new, which reduced the demand for imported gold doré

Further, India imports most of its gold doré from Peru, Ghana, and Bolivia. India imported 15,272 shipments of gold doré during March 2023 to February 2024. These shipments were supplied by 810 foreign exporters to 65 Indian buyers, marking a growth rate of 11% over the preceding 12 months. In February 2024 alone, India imported 2,317 gold doré shipments. This marks a year-on-year growth of 182% compared with February 2023 and a 90% sequential increase from January 2024.

Imports of other unwrought forms of gold (HS Code: 71081200)



Source: Ministry of Commerce and Industry

This transformation towards more organised refining practices has set the stage for the Indian gold refining industry to continue its upward trajectory in the coming years, fueled by domestic demand and regulatory support.

9 Sectoral overview- heavy minerals & mining industry

9.1 Overview of heavy minerals

Heavy minerals are high-density minerals often found concentrated in mineral sand deposits, which are characterized by two critical factors:

Grade: The percentage of heavy minerals in the deposit, typically ranging from 0.5% to over 20%. For instance, a deposit with a grade of 5% indicates that 100 tonnes of mineral sand contain 5 tonnes of heavy minerals.

Assemblage: The composition of the heavy mineral suite, including ilmenite, zircon, rutile, monazite, garnet, and others, depending on the geological setting of the deposit.

Heavy mineral deposits, often located in coastal and near-shore environments, serve as critical resources for extracting high-value minerals such as titanium dioxide (from ilmenite and rutile), zirconium (from zircon), and rare earth elements (from monazite). These minerals are vital to industries ranging from construction and electronics to aerospace and energy.

Common heavy minerals include:

Sr. no.	Heavy mineral sand	Picture	Brief description
1	Rutile		A titanium dioxide mineral, also an important source of titanium, valued for its high purity and brightness in pigments
2	Ilmenite		An iron titanium oxide, a major source of titanium dioxide, used in pigments, cosmetics and aerospace components
3	Garnet		A hard, dense mineral, having a vitreous lustre, which means it has a glass-like appearance used as an abrasive and in water filtration

Sr. no.	Heavy mineral sand	Picture	Brief description
4	Zircon		A zirconium silicate, used in ceramics, refractory materials and as a foundry sand due to its high melting point and resistance to corrosion
5	Monazite		A phosphate mineral containing rare earth elements, thorium and uranium. Rich in rare earth elements, essential for electronics, renewable energy technologies and various advanced materials

Source: Industry

The two main product streams of heavy minerals are:

1. **Titanium dioxide minerals**: The titanium dioxide minerals are ilmenite, rutile, and leucoxene. Ilmenite is also used to manufacture titanium slag and synthetic rutile products; and
2. **Zircon minerals**

The titanium dioxide products (ilmenite, rutile, etc.) are normally in the greater preponderance, relative to zircon. It has been observed that in a typical heavy mineral deposit, an average ratio of titanium dioxide minerals to zircon is around 5:1 i.e. heavy mineral consists of 83.3% of titanium dioxide minerals and 16.7% of Zircon.

Australia, South Africa, India and Mozambique are key producers of heavy mineral sands. Countries such as Kenya, Madagascar and Sri Lanka are developing their heavy mineral sand mining capabilities, contributing to global supply.

According to USGS, the details of global reserves of heavy mineral sands are as follows:

Mineral	Unit	Reserves
Ilmenite*	*Million tonne*	690.00
Rutile	*Million tonne*	55.00
Zirconium	*Million tonne*	74.00
Garnet	*Million tonne*	50.92 (moderate to large)*

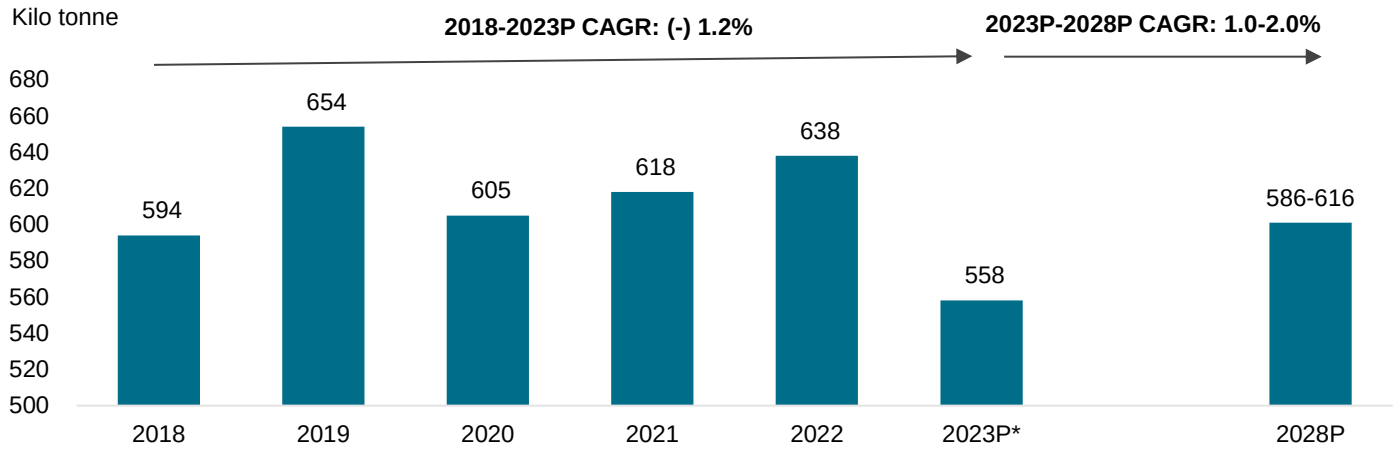
Source: USGS

**For Garnet, Australia's reserves have been reported qualitatively as "moderate to large". World total reserves have been reported as "moderate to large". The reserves number of 50.92 million tonnes are of US, China, India, as reported by USGS.*

Rutile

Rutile is a mineral composed primarily of titanium dioxide (TiO2). It is a significant ore of titanium and known for its high refractive index and optical dispersion, making it valuable in various industrial applications. It is a mineral with a distinctive combination of red, reddish-brown, yellow and black colours, exhibiting adamantine to metallic lustre.

Global production review- Rutile



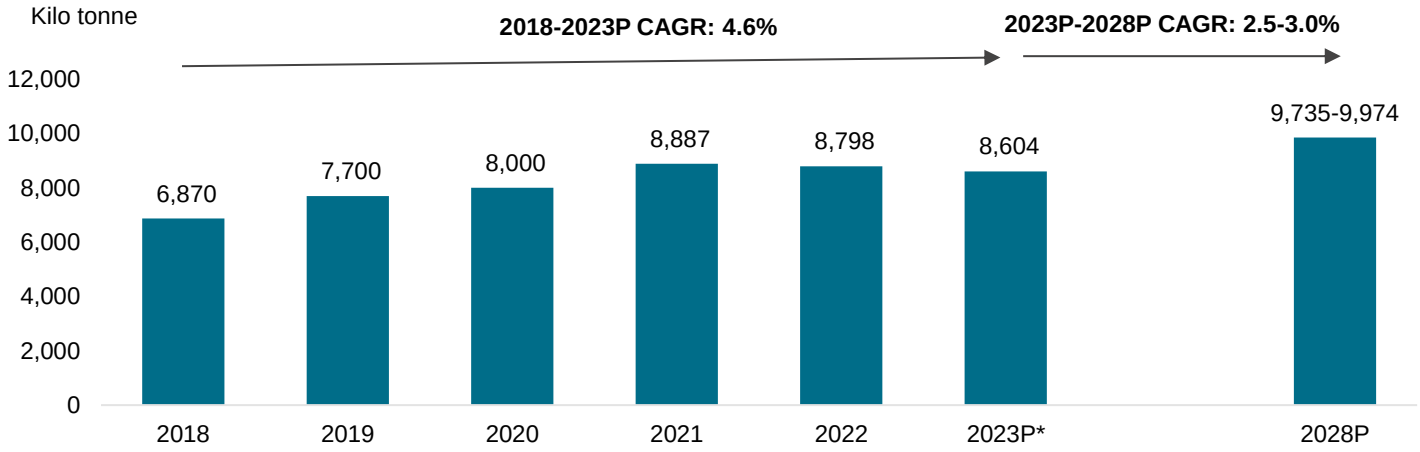
P: provisional
Sources: USGS

Global production of rutile stood at 558 KT in 2023. In 2023, the global production of rutile experienced a decline because of reduced production in Ukraine which accounted for 15% (~95 KT) in 2022 and just 9% (50KT) in 2023 of the overall rutile production, caused by the ongoing Russia-Ukraine war. Major producers around the globe for rutile include Australia, South Africa and Sierra Leone.

Ilmenite

Ilmenite is a titanium-iron oxide mineral. It is an important source of titanium and is typically found in igneous and metamorphic rocks as well as in placer deposits. It is a dark brown to black mineral with a metallic to submetallic lustre, characterized by a smooth, glassy appearance with a slight iridescence.

Global production review-Ilmenite



P: provisional
Source: USGS

Global production of ilmenite stood at 8,604 KT in 2023. The global production of ilmenite saw a slight decrease in 2023 because of reduced production in Ukraine, which contributed to 190 KT in 2022 (2.2%) and just 60 KT in 2023 (0.7%) caused by the ongoing Russia-Ukraine war. Major ilmenite producing countries include Australia, South Africa, Canada, and Norway.

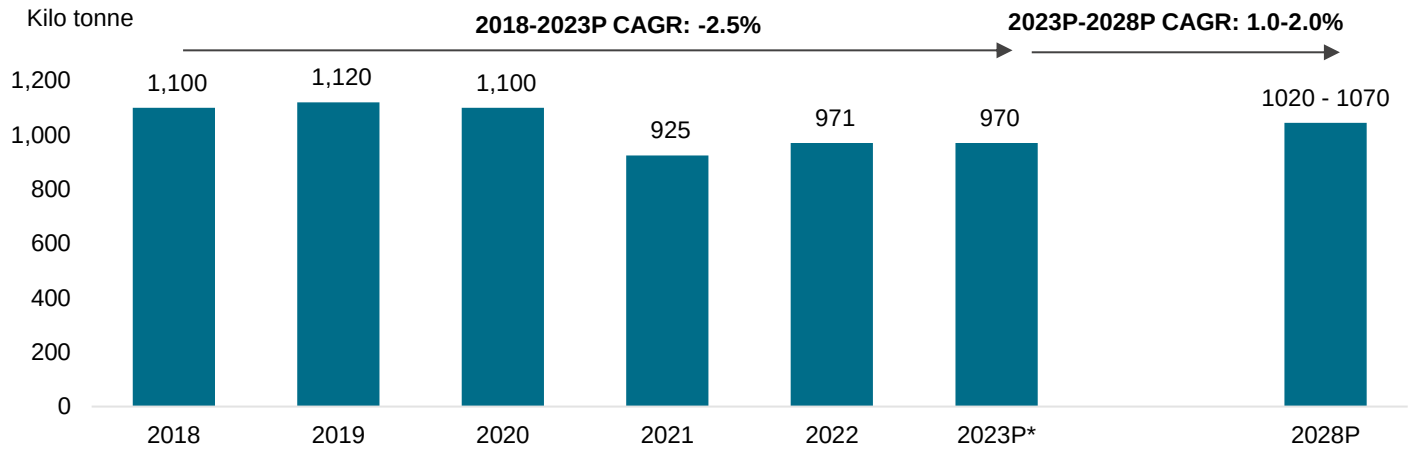
During 2023-2028, the global production of Rutile is expected to increase at a CAGR of 1.0-2.0% to reach ~586- 516 KT whereas the global production of Ilmenite is expected to increase at a CAGR of 2.5-3.0% to reach ~9,735- 9,974 KT, driven by global demand for titanium minerals.

Garnet

Garnet is a group of silicate minerals and are widely distributed in the Earth's crust, found in a variety of geological settings, including metamorphic rocks, igneous rocks, and sedimentary rocks, making up about 4% of the Earth's crust by volume.

It is a hard, dense mineral, having a vitreous lustre, which means it has a glass-like appearance when polished. It is a brittle mineral, which means it can break easily along cleavage planes. It is found in a wide range of colours, including red, orange, yellow, green and purple.

Global production of garnet (industrial)



P: provisional

Sources: USGS

Global production of garnet (industrials) stood at 971 KT in 2022. In 2023, the production of garnet (industrial) is projected to be at 970 KT. As per USGS, the US natural gas and petroleum industry is one of the key end use industries which uses garnet for cleaning the drilling pipes and well casings. The expected decrease in the production can be attributed to the decline in the number of drill rigs operating in United States during 2023.

Furthermore, the decline in garnet imports in 2023, which decreased by 40% compared to 2022, also contributed to the slow growth in production. This decrease was largely driven by reduced imports from Canada, China, and India, with the average unit value of garnet imports dropping slightly to $190 per ton in 2023[17].

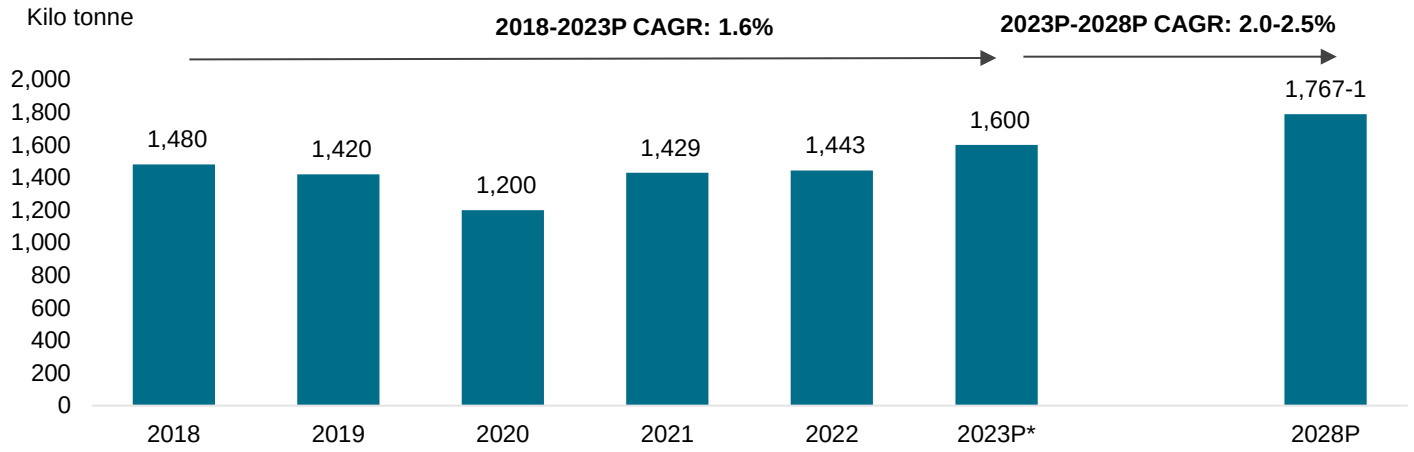
Zircon

Zircon is a mineral that belongs to the group of silicates and is characterized by its high density, hardness, and resistance to corrosion and heat. The heat-resistant properties also make it suitable for use in refractories in foundries and other high-temperature industrial applications.

It is a common mineral found in igneous, metamorphic, and sedimentary rocks, and is used in a variety of industrial and commercial applications. It is highly resistant to corrosion, even in the presence of acidic or alkaline substances.

[17] USGS

Global production review- zircon



P: provisional

Sources: USGS

As per U.S. Geological Survey (USGS), Global production of zircon increased from 1,480 KT in 2018 to 1,600 KT in 2023, clogging a CAGR of 2% over years 2018-2023.

The global production of zircon is expected to increase at a CAGR of 2.0-2.5% over 2023-2028, to reach ~1,767-1,810 KT by 2028 whereas the global production of garnet is expected to grow at a slightly lower CAGR of 1-2% reaching 1020-1070 kT by 2028. However, this slow growth can be attributed to several factors. One key reason is the decline in drill rig operations in the United States, which decreased from 772 at the beginning of 2023 to 622 by the end of October 2023, likely resulting in reduced garnet consumption in well drilling.

Additionally, the highly competitive garnet market may lead to production restrictions, with producers focusing on high-grade garnet ores or extracting garnet as a byproduct of other valuable minerals such as kyanite, marble, metallic ore minerals, mica minerals, sillimanite, staurolite, or wollastonite to maintain profitability.

The following table highlights the applications and the value of the global market of the enlisted heavy minerals:

Product	Key End-Use Industries
Ilmenite and Rutile	In 2023, more than 95% of titanium mineral concentrates were consumed by TiO2 pigment producers, while the remaining portion was consumed in various other applications, including welding-rod coatings, as well as the manufacturing of carbides, chemicals, and titanium metal.
Garnet	In 2023, the primary end uses of garnet, in order of descending consumption percentage, were: abrasive blasting, water-filtration media, water-jet-assisted cutting, and other miscellaneous applications, including abrasive powders, nonslip coatings, and sandpaper.
Zircon	In 2023, the major end uses for zircon were ceramics, foundry sand, opacifiers, and refractories, which collectively accounted for the majority of consumption. Other notable applications for zircon included abrasives, chemicals, metal alloys, and welding rod coatings. Meanwhile, the primary industries driving demand for zirconium metal were the chemical process and nuclear energy sectors, which relied heavily on this versatile metal

9.2 Heavy minerals: Key demand drivers

- **Rising Demand in Key End-Use Industries:** Heavy minerals are critical raw materials for producing titanium dioxide (derived from ilmenite and rutile) and other high-value products. Minerals like zircon, which is directly extracted from heavy mineral sands, are widely used in ceramics, refractories, and foundry applications. Industries such as construction, ceramics, electronics, aerospace, and energy are driving increased demand due to their reliance on these minerals for high-performance and specialty applications.
- **Urbanization and Infrastructure Development:** Rapid urbanization and infrastructure development, particularly in emerging economies, are fueling demand for heavy mineral-based products. For example, titanium dioxide is widely used in architectural coatings and paints, while zircon finds applications in tiles and sanitary ware—key components of urban infrastructure.
- **Global Supply Constraints:** Limited availability of economically viable deposits, coupled with increasing geopolitical concerns and export restrictions in major producing regions, has created a global supply crunch. Sectors such as electronics, automotive, and defense, which heavily rely on these minerals, are experiencing price increases, encouraging investments in new mining projects and exploration.
- **Technological Advancements in Mining and Processing:** Continuous advancements in mining and mineral processing technologies have improved efficiency and recovery rates, lowering costs and enabling the exploitation of lower-grade deposits. Innovations such as automated separation techniques and sustainable beneficiation processes are also expanding the feasibility of mining operations, thereby enhancing supply and meeting demand.

10 Plastic recycling industry

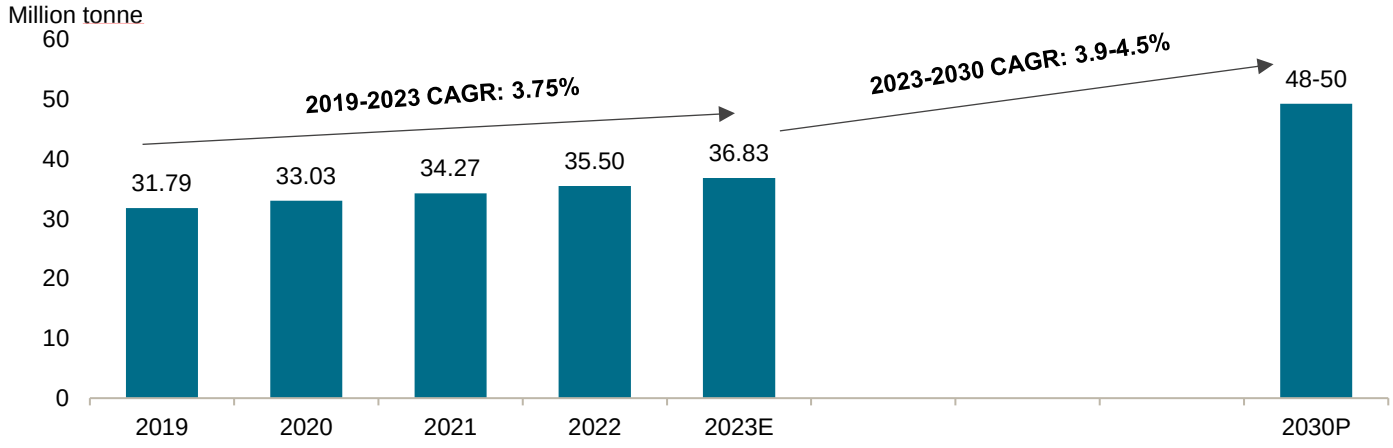
10.1 Global overview

The global plastic recycling industry plays a crucial role in mitigating the mounting plastic waste crisis. According to the OECD's Global Plastic Outlook, the world generated 353 million tonne of plastic waste in 2019, marking a more than twofold increase since 2000. Despite the staggering volume of waste, only 9% was recycled, with nearly 50% ending up in landfills, 19% being incinerated and 22% being discarded in uncontrolled sites or the environment. The accumulation of plastic waste in landfills and the environment is alarming, with nearly 80% of all plastic produced since the 1950s meeting this fate.

Compounding the issue is the inadequate infrastructure for waste management, particularly in developing regions. The UNEP's Global Waste Management Outlook highlights that 3 billion people lack access to controlled disposal services and 2 billion people still do not have regular waste collection services. As a result, vast amounts of plastic waste are either littered or disposed of improperly, exacerbating environmental degradation. If current production and disposal practices continue unchanged, another 33 billion tonne of plastic is expected to accumulate on Earth by 2050.

The world's recycled plastics production continued to increase in 2022, reaching 35.5 million tonne or 8.9% of overall global plastics production. Europe accounted for 21% of global recycled plastics production. Recycled plastic production is estimated to be 36.83 million tonne in 2023 and is projected to grow at a CAGR of 4-4.5% to reach 48-50 million tonne by 2030.

Global plastic recycling market size 2019-2030



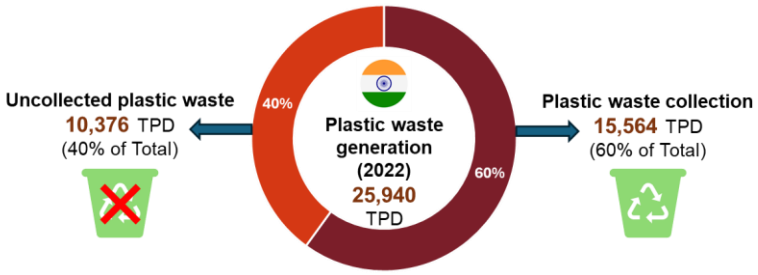
E: Estimated, P: Projected
Source: OECD, UNDP, Crisil Intelligence

As per the OECD Global Plastics Outlook, the build-up of plastic waste in lakes, rivers and oceans will nearly triple from 353 million tonne in 2019 to 1,014 million tonne in 2030. The share of plastic waste that is successfully recycled is projected to rise to 17% in 2060 from 9% in 2019[18].

[18] https://www.oecd.org/en/about/news/press-releases/2022/06/global-plastic-waste-set-to-almost-triple-by-2060.html

10.2 The Indian plastic recycling industry

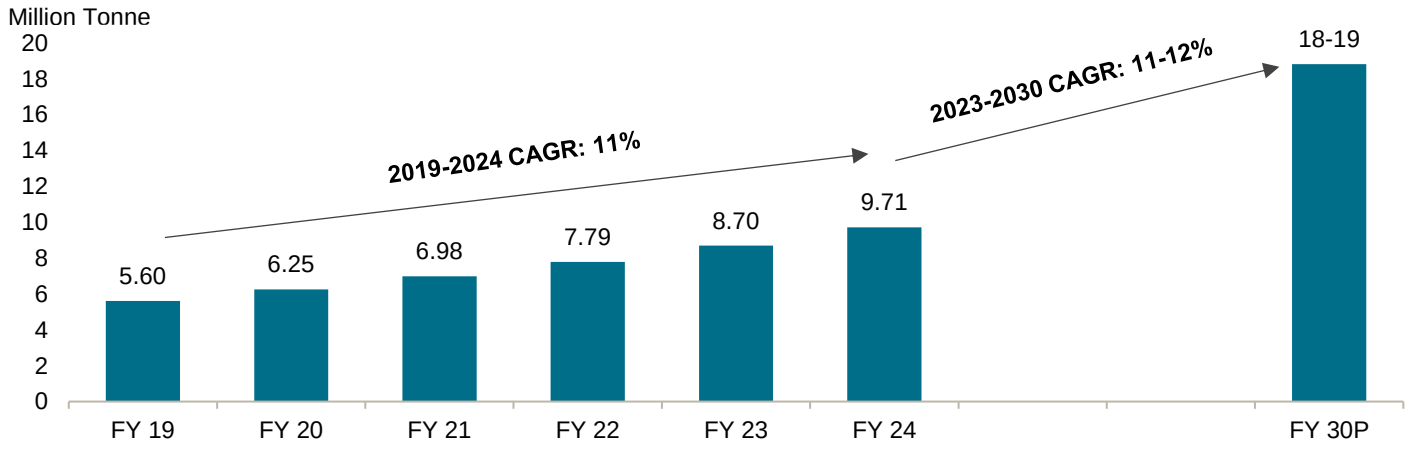
India generates approximately 9.5 tonne per annum of plastic waste as of 2024, ranking it among the top generators globally after the USA (80 million tonne per annum) and the European Union (30 million tonne per annum). The bulk of this waste comprises polypropylene (PP), polyethylene (PE) and polyvinyl chloride (PVC), with packaging representing the largest share of consumption.



Source: CPCB

India's plastic recycling industry is rapidly evolving, driven by increased consumption, rising awareness of environmental sustainability and government initiatives aimed at managing the country's growing plastic waste problem. The market for recycling plastic waste stood at 9.71 million tonne in FY 2024, growing 11.6% YoY from 8.70 million tonne in FY 2023. It is projected to rise at a CAGR of 11-12% to reach 18-19 million tonne from 2023 to 2030. As per the National Circular Economy Roadmap for Reducing Plastic Waste in India, recycled plastic is projected to increase to 35.2 million tonne by 2035.

Indian plastic recycling market size 2019-2030



P: Projected
Source: National Circular Economy Roadmap for Reducing Plastic Waste in India, Crisil Intelligence

South Korea (70%), Germany (67.5%), and Austria (59%) have the highest plastic recycling rates in the world.

10.3 Key drivers

Environmental concerns: The impact of plastic waste, particularly on marine ecosystems, has resulted in greater public awareness. Environmental organisations and global campaigns have emphasised the importance of reducing plastic

waste and adopting sustainable practices. This growing environmental consciousness is pushing industries to prioritise recycling as part of their production and waste management processes.

Regulatory measures: The government has launched several initiatives aimed at improving plastic waste management, including the Swachh Bharat Mission, Swachh Survekshan, Extended Producer Responsibility (EPR) schemes, the Plastic Waste Management Rules 2016 and a ban on single-use packaging plastics.

Technological advancements: Innovation in both mechanical and chemical recycling has made recycling more cost-effective and efficient, producing higher-quality recycled materials that can compete with virgin plastics. Chemical recycling, for example, breaks down plastic into its molecular components, enabling the reuse of plastics that were previously difficult to recycle.

The combination of these factors is creating substantial opportunities for growth in the market, as industries and governments align on reducing plastic waste and promoting sustainable practices.

11 Competition benchmarking

11.1 Operational benchmarking

The Indian metal recycling industry is increasingly driven by organized players committed to sustainable metal recovery and efficient processing. Jain Metal Group's operational and production capacities and market focus have been benchmarked against competitors with comparable operational strengths and similar product portfolios, such as Gravita India and Pondy Oxides and Chemicals Ltd (POCL).

Overview of products recycled, capacity and production in fiscal 2024

The following table provides an overview of the products recycled by Jain Metal Group and the capacity and production details in comparison to its peers

	Products recycled	Capacity (tonne per annum)	Production (tonne)
JAIN METAL GROUP | recycle today, greener tomorrow.	Lead, copper, aluminium	• Lead-170,352 • Copper-112,322 • Aluminium-22,880	• Lead-100,953 • Copper-22,073 • Aluminium-9,850
GRAVITA	Lead, aluminium, rubber	• Lead-236,559 • Aluminium-30,000 • Rubber-3,000	• Lead-148,501 • Aluminium-10,778
POCL® PONDY OXIDES & CHEMICALS LTD	Lead, copper, aluminium	• Lead-132,000 • Copper-6,000 • Aluminium-12,000	• Lead-72,531 • Aluminium-1,852

Source: Company websites, annual reports, Crisil Intelligence

Product portfolio

	Products
JAIN	Refined lead ingot, remelted lead ingot, lead alloys, copper wires, refined copper ingots, refined copper billet, aluminium alloys and molten aluminium
GRAVITA	Lead sheet, lead powder, pure lead, lead alloys, remelted lead ingots, polypropylene granules, aluminium alloys, rubber granules, PET flakes (food grade)
POCL	Pure lead, lead calcium alloys, lead tin alloys, lead antimony alloys, lead master alloys, specialty alloys, industrial and engineering plastic granules, copper (clove, cobra, mill berry, grease mill berry, tin mill berry), aluminium ADC series (JIS standard) LM series (BS standard) customised alloys)

Source: Company websites, annual reports, Crisil Intelligence

Manufacturing facilities and focus industries

	Manufacturing facilities
JAIN	Facility 1 in Gummidipoondi (Chennai): Lead recycling unit (capacity: 170.352 KTPA); Copper recycling unit (capacity: 47.520 KTPA) Facility 2 in Gummidipoondi (Chennai): Copper recycling unit (capacity: 64.802 KTPA) Facility 3 in Gummidipoondi (Chennai): Aluminium scrap recycling unit (capacity: 22.880 KTPA of aluminium alloys)
GRAVITA	Phagi (Jaipur): Lead alloys, refined lead, aluminium alloys, plastic chips and value-added products (capacity: 53 KTPA) SEZ (Jaipur): Hub of innovation and technology Chittoor (Andhra Pradesh): Lead recycling unit (capacity: 70.64 KTPA) Mundra (Gujarat): Lead recycling unit (capacity: 65 KTPA), red lead (capacity: 4.8 KTPA) and plastic granules (capacity: 7.5 KTPA) Kathua (J&K): Lead ore, lead concentrate and lead battery scrap recycling unit (Capacity of 6 KTPA)
POCL	Tamil Nadu: Lead smelter division I (capacity - 48 KTPA) Tamil Nadu: Aluminium division (capacity - 12 KTPA) Tamil Nadu: Plastics division (capacity - 9 KTPA) Tamil Nadu: TKD lead division (capacity - 72 KTPA) Phase - 1 and 2 (36 KTPA each in progress) Andhra Pradesh: Smelter division II (lead capacity - 84 KTPA and copper capacity - 6 KTPA) Mundra (Gujarat): Acquired 123 acres that is attributable to domestic geographical presence and access to global markets

Source: Company websites, annual reports, Crisil Intelligence

Focus Industries

	Focus industries
JAIN	Battery OEMs, electrical and electronics, automotive, construction, road safety, pipes, cables and footwear
GRAVITA	Battery OEMs, automotive, packaging, telecommunications and electronics
POCL	Lead acid battery and other battery OEMs, automobile, appliances, furniture, paints, battery OEMs, electronics, copper wire and other copper applications and automobile

Source: Company websites, annual reports, Crisil Intelligence

In the competitive landscape of metal recycling, Jain Metal Group stands out with its strategic focus on a diverse array of end-use industries, encompassing energy storage, automotive, construction and infrastructure, electrical and electronics, consumer goods, building materials, textiles and footwear, pipes and road safety. This broad-spectrum positions Jain Metal Group to capitalize on multiple growth avenues and mitigate risks associated with market fluctuations in any single sector.

In contrast, its peers, such as Gravita and POCL, tend to concentrate their efforts on specific industries, primarily limited to battery manufacturing, automotive applications, and telecommunications. While these companies have established their footholds within narrower market segments, Jain Metal Group's commitment to a wider portfolio underscores Jain's potential for sustained growth and resilience in an evolving market landscape.

11.2 Financial benchmarking and benchmarking with respect to other related parameters

The financial performance of Jain Metal Group, specifically in terms of profitability, liquidity, and leverage, has been benchmarked against its peers in the industry, including Gravita India and POCL. In the benchmarking of its financial performance against its industry peers, Jain Metal Group has emerged as one of the major recyclers in terms of revenue in the recycling business in India. This financial position of Jain Metal Group reflects its efficient operations, strategic business decisions, and commitment to excellence.

Key performance indicators (financial and related parameters)

S. No.	Key Performance Indicators (KPIs)	Units	Jain Metal Group			
			September 30, 2024	Fiscal 2024	Fiscal 2023	Fiscal 2022
	Financial KPIs					
1	Revenue	₹ million	28,886.22	44,284.18	30,640.71	28,495.99
2	Revenue Growth	%	NA	44.53%	7.53%	NA
3	EBITDA	₹ million	1,793.01	2,272.18	1,241.76	1,164.36
4	EBITDA Margin	%	6.21%	5.13%	4.05%	4.09%
5	EBITDA Growth	%	NA	82.98%	6.65%	NA
6	PAT	₹ million	1,121.51	1,638.27	918.10	868.00
7	PAT Margin	%	3.88%	3.70%	3.00%	3.05%
8	PAT Growth	%	NA	78.44%	5.77%	NA
9	ROE	%	26.31%	57.66%	59.94%	80.91%
10	ROCE	%	12.62%	19.13%	12.31%	12.47%
11	Networth	₹ million	4,818.34	3,671.81	1,969.73	1,059.10
12	RONW	%	26.42%	58.08%	60.62%	81.96%
13	NAV	₹	14.89	11.35	6.09	3.27
*14	Inventory Days	Days	73.96	39.69	43.59	46.99
*15	Debtor Days	Days	22.71	18.03	27.67	26.96
*16	Creditor Days	Days	7.85	2.68	4.52	5.16
*17	Working Capital Days	Days	88.82	55.04	66.74	68.79

S. No.	Key Performance Indicators (KPIs)	Units	Jain Metal Group			
			September 30, 2024	Fiscal 2024	Fiscal 2023	Fiscal 2022
18	Net Debt	₹ million	8,273.66	6,091.79	5,870.42	5,352.71
19	Net Debt / Equity	Ratio	1.71	1.65	2.95	4.99
*20	Fixed Asset Turnover	Ratio	34.62	57.75	47.85	51.97
	Other KPIs					
21	No. of Customers	Number	251.00	342.00	317.00	268.00
22	No. of Recycling plants	Number	4.00	4.00	4.00	3.00
23	Export revenue %	%	50.06%	54.11%	51.63%	72.26%
24	Revenue split by segments (%)					
	Aluminium & Alluminum Alloys	%	2.49%	6.14%	1.15%	0.00%
	Lead & Lead Alloy Ingots	%	41.03%	46.88%	34.93%	37.35%
	Copper & Copper Ingots	%	51.62%	43.54%	59.25%	61.35%
25	EBITDA per tonne	₹ per tonne	8,768.70	5,820.27	4,959.35	6,138.13

Source: Company financials, Crisil Intelligence

S. No.	Key Performance Indicators (KPIs)	Units	Gravita India Ltd.			
			September 30, 2024	Fiscal 2024	Fiscal 2023	Fiscal 2022
	Financial KPIs					
1	Revenue	₹ million	18,352.80	31,607.50	28,006.00	22,158.70
2	Revenue Growth	%	19.21%	12.86%	26.39%	57.18%
3	EBITDA	₹ million	1511.60	2,835.50	1,976.10	2,109.10
4	EBITDA Margin	%	8.24%	8.97%	7.06%	9.52%
5	EBITDA Growth	%	15.35%	43.49%	-6.31%	88.48%
6	PAT	₹ million	1,399.20	2,422.80	2,040.90	1,484.50
7	PAT Margin	%	7.62%	7.67%	7.29%	6.70%
8	PAT Growth	%	25.61%	18.71%	37.48%	161.26%
9	ROE	%	NA	35.19%	42.47%	46.04%
10	ROCE	%	NA	21.96%	20.65%	29.53%
11	Networth	₹ million	NA	7,875.40	5,769.90	3,772.10
12	RONW	%	NA	35.51%	42.78%	46.26%
13	NAV	₹	NA	114.07	83.58	54.64
*14	Inventory Days	Days	NA	87.80	85.74	87.91
*15	Debtor Days	Days	46.66	23.17	16.07	13.92
*16	Creditor Days	Days	NA	10.83	12.86	21.47

S. No.	Key Performance Indicators (KPIs)	Units	Gravita India Ltd.			
			September 30, 2024	Fiscal 2024	Fiscal 2023	Fiscal 2022
*17	Working Capital Days	Days	NA	100.15	88.96	80.37
18	Net Debt	₹ million	4,658.90	4,463.50	3,444.60	3,874.20
19	Net Debt / Equity	Ratio	NA	0.56	0.53	0.93
*20	Fixed Asset Turnover	Ratio	4.61	8.91	10.14	10.58
	Other KPIs					
21	No. of Customers	Number	NA	NA	NA	NA
22	No. of Recycling plants	Number	11	11	12	13
23	Export revenue %	%	NA	38.16%	55.07%	53.23%
24	Revenue split by segments (%)					
	Aluminium & Alluminum Alloys	%	6.38%	8.07%	12.10%	9.33%
	Lead & Lead Alloy Ingots	%	90.96%	87.98%	83.32%	84.41%
	Copper & Copper Ingots	%	NA	NA	NA	NA
25	EBITDA per tonne	₹ per tonne	NA	NA	NA	NA

Source: Company financials, Crisil Intelligence

S. No.	Key Performance Indicators (KPIs)	Units	Pondy Oxides & Chemicals Ltd			
			September 30, 2024	Fiscal 2024	Fiscal 2023	Fiscal 2022
	Financial KPIs					
1	Revenue	₹ million	10,240.47	15,405.97	14,761.81	14,548.01
2	Revenue Growth	%	41.88%	4.36%	1.47%	44.86%
3	EBITDA	₹ million	517.73	702.70	1,061.05	771.55
4	EBITDA Margin	%	5.06%	4.56%	7.19%	5.30%
5	EBITDA Growth	%	83.96%	-33.77%	37.52%	230.25%
6	PAT	₹ million	282.14	318.72	756.18	482.48
7	PAT Margin	%	2.76%	2.07%	5.12%	3.32%
8	PAT Growth	%	188.21%	-57.85%	56.73%	347.66%
9	ROE	%	NA	10.25%	31.98%	26.12%
10	ROCE	%	NA	13.61%	26.36%	22.00%
11	Networth	₹ million	NA	3,361.11	2,643.20	2,079.09
12	RONW	%	NA	10.62%	32.03%	26.13%
13	NAV	₹	NA	133.26	104.80	82.43
*14	Inventory Days	Days	NA	37.39	41.53	36.83
*15	Debtor Days	Days	42.95	24.41	23.35	24.61

S. No.	Key Performance Indicators (KPIs)	Units	Pondy Oxides & Chemicals Ltd			
			September 30, 2024	Fiscal 2024	Fiscal 2023	Fiscal 2022
*16	Creditor Days	Days	NA	2.53	2.32	2.16
*17	Working Capital Days	Days	NA	59.27	62.56	59.28
18	Net Debt	₹ million	1,381.99	706.12	1,462.48	1,049.30
19	Net Debt / Equity	Ratio	NA	0.20	0.55	0.50
*20	Fixed Asset Turnover	Ratio	5.57	9.92	14.53	28.45
	Other KPIs					
21	No. of Customers	Number	NA	NA	NA	NA
22	No. of Recycling plants	Number	4	3	3	3
23	Export revenue %	%	NA	56.36%	56.40%	54.25%
24	Revenue split by segments (%)					
	Aluminium & Alluminum Alloys	%	NA	NA	NA	NA
	Lead & Lead Alloy Ingots	%	NA	NA	NA	NA
	Copper & Copper Ingots	%	NA	NA	NA	NA
25	EBITDA per tonne	₹ per tonne	NA	11,843.00	12,941.00	13,039.00

Source: Company financials, Crisil Intelligence

**Not annualized*

Formulae:

1. *Revenue = Revenue from Operations*
2. *Revenue Growth (%)= ((Revenue in Current Period−Revenue in Previous Period)/Revenue in Previous Period) * 100*
3. *Earnings Before Interest, Taxes, Depreciation, and Amortization (EBITDA) = Profit Before Tax (PBT) + Finance Costs + Depreciation & Amortization - Other Income*
4. *EBITDA Margin (%) = (EBITDA / Revenue from operations) * 100*
5. *EBITDA Growth (%) = ((EBITDA in Current Period - EBITDA in Previous Period) / EBITDA in Previous Period) * 100*
6. *Profit After Tax (PAT)= PBT - Total Tax Expenses*
7. *PAT Margin (%) = (PAT / Revenue from Operations) * 100*
8. *PAT Growth (%) = ((PAT in Current Period - PAT in Previous Period) / PAT in Previous Period) * 100*
9. *Return on Equity (ROE) (%) = (PAT / Average Equity (here Equity = Equity Share Capital + Other Equity - OCI reclassifable to P&L)) * 100*
10. *Return on Capital Employed (ROCE) (%) = (Earnings Before Interest and Taxes (EBIT) / Average Capital Employed (here Capital Employed = Net worth + Total Debt + Deferred Tax Liability)) * 100*
11. *Net worth = Paid-up Share Capital + Other Equity - OCI reclassifable to P&L - Accumulated Losses - Deferred Expenditure - Miscellaneous Expenditure - Revaluation Reserve - Write-back of Depreciation - Amalgamation Reserve - Share Pending Allotment*
12. *Return on Net worth (RONW) (%) = (PAT / Average Net worth) * 100*
13. *Net Asset Value (NAV) = Net Worth / Total Number of Equity Shares Outstanding*
14. *Inventory Days = Average Inventory / (Cost of Goods Sold (here COGS = Cost of materials consumed + Purchases of Stock -in-trade + Changes in Inventories of finished goods, work-in-progress and stock in trade + Direct Manufacturing Costs) / 365)*
15. *Debtor Days = Average Trade Receivables / (Revenue from Operations / 365)*
16. *Creditor Days = Average Trade Payables / (COGS / 365)*
17. *Net Working Capital Days = Inventory Days + Debtor Days – Creditor Days*
18. *Net Debt = Total Borrowings (including both Long-term & Short-term) - Cash & Bank Balances*

19. *Net Debt to Equity = Net Debt / Equity*
20. *Fixed Asset Turnover = Revenue from Operations / Average Net Fixed Assets (here Net Fixed Assets = Total Fixed Assets (excluding Intangibles) - Accumulated Depreciation)*
21. *Customer Count data = No. of Customers (Each customer making a purchase during a particular FY is counted)*
22. *Recycling Plants = No. of Fully operational plants operated during the year or period*
23. *Export Revenue (%) = (Export revenue / Revenue from Operations) * 100*
24. *Revenue Split by Segments (%) = (Segment Revenue / Revenue from Operations) * 100*
25. *EBITDA per Ton = EBITDA / Total Volume of Goods Sold (in Tons)*

Notes

i) *For the stub period ended September 30, 2024, growth-related KPIs for peer companies have been computed by comparing their respective quarterly financial results for the corresponding quarter of the previous year (i.e., September 2023), as filed with the stock exchanges. However, in the case of JMG, no such quarterly financial results were prepared or filed in the previous year, since it was then a private limited company. Accordingly, growth KPIs for the stub period are not ascertainable for JMG.*

ii) *For both JMG and its listed peers, components of Other Equity have been considered after excluding balances of Other Comprehensive Income (OCI) that are subject to potential reclassification to the Statement of Profit and Loss in the future. Such re-classifiable items have been excluded on the basis that they do not represent permanent equity and may affect future earnings.*

iii) *Direct manufacturing costs primarily comprise power and fuel expenses along with direct labor charges. Due to the non-availability of detailed notes to accounts for the stub period relating to the peer group, such cost components could not be accurately determined. Consequently, KPIs dependent on such information could not be computed.*

iv) *With respect to the disclosure of contract employee strength, JMG has adopted the maximum cap for labour engagement permitted under the CLRI (Central Labour Resource Identification) norms as a proxy measure. Accordingly, the contractual employee strength disclosed is based on such CLRI cap limits, and not on actual headcount verification.*

v) *The financial information of the listed industry peers referred to above has been obtained from their respective financial results, annual reports, and investor presentations published on the stock exchange websites and their official company websites.*

vi) *For the Fiscal 2022, KPIs requiring average values have been computed using closing balances, as JMG was incorporated on February 25, 2022, and opening balances were not available for that period.*

vii) *Wherever 'NA' is mentioned in relation to the operational Key Performance Indicators (KPIs) of peer companies, it denotes that the relevant information could not be accurately ascertained from the disclosures made by the respective companies in their regulatory filings.*

viii) *The total employee strength disclosed by JMG, comprising both permanent and contractual employees, is based on management-prepared internal records and has not been derived from, nor does it form part of, the JMG's financial reporting system or records subject to internal financial controls. In particular, the contractual employee count which consists of piece-rated employees and time-rated employees has been estimated by JMG using the maximum cap for labour engagement permitted under the Central Labour Resource Identification (CLRI) norms, adopted as a proxy in view of practical limitations in determining actual headcount across locations. We have not performed any procedures on this data and express no conclusion or assurance on its accuracy or completeness.*

ix) *JMG's KPI pertaining to the total number of customer count is derived from internal Customer Relationship Management (CRM) and sales records provided by Management. We have not performed any audit or assurance procedures on this data and express no conclusion thereon.*

x) *JMG's KPI pertaining to the number of recycling plants is based on management-prepared internal operational records and inputs. We have not performed any procedures to verify the physical existence, operating status, or commercial functionality of such facilities, and express no assurance in this regard.*

xi) *JMG's Export Revenue % has been computed based on management-prepared workings using the revenue from operations split by geography, as disclosed in the restated financial information. We have performed procedures to verify that the underlying data agrees with the audited segment disclosures and the relevant accounting records.*

xii) *JMG's revenue split by product/metal category is based on management-prepared workings derived from JMG's restated financial information, as disclosed in the segment reporting notes. We have performed procedures to verify that the stated figures are in agreement with the audited segment disclosures and underlying accounting records.*

xiii) *JMG's KPI pertaining to the calculation of EBITDA per ton (in rupees) has been computed based on management-prepared workings using unaudited operational data relating to production volumes, combined with financial data. As we have not performed any procedures on the volume data, we do not express any conclusion or assurance on the accuracy or reliability of the resulting KPI.*

xiv) *The Net Asset Value (NAV) of JMG has been calculated based on the adjusted number of equity shares, incorporating corporate actions that took place after September 30, 2024. Such events are as follows:*

a. On February 4, 2025, pursuant to a scheme of merger, JMG issued 2,12,14,393 equity shares of ₹10 each to the shareholders of Jain Recycling Private Limited.

b. On March 11 and March 12, 2025, JMG issued 4,30,008 equity shares of ₹10 each as a rights issue to its existing shareholders.

c. On March 13, 2025, JMG issued 20,36,776 equity shares of ₹10 each upon the conversion of Optionally Fully Convertible Debentures (OFCDs).

d. As a result of these actions, the total number of equity shares stood at 6,47,06,818 of ₹10 each. Subsequently, on March 18, 2025, JMG undertook a share split, reducing the face value of each share from ₹10 to ₹2, thereby increasing the total number of equity shares to 32,35,34,090 of ₹2 each.

Revenue CAGR

Jain Metal Group is India's largest and fastest-growing non-ferrous metal recycling businesses, in terms of revenue for Fiscal 2024, Fiscal 2023 and Fiscal 2022. In fiscal 2024, Jain Metal Group recorded the highest revenue growth among its peers, achieving a 44.53% on-year increase. Comparatively, Gravita and POCL posted revenue growth rates of 12.86%, and 4.36%, respectively. Between fiscals 2022 and 2024, Jain Metal Group's revenue rose significantly at a CAGR of 24.66%, from ₹28,495.22 million to ₹44,284.18 million. During the same period, the revenue CAGR for Gravita and POCL stood at 19.43%, and 2.91%, respectively.

EBITDA CAGR

In fiscal 2024, Jain Metal Group recorded the highest on-year EBITDA growth of 82.98%, followed by Gravita at 43.49%. Between fiscals 2022 and 2024, Jain Metal Group's EBITDA demonstrated a robust CAGR of 39.69%, expanding to ₹2,272.20 million from ₹1,164.36 million. EBITDA CAGR over the same period for Gravita was 15.94%. POCL's EBITDA decreased from ₹771.55 million to ₹702.70 million, registering a negative CAGR of (-) 4.57%.

PAT CAGR

Further, in fiscal 2024, Jain Metal Group recorded the highest PAT growth at 78.44% on-year, wherein its PAT rose sharply to ₹1,638.27 million from ₹918.10 million. On the other hand, the on-year growth of PAT in fiscal 2024 amounted to 18.71% for Gravita and -57.85% for POCL Enterprises.

ROE & ROCE

The ROE for Jain Metal Group remained higher than that of its peers throughout the period from fiscal 2022 to fiscal 2024. The ROCE for Jain Metal Group increased from 12.31% in fiscal 2023 to 19.12% in fiscal 2024, indicating improvement in pricing strategy, cost structure and operational efficiency.

Working capital days

In fiscal 2024, working capital days for Jain Metal Group (55 days) were considerably lower than those of Gravita India (100 days) indicating a competitively high operational efficiency of the company in the industry.

Fixed asset turnover

In fiscal 2024, Jain Metal Group recorded the highest fixed asset turnover ratio of 57.75 indicating efficient plant operations. During the same fiscal, the fixed asset turnover for Gravita India and POCL stood at 8.91 and 9.92 respectively.

12 Company profile: Jain Metal Group

12.1 Business profile of Jain Metal Group

With a rich legacy spanning seven decades, Jain Metal Group[19] has established itself as a pioneer in the recycling and production of non-ferrous metals in India. Since its inception in the 1950s, the Chennai-based group has grown to become one of the biggest players in the recycling business in India, boasting impressive revenues, capabilities to handle multiple commodities, and an extensive sourcing network. As one of the two Indian brands registered with the London Metal Exchange (LME) and a registered member of the Multi Commodity Exchange (MCX) in India, Jain Metal Group has solidified its position as a leader in the industry. *(Source: Crisil Intelligence)*

The group's success can be attributed to its state-of-the-art infrastructure and capabilities to handle multiple products in recycling at a single location, as well as its extensive global network for sourcing recyclable materials. Additionally, the company has one of the largest battery shredding machines. The company's recycling operations are vertically integrated with end-to-end recycling processes wherein the raw materials are procured both domestically and internationally. Over the last three years, the Jain Metal Group has imported materials from over 120 countries and has also developed a deep sourcing network across the globe, sourcing recyclable materials from retail scrap yards from those countries. The company is India's largest and fastest-growing non-ferrous metal recycling business, in terms of revenue for Fiscal 2024, Fiscal 2023, and Fiscal 2022. In the domestic copper recycling industry, Jain Metal Group (in terms of production) accounted for around 3.5% share in the overall domestic demand, indicating company's strong position in the relatively fragmented metals recycling industry. The company is also amongst the top ten players in the world in the recycling space with significant presence in over 50 countries.

Jain Metal Group's diverse portfolio includes recycling and manufacturing of copper and copper alloys, lead and lead alloys, aluminium and aluminium alloys, and trading in non-ferrous metals and scrap. The group is now expanding its portfolio to include high-value, high-margin heavy minerals through its entry into Sri Lanka and precious metals through its gold refining business in the UAE. This strategic expansion will further solidify Jain Metal Group's presence in the industry.

Throughout its operations, Jain Metal Group remains committed to Environmental, Social, and Governance (ESG) requirements, ensuring that its growth is sustainable and responsible. With a foundation built over four generations, the group has sustained rapid growth by integrating cutting-edge technology and efficient recycling and manufacturing processes. Its skilled and experienced team has been instrumental in driving the success, making it one of the most reliable players in the industry.

Journey of the Jain Metal Group

Since its inception in the 1950s, the Chennai-based group has grown to become one of India's largest recyclers of non-ferrous metals and alloys. With a rich legacy of over 75 years in the non-ferrous metals manufacturing industry, the Jain family has established a strong foundation in the sector. The family's early manufacturing businesses, set up until the 1980s, were later divided among the family members. Building on their extensive expertise in non-ferrous metals, Mr. Kamlesh Jain embarked on a new journey in 2002 by importing recyclable non-ferrous scrap. This marked the beginning of a forward integration strategy, which led to the establishment of a lead recycling unit in Gummidipoondi, Chennai in 2013. The group's growth trajectory continued with the subsequent setup of cable recycling, copper, and aluminium

[19] *Unless otherwise stated or the context requires otherwise, the references in this section (namely "12 Company Profile: Jain Metal Group") to "The company" or "Jain Metal Group" refers to Jain Resource Recycling Limited along with its subsidiaries.*

recycling units in the same location. Today, the Jain Metal Group has emerged as the largest player in the recycling business in India, a testament to the family's vision, expertise, and commitment to sustainable growth.

Market share of Jain Metal Group across different product categories (2024)

Secondary Metal	Jain Metal Group production (kT)	Overall demand in India (kT)	% share of Jain Metal Group
Lead	100.953	1180.0	8.55%
Copper	22.073	645.0	3.42%
Aluminium	9.850	1900.0	0.52%

Source: Jain Metal Group, Crisil Intelligence

SWOT analysis

Strengths

- Multi-purpose facilities that are designed to allow a level of flexibility enabling the company to manufacture a diverse range of products and provide it with the ability to modify and customize its product portfolio to address the changing requirements of customers.
- The company's diverse portfolio of products from recycling of lead, copper and aluminium scrap along with its expansion in precious metals through the gold refining business in the UAE has strategically positioned it in the metal industry in the domestic and international markets.
- Due to its diversified product portfolio, the company caters to various segments in the renewable energy, in various industrial sectors such as electrical, off highway equipment, infrastructure and general engineering, in mobility segments such as automotive and railways, and as a result, it competes with various companies for each of its business segments.
- Jain Metal Group's recycling operations are vertically integrated with end-to-end recycling processes wherein raw materials are procured both domestically and internationally. This makes supply chain of the company highly efficient and also reduces sales concentration risk.
- Caters to customers in various industries including lead acid battery, electrical and electronics, pigments, and automotive.
- Part of one of the oldest groups which has 7 decades track record in Metal manufacturing and Trading
- Strong Management with hands on experience in managing Non-ferrous metals recycling business
- Deep raw material sourcing network across 70 + countries
- LME & MCX Registered, leading to lesser sale risk
    - One of the only two recycling companies in India in the recycling segment whose lead ingot is registered as a brand by London Metal Exchange offering distinct advantages to the Company with respect to supply of its goods in global markets
- State of the art manufacturing facilities present in close proximities to Ennore and Kaatupalli port
- Further, the Chennai Port is one of the principal gateways on the east coast of India that helps Jain Metal Group to serve imports and exports from/to China and South-East Asian countries.
- Sustainable operations with zero discharge manufacturing initiatives, 100% recycling, use of green power for operations
- The company is a leading recycler of copper scrap, which includes wires, cables, and electronic waste.
- Jain Metal Group has established itself as a significant player in the aluminium recycling industry, contributing to the sustainable use of resources by recovering aluminium from various waste streams
- The company's large and automatic lead acid battery scrap breaking machine is one of its kind in India
- Sound Hedging Strategy to counter the price fluctuations
- Ability to process multiple metals / products in the same premises – lead, copper, Aluminium
- Huge entry barrier for any new entrant to enter the business

- Largest company in India in terms of gross revenues in the industry
- In fiscal 2024, Jain Metal Group recorded the highest revenue growth among its peers, achieving a 44.53% on-year increase in addition to the highest on-year EBITDA growth of 82.98%. The company's EBITDA demonstrated a robust CAGR of 39.69% between fiscals 2022 and 2024, expanding to ₹2,272.20 million from ₹1,164.36 million.
- ESG compliant
- Has grown to become the largest in terms of revenues in India in the shortest possible time, compared to its peers.
- The company has achieved its strong market positions through its inhouse product and process improvements & enhancements with the help of their state of art technology.
- The process of cable sorting and stripping of cables has been evolved in-house by the company which has become a benchmark in the industry in India.
- Further, the company operates in an industry with high regulatory barriers to entry in the metals industry like high cost, complex regulatory approvals, building customer confidence and relationships, which can only be achieved over a period of time creating a huge entry barrier for any new entrant to enter the business.
- The company enjoys freight cost advantages with respect to its trade. For example, the ocean freight costs as of March 2025 as quoted by the company are USD 25/20' for Ho Chi Minh City (Vietnam), USD 10/20' for Qingdao (China), and USD 60/20' for Osaka (Japan), and seal charge of USD 5 per container, which are highly competitive and helps the company to have strong international presence.

Weakness

- Usage of low quality domestic scrap can lead to inefficiencies, higher costs, and low-grade end products.
- The company's focus on lead, copper, and aluminum makes it vulnerable to fluctuations or downturns in these specific markets. Diversification into a broader range of metals or value-added products could enhance market competitiveness.

Opportunities

- The company has an established presence in international markets, which is a strong complement to its domestic business and presents strong opportunities for growth.
- New revenue streams by venturing to gold refinery business (UAE) & processing Ilmenite, Garnet, Rutile & Zircon (Sri Lanka).
- UAE is low margin high volume business, whereas Sri Lanka is high margin high volume business.
- GOI's Green Metal Revolution initiative leading to all new products are to be made from non-ferrous metals which must contain a minimum of 5% recycled content.
- Also, with its expansion into gold refining business in India, the company would benefit from lower customs duty of 5.35% on gold doré bars, which is 0.65% lower than the applicable duty on refined gold of 6%, directly adding to its profit margins. This cost advantage shall make refining doré bars locally more profitable than importing refined gold.
- The growth in the scrap market in the new age and niche segments will provide business opportunities in the recycling sector. For instance, potential market growth opportunities in the segments of end-of-life solar panel scrap, automotive tyre scrap, copper-aluminium radiator scrap, brass scrap, electronic waste, and green cathode production industry will support recycling industry.
    - An increase in the market size of end-of-life solar panel scrap will aid in an increase in recovery of valuable components such as aluminium, glass, plastic, silver, and rare earth metals. The growth in this market is expected to be led by India's continued push for renewable energy combined with aging solar panels and increasing focus on sustainability by the domestic companies.

- A growth in the automotive tyre scrap industry will be supported by rising number of vehicles leading to higher volume of tyre replacements and a growing demand for recycled rubber and retreaded tyres in multiple industries including road construction.
- The copper-aluminium radiator scrap industry will help in increase in aluminium ingot production and is expected to grow on the back of increasing number of vehicles implying higher radiator replacement. Further, rising prices of virgin metals is also encouraging an increased use of scrap of copper and aluminium, causing a growth in the copper-aluminium radiator scrap industry.
- The scrap of brass of various grades is highly essential for producing high precision brass alloys. The brass scrap industry will grow on the back of an increasing usage of brass in electrical, plumbing and industrial requirements and its high recyclability. Further, a growing focus of the government and the industries on reducing raw material extraction by increasing brass recycling will help spur growth in the brass scrap industry.
- From the electronics waste or e-waste, a wide array of plastics, base metals, stainless steel, precious metals, and rare earth minerals can be extracted. An increase in the market of smartphones, laptops, and appliances has supported and will continue to support the e-waste generation. Further, an increasing shift from unorganized to organized e-waste processing has increased efficiency and will support the growth in electronics scrap generation.
- There is a continued push towards green copper cathode production which is manufactured in a sustainable manner with the usage of significant percentage of recycled copper. This increase in the push has been coming from government’s policies supporting eco-friendly production methods and high tendency of the companies to use sustainable copper especially in the new age and sustainable industries (such as electric vehicles, renewable energy, etc.).

Threats to Jain Metal Group & its products

- Working capital intensive business with low margins. While Jain Metal Group's large size provides some cushioning, the company is not entirely immune to these industry-wide challenges.
- High import dependency for key raw material such as copper, aluminium scrap on account of low domestic scrap availability coupled with unorganized scrap collection mechanisms.
- Exposure to volatile metal prices and currency risks due to reliance on imported raw materials.
- Strict and evolving environmental regulations could increase compliance costs.
- Competitive pressures from global and domestic players with advanced technologies.
- Risks from global trade policies, tariffs, and potential export restrictions.

13 Annexure - Abbreviations

The abbreviations in the report and their respective full-form are as follows:

Abbreviation	Full Form	Abbreviation	Full Form	Abbreviation	Full Form
$	United States Dollar	GJ	Giga Joule	PAT	Profit after tax
€	Euro	GNI	Gross National Income	PE	Polyethylene
ACs	Air Conditioners	HVAC	Heating, Ventilation, and Air Conditioning	PET	Polyethylene Terephthalate
ADC	Aluminum Die Casting	HV-EHV	High Voltage - Extra High Voltage	PLI	Production Linked Incentive
B&C	Building and Construction	ICA India	International Copper Association India	POCL	Pondy Oxides and Chemicals Ltd
BCM	Battery Cutting Machine	ICW	Insulated Copper Wires	PP	Polypropylene
BS	British Standard	IIP	Index of Industrial Production	PV	Photovoltaic
CAGR	Compounded Annual Growth Rate	IMF	International Monetary Fund	PVC	Polyvinyl Chloride
CMR	Century Metal Recycling	ISRI	Institute of Scrap Recycling Industries	Q	Quarter
CNFC	Century NF Casting	JIS	Japanese Industrial Standards	RBI	Reserve Bank of India
CO2	Carbon Dioxide	JMG	Jain Metal Group	RER	Recycling Efficiency Rate
CPCB	Central Pollution Control Board	kg	Kilo-gram	RIR	Recycling Input Rate
CPI	Consumer Price Index	KT	kilo Tonnes	RML	Re-melted lead
CSO	Central Statistical Office	KTPA	kilo Tonnes per annum	ROCE	Return on Capital Employed
D&A	Depreciation and Amortization	kW	Kilo-Watt	ROE	Return on Equity
De-ox	Deoxidiser	Kwh	kilo Watt-Hour	RVSFs	Registered Vehicle Scrapping Facilities
E:	Estimated	LABs	Lead Acid Batteries	SBAC	Shree Balaji Alumnicast
EBITDA	Earnings Before Interest, Taxes, Depreciation, and Amortization	LM	Liquid Metal	SCM	Smart Cities Mission
ELVs	End-of-Life Vehicles	LME	London Metal Exchange	SIPCOT	State Industries Promotion Corporation of Tamil Nadu
EOL	End-of-Life	M&HCV	Medium and Heavy Commercial Vehicles	SOP	Standard Operating Procedure
EPR	Extended Producer Responsibility	MCX	Multi Commodity Exchange	TiO2	Titanium Dioxide

Abbreviation	Full Form		Abbreviation	Full Form		Abbreviation	Full Form
ESG	Environmental, Social, and Governance		MoEFCC	Ministry of Environment, Forest and Climate Change		UAE	United Arab Emirates
ETP	Electrolytic Tough Pitch		MoU	Memorandum of Understanding		UK	United Kingdom
EU	European Union		MT	Million tonnes		UNDP	United Nations Development Programme
EV	Electric Vehicle		NA	Not Applicable		UNEP	United Nations Environment Programme
E-waste	Electronic waste		NALCO	National Aluminium Company		UPS	Uninterruptible Power Supply
FAME	Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles		NEMMP	National Electric Mobility Mission Plan		US	United States
FCEV	Fuel-Cell Electric Vehicle		NIP	National Infrastructure Pipeline		USD	United States Dollar
Fed	Federal Reserve		NSO	National Statistical Office		USGS	United States Geological Survey
FRPs	Flat rolled products		NTPC	National Thermal Power Corporation		VRLA	Valve-Regulated Lead-Acid
FY	Fiscal Year		OECD	Organisation for Economic Co-operation and Development		WPCB	Waste-Printed Circuit Boards
GAIL	Gas Authority of India Limited		OEM	Original Equipment Manufacturer		WRP	Waste Recycling Park
GDP	Gross Domestic Product		P:	Projected		y-o-y	year-on-year

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