

perspectives

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Waste Management and Circular Economy: Industry Innovations

Circularity as India's Next Growth Engine

How innovation in waste management can turn resource security, climate resilience and economic growth into a single agenda

GUEST VIEW

In April 2025, China restricted the export of seven rare-earth elements and the high-performance magnets made from them. Within weeks, carmakers across the United States, Europe and Japan were warning of shortages, and several – Ford and Suzuki among them – slowed or idled production lines for want of materials most people have never heard of. A wider round of controls followed in October. Where European buyers could secure these materials at all, they were paying several times the prices prevailing within China.

The episode carried a lesson India cannot afford to ignore. In the modern economy, the materials that make growth possible can be switched off by someone else. And a striking share of those same materials – lithium, cobalt, nickel, copper, rare earths, even gold and palladium – already sits inside the country, embedded in the electronics we discard, the batteries we retire and the industrial residues we bury.

For decades, waste was treated as the end of the line: something industries produced, cities collected and landfills absorbed. Success was measured by how cheaply it could be hauled away and made to disappear. That view is now not only environmentally outdated but strategically expensive.

The real question for India is no longer how efficiently we dispose of waste, but whether we can convert it into one of our most reliable domestic sources of materials, energy and economic value – at a moment when reliable domestic sources have rarely mattered more.

As India advances towards its ambition of a US\$30 trillion economy by 2047, the growth path will depend less on how much we produce and more on how intelligently we use what we already have.

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Circular economy principles, applied at industrial scale offer a way to keep growing while breaking the old link between prosperity and raw-material consumption – and, increasingly, a way to reduce a strategic vulnerability that has become impossible to overlook.



Mr. Masood Mallick

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Re Sustainability

From Waste Management to Resource Management

The pressure behind this shift is easy to understate. Global extraction of raw materials has more than tripled since 1970, from about 30 billion tonnes a year to 106 billion, and the UN's International Resource Panel expects it to climb a further 60 per cent by 2060 on current trends. Extracting and processing those materials already accounts for more than half of the world's greenhouse-gas emissions and a large part of its biodiversity loss. We are digging up and burning through the planet faster than at any point in history – and labelling what is left over as 'waste'.

India sits close to the centre of this trend. The World Bank's latest global assessment puts municipal solid waste at roughly 2.6 billion tonnes a year, on course for 3.9 billion by 2050, with about a third of it still openly dumped or burned. India alone generates more than 170,000 tonnes of municipal waste every day and formally treats only around half; on present trajectories its cities could be producing more than 400 million tonnes a year by 2050. Alongside this are fast-growing streams of construction debris, plastics, e-waste, industrial hazardous waste and wastewater.

The nations that will hold an advantage in the coming decades are not necessarily those blessed with the richest ore bodies, but those that extract the most value from every tonne they have already brought above ground.

But the numbers that should most concentrate the mind are the strategic ones. India imports more than 80 per cent of the critical minerals it needs, at a cost of over ₹80,000 crore a year in foreign exchange, and remains almost entirely dependent on imports for lithium, cobalt and nickel - the backbone of every battery, motor and grid-storage system on which the energy transition rests. At the same time, NITI Aayog estimated in early 2026 that recoverable materials in India's discarded electronics alone are worth in the order of ₹51,000 crore a year. The country currently captures barely a fifth of that value; the rest is lost to crude informal processing or simply buried.

Viewed together - hard currency flowing out to buy minerals, recoverable value being thrown away at home - and circularity stops being an environmental aspiration and becomes an industrial and security proposition. The nations

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Innovation is Redefining What Recovery can Achieve

What makes this achievable now, rather than merely desirable, is that the underlying technologies have advanced significantly. Modern material-recovery facilities combine optical sorting, machine learning and robotics to pull clean, saleable material streams out of mixed waste at volumes and purities that were out of reach a decade ago. The best plants in India already recover copper at purities above 99.9 per cent. Robotics is also reducing human exposure to hazardous handling, improving both safety and yield.

The economics of recovery are often better than intuition suggests. A printed circuit board carries gold at concentrations of roughly 250 to 300 grams per tonne - some sixty times richer than much of the natural ore now being mined for the same metal. Recovering it is a problem of chemistry and process engineering, not geology. This is why 'urban mining' has ceased to be a slogan: hydrometallurgical and advanced thermal routes can now pull cobalt, nickel and lithium out of spent batteries; chemical recycling can return hard-to-recycle plastics to manufacturing feedstock; and used oil, industrial residues and organic waste can be re-refined or converted into fuels and inputs rather than landfilled.

The gains compound down the value chain. Battery recycling can lower raw-material procurement costs by an estimated 25 to 30 per cent and cut dependence on imported critical minerals by 15 to 20 per cent. Recovered steel scrap tells an even sharper story: every tonne substituted for virgin production cuts associated carbon emissions by around 58 per cent, water use by 40 per cent, and mining waste by 97 per cent. Recovery, in other words, is

India recycles only about a fifth of its waste, compared with nearly 70 per cent in parts of Europe. Closing that gap lowers input costs, insulates manufacturers from imported-commodity shocks, advances the goal of *Atmanirbharta* in strategic materials, and opens entirely new revenue streams in secondary raw materials.

not a lesser substitute for primary production - on cost, carbon and resilience, it is frequently the superior option.

Circularity is Becoming a Business Imperative

The conversation has shifted inside boardrooms as well. Investors increasingly price companies on resource efficiency and climate resilience; global buyers demand lower-carbon materials and credible traceability; and a tightening web of rules - Extended Producer Responsibility, carbon border adjustments, sustainable-procurement mandates - is making circular practice a condition of market access rather than a matter of reputation.

For Indian industry, the size of the prize is now quantifiable. Analysis by the Ellen MacArthur Foundation with UNCTAD estimates that a circular pathway could generate annual benefits approximately ₹40 lakh crore - about US\$624 billion - for India by 2050, equivalent to roughly 30 per cent of current GDP, while cutting greenhouse-gas emissions by around 44 per cent and supporting millions of new livelihoods. Even the near-term markets are moving quickly: India's municipal-waste-management sector is projected to grow past US\$10 billion by 2030, and its e-waste management market to more than triple to over US\$15 billion by 2034.

The gap between ambition and current practice is itself the opportunity. India recycles only about a fifth of its waste, compared with nearly 70 per cent in parts of Europe. Closing that gap lowers input costs, insulates manufacturers from imported-commodity shocks, advances the goal of *Atmanirbharta* in strategic materials, and opens entirely new revenue streams in secondary raw materials. Circularity has stopped being a compliance cost and become a source of competitive advantage - and, for some inputs, of basic supply security.

Policy and Collaboration Are Turning Intent into Capacity

No single organisation can build a circular economy on its own; the complexity of modern material flows requires close coordination between government, industry, finance, research institutions, start-ups and the communities that already handle much of the country's waste. Encouragingly, policy is beginning to convert intent into capacity. The National Critical Mineral Mission, launched in January 2025 with an outlay of around ₹34,300 crore, treats recycling as a pillar of resource security rather than an afterthought; its dedicated recycling incentive scheme has already drawn commitments well beyond its initial capacity targets, with dozens of recyclers approved in its first months. A maturing EPR regime, backed by a national digital-traceability portal, is steadily pulling material and accountability from the informal margins into the formal economy.

Industry bodies have a particular role in moving this from awareness to implementation. The Confederation of Indian Industry, through its National Circular Economy Framework and the National Council on Waste-to-Worth Technologies, continues to bring policymakers, businesses, researchers and practitioners around the same table, and to translate broad principles into practical pathways that companies can actually adopt in their operations. The next phase of progress will be built not through isolated flagship projects but through integrated ecosystems - where

collection, processing, standards, financing and end-markets are designed to work together.

A fast-growing climate-tech ecosystem is bringing new capability to recycling, material science, digital tracking, bio-based materials and circular manufacturing. Connecting established industry with these entrepreneurs, research institutions and local communities gives India a rare chance to build a circular economy that is not only advanced but genuinely inclusive.

Inclusive Circularity Creates Shared Prosperity

India's greatest advantage here may be its people. More than a million workers already sustain the country's recycling economy through collection, aggregation, dismantling and recovery - the informal sector still handles the overwhelming majority of e-waste, often with remarkable ingenuity but at real cost to their own health and safety. Formalising these value chains, improving occupational safety, extending access to better technology and investing in skills would lift both productivity and dignity, and would keep recovered value inside the domestic economy rather than losing it to unsafe, low-yield processing.

At the same time, a fast-growing climate-tech ecosystem is bringing new capability to recycling, material science, digital tracking, bio-based materials and circular manufacturing. Connecting established industry with these entrepreneurs, research institutions and local communities gives India a rare chance to build a circular economy that is not only advanced but genuinely inclusive - one that expands economic opportunity rather than simply reducing environmental harm.

India's Moment - and the Discipline it Demands

The move from a linear to a circular economy is one of the defining industrial transitions of this century, and India possesses nearly every ingredient to lead it: a large and expanding manufacturing base, a vibrant start-up ecosystem, increasingly purposeful policy, strong digital infrastructure and deep-rooted habits of reuse and repair. The binding constraint is not technological capability. It is the speed and discipline of adoption.

That means treating the coming decade as one of execution: sustained investment in advanced recovery infrastructure; genuine, liquid markets for secondary raw materials; traceability and quality standards that let recovered material compete on equal terms with virgin supply; and product design that assumes recovery from the outset. Above all, it means moving waste management out of its historic place as a downstream municipal service and into the core of industrial planning, climate strategy and national resource security.

The prize is worth the discipline. A country that today ships tens of thousands of crores abroad to import minerals - and then discards much of the same material at home - has an obvious, unglamorous source of both savings and strength waiting to be captured. The nations that lead the next era will not be those with the greatest natural endowments, but those that waste the least of what they already hold. India has both the scale and the ambition to prove that economic growth, environmental stewardship and strategic resilience are not competing goals but a single agenda. The technologies exist, the policy momentum is real, and the case has never been clearer. The task now is to build.

Views expressed are personal.

MY VIEW

A Commitment For Change



Shivani Kumar
CEO
CII Foundation

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At CII Foundation, our approach to social development is increasingly shaped by one question: how do we build systems and ecosystems that make change sustainable?

A successful intervention cannot remain an isolated project. Whether strengthening community resilience, improving waste management or preparing communities for disasters, the focus must be on identifying gaps in existing systems and addressing them through collaboration, capacity building and better practices.

Circularity offers an important opportunity to take this thinking beyond waste management and embed it within community development—creating local enterprises, strengthening sustainable livelihoods and enabling communities to become active participants in resource conservation and climate action.

India's circular economy can therefore deliver more than resource efficiency. Done well, it can create economic opportunity while building environmental and community resilience. As we invest in the systems and technologies of the future, we must equally invest in the people who will make this transition possible, building stronger ecosystems that enable communities to adapt, participate and thrive.”



Clean Water and Sanitation

Ensure availability and sustainable management of water and sanitation for all

Targets and Indicators

Target 6.1

By 2030, achieve universal and equitable access to safe and affordable drinking water for all

Target 6.2

By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations

Target 6.3

By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of

hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally

Target 6.4

By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity

[Click here to read more](#)

From Social Stigma to Community Leadership The Journey of Stanzin Lamo

For years, financial hardship defined Stanzin Lamo's life. A 30-year-old single mother from Chuchot Block in Leh, Ladakh, and the sole provider for her family, she struggled to make ends meet in the face of limited livelihood opportunities and an unstable income. Every day was a struggle to provide for her family and coping with the social and economic challenges of raising her child on her own.

In October 2024, Stanzin joined the Material Recovery Facility (MRF) in Chuchot as a waste worker under the CII Foundation's waste management



initiative. While the role provided a stable source of income, it also came with its own challenges.

Her story demonstrates that when vulnerable individuals are provided with meaningful employment, skill development, and continuous support, they can break social barriers, gain dignity, and become champions of change.

Waste workers often face social stigma, and at the beginning, she lacked formal training in waste management, sanitation, hygiene, and occupational safety. The absence of technical skills and social recognition made it difficult to perform her duties with confidence and dignity.

Recognizing the importance of capacity building, the CII Foundation provided structured training on source segregation, scientific waste management, workplace sanitation, hygiene, and safe handling of waste. These interventions transformed Stanzin into a semi-skilled waste management professional, equipping her with practical knowledge and confidence.

Today, Stanzin Lamo's journey reflects the transformative power of skill development and dignified employment. She is no longer seen merely as a waste worker; she has become a resource person within her community. She regularly conducts awareness sessions on source segregation of waste at the community

level, helping households adopt responsible waste management practices and encouraging sustainable practices.

Her dedication and professionalism have earned the respect and appreciation of community members, local stakeholders, and colleagues. In addition to her operational responsibilities at the MRF, she supports her supervisor in maintaining records and bookkeeping, demonstrating her growing administrative capabilities.

The transformation has extended beyond her workplace. Stanzin now enjoys greater social acceptance, greater financial stability, and enhanced self confidence. As a single mother, she can provide a better future for her family while serving as an inspiration for other women in her community.



Stanzin Lamo's story demonstrates that when vulnerable individuals are provided with meaningful employment, skill development, and continuous support, they can break social barriers, gain dignity, and become champions of change within their communities. Her journey is a testament to the impact of the CII Foundation's intervention at the MRF Chuchot, where waste management has become not only a livelihood but also a pathway to empowerment and community leadership.



To know more about CII Foundation's initiatives write to Priya Shirali, Head - Communication at Priya.Shirali@cii.in

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