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February 2025

Consumer led E-Waste Market Assessment

redseer

Report

Bangalore. Delhi.

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Key themes covered across the report

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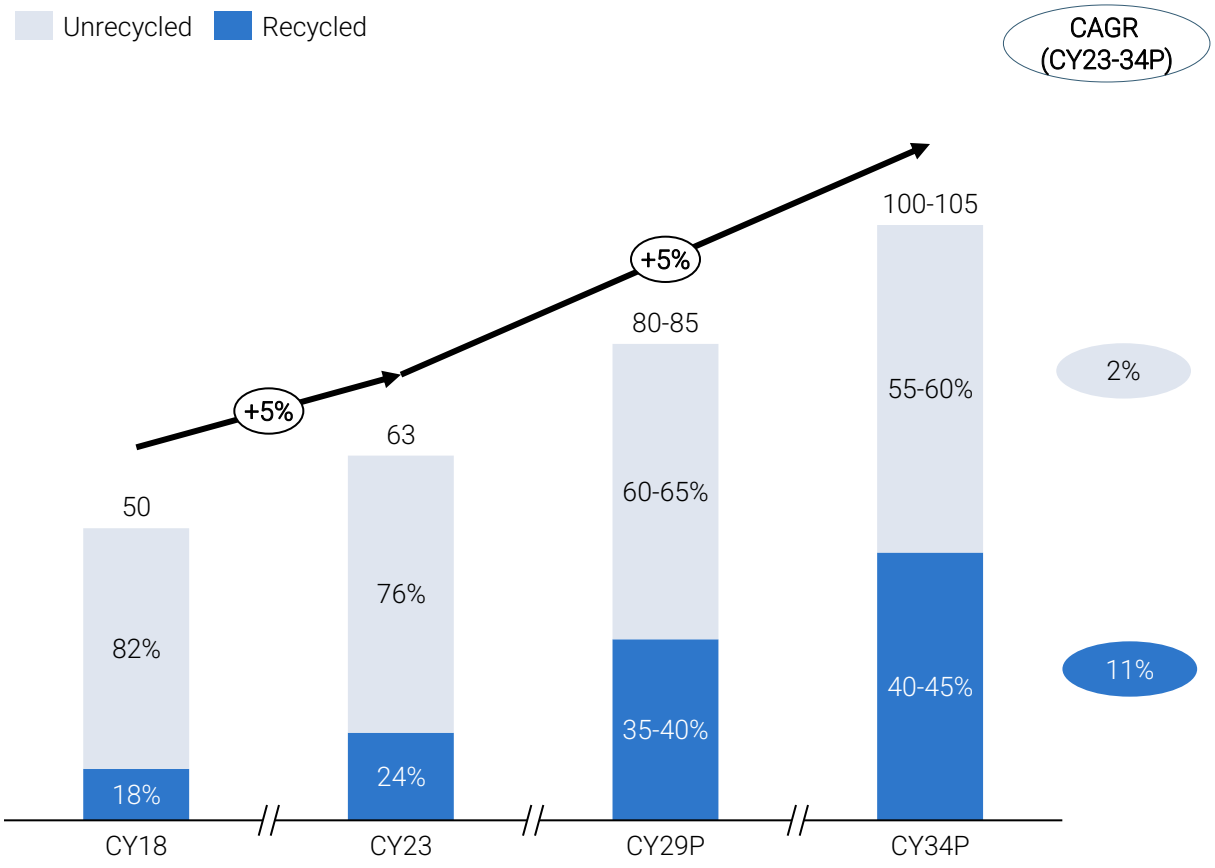
1

E-waste generation – *Across the globe*

Based on Global e-waste monitor data, ~63 MMT of e-waste is generated globally in CY23

E-waste generation in the World

In MMT[4], CY18, 23, 29P, 34P



Key Remarks

- **What is E-Waste?**
  UNITAR defines e-waste as discarded electrical and electronic equipment (EEE) across 54 product types within six categories, including appliances and IT devices
- **E-waste inventory quantification:**
  UNITAR and ITU utilize a product lifespan model, incorporating sales data and the Weibull function for average item lifespan, to estimate e-waste generation
- **E-waste regulations across the globe:**
  Currently, 81 countries have established e-waste policies, reflecting a rising global commitment to sustainable e-waste management

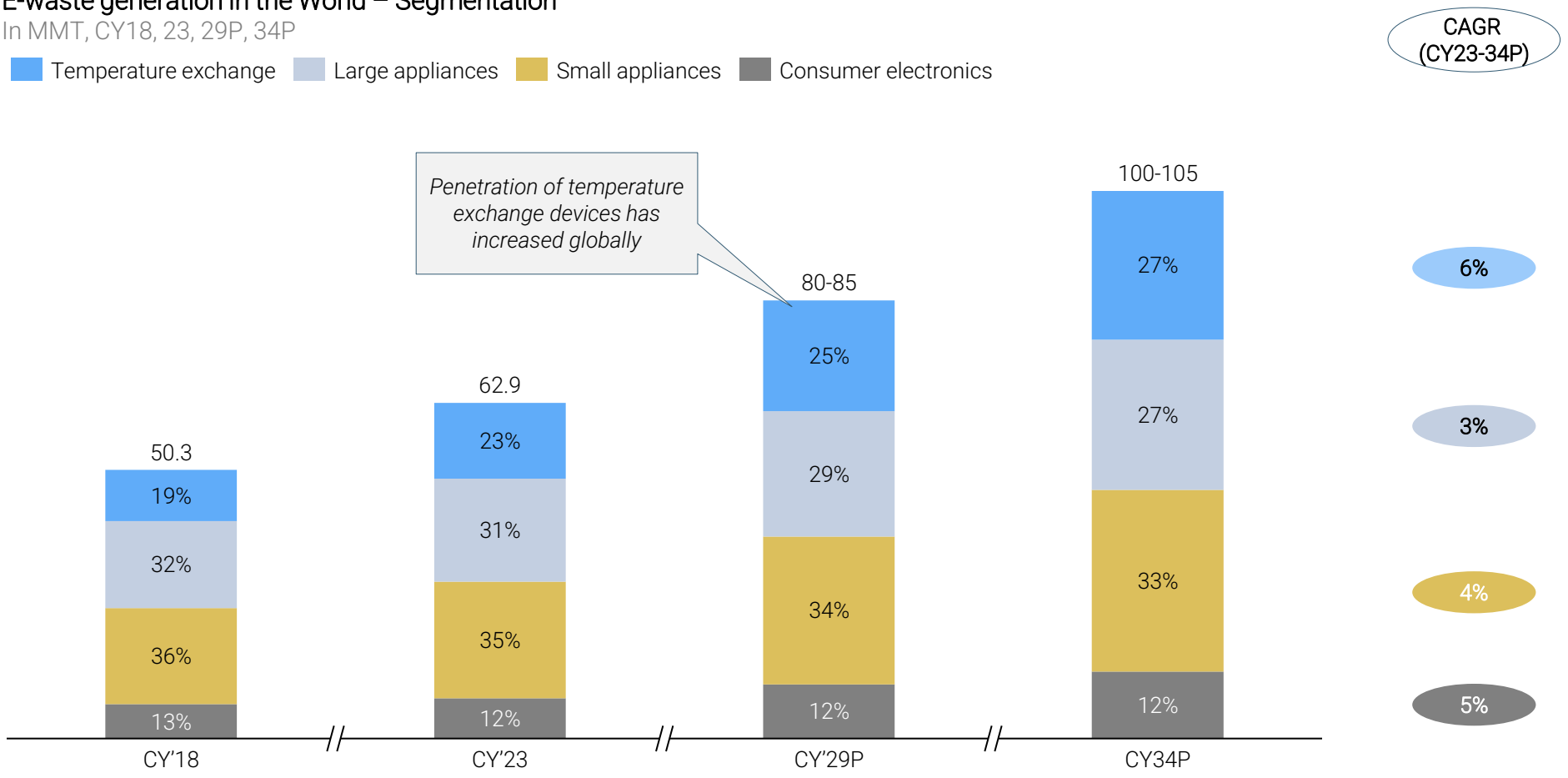
Note(s): (1) UNITAR: United Nations Institute for Training and Research (2) ITU: International Telecommunication Union (3) The Weibull function models the time until events like failure or disposal, estimating the lifespan and obsolescence rates of electronic products (4) MMT: Million Metric Tonnes (Bn Kgs) (5) Lithium-ion batteries have been excluded

Source (s): Redseer analysis, Global e-waste monitor

Temperature exchange items and consumer electronics are expected to grow the fastest in next 10 years

E-waste generation in the World – Segmentation

In MMT, CY18, 23, 29P, 34P



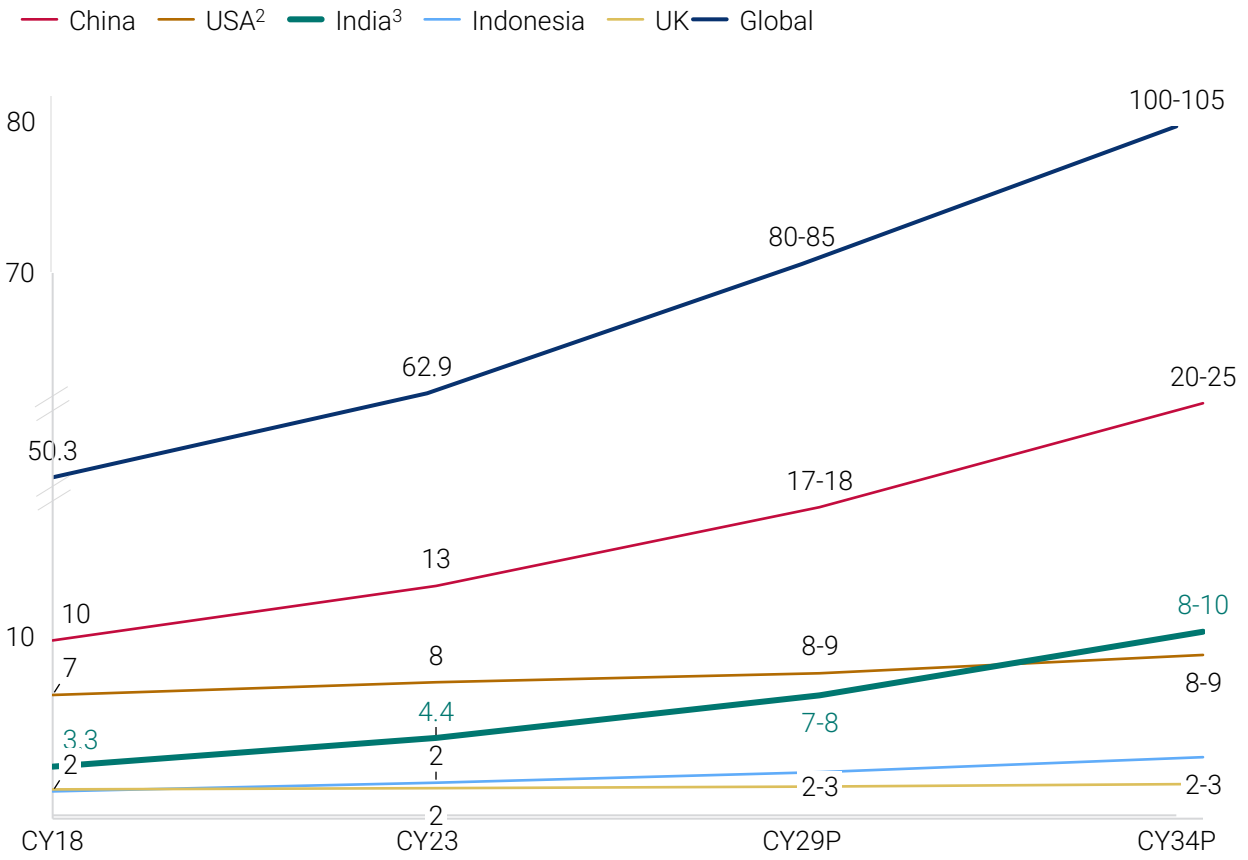
Note(s): (1) Temperature exchange includes refrigerators, air conditioners, radiators, coolers, etc. (2) Large appliances include washing machines, dishwashers, and TVs etc. (3) Small appliances include set-top boxes, routers, fans, cookers, microwaves, toasters, chimneys, ovens, lights, lamps, and photovoltaic cells etc. (4) Consumer electronics include phones, tablets, laptops, monitors, peripherals, chargers, printers, and cameras etc.

Source (s): Redseer analysis, Global e-waste monitor

India ranks 3rd in e-waste generation globally trailing China and USA

E-waste generation – Country of origin (Selective)

In MMT, CY18, 23, 29P, 34P



Key Remarks

- **Rapid digital transformation (China)**
  China shows the steepest growth trajectory, nearly double over the last decade from FY14-24 from 6 to ~13 MMT, driven by massive tech adoption and shorter device replacement cycles in its urban population
- **Steady mature market (USA)**
  USA maintains relatively stable growth, due to it being a mature digital market with a high per capita electronics ownership
- **Emerging Tech Hub (India)**
  India's e-waste shows generation has increased from ~2 to ~4 MMT from FY14 to 24 fueled by increased urbanization and disposable income and tech adoption over the last decade

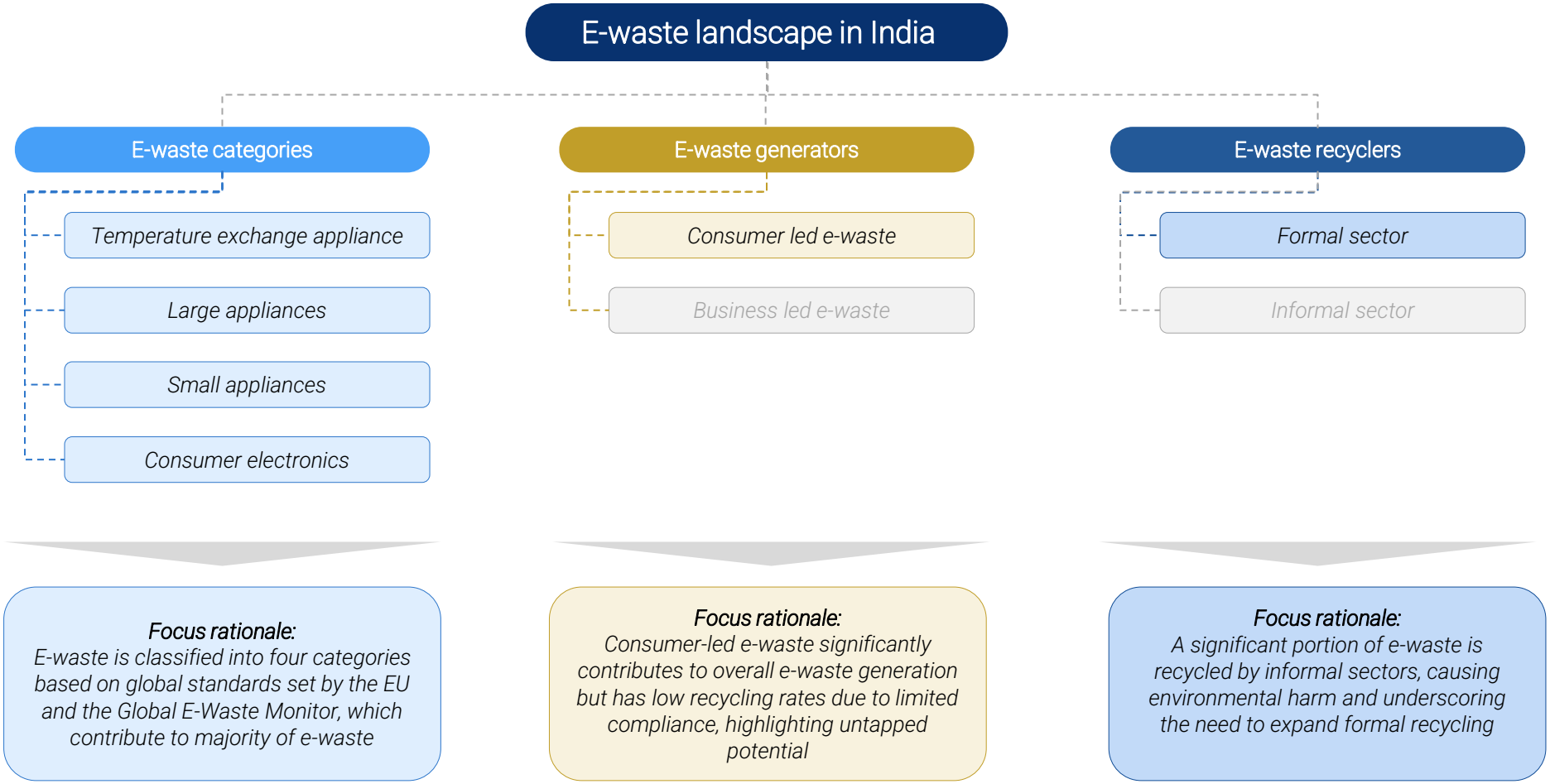
Note(s): (1) The UK includes Great Britain and Northern Ireland (2) The Dip in US e-waste production can be primarily attributed to the National stewardship policy of the US (3) Redseer estimates are 10% lower than, e-waste generation figures sourced from UNITAR's Global E-Waste Monitor Report 2024 depicted in above graph

Source (s): Redseer analysis, Global e-waste monitor

2.1

E-Waste Trends in India

The report focuses on analyzing the consumer-driven e-waste landscape in India

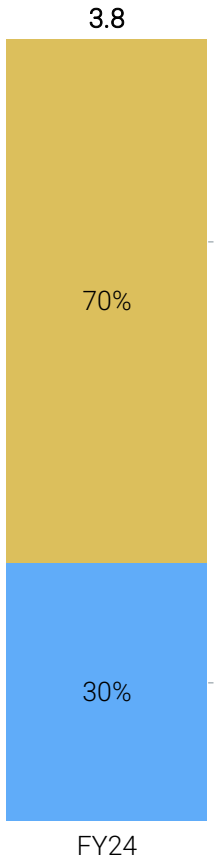


Source(s): Redseer approach

E-waste is primarily generated through 2 channels, with households accounting for ~70% of the annual total

E-waste generation– Split

In MMT, FY24



Categories	Projected Increase	Key waste generating items
Households (Consumer led)	High	Air conditioners, refrigerators…
		Washing machines, television, coolers…
		Toasters, blenders, vacuum cleaners, electric kettles, irons, hairdryers…
		Laptops, desktops, smartphones, tablets, accessories…
Businesses	Moderate	Refrigerators, Water coolers, centralized air conditioners, cool and hot dispensers…
		Industrial printers and copiers, commercial washing machines, Lab equipment, Professional medical devices…
		Coffee machines, shredders, hand dryers, power tools, …
		Servers, desktops, monitors, smartphones, laptops…

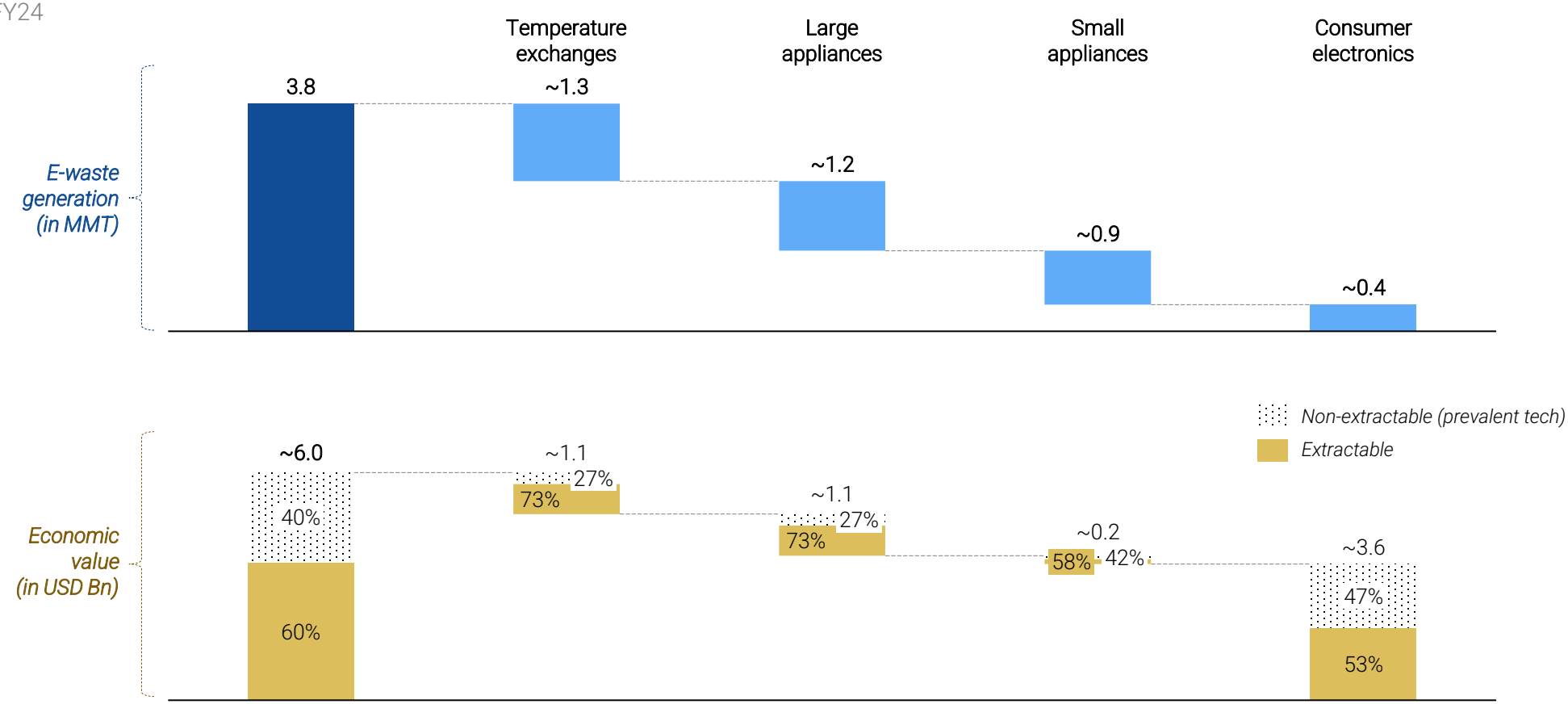
Note(s): (1) High: 10-15% CAGR, Moderate: 5-10% CAGR (2) Businesses includes government (3) As per E-waste monitor India's e-waste generation in FY'24 would be ~4.4

Source(s): Secondary Research, Redseer analysis

India generated 3.8 MMT of e-waste in FY24 with an estimated economic potential of ~USD 6 Bn from recoverable materials through metal extraction

India's e-waste split - Overall

FY24



Note(s): (1) Temperature exchange includes refrigerators, air conditioners, radiators, coolers, etc.; (2) Large appliances include washing machines, dishwashers, and TVs (3) Small appliances include set-top boxes, routers, fans, cookers, microwaves, toasters, chimneys, ovens, lights, lamps, and photovoltaic cells (4) Consumer electronics include phones, tablets, laptops, monitors, peripherals, chargers, printers, and cameras (5) Economic value refers to the value of metals present in e-waste (5) $ 1 = INR 83

Source(s): Redseer analysis

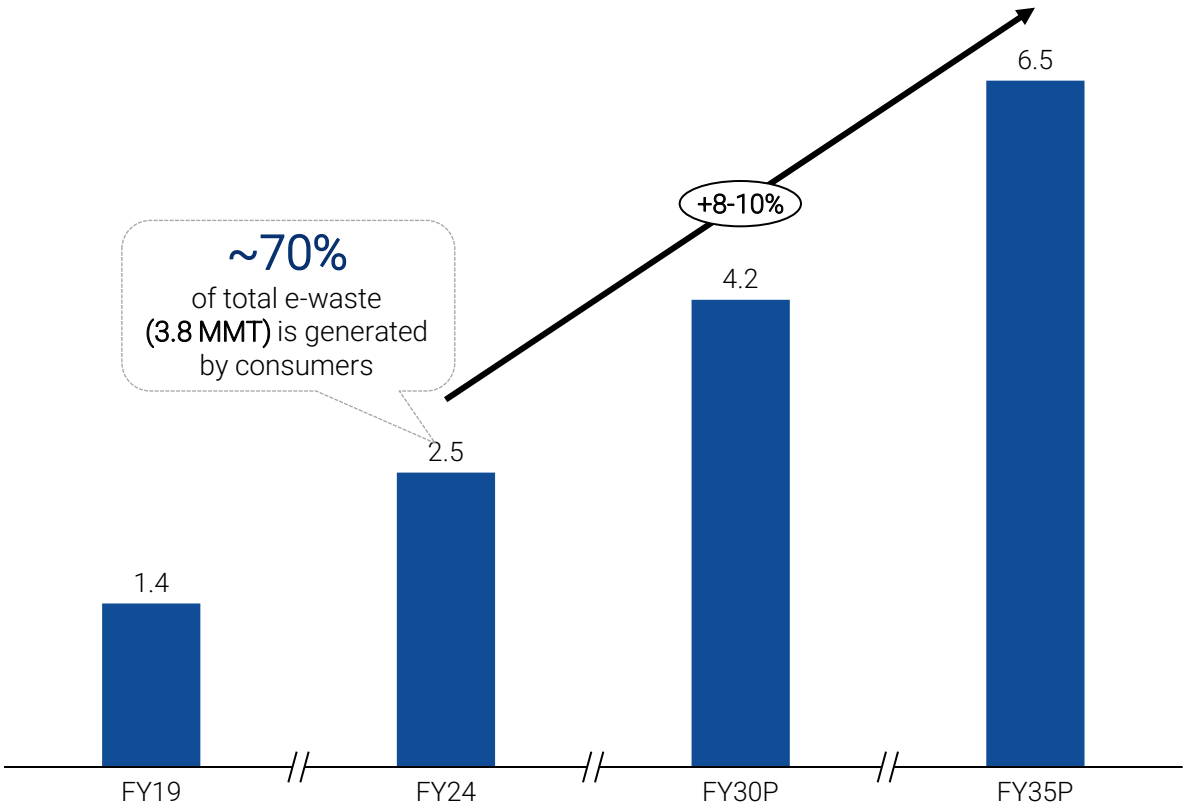
2.2

Consumer-driven E-Waste in India

Consumer led e-waste stands at 2.5 MMT in FY24 and is expected to grow at a CAGR of 8-10% over the next decade

Consumer led E-waste - Generation

In MMT, FY19, 24, 30P, 35P



Growth drivers

- **Reduction in item weight for key categories:** As technology evolves, electronic devices have become lighter and more compact. For instance, the shift from bulky CRT TVs to slim LCD and LED TVs has significantly reduced the per-unit weight of e-waste
- **Shift in material composition:** Many modern electronic devices now use lighter and more efficient materials, such as aluminum and plastics, instead of heavier metals like steel or lead. This change reduces the overall weight and volume of e-waste generated.

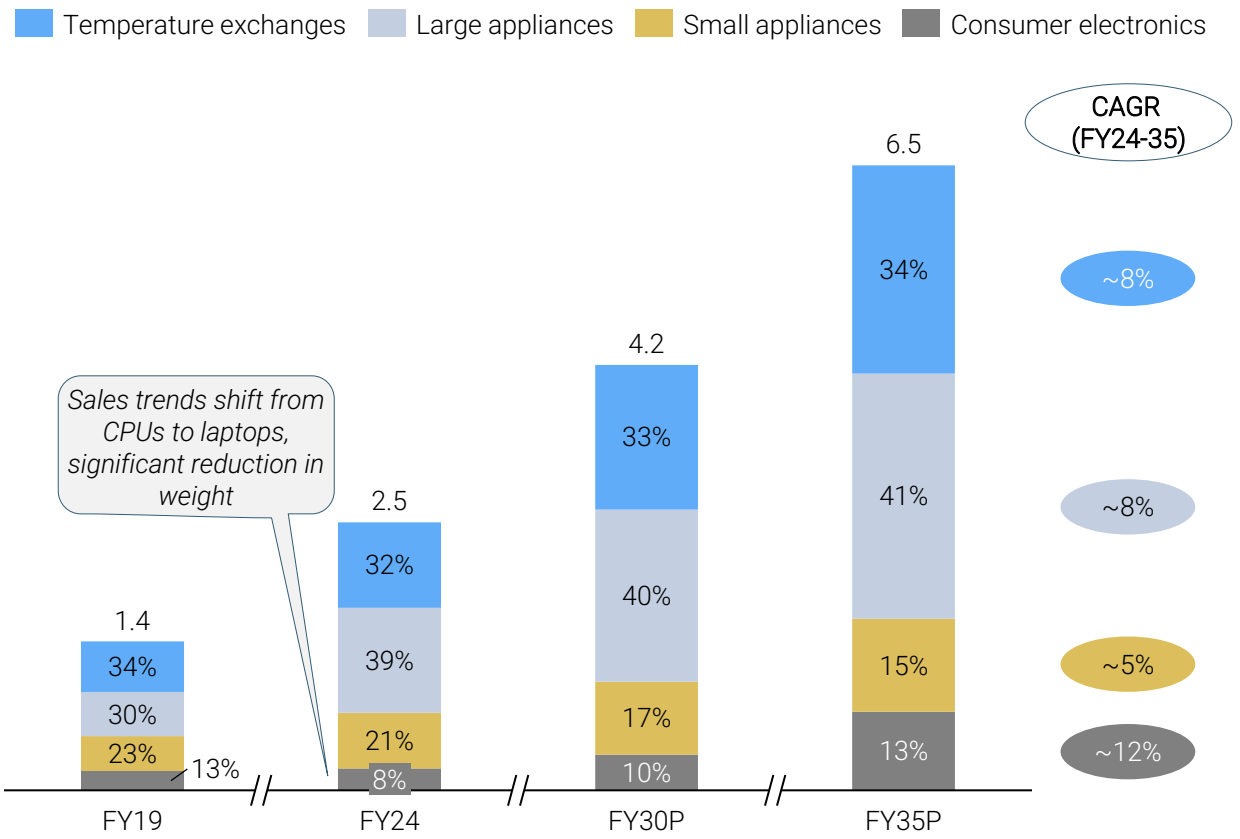
Note(s): (1) Consumer e-waste includes large appliances, small appliances, consumer electronic items, and other household electronic/electrical items

Source(s): Redseer analysis

~70% of consumer led e-waste is generated by large appliances & temperature exchange items...

Consumer led E-waste - Generation

In MMT, FY19, 24, 30P, 35P



Remarks

- **Shifting Material Intensity:** Despite a general in weight decline, large appliances account for an increased share of e-waste by FY30 by mass, due to the growing quantity of these items entering the disposal stream
- **Growth of large appliances between FY19-24:** Growth of e-waste between FY19-24 is driven by significant adoption of washing machines & televisions between 2008-13, contributing significantly to e-waste
- **Decreasing contribution of small appliances:** Over time, small appliances like microwaves have become more compact and are now manufactured using lighter materials such as aluminum and steel, replacing the heavier metals such as iron used in older appliances

Note(s): (1) Temperature exchange includes refrigerators, air conditioners, radiators, coolers, etc.; (2) Large appliances include washing machines, dishwashers, and TVs (3) Small appliances include set-top boxes, routers, fans, cookers, microwaves, toasters, chimneys, ovens, lights, lamps, and photovoltaic cells (4) Consumer electronics include phones, tablets, laptops, monitors, peripherals, chargers, printers, and cameras (5) Large appliance e-waste grew faster between FY'19-24 due to increased adoption of items in the purchase year

Source(s): Redseer analysis

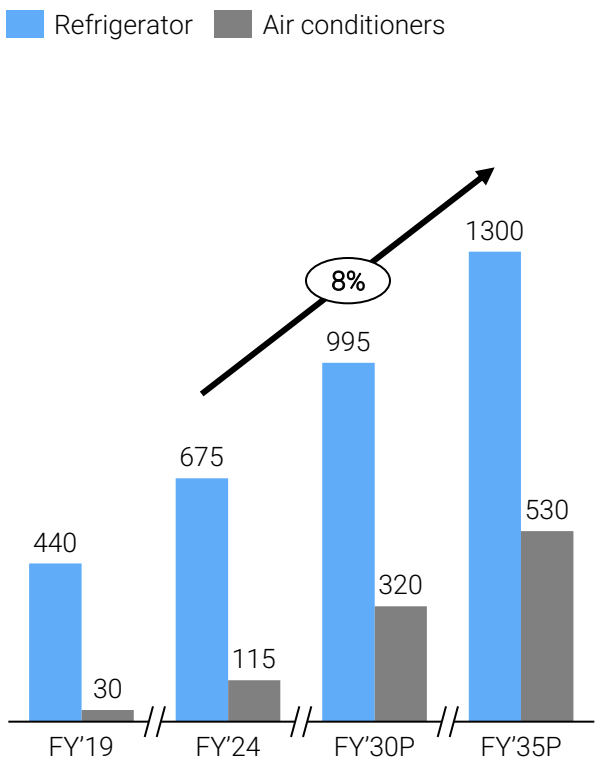
...and few items across each category contribute to majority of e-waste

Non-exhaustive

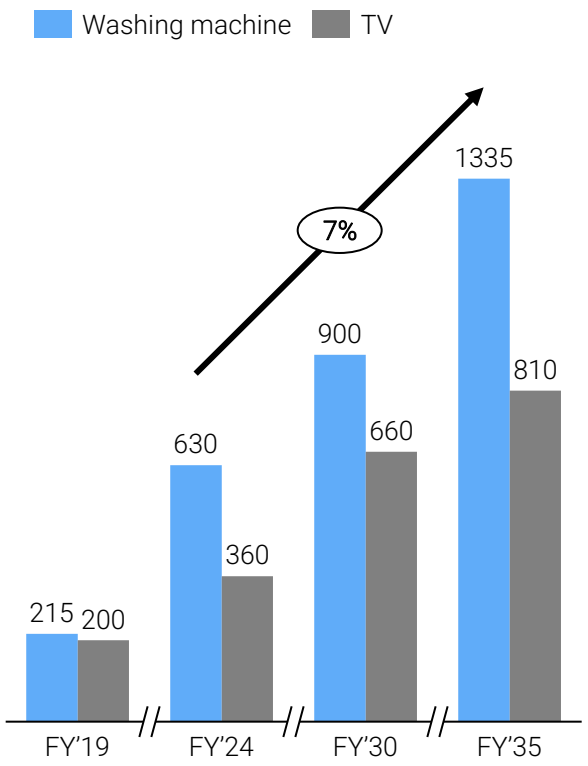
Consumer led E-waste generation

In '000 Tonne, FY19, 24, 30P, 35P

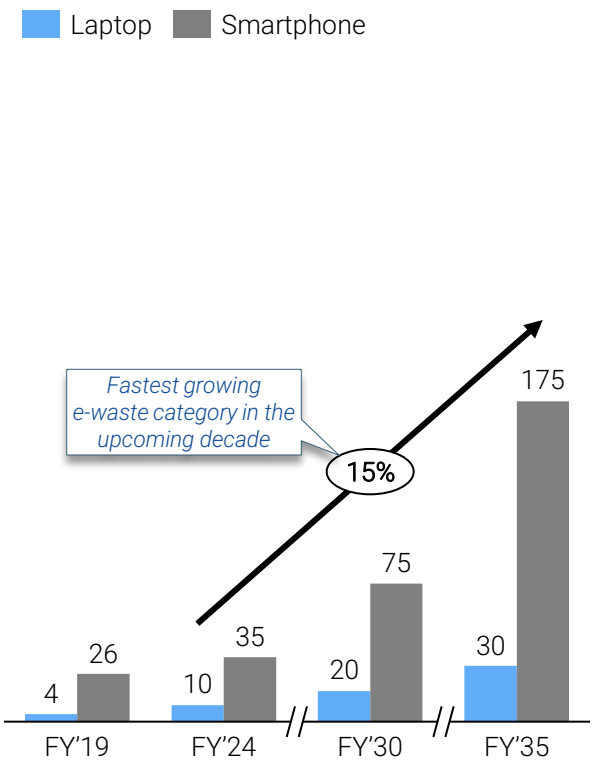
Temperature Exchange



Large appliances



Consumer electronics



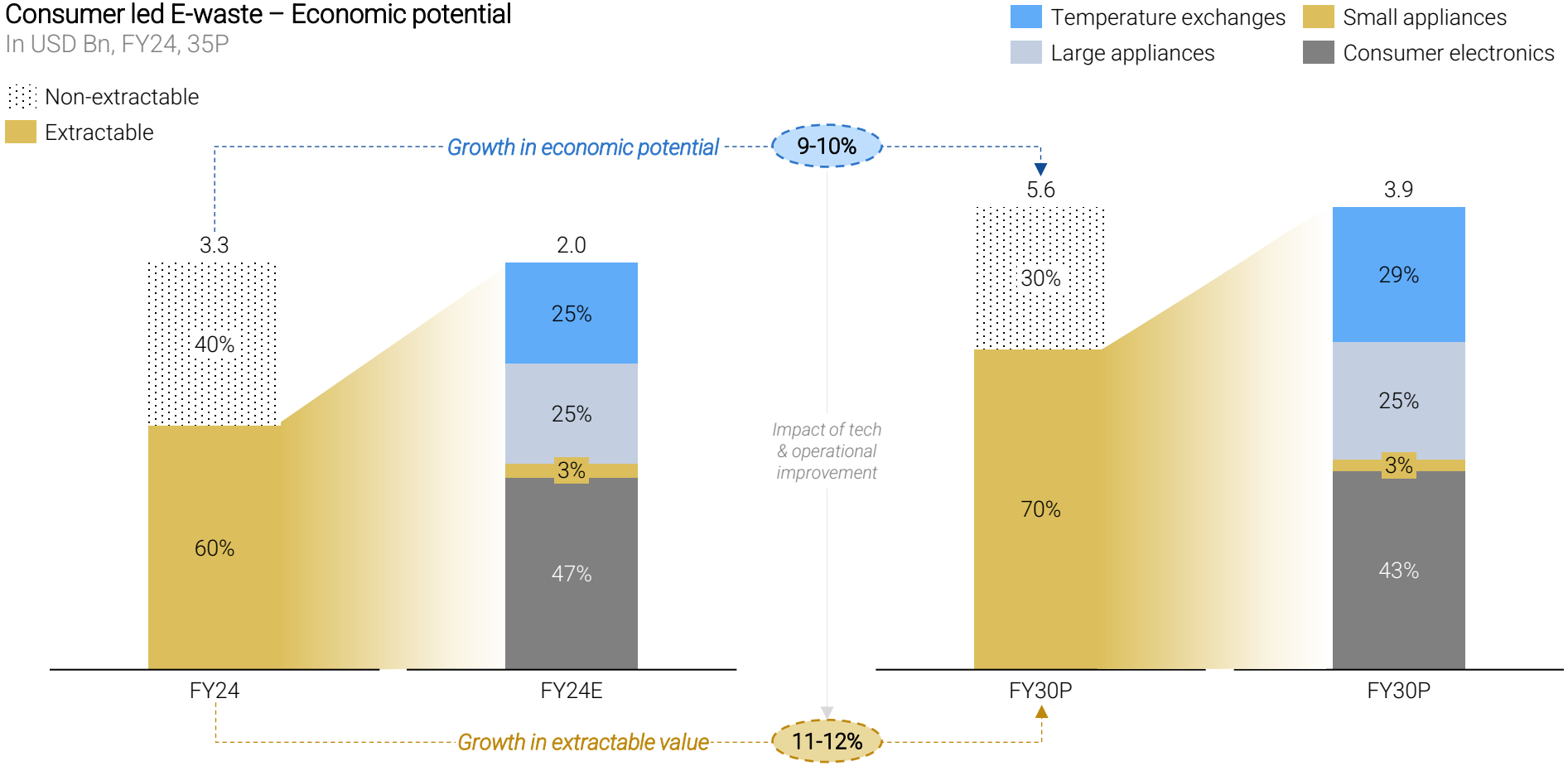
Note(s): (1) List of appliances is non exhaustive; (2) Representation of appliances accounting for more than 30-40% of the total category weight (3) Numbers are rounded off to 5

Source(s): Redseer analysis

Consumer led e-waste in FY24 holds an toal economic potential of ~ USD 3.3 Bn from recoverable materials

Consumer led E-waste – Economic potential

In USD Bn, FY24, 35P



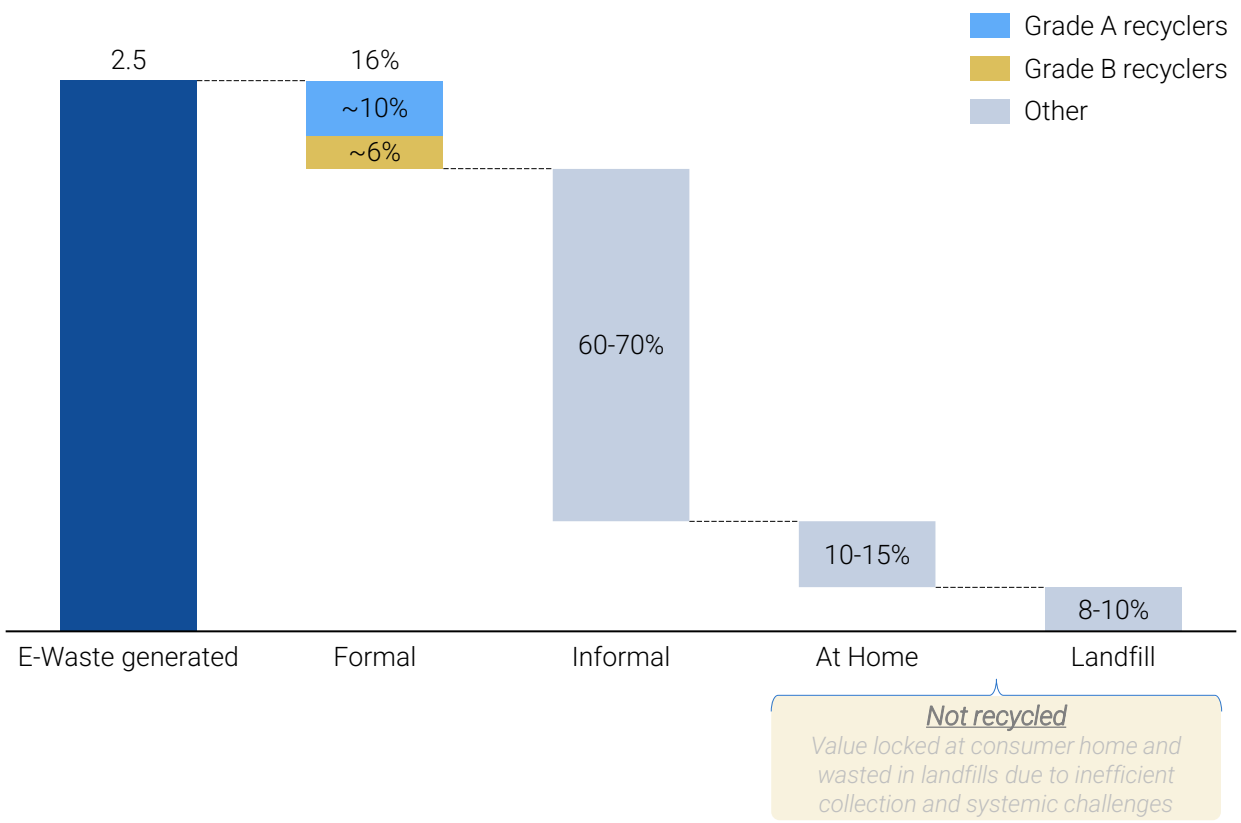
Note(s): (1) Economic potential of materials refers to the value of metals and plastic content at current prices present in e-waste (2) Temperature exchange includes refrigerators, air conditioners, radiators, coolers, etc.; (3) Large appliances include washing machines, dishwashers, and TVs (4) Small appliances include set-top boxes, routers, fans, cookers, microwaves, toasters, chimneys, ovens, lights, lamps, and photovoltaic cells (5) Consumer electronics include phones, tablets, laptops, monitors, peripherals, chargers, printers, and cameras

Source(s): Redseer analysis

~70% of consumer e-waste continues to flow through informal channels

Consumer led E-waste - Processing (by channel)

In MMT, FY'24



Remarks

- **Informal Sector Dominance:** While 60-70% of e-waste flows through informal channels making them key collection points, this extensive network presents an opportunity to establish formal partnerships and transition towards regulated processing systems
- **Significant Home Storage:** 10-15% of e-waste largely constituted by smaller consumer electronics such as smartphones, laptops, and accessories, remains stored in households due to retention pattern such as irregular disposal practices and little awareness of disposal methods
- **Trade-Ins for Large Appliances:** Large household appliances are often traded in when consumers upgrade to newer models, and may find a new life through informal resale networks or make their way into formal recycling channels, if traded to large retailers

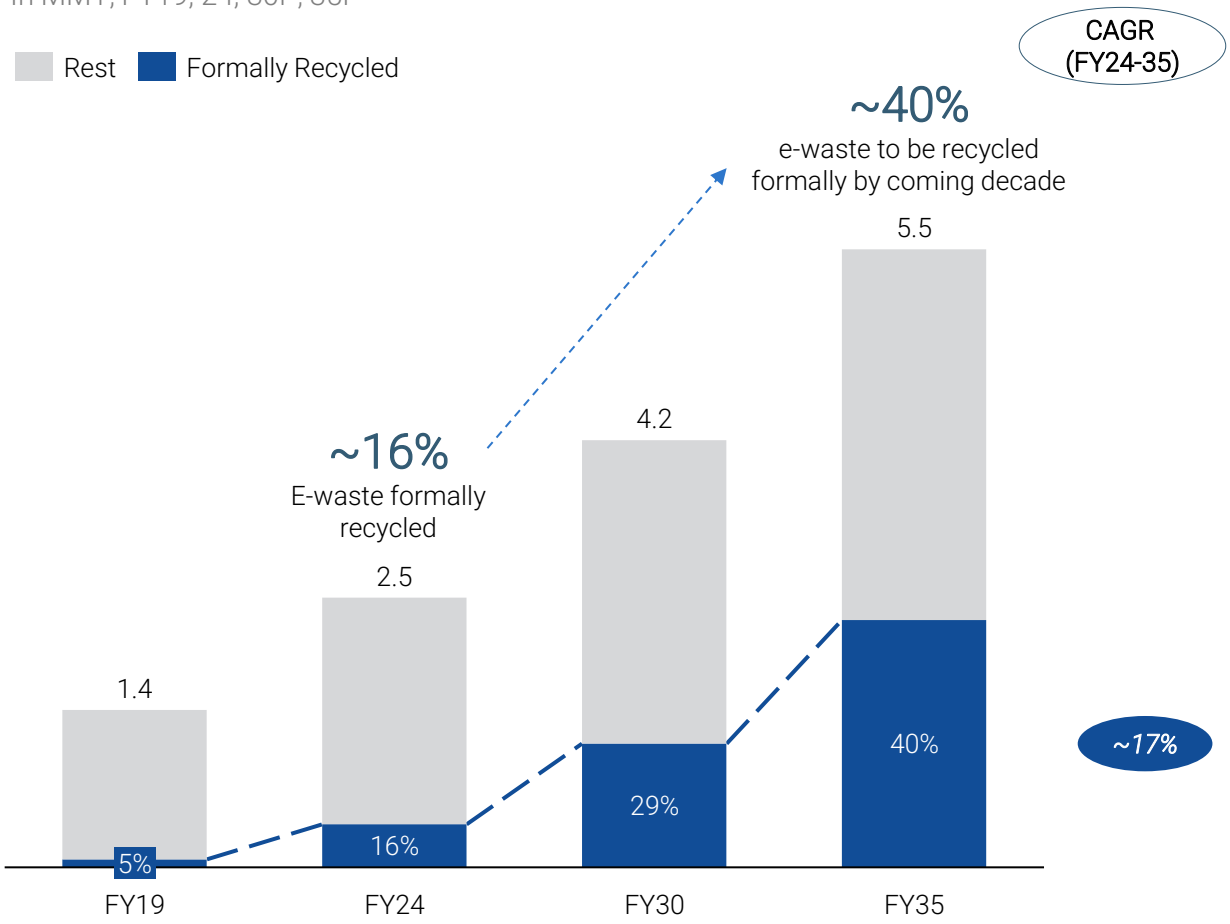
Note(s): (1) Formal recycling - E-waste is processed by authorized facilities adhering to environmental regulations, includes Grade A recyclers, and Grade B recyclers. (2) Grade A Recyclers employ advanced tech for metal recovery from e-waste with minimal environmental and have obtained recycler's license from CPCB (3) Grade B recyclers are dismantlers focusing on disassembling e-waste into components and preliminary metal extraction and registered as dismantler with CPCB (4) Informal Sector - Unregulated workers handle e-waste using unsafe methods to extract valuable materials (5) At Home - E-waste is stored in households without proper disposal (4) Landfill - E-waste is discarded in landfills, causing pollution and resource loss

Source(s): Expert interaction(s), Desk Research, Redseer analysis

Formal e-waste recycling is set to grow ~17% but will cover only 40% of e-waste in a decade

Consumer led E-waste – Formal processing

In MMT, FY19, 24, 30P, 35P



Remarks

- **Competition from Informal Sector::** Informal players dominate the recycling market due to their ability to operate with significantly lower compliance costs and streamlined access to waste streams
- **Negative externalities caused by prevalent informal sector:**
  - **Hazardous recycling practices** releasing toxins, polluting environment
  - **Health risks** to informal workers due to exposure to dangerous substances
  - **Inefficient metal recovery** wastes valuable materials, increasing resource dependency

Source (s): Redseer analysis, CPCB

India's current formal system has 595 authorized dismantlers and recyclers with a capacity of ~1.8 MMT as of FY24

Indian e-waste management landscape

Non-exhaustive

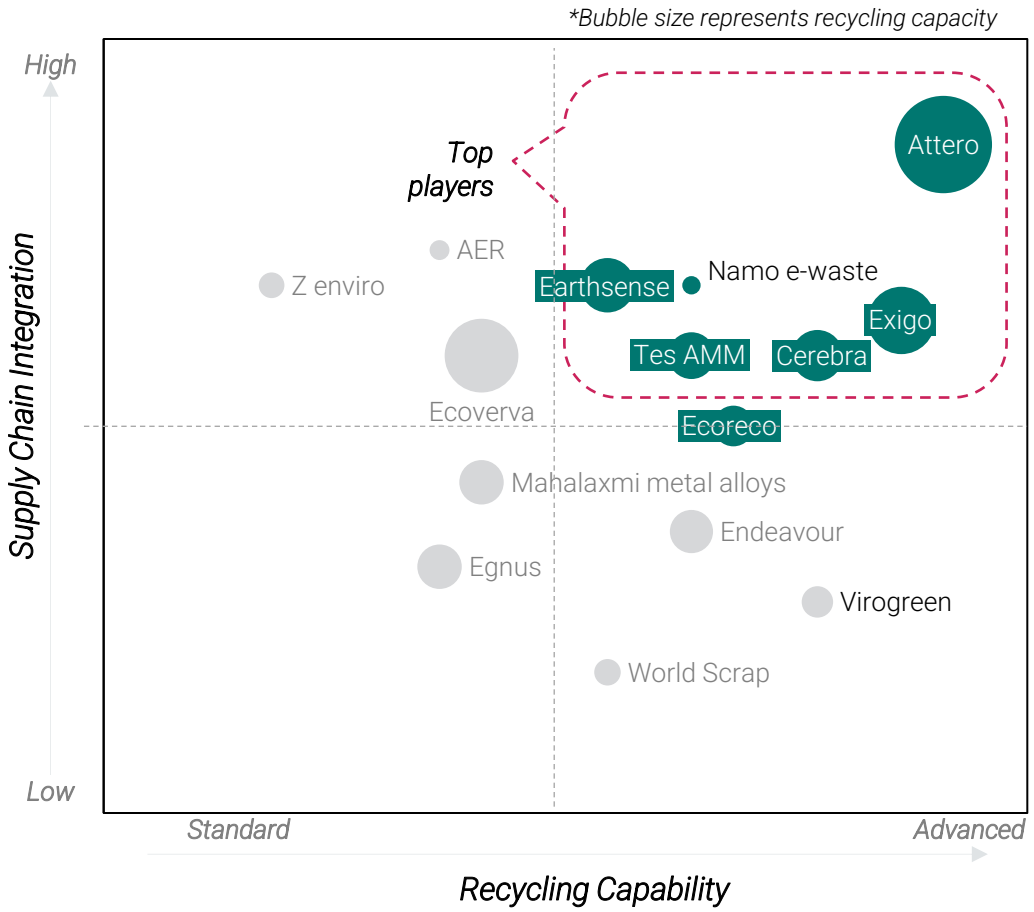
Note(s): (1) Number of recyclers as per CPCB dashboard as on December 2024

Source(s): CPCB, Desk Research, RedCore analysis

However, only a few players in India have advanced recycling capabilities

Mapping key recyclers - Supply chain and Recycling capability

Non-exhaustive



Definition

- Supply Chain Integration
  - **Low:** Limited reach with few collection centres, basic D2C procurement, and minimal pin code and mobile app access
  - **High:** Extensive network with numerous collection centres, strong D2C presence, broad pin code coverage, and easy mobile app access
- Recycling Capability
  - **Standard:** Basic recycling, partial PCB processing, limited rare earth, and metal extraction, often requiring third-party support
  - **Advanced:** Full in-house recycling, high PCB processing, and efficient rare earth and metal extraction without external help

Source(s): Company websites, Desk Research, Expert interaction(s), RedCore analysis

Majority of recyclers rely on traders and aggregators for e-waste sourcing…

Intensity

Low — High

Business benchmarking – Indian E-waste Recyclers

Parameters		Attero	Exigo	Namo e-waste	Cerebra	TES AMM	Earth Sense	Ecoreco[3]
Founding year		2010	2012	2014	1992	2007	2008	2017
Offerings	D2C Pickups	✓	×	✓	×	✓	✓	✓
	Marketplace	✓	×	×	×	×	×	×
	EPR partnering	✓	✓	✓	✓	✓	✓	✓
	Mobile app	✓	×	×	×	×	×	✓
Sourcing channel split	E-waste traders							
	Bulk Consumers							
	OEMs							
	Online bidding							
	Retailers							
	Individuals							
Coverage	# Recycling plants	4*	2	4	1	3	5	1
	Plant location	Uttarakhand, Karnataka, Maharashtra, Haryana	Haryana	Haryana & Maharashtra	Karnataka	Karnataka, Telangana & Haryana	Tamilnadu, Karnataka, Telangana, Maharashtra & Haryana	Maharashtra
	Coverage	Pan India	100+ cities	NA	25+ centers	NA	20+ centers	100+ centers

Note(s): *3 plants are proposed to be setup in next 2-3 months (1) E-waste Traders: Trade e-waste; Bulk Consumers: Large producers (e.g., FMCG, IT); Online Bidding: Auction platforms like MSTC; Retailers: Sell electronics to consumers; Individuals: Dispose of personal devices; OEMs: Device manufacturers (2) Ecoreco also operates a consumer donation channel, allowing individuals and corporations to donate their e-waste free of cost

Source(s): Expert interaction(s), Desk Research, RedCore analysis

…. And exhibit low EBITDA margins

Operation and financial KPIs – Indian E-waste Recyclers

		Operational KPI (FY24)				Financial Performance (FY24)			
		Operational Capacity (in MT)	Volume recycled (In MT)	Capacity Utilization(%)	Metal recovery(#)	Revenue (INR Cr)	Gross Margin	EBITDA Margin	EPR[4] (% of Revenue)
Indian Players	ATTERO	1,44,000	72,000	50%	22+	446	23%	8%	20%
	EXIGO	69,000	10,000[1]	15%	15+	74[2]	21%	6%	10-20%
	NAMO eWaste	1,00,000[3]	*NA*	*NA*	5+	59[2]	12%	7%	5-10%
	EARTH Sense	45,000	20,023[1]	45%	5+	132[2]	26%	7%	*NA*
Int'l players	CEREBRA	40,000	*NA*	*NA*	10+	231[1]	30%	20%	*NA*
	TES-AMM	47,040	*NA*	*NA*	10+	281[2]	35%	21%	*NA*

Note(s (1) FY'22 data (2) FY'23 data (3) As mentioned on their website (4) EPR Revenue: Extended Producer Responsibility (EPR) refers to fees paid by manufacturers in exchange for metal recycling certificates issued by recyclers, as mandated under the E-Waste (Management) Rules, 2022.

Source(s): Tofler,Expert interaction(s), Desk Research, RedCore analysis

PCB recycling and Rare earth extraction (REE) capabilities are limited to a few large players

Attero has the most comprehensive and scalable PCB and REE capabilities

Degree of extraction

Recycling capabilities comparison[5]

Y Present & verified | L Claimed | N Not present

	REE Metal	PCB	Precious Metal	Pure Non Ferrous Metals	Scrap Non Ferrous Metal	Ferrous Metal	Plastic	Glass	Carbon Credits
ATTERO	Y	Y[1]	Y	Y	Y	Y	Y	Y	Y
EXIGO	L	L	L	N	Y	Y	Y	Y	N
NAMO eWaste	L	L	L	N	Y	Y	Y	Y	N
CEREBRA	N	L	L	N	Y	Y	Y	Y	N
TES-AMM	N	L	L	N	Y	Y	Y	Y	N
EARTH Sense	N	L	L	N	Y	Y	Y	Y	N
Ecoreco	N	L	L	N	Y	Y	Y	Y	N

Remarks

- **Comprehensive Recycling Advantage:** Attero is the only players with verified and comprehensive capabilities for Printed Circuit Board (PCB) recycling and precious metal refining
- **Capability Gaps in Key Players**: While most players handle common materials like plastic and non-ferrous metals, limited expertise in PCB and REE processing among competitors signals missed opportunities for value creation
- **GHG emissions:** Attero recycles base metals (Iron, aluminum, copper) with 40-80% and precious metals (gold, silver) with 99% lower GHG emissions than the baseline

Note(s): (1) Attero's PCB recycling capability is verified (2) REEs include the 15 lanthanide elements on the periodic table, plus the transition metals scandium and yttrium (3) Precious metal includes gold, silver, platinum, palladium (4) Ferrous metals include iron and steel (5) Non-ferrous metals include copper, aluminum, etc. (6) Recycling capabilities are benchmarked based on information available on company websites and public documents, including annual reports and earnings calls.

Source(s): Expert interaction(s), Company website(s), Desk Research, RedCore analysis

Attero is the only recycler in India with self-generated patents, along with certifications from an international ESG auditor and ISO 14064 for GHG reduction

E-waste recycling patents

	Patents	Currently held patents
ATTERO	✓	45
EXIGO	✓1	1 *(Transferred)*
NAMO eWaste	×	-
CEREBRA	×	-
TES-AMM	×	-
EARTH Sense	×	-
Ecoreco Eco Recycling Limited	×	-

Key Patents held by Attero

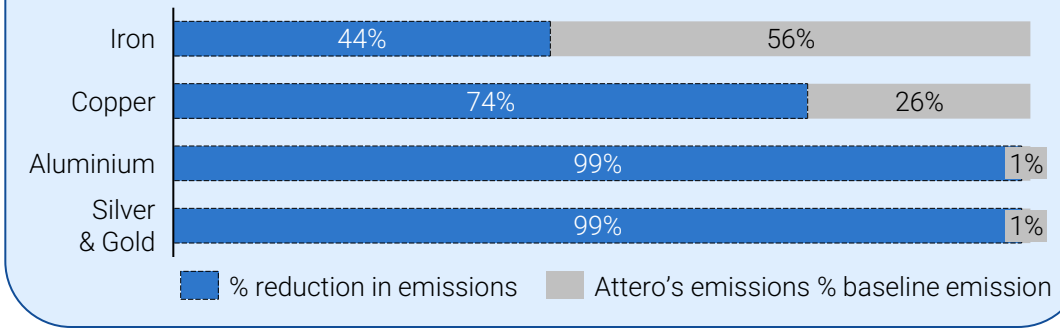
200+ patents applied

9+ global patents assigned in US, China, Singapore, Australia, etc

Key patents include:

- *A process of recovering metal values from chips of waste printed circuit boards (PCBs)*
- *Process of recovering metal values from waste monolithic ceramic capacitors*
- *Automatic component segregator enabled with smart inductor testing kits*
- *Method and apparatus for components removal from PCB*

Proprietary tech enabling Attero's low emissions recycling[2]



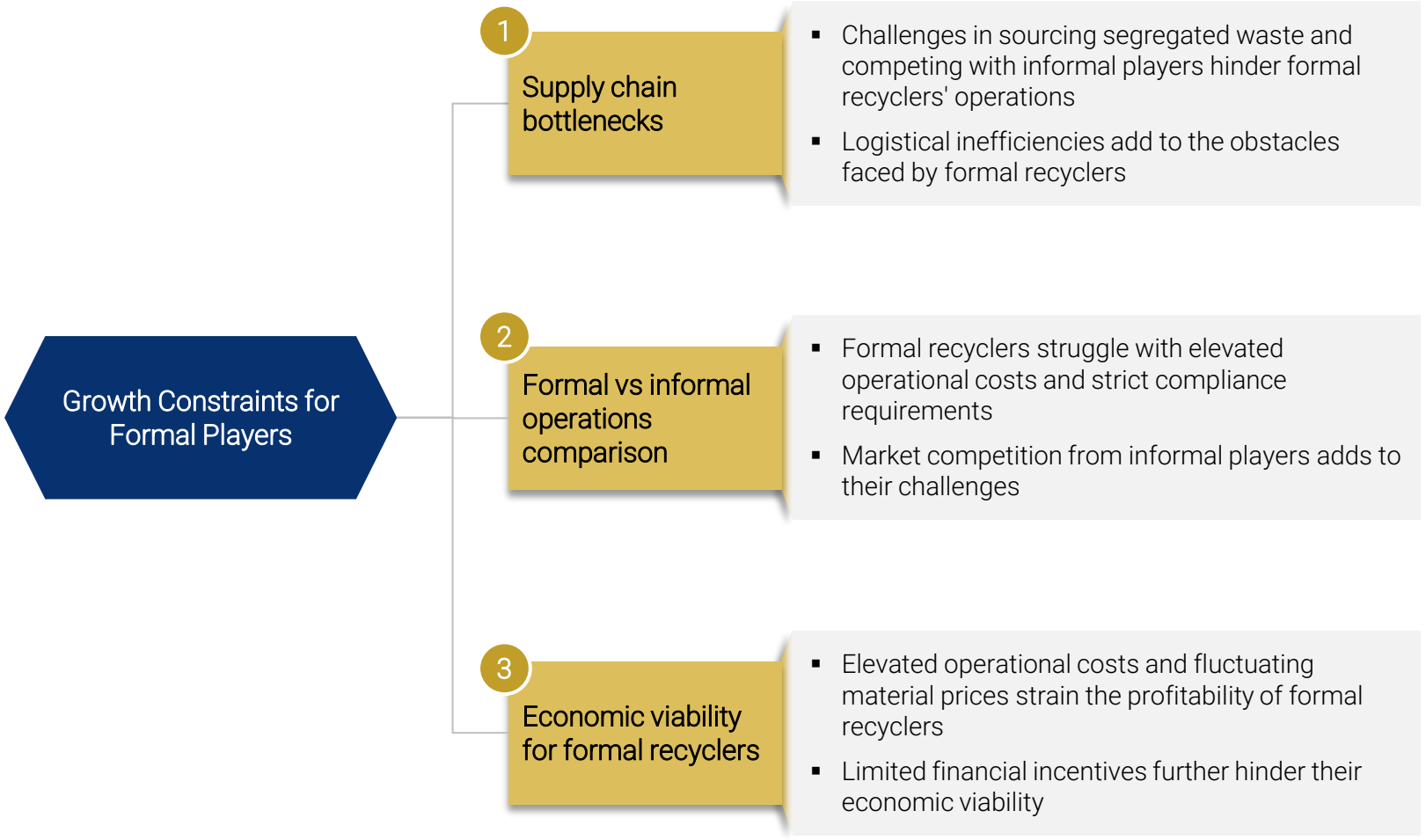
Note(s): (1) Patent held by Exigo is shared via technology transfer by CSIR NML Jamshedpur (2) Attero is the only player with certified GHG emission reduction from a renowned international ESG auditor and holds ISO 14064 certification for GHG emissions verification

Source(s): Expert interaction(s), Desk Research, RedCore analysis

Addressing three key constraints could unlock significant growth opportunities for the formal recycling sector

Growth Constraints for Formal players

Descriptive

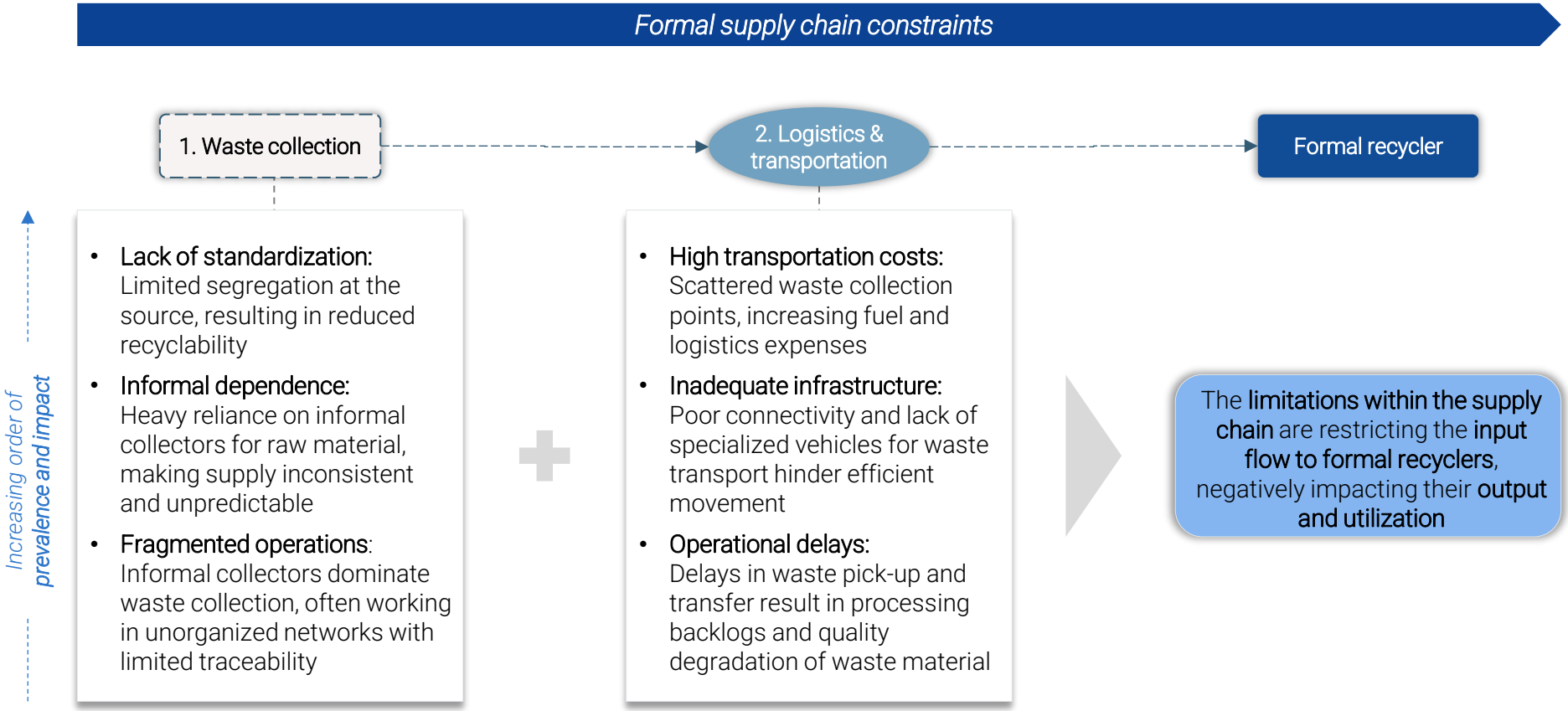


Source (s): Redseer analysis

1 Sourcing and logistical inefficiencies limit the availability of high-quality recycling materials for formal players

Supply chain bottlenecks

Descriptive



Source (s): Redseer analysis

2 The operational differences with the informal sector further amplifies these bottlenecks

Unfavourable

Formal vs. Informal: Evaluation

Descriptive

	Raw material dependency	Sensitivity to price fluctuations	Operational costs	Profit margins	Compliance with regulations
Informal sector	Low *(Superior collection through strong direct collection)*	Low *(Direct access to e-waste from customer)*	Low *(Use of unskilled labour & low level equipment)*	High *(Comparatively higher)*	NA *(Operate outside the purview of regulations)*
Formal sector	High *(Reliant on intermediaries for quality materials)*	High *(Fluctuation due to taxes & metal prices)*	High *(High compliance, skilled labour, machinery costs)*	Low *(Single digits due to high capital & operational costs)*	High *(Mandatory and penalised compliances)*

Above challenges are fuelled by :

Cost Structure

Formal recyclers are burdened by regulatory compliance and operational costs, whereas informal recyclers benefit from a low-cost model

Policy Gaps

Formal recyclers are burdened by regulatory compliance and operational costs, whereas informal recyclers benefit from a low-cost model.

Market Potential

Formal recyclers could capture higher-value markets with appropriate support, while informal recyclers risk stagnation without formalization

Source (s): Redseer analysis

3 And results in reduced margins for formal players in e-waste recycling

Contribution margin comparison: Formal vs Informal recyclers

Indicative

Particulars	Comparison		Remarks
	Formal recyclers	Informal recyclers	
Revenue	130	125	Formal recyclers have better yield as compared to informal recyclers
Cost	(125-130)	(110-115)	Higher for formal players due to additional cost heads
Waste sourcing	*100*	*100*	*Assumed to be 100 for both type of players; per kg material procurement cost is 10-20% cheaper for informal players*
Logistics	*7-8*	*2-3*	*High logistics cost for formal channel as the collection centres are far from recycling facilities*
Labour and wages	*6-7*	*8-9*	*Skilled labour adds to the efficiency of formal players as compared to informal requiring more resources*
Energy and utilities	*4-5*	*1-2*	*High end equipments in formal sector leads to greater energy consumption*
Equipment and maintenance	*3-4*	*0-1*	*High end equipments used in formal recycling as against basic equipment used in informal recycling*
Legal and compliance costs	*3-4*	-	*Nil compliance cost for informal sector due to no regulatory oversight*
Contribution margin	0-5	10-15	Informal sector has a higher net margin over formal players

Single-digit** and often **negative margins** make it **unsustainable** for formal players **to operate without external support

Single digit margins

Double digit margins

Hefty margins** due to a **localized strong collection network** and **low operational** costs, due to the **absence of compliance standards

Source (s): Expert interaction(s), Desk Research, Company filings, Redseer analysis

Policy interventions on both demand and supply sides will be crucial to accelerating the growth of the formal sector

Demand and supply policy interventions
Descriptive

Demand side

How can policy interventions drive participation in formal e-waste recycling through incentives and awareness initiatives ?

Nationwide E-Waste Collection Networks

- *Establish easy-to-access collection points across the country*
- *Similar to the UK's well-developed drop-off network for e-waste, ensuring consumers can easily dispose of e-waste for recycling*

Incentivize E-Waste Returns

- *Policy incentives should offer financial incentives or discounts for consumers returning their old electronics for recycling, similar to Japan's "Take-Back" programs*

Policy Interventions

Supply side

How can policy intervention enhance the infrastructure and systems for efficient and accessible e-waste collection and recycling ?

Extended producer responsibility

- ***(EPR):** Enforce EPR policies, making producers responsible for recycling end-of-life products, as seen in Germany and India*

Mandate for Green Metals in Manufacturing

- *Effective from 2028, India will mandate 5% of non-ferrous materials in new products to be recycled metals*

Source (s): Redseer analysis

3

EPR Regulations: *The Indian Perspective*

India revised its EPR regulations in 2016 to enhance implementation

Comparison of EPR regulations across leading e-waste generating countries

Emergence of EPR in developed nations → *Pre 2005* | *Followed by developing nations* → *Post 2005*

	Germany	Japan	USA	China	India
Year of Introduction	1991	2001	2003 (state-level)	2009	2011 (Implemented in 2016)
Type of EPR Regulations	EU-mandated, Individual producer responsibility	Take-back for key appliances	State-specific laws	Recycling fund system	Mandatory producer responsibility
Recycling Targets	65% annually	70–80% covered appliances	Varies by state	50% by 2025	80% by 2030
Formal Recycling Rate[3]	~50%	~55%	~15%	~15%	~20%
Informal Sector Presence	Minimal	Minimal	Minimal	High	High
Scope of Coverage	Broad EEE coverage	32 Appliance & equipments	Varies by states laws	14 categories	106 categories

Key Remarks

- **Effective Systems in Developed Markets**: Germany and Japan showcase the highest formal recycling rates (85–90%), driven by stringent enforcement, broad product coverage, and minimal informal sector interference
- **Challenges in Emerging Markets:** India and China face significant challenges with informal sectors dominating ~70% of e-waste management, limiting the impact of formal EPR frameworks despite ambitious recycling targets
- **Diverse Approaches to EPR**: While developed nations focus on compliance and broad product categories, developing nations emphasize fund-based systems to incentivize recycling amidst limited formal infrastructure

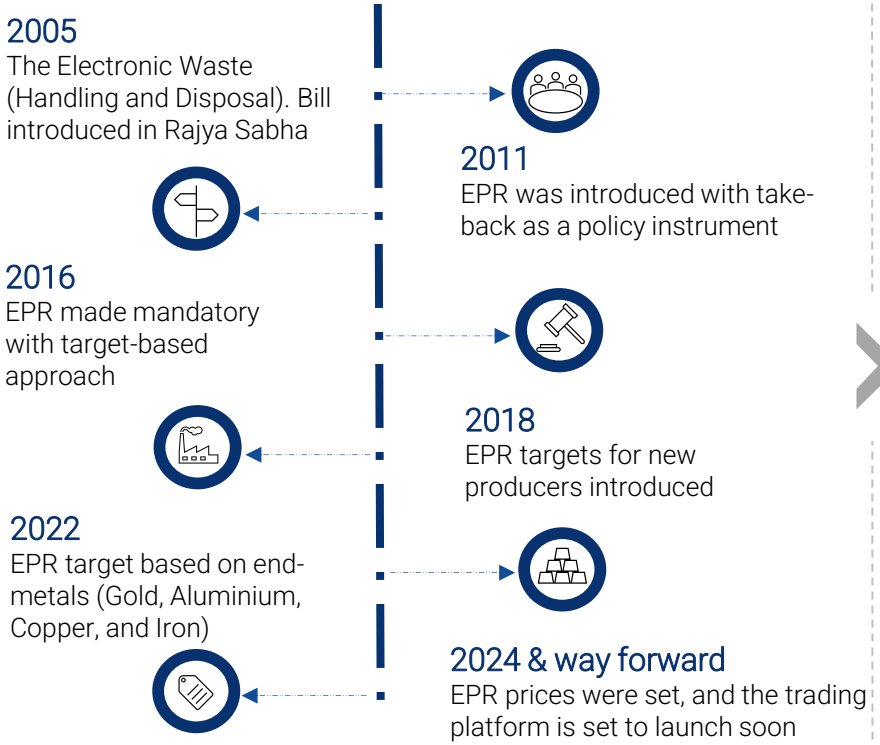
Note(s): (1) Recycling Fund System (China):Producers pay into a government-managed fund to subsidize formal recycling operations (2)Individual Producer Responsibility (Germany):Producers are responsible for collecting and recycling their products at end-of-life, covering costs to meet targets (3) Formal recycling rates for countries except India is as per Global E-waste monitor report, 2024

Source (s): Desk Research, Redseer Analysis

Indian EPR regulations have transitioned from voluntary initiatives by producers to mandated & target-driven obligations

Evolution of e-waste EPR in India

Descriptive



Key Features

2016: Collection Mechanism-based approach adopted

- The CPCB's Pan-India EPR Authorization replaced state-specific authorizations, setting unified collection targets that increased from 30% to 70% by 2023
- Producers entitled to set up PROs, e-waste exchanges, e-retailers, and Deposit Refund Schemes as additional EPR channels to ensure efficient channelization of e-waste

2022: EPR certification generation

- The EPR regime expanded from 21 to 106 types of EEE, with a new provision for generating and trading EPR certificates
- Recycling quantities based on end products (Gold, Aluminium, Copper, and Iron) to prevent false claims by producers

2024 & way forward: Price Fixing and Exchange Platforms

- EPR certificate prices capped at 100% and floored at 30% of environmental compensation for unmet obligations
- The central government may extend return deadlines by up to nine months and establish platforms for EPR certificate trade and exchange

EPR holds producers accountable for their products' entire lifecycle, from sales to safe disposal, reuse, and recycling

Note(s): (1) PROs are intermediaries between producers and recyclers in the e-waste management system (2) E-waste Exchanges are market platforms where organizations can buy and sell end-of-life electronic waste (3) E-retailers sell goods using the internet (4) Deposit fund schemes offer refundable deposits for returned electronics

Source (s): CPCB, Redseer Analysis

1 EPR targets for producers began at 30% in FY17 and are set to rise to 80% by FY29, with the inclusion of additional e-waste categories

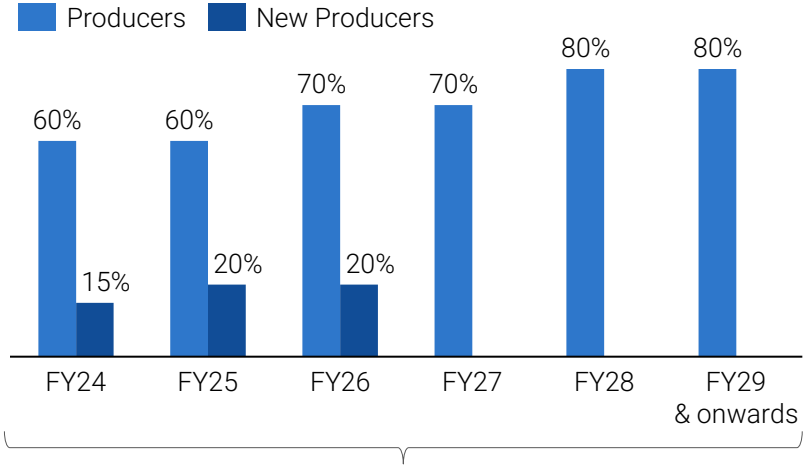
E-waste recycling targets – Producers
Descriptive

EPR target calculation

The quantity eligible for generation of extended producer responsibility certificate shall be calculated by the following formula namely:

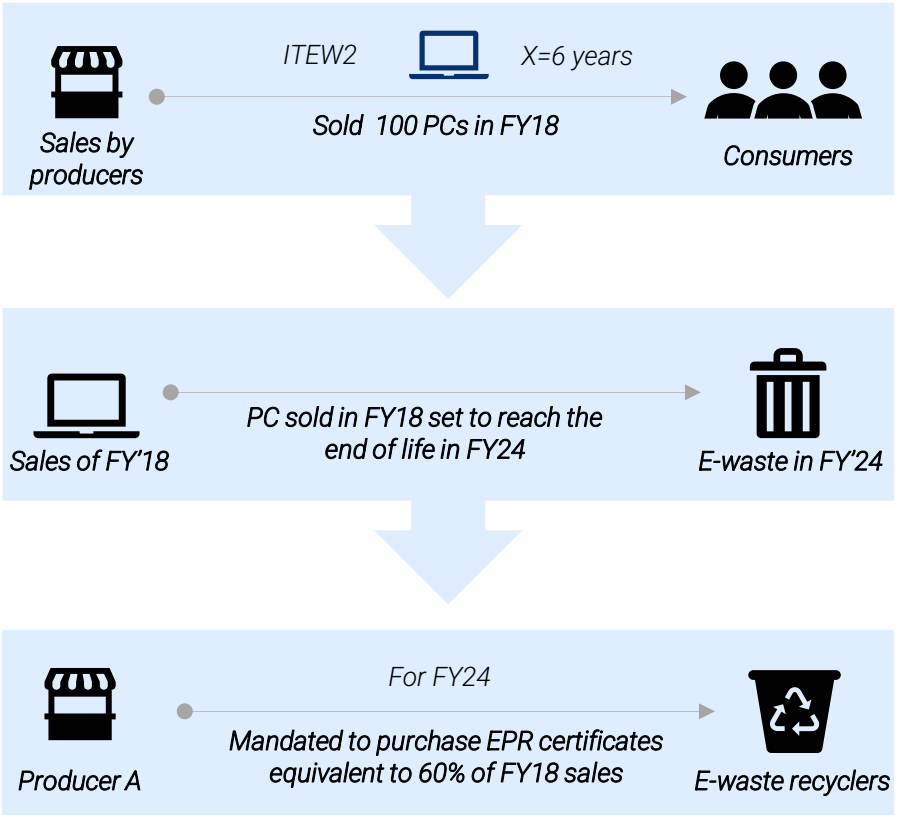
$$Q^{EPR} = Q^{p} \times C^{f}$$

Q^{EPR} is the quantity eligible for generation of the certificate, Q^{p} is the quantity of the end product and C^{f} is the conversion factor (quantity of inputs required for production of one unit of output) as defined by E-waste rules, 2022



% of e-waste from FY Y-X mandated to be recycled*

Recycling target calculation
Illustrative



Note(s): (1) New producers are those with sales operations shorter than their products' average lifespan, as per CPCB guidelines (2) Y is the current year, and X is the average life of the product (3) PC refers to Personal Computers (4) X is decided by CPCB for list of EEE items (5) 'End-of-life' refers to when a user intends to discard a product

Source (s): CPCB, Redseer Analysis

1 In India, EPR obligation is tied to extraction of 4 key metals from e-waste

Framework for generation of EPR certificates

Au Gold
Fe Iron
Cu Copper
Al Aluminum

EPR Obligation for 4 metals

- Exceeded by X% or Y kg
  - *Liability for concerned metal reduced by Y kg*
  - *Liability for other metals reduced by X%*
  - *Credit can be utilized to set off next year's liability*
- Exactly as target
  - *No action required*
- Shortfall by X% or Y kg
  - *Liability for concerned metal increased by Y kg*
  - *Liability for other metals increased by X%*
  - *Liability for payment of EC and buying EPR credits*

EPR certificates

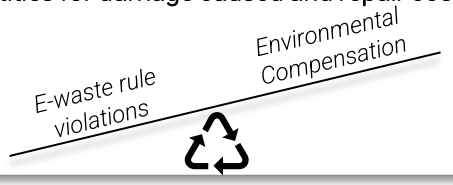
Target based on recovery of end products

EPR obligation for Gold set to 20% for FY24 while for the other two category, it is 100%

The gap is to be bridged by FY28-29

Gold → Gold

EC holds violators accountable by charging entities for damage caused and repair costs

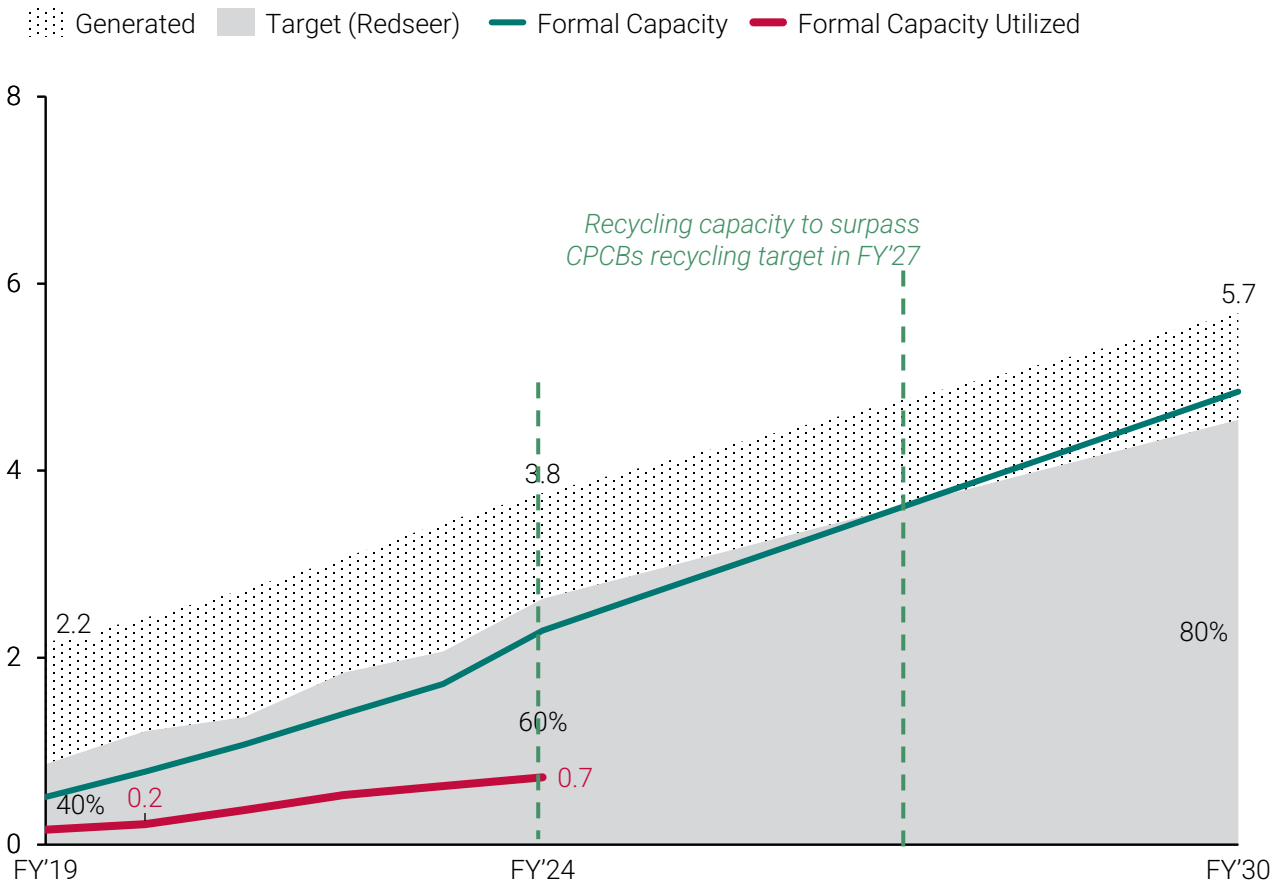


Note(s): (1) Based on the end metals collection target (2) Environmental compensation (EC) for e-waste is a monetary fine imposed on producers, manufacturers, recyclers, or refurbishers who violate the E-Waste (Management) Rules, 2022 (3) Ferrous metals: Iron, Non-ferrous metal: Copper and Aluminium

Source(s): CPCB, RedCore analysis

2 Current formal capacity is below the target for e-waste recycling

E-waste - Generation, target & formal recycling capacity
MMT, %, FY19-30P



Key Remarks

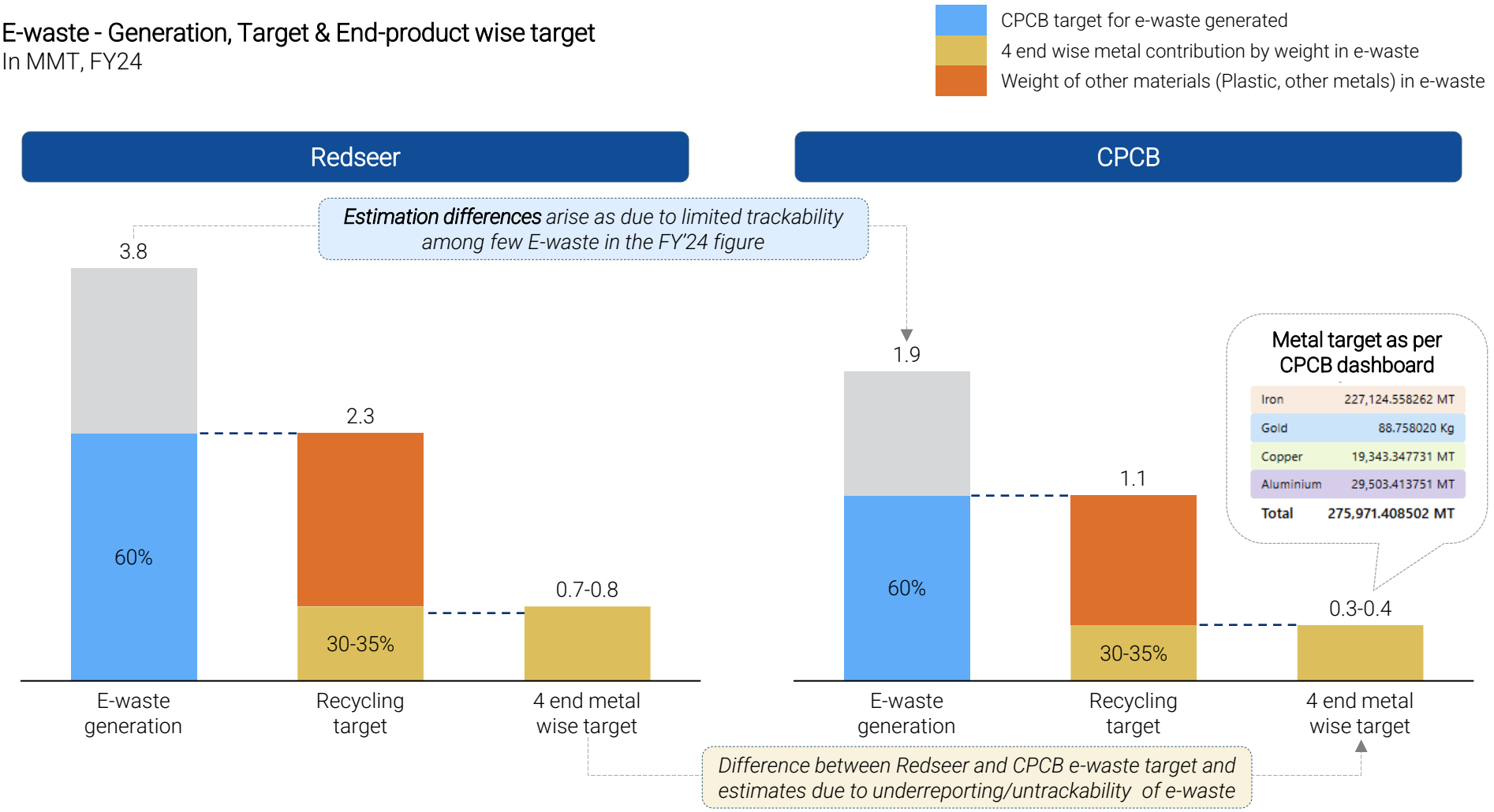
- **Focus on Extended Producer Responsibility (EPR):** CPCB's emphasis on implementing strict EPR norms compels producers and brand owners to recycle more aggressively, even before formal recycling infrastructure catches up
- **Increase in recycling capacity to keep up with EPR mandates:** Aggressive recycling goals as per CPCB guidelines is likely to push compliance and recycling efforts at a faster rate, independent of the formal capacity-building pace

Note(s): (1) The mandated e-waste targets are based on RedCore estimates of e-waste generation. As per CPCB's calculation, the target for four key metals in FY'24 was 0.27 MMT

Source (s): Desk Research, RedCore Analysis

2 The CPCB's estimate for the four metals is lower due to the limited trackability in certain categories of e-waste

E-waste - Generation, Target & End-product wise target
In MMT, FY24

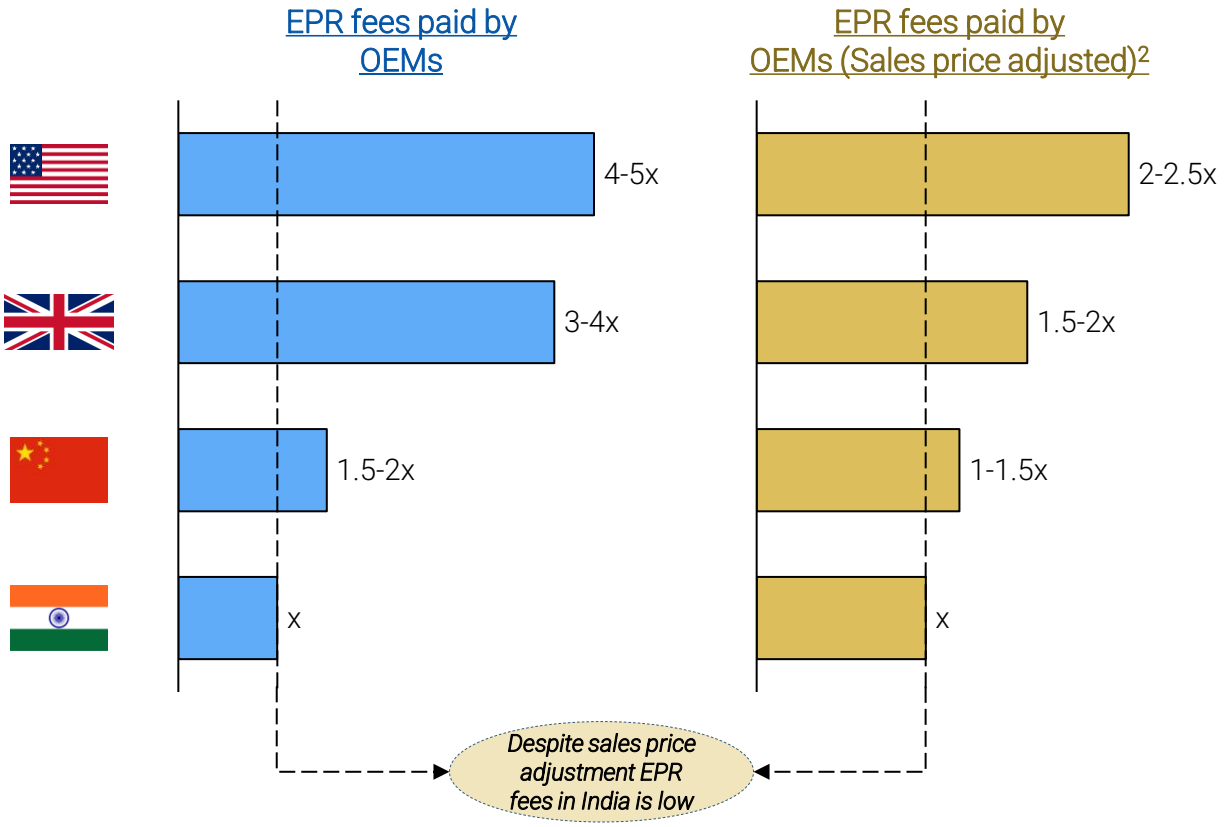


Note(s): (1) EPR mandates for FY'24 is 60%

Source (s): Desk Research, Redseer Analysis

3 EPR based fees is significantly low is India as compared with global peers

Divergence between India & other countries
Indicative



Key Remarks

EU

Advance recycling fees: Consumers contribute to e-waste recycling through fees, including an advanced recycling fee (6-10%) that pre-funds a portion of the recycling costs traditionally borne by manufacturers

CHINA

E-waste is managed under a dual system where manufacturers are mandated to take responsibility for recycling their products, and consumers pay recycling fees

- **Consumer**: Pay collection or trade-in fees
- **Manufacturers**: Fund recycling under EPR

Note(s): (1) Fund Recycling in China: Manufacturers finance e-waste recycling, including dismantling, processing, and supporting certified recyclers under EPR (2) Sales price adjustment accounts for the comparative purchasing prices of electronics with similar specifications across different countries

Source (s): Desk Research, Redseer Analysis

Strengthening India's EPR framework through enhanced compliance measures and aligned fees is critical to driving the growth of the formal recycling

Source (s): Redseer Analysis

4

Secondary metal extraction – Opportunity Landscape

India lags behind developed nations but is expanding recycling opportunities with recent regulatory support

Global comparison
Non exhaustive

Formal recycling: ↑ *Growth factor*; ↓ *Limiting factor*

Stakeholders in E-waste recycling

	China	United States	India	Indonesia	United Kingdom
↓ Informal sector	• **Significant** Hazardous e-waste practices followed in various rural areas	• **Limited** Low domestic figures as e-waste exported abroad for illegal processing	• **Significant** Various specialized hubs informal processing of e-waste in sub-urban regions	• **Significant** Similar to India, many specialized hubs for e-waste processing across regions	• **Minimal** Large shipments of e-waste exported to mid and low-income countries
↑ Formal sector	• **Significant** 100+ licensed recyclers supported with superior infra in urban industrial zones	• **Limited** Fewer formal facilities compared to generation volumes	• **Rising significantly** Emerging and high growth formal sector post introduction of E-Waste Rules (2016)	• **Limited** Basic segregation facilities, and limited formal capacity	• **Significant** Extensive network for WEEE collection through 1500+ points
↑ Policy support	• **Significant** Financial subsidies for formal recyclers; EPR mandates	• **Limited** Tax benefits and subsidies vary by state	• **Significant** EPR-driven revenue; incentives for formal recyclers under state collaboration	• **Limited** Early-stage EPR-driven policies; limited adoption by private sector	• **Significant** EPR mandates with penalties and subsidies

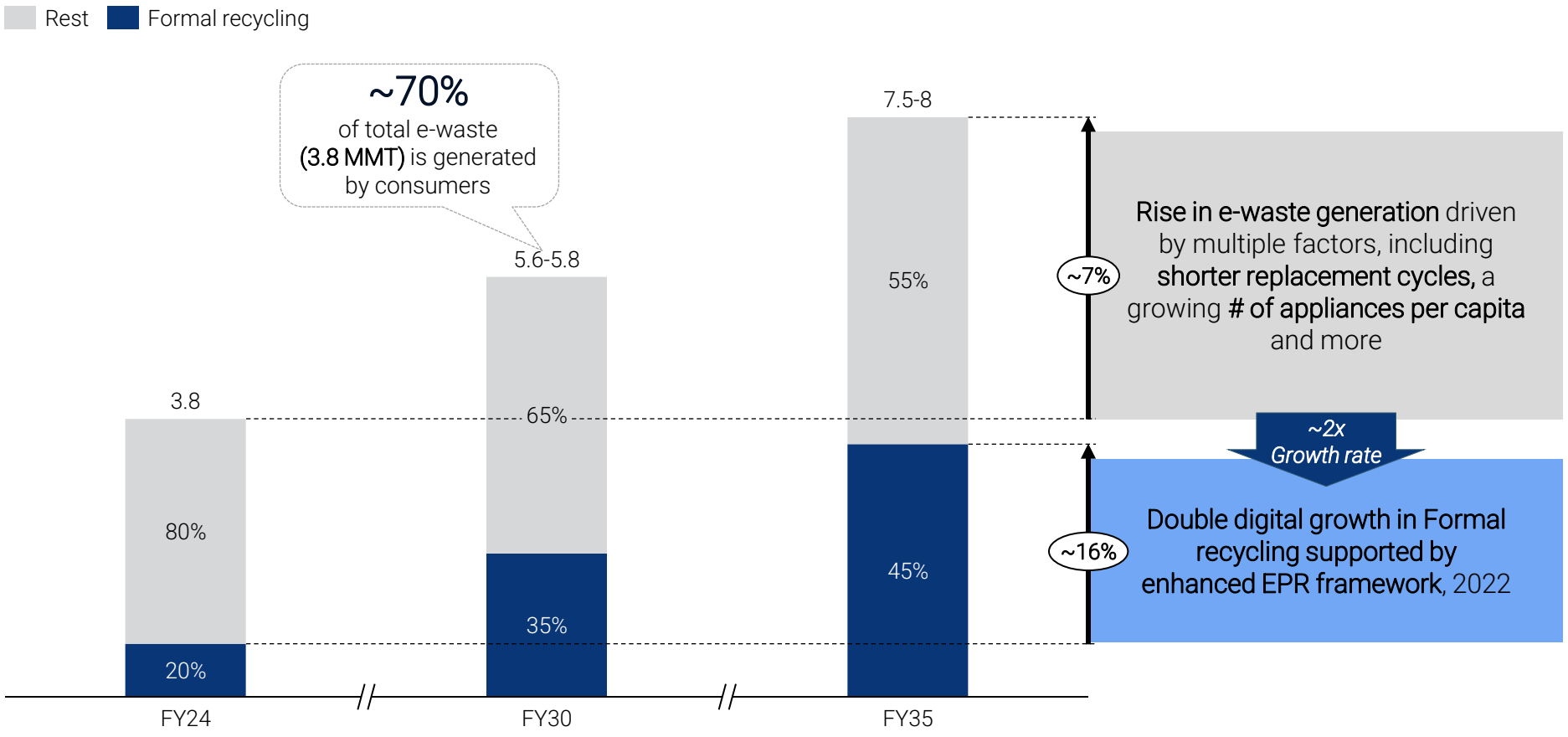
Note(s): (1) The first regulatory framework for E-waste in the USA was set in 2003 when California passed the Electronic Waste Recycling Act (EWRA)

Source (s): Redseer analysis, Desk research

Formal recycling is set to grow twice as fast as e-waste generation over the next decade

E-waste recycling – Overall

In MMT, 24, 30P, 35P

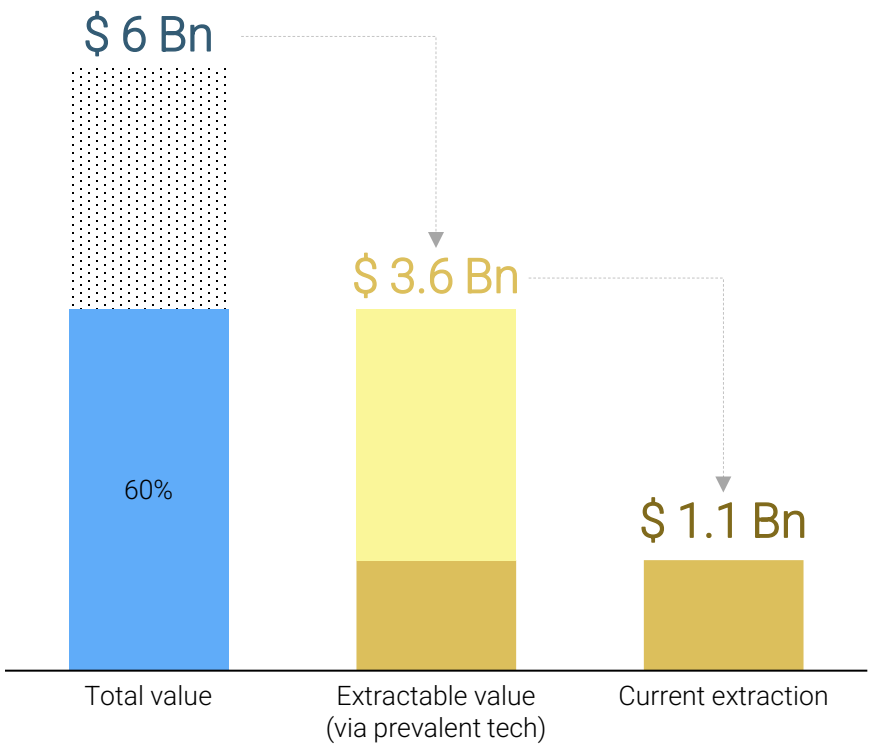


Source (s): Redseer analysis, CPCB

Currently, only 1/3rd of extractable value is being extracted from e-waste

Current secondary metal extraction

In Bn USD, FY24



Secondary metal extraction opportunities

1. Latent value in consumer households

- ~10% of e-waste is stored in homes, mainly comprising high-value consumer electronics
- These electronics contain significant quantities of valuable metals, representing a key recovery opportunity

2. Advancing E-Waste Processing Efficiency

- India lags behind other nations in technological capabilities for e-waste extraction
- Enhancing innovation and efficiency can unlock significant value and drive growth in the sector

3. E-waste processing done by informal sector is

- The informal sector processes over 60% of the total metal value recovered from e-waste
- Informal inefficiencies represent untapped potential to scale formal operations

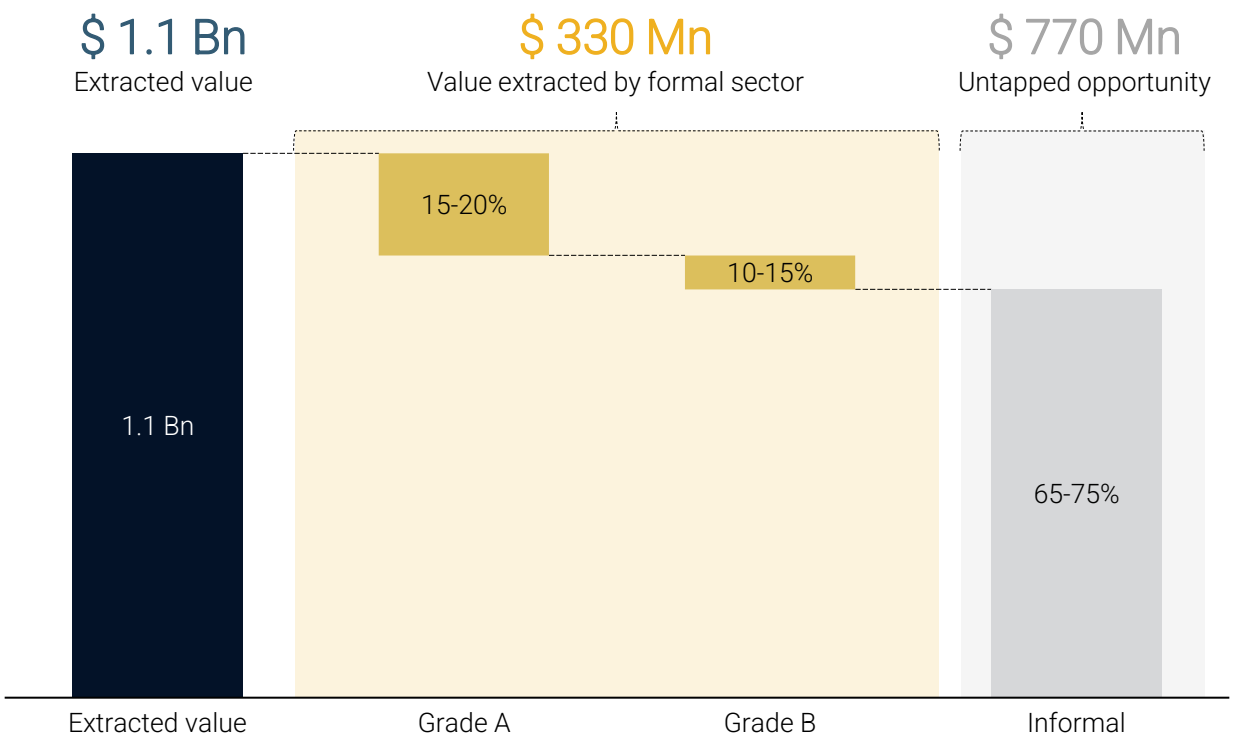
Note(s): (1) Total value represents total value of metals and plastics present in e-waste (2) Extractable value refer to the total value that is extractable using prevalent technologies and methods (3) Current extraction refers to the total value extracted by formal and informal channels from the generated e-waste

Source (s): Redseer analysis

India generates over USD 1 Bn in recoverable materials, with formal recyclers capturing just 25-30% of the economic value

Metal recovery potential of E-waste

In USD Bn, FY24



Key Remarks

- **Untapped Potential in Metal Recovery:** A significant gap exists between the potential and actual recycled metal value in e-waste, highlighting missed opportunities to capture valuable resources
- **Recycling Efficiency**: Despite advancements, metal recovery from e-waste remains inefficient, suggesting gaps in infrastructure and processes to handle rising volumes
- **Growing Economic Opportunity**: The increasing metal value in e-waste presents a substantial opportunity for India to enhance recovery efficiency and `lead in sustainable metal extraction

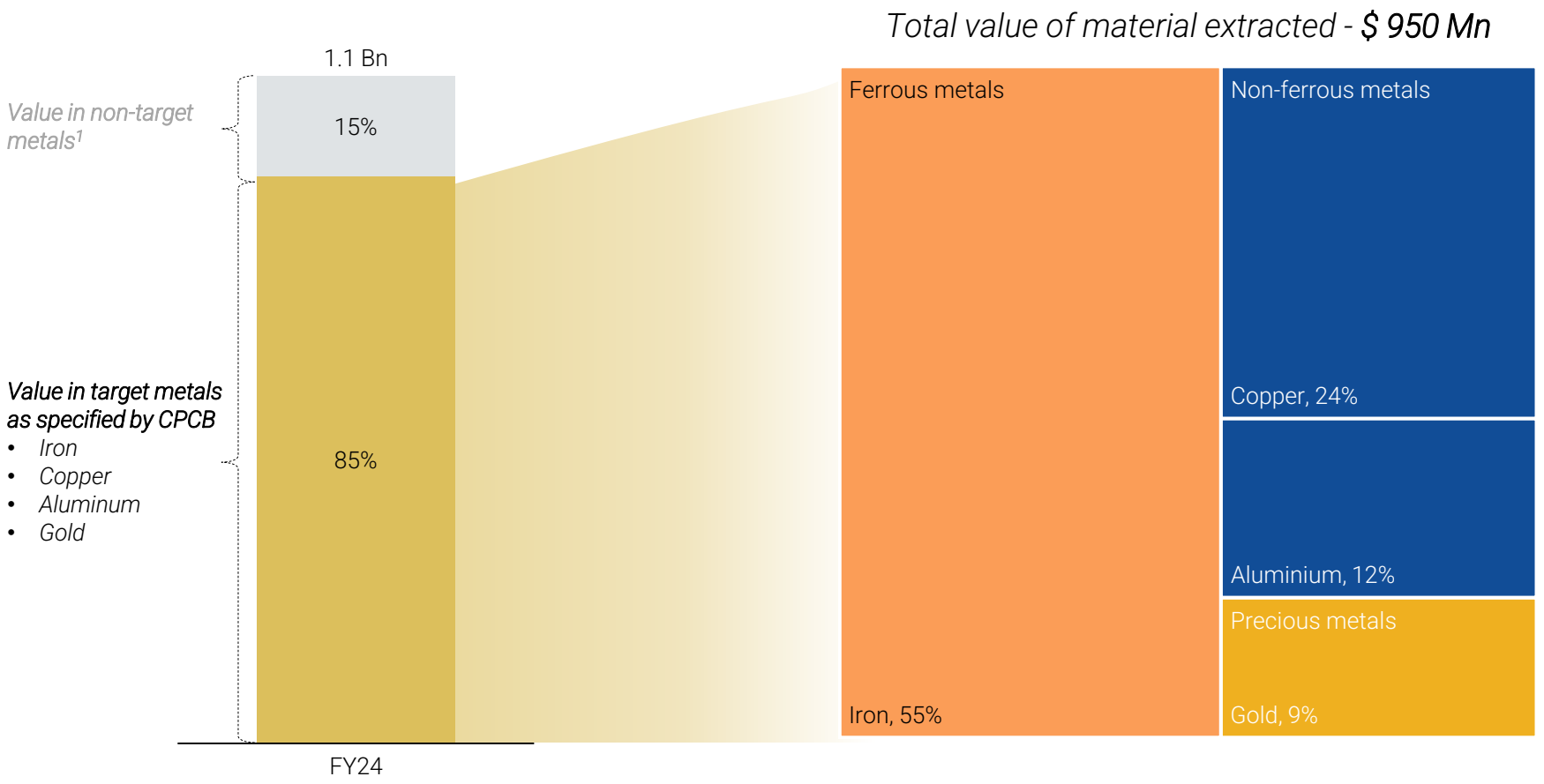
Note(s): (1) Grade A Recyclers employ advanced tech for metal recovery from e-waste with minimal environmental (3) Grade B recyclers are dismantlers focusing on disassembling e-waste into components and preliminary metal extraction lacking advanced recovery capabilities

Source (s): Redseer analysis

Four key metals targeted by CPCB account for 85% of the economic value from e-waste recycling

Material value composition of E-waste

% total value, FY24



Note(s): (1) Non-target metals includes silver, palladium, nickel, cobalt, indium, etc.

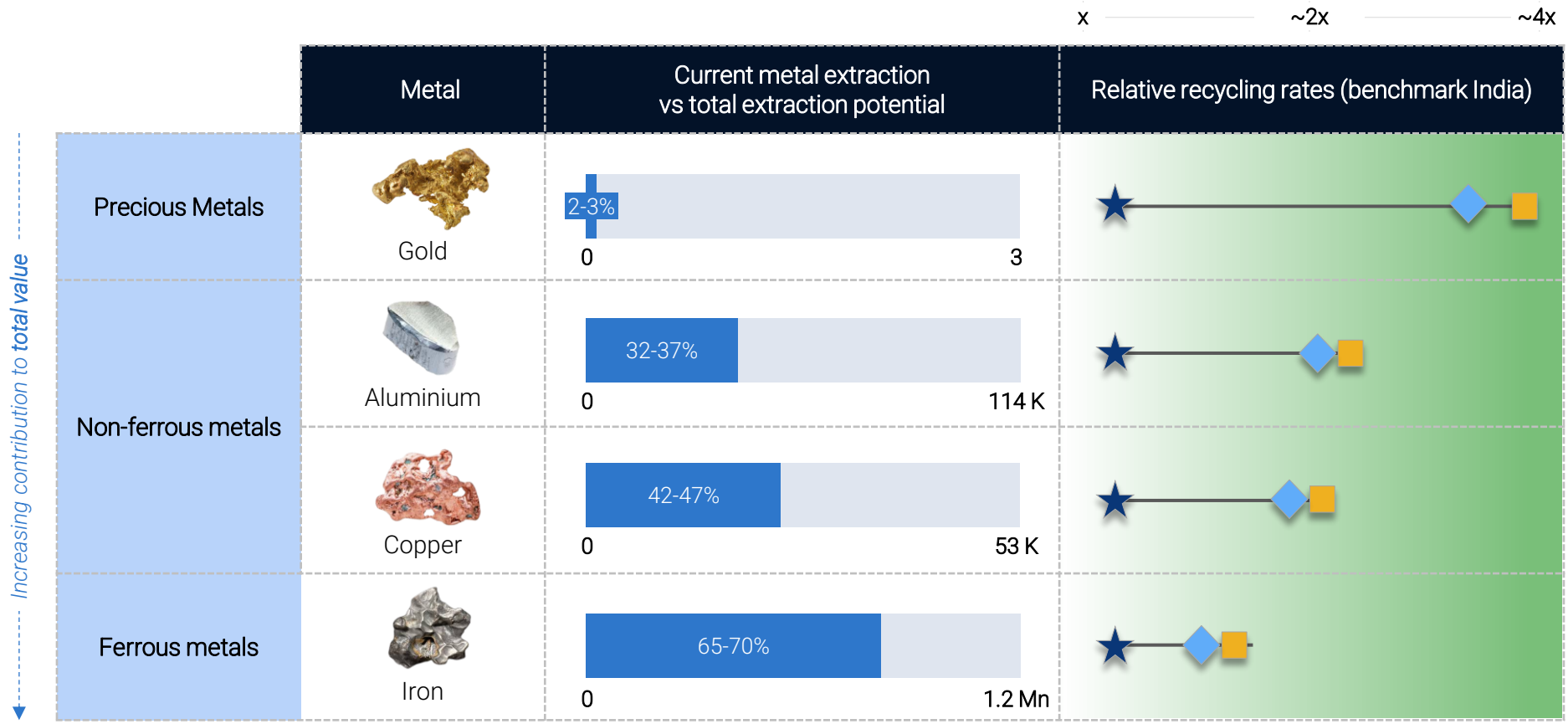
Source (s): Redseer analysis, Expert Discussions

However, India's recycling rate still lags behind other major economies....

India USA China

E-waste metal value potential

In tonnes, FY24



Note(s): (1) Current extraction defined as recovered metals in a year as % total metal present in e-waste generated in that year

Source (s): Redseer analysis

….due to high informal presence and limited adoption of advanced metal extraction techniques

Global Comparison REE extraction methodology

Unavailable in India

		China	USA	UK	India
Extraction process	Hydrometallurgical processes	✓	✓	✓	✓
	Pyrometallurgical processes	✓	✓	✓	✓
	Bioleaching	✓	✓	✓	×
	Supercritical fluid extraction	✓	✓	✓	×
	Ionic liquid Extraction	✓	✓	✓	×
Specialised machinery	High temperature rotary kilns	✓	✓	✓	✓
	Magnetic separation units	✓	✓	✓	○[1]
	Ion-exchange chromatography columns	✓	✓	✓	×
	ICP reactors	✓	✓	✓	×

Key Remarks

- **Technological Disparity**: India lacks advanced REE extraction technologies such as bioleaching, supercritical fluid extraction, ionic liquid extraction, and electrochemical methods, which are prevalent in other major REE-extracting countries
- **Advanced Machinery Gap**: India lacks access to REE-specific machinery like ICP reactors and ion-exchange columns, which limits extraction efficiency
- **Strategic Opportunity**: Investing in these technologies may reduce India's dependence on imported REEs and capitalize on the increasing e-waste generated domestically

Note(s): (1) In some facilities basic magnetic separation units might be present in India

Source (s): Redseer analysis

While these recycling processes are cost-effective, they have a lasting environmental impact

Low — High

Technical extraction process

		Recovery Efficiency (%)	Processing Time (hours)	Cost effectiveness	Environmental Impact
Available in India	Hydrometallurgical processes	80-95	1-4	Low	
	Pyrometallurgical processes	60-95	2-4	Low	
Unavailable in India	Bioleaching	40-90	48-96	Moderate	
	Supercritical fluid extraction	80-95	2-3	Moderate	
	Ionic liquid Extraction	85-98	2-6	High initial cost	

Key Remarks

- **Hydrometallurgical Processes:** Generate toxic effluents and acidic waste, leading to soil and water contamination and long-term ecosystem degradation
- **Pyrometallurgical Processes:** Release harmful emissions like SO_2 and heavy metals, contributing to air pollution, acid rain, and global warming
- **Scalability of Advanced Extraction Techniques**: While scalable in other countries, India's slow uptake of SFE and ILE risks missing out on these innovations that could enhance domestic REE extraction

Source (s): Redseer analysis

For instance, even with the methods India employs, India lags behind China in extraction purity, processing speed, and efficiency, except for a few players

Low — High

Technical extraction process – Comparison
Available in India

		Hydrometallurgical processes			Pyrometallurgical processes		
		Extraction Purity (%)	Processing Time (hrs)	Operational Efficiency (%)	Extraction Purity (%)	Processing Time (hrs)	Operational Efficiency (%)
Prevalent techniques in India	*India vs China*						
	China	High	Low		High	Low	
	India	Moderate	Moderate		Low	Moderate	
	Indian players comparison						
	Attero	High	Moderate		Moderate	Low	
	Ecoverva Ewaste Recycling Pvt Ltd	Moderate	Moderate		Low	Moderate	
	Tes - Amm	Moderate	Moderate		Moderate	High	

Note(s): (1) A+ recyclers includes players with MMT 20k+ recycling capacity

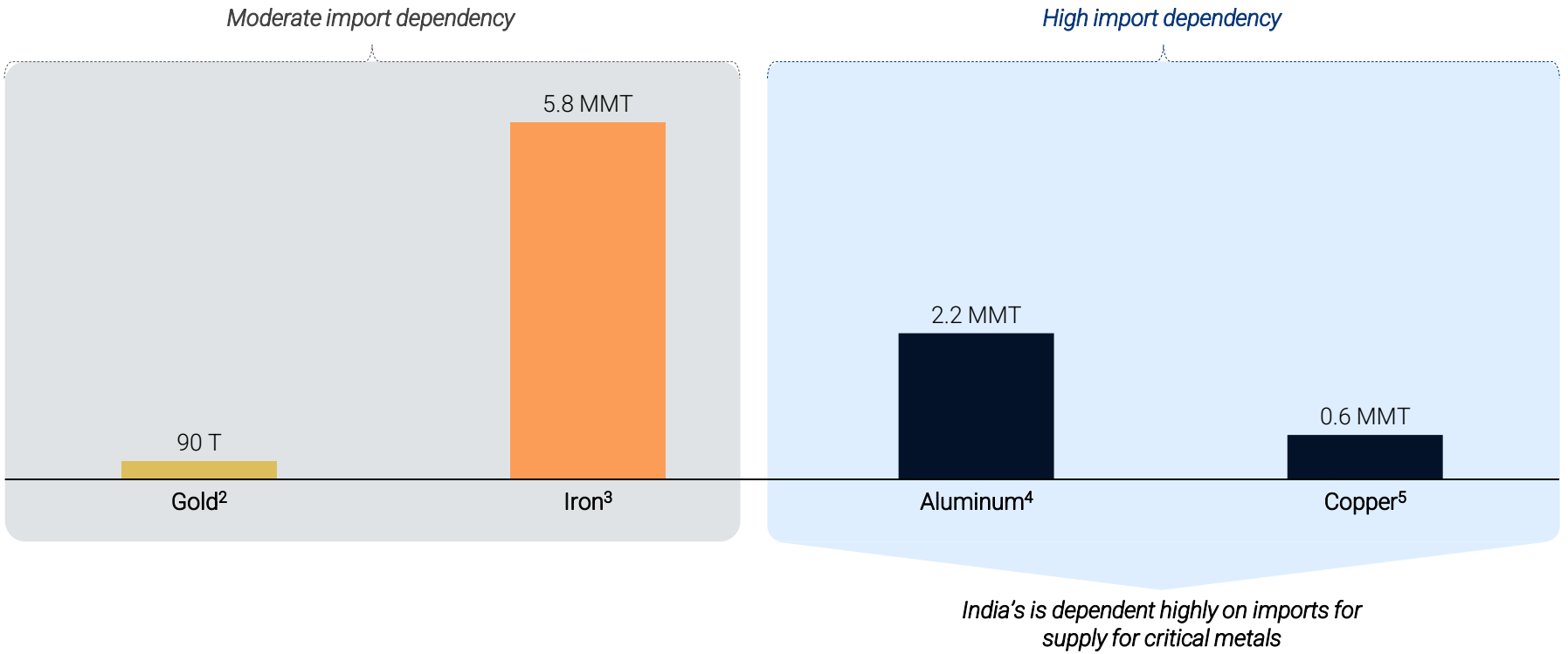
Source (s): Redseer analysis

Insufficient secondary metal extraction increases India's dependence on imports

Metal imports in India[6]

2022, Tonnes, MMT

Precious metals | Ferrous metals | Non-Ferrous metals



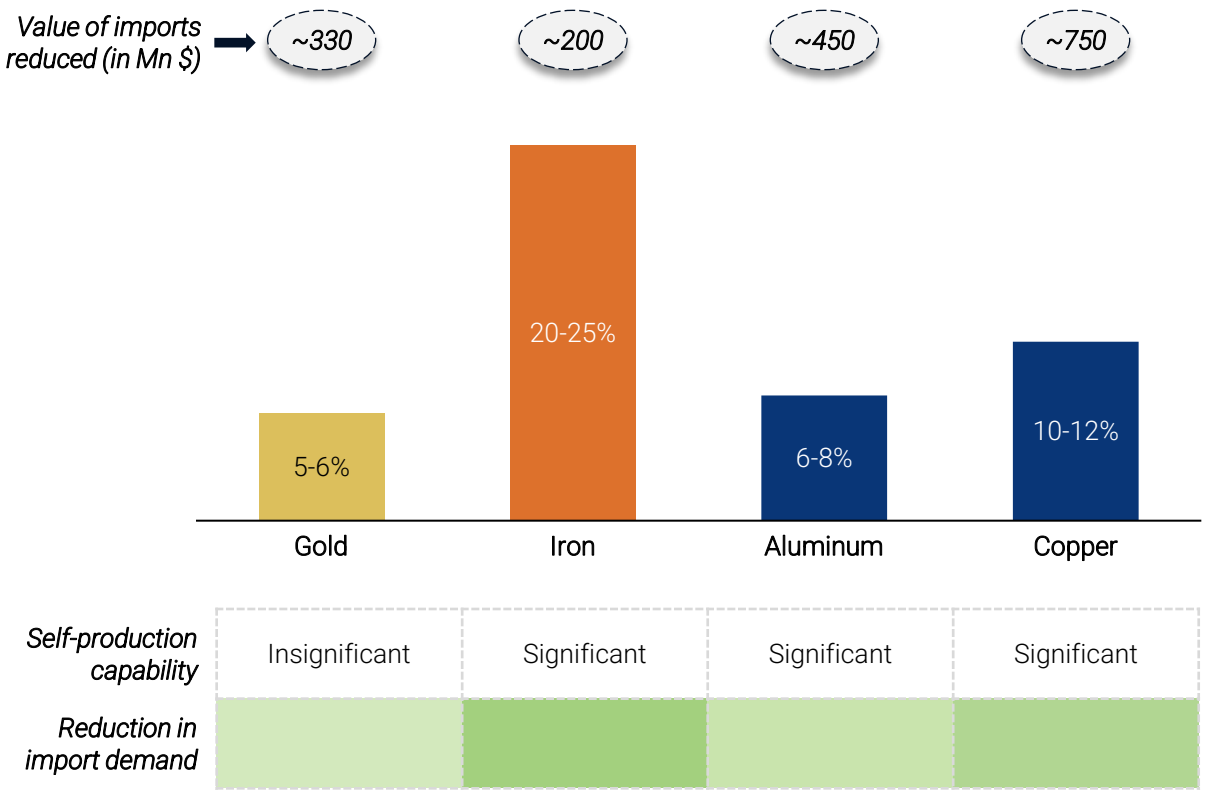
Note(s): (1) Import dependency refers to the proportion of industrial demand met through imports, categorized as Moderate (<50%) and High (>50%). (2) Gold imports exclude imports for jewelry manufacturing (3) Iron imports include iron and steel products but exclude iron and steel scrap (4) Aluminum imports include aluminum scrap, and aluminum alloys (5) Copper imports exclude alloys such as brass and bronze (6) Import volume has been sourced from Indian Mineral Yearbook published in October 2024

Source (s): Redseer analysis, Indian Mineral Yearbook

An efficient secondary metal extraction infrastructure can significantly reduce import dependency for key metals

Low — High

Import demand reduction
% total import demand, 2024



Externalities of secondary metal extraction
Descriptive

Support for Circular Economy
- Boosting formal recyclers can enhance metal recovery, fosters sustainability, and integrates recycled materials into production, reducing waste and raw material import dependency

Improved Environmental Compliance
- Promoting secondary metal use ensures compliance to environmental standards, reducing toxic emissions, and improper e-waste disposal

Higher investment in e-waste recycling
- Shifting to formal recycling will lead to increased investments strengthening India's recycling ecosystem, attracting both domestic and foreign funding

Source (s): Council for Energy Environment and Water (CEEW) Redseer analysis

Policy support is critical to the growth of formal recyclers, enabling them to compete on a global scale in secondary metal extraction

Policy support areas

- Enhanced regulatory and financial support
- Promote formal players with superior capabilities
- Increased access to collection facilities

Support areas for success in secondary metal recovery

ENHANCED REGULTORY AND FINANCIAL SUPPORT

- Introducing **targeted subsidies or tax benefits** to encourage investments in advanced facilities and technology
- Implementing **consistent and robust regulations** to support formal operators, promote best practices, and enhance efficient resource extraction

PUSH FOR FORMAL PLAYERS WITH SUPERIOR CAPABILITIES

- Encouraging formal players to **adopt advanced, efficient technologies** for metal extraction, ensuring optimal recovery rates and minimizing waste
- Supporting formal channels that use proper methods to **preserve metal integrity** during extraction, improving quality and suitability for secondary use

INCREASED ACCESS TO COLLECTION FACILITIES

- Establishing **easily accessible collection systems** to ensure a steady supply of high-quality input for large-scale recycling operations
- **Raising awareness of authorized E-waste collection** points to boost input for efficient recycling facilities

Source (s): Desk Research, Expert interviews, Redseer analysis

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