IMC 25

# GREEN TECH

## A Foundational Understanding of Green technology and ESG Manufacturing

zamun.

# Contents

01

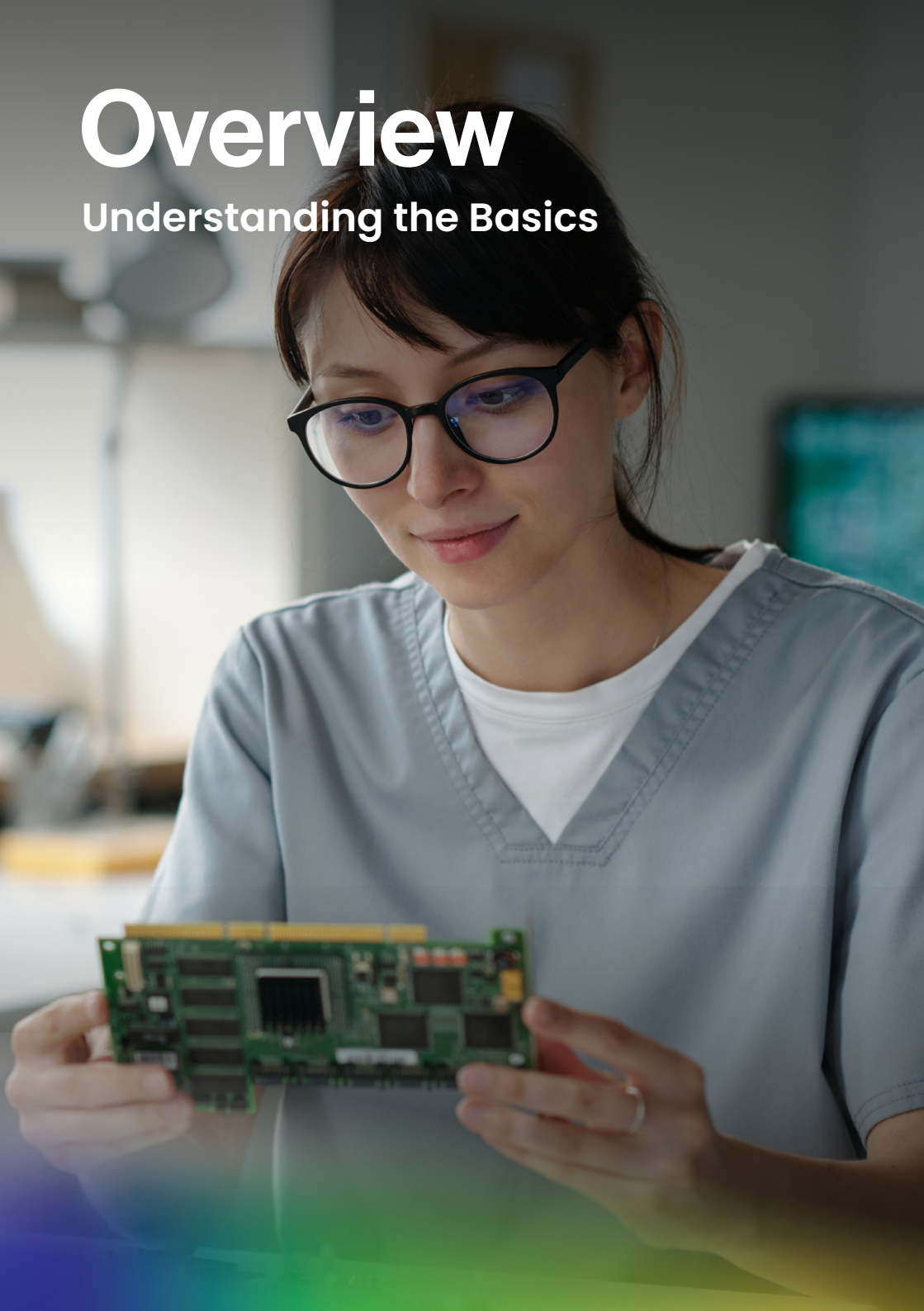
# Be Aware! This book is for the leaders of tomorrow!

The global electronics industry, stands at a crossroads. This book is your guide through the massive shift toward Green Electronics, driven by converging regulations, ESG mandates, and the rising e-waste crisis. We dissect the five core pillars of sustainability—from modular design to energy efficiency—and reveal the urgent transition from a polluting linear model to a closed-loop circular economy. This is about making profit and preserving the planet.

Atta Buoy, prepare for a read through!

# Overview

## Understanding the Basics



# What are Green Electronics?

Green electronics refers to the holistic application of sustainability principles across design, production, usage, and disposal stages of electronic products, aiming to minimize environmental harm, ensure ethical labor, and support economic viability.

## Five Core Pillars

- Sustainable Product Design – Modular designs that enable repair, part replacement, and upgrades; reduces waste by extending product life.
- Responsible Material Sourcing – Avoiding restricted substances per RoHS; sourcing conflict-free cobalt, tantalum, and lithium.
- Energy Efficiency – Integrating low-power chips, adaptive brightness, and intelligent power-off to reduce operational footprint by up to 40%.
- Lifecycle Management – Producer take-back schemes; integration with urban mining facilities.
- Transparency & ESG Reporting – Annual public disclosure of environmental performance aligned with GRI or SASB frameworks.

## Impact of Core Pillars on Sustainability Outcomes

| Pillar | Typical Emission Reduction | Additional Benefits |
|---|---|---|
| Sustainable Design | 20–25% | Cost savings, brand loyalty |
| Responsible Sourcing | 15–20% | Reduced supply chain risks |
| Energy Efficiency | 25–40% | Lower TCO for customers |
| Lifecycle Management | 30–50% | Regulatory compliance |

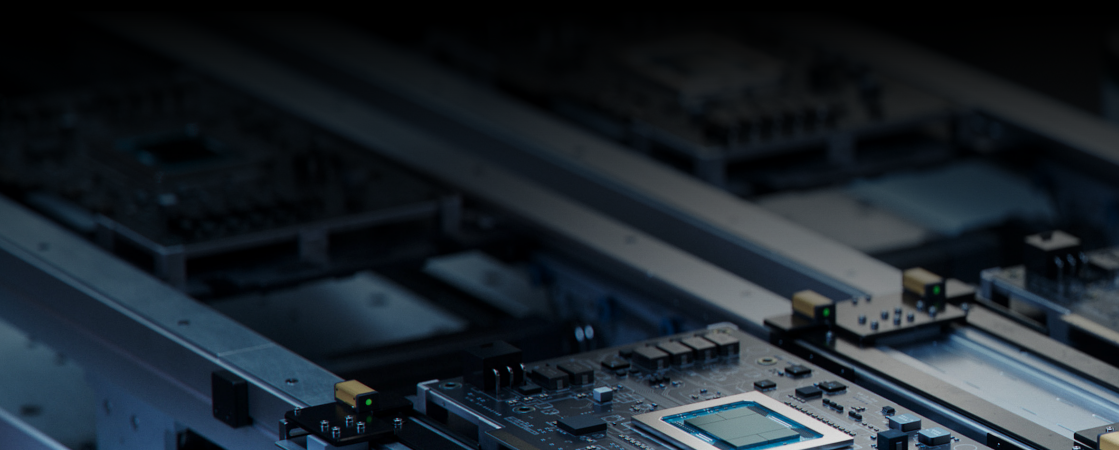
# Evolution of Electronics

## From Linear to Circular Models

Historically, electronics followed a linear value chain—resource extraction, manufacturing, consumption, and disposal—resulting in 62 million tonnes of e-waste in 2022, only 20% of which was formally recycled. The shift to a circular model aims to close resource loops, recover valuable materials, and drastically cut waste.

### Key Shifts in Industry Practice

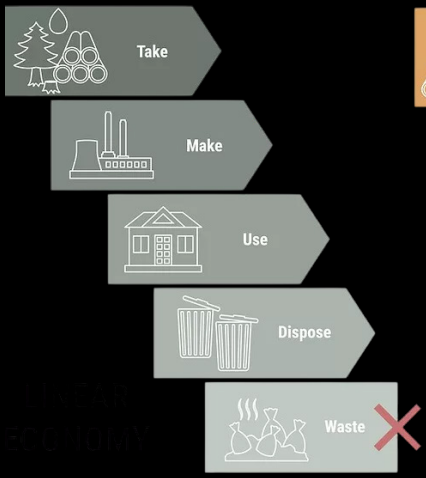
- Design for Longevity: Extending average device life from 3–4 years to 7–10 years.
- Component Harvesting: Recovering high-value materials (semiconductors, rare earth magnets).
- Service-Based Models: Leasing and upgrade plans reduce ownership waste.
- Advanced Recycling: Chemical recycling for plastics; hydrometallurgy for metals.



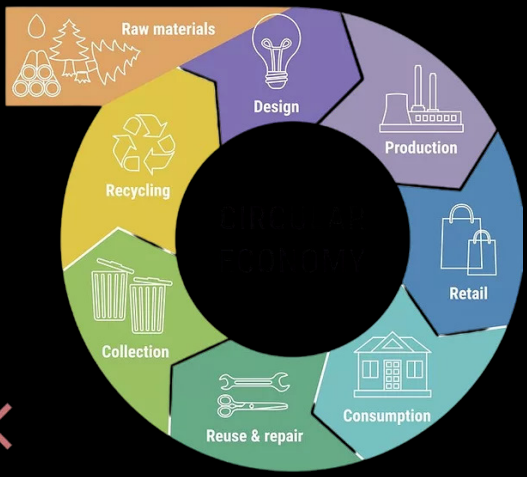
## Linear vs Circular Model in Electronics

| Dimension | Linear Model | Circular Model |
|---|---|---|
| Resource Flow | Extract -Manufacture -Discard | Extract - Manufacture - Reuse/Recycle |
| Waste Generation | High | Minimal |
| Material Value Retention | <10% | 60–80% |
| Example | Single-use PCB | Modular PCB with replaceable chips |

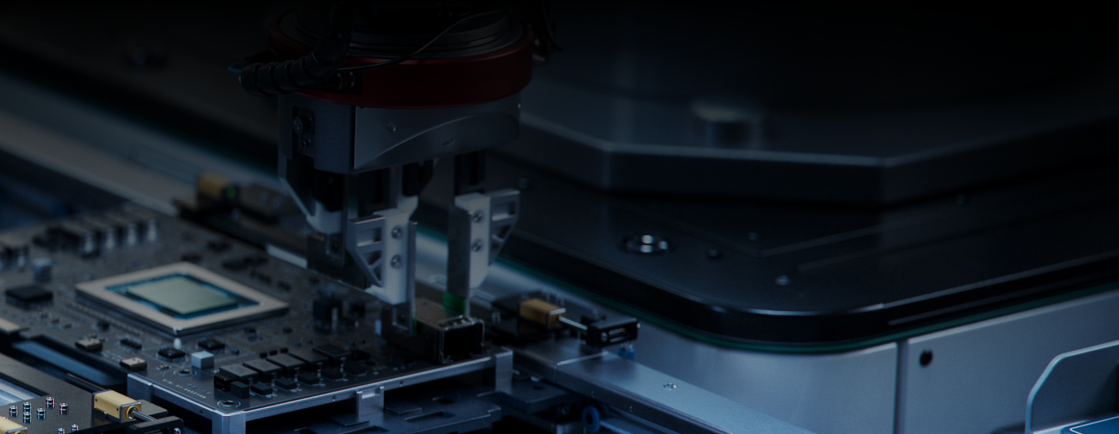
## Linear Economy




## Circular Economy




Source. dreamstime.com



# ESG in Electronics

## Environmental (E)

Environmental efforts include achieving net-zero carbon manufacturing via renewables, like TSMC's 2050 goal, eliminating hazardous materials per RoHS 3, and reducing plastic packaging by 30-50%.

## Social (S)

Social initiatives focus on ethical labor and inclusion; Sony, for example, trains over 5,000 workers annually.

## Governance (G)

Governance ensures transparency, with 78% of top firms publishing audited ESG reports, alongside strict anti-corruption compliance.

## ESG Impact Metrics for Electronics

| ESG Pillar | Sample KPI | Industry Average |
|---|---|---|
| E | Scope 1+2 Emissions (tCO2e) | 15,000–50,000/year for large OEMs |
| S | % Workforce Trained in ESG Skills | 25–40% |
| G | % Supply Contracts with ESG Clauses | 60–70% |


Sustainable gadgets,
reduced environmental
impact.

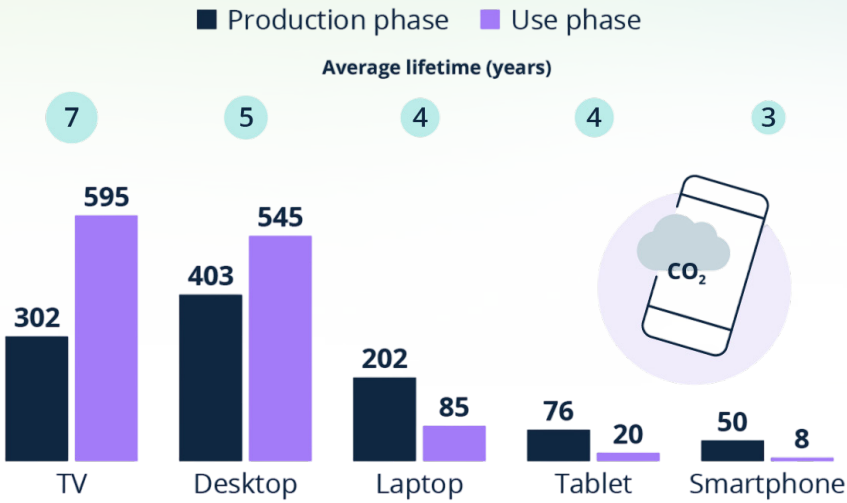
# Lifecycle Emissions

Lifecycle Assessment (LCA) evaluates a product's environmental footprint across five stages:

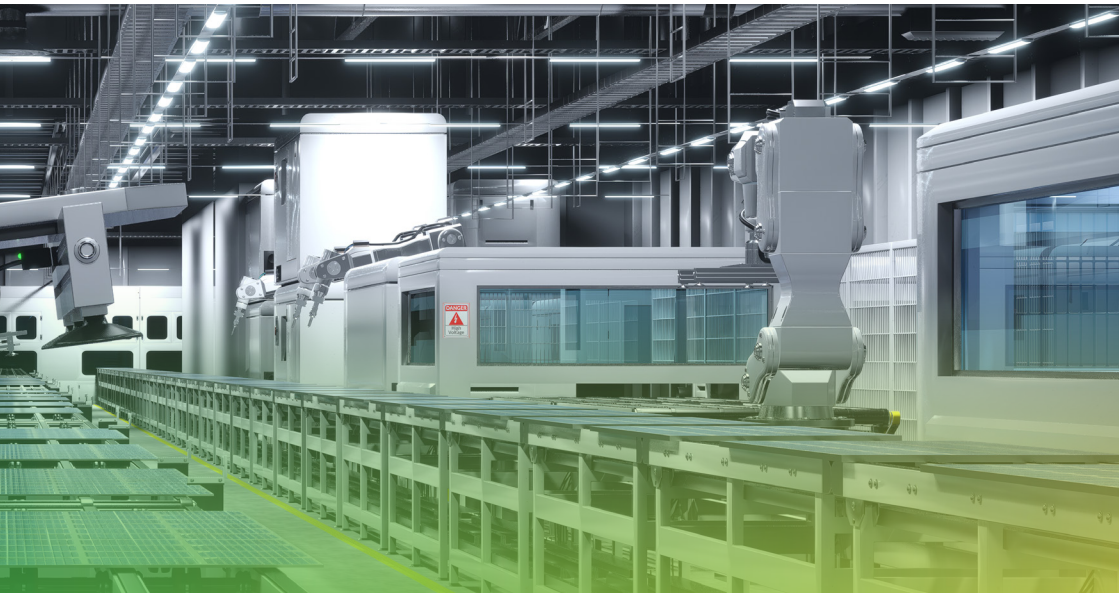
1. Raw Material Extraction – Mining for cobalt and lithium generates 15–25 $tCO_2e$ per tonne.
2. Manufacturing – Assembly lines powered by fossil fuels contribute 25–30% of lifecycle emissions.
3. Transportation – Global shipping of components adds 5–10% to the footprint.
4. Usage – Operational energy demand, especially for servers, can exceed 1,200 kg $CO_2e$/year.
5. End-of-Life – Improper disposal contaminates soil and groundwater with lead, cadmium, and mercury. Transformers: Still the backbone of generative models.

# The Carbon Footprint of Your Devices

Estimated life-cycle greenhouse gas emissions of electronic devices in 2020 (in kg of $CO_2$ equivalent)




Source: UN Trade and Development based on Malmodin and Lundén (2018)



# Global Regulations

## Driving Green Tech

The electronics sector operates under a complex web of environmental regulations designed to reduce hazardous substances, promote recycling, and ensure safe material handling. Compliance with these regulations is now a baseline expectation for accessing major global markets.

### Major Regulatory Frameworks

- RoHS (Restriction of Hazardous Substances) – Limits use of 10 hazardous substances in electronics; enforced in the EU and replicated in over 50 countries.
- WEEE (Waste Electrical and Electronic Equipment Directive) – Requires producers to finance collection, treatment, and recycling of e-waste; recovery targets set at 65% of average weight of equipment placed on market.
- REACH (Registration, Evaluation, Authorisation, and Restriction of Chemicals) – Governs the use of over 22,000 substances in the EU to protect human health and the environment.
- China RoHS 2 – Expands scope to cover nearly all electronic products sold domestically, with stricter labeling requirements.
- India's E-Waste (Management) Rules – Mandates Extended Producer Responsibility (EPR) with annual collection targets rising to 70% by 2025.

# Can electronic trash be managed?

# E-Waste Crisis

## The Scale of the Problem

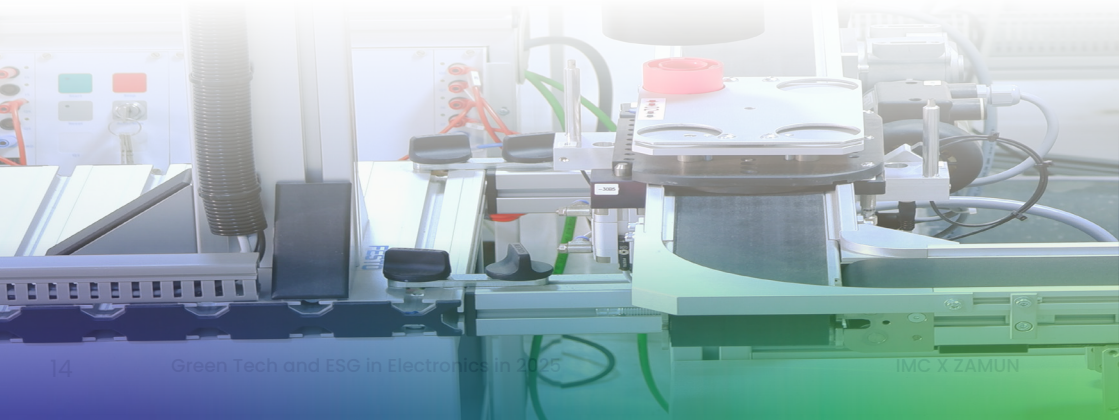
In 2022, global e-waste generation reached 62 million tonnes, projected to hit 74 million tonnes by 2030. Only 20% was formally recycled, with the rest incinerated, dumped, or processed in unsafe informal sectors.

### Key Challenges

- Low Collection Rates – Limited infrastructure in developing markets.
- Hazardous Substances – Lead, mercury, and cadmium leach into soil and water.
- Complex Disassembly – Multi-material components hinder efficient recycling.

### Solutions through Circular Economy Principles

- Urban Mining – Recovering gold, silver, and palladium from discarded devices; 1 tonne of e-waste yields 100x more gold than 1 tonne of ore.
- Deposit-Return Schemes – Incentivizing consumers to return devices.
- Design for Disassembly – Use of modular screws and fewer adhesive bonds.



# Get Wise with Waste this August

## Our Growing E-waste Problem

### What is E-waste?

Electronic Waste (E-waste) consists of obsolete, damaged or discarded electronic devices and peripherals. Computer and TV parts, damaged CDs, used cartridges, old cellphones, calculators, old batteries, refrigerators all qualify as e-waste.

CRTs of old TVs are considered one of the hardest types of e-waste to recycle.

## How Much E-waste Do We Generate In India?

8 lakh tonnes by 2012 (Moef annual report)

8 Lakh Tonnes

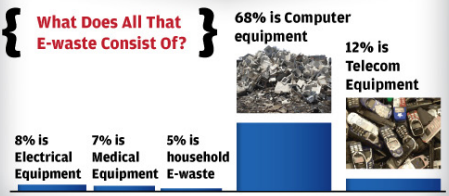
=

that's equal to

110 million laptops

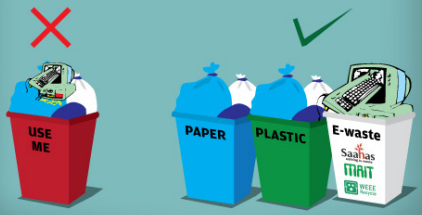
Bangalore City alone generates around 400,000 batteries as E-waste every month

## What Does All That E-waste Consist Of?




## What Can You Do?

Start by not disposing of your E-waste with regular garbage. Gather it up and put it in designated E-waste collection bins. It will then be handed over to organisations that will recycle or refurbish it with minimal damage to the environment.




## E-waste you can dispose:

- CDs
- Chargers
- Pen drives
- Headphones
- Cartridges
- Cameras
- Mice
- Wires
- Keyboards
- Calculators
- PCB boards
- Remotes
- CD/DVDs
- Dry Cell Batteries
- Laptop Batteries
- Phones
- Small Electronic Toys

Source. behance.net/gallery

# Green Certifications

## Purpose of Green Certifications

Certifications signal compliance with sustainability benchmarks, aiding procurement decisions and building brand credibility.

### Major Certifications

- ENERGY STAR – U.S. EPA program for energy efficiency; covers 75+ product categories.
- EPEAT (Electronic Product Environmental Assessment Tool) – Rates electronics on lifecycle environmental performance.
- TCO Certified – Covers sustainability, social responsibility, and circularity in IT products.
- Blue Angel (Germany) – Focuses on low-emission, recyclable products.

### Green Certification Overview

| Certification | Key Focus | Impact Metric |
|---|---|---|
| ENERGY STAR | Energy efficiency | 5.3B tonnes $CO_2$ saved since 1992 |
| EPEAT | Lifecycle sustainability | 15M tonnes $CO_2$ avoided |
| TCO Certified | IT product responsibility | 80%+ procurement adoption in EU |

Hey Leaders!

We've defined Green Electronics by its five pillars, and charted the shift from the linear to circular economy. We covered the E-Waste crisis, key ESG metrics, and major global regulations and certifications driving sustainability in the sector.

Now brace yourselves with some coffee's and let's move forward towards the next chapter of exploring the green tech world.


The aim of tech
should be – to enrich
lives globally.

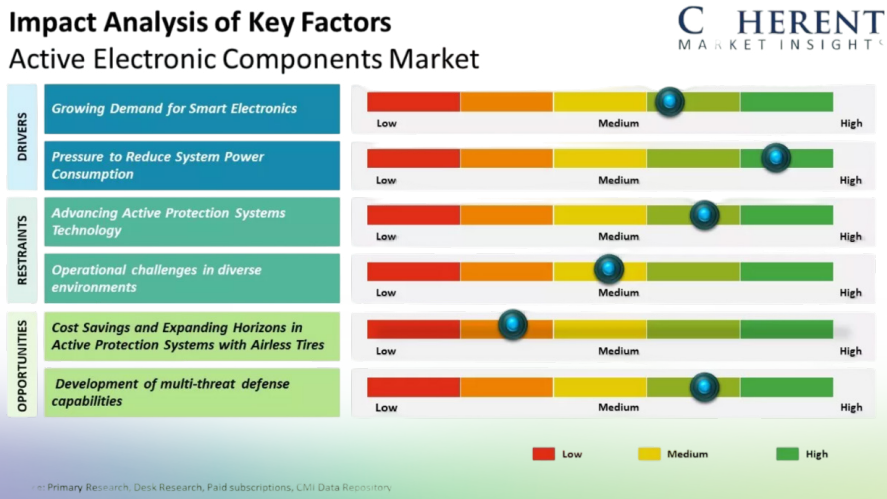
# Market Sizing and Trends

# Global Overview

The USD 3.7 trillion global electronics industry is prioritizing sustainability due to converging regulations, ESG investments, and consumer demand. Green electronics involves sustainable design, responsible sourcing, energy efficiency, and lifecycle accountability. The market is projected to grow from USD 98.5 billion (2023) to USD 245.7 billion by 2030 (14.1% CAGR), driven by stricter e-waste directives and transparent supply chains.

## Key Global Trends Driving Green Electronics

- Circular Economy Mandates: Over 40% of new electronics should use recycled materials by 2030.
- Eco-Label Influence: ENERGY STAR and EPEAT influence 62% of enterprise purchasing.
- Material Substitution: Lead-free and halogen-free components are standard; bio-based polymers will replace 15% of plastics by 2030.
- Policy Acceleration: Over 80 nations enforce e-waste laws; the EU targets 7–10 Year product lifespans.
- Investor Pressure: ESG funds managing USD 2.5 trillion favor manufacturers with net-zero commitments.



# Electronics Refurbishment Market

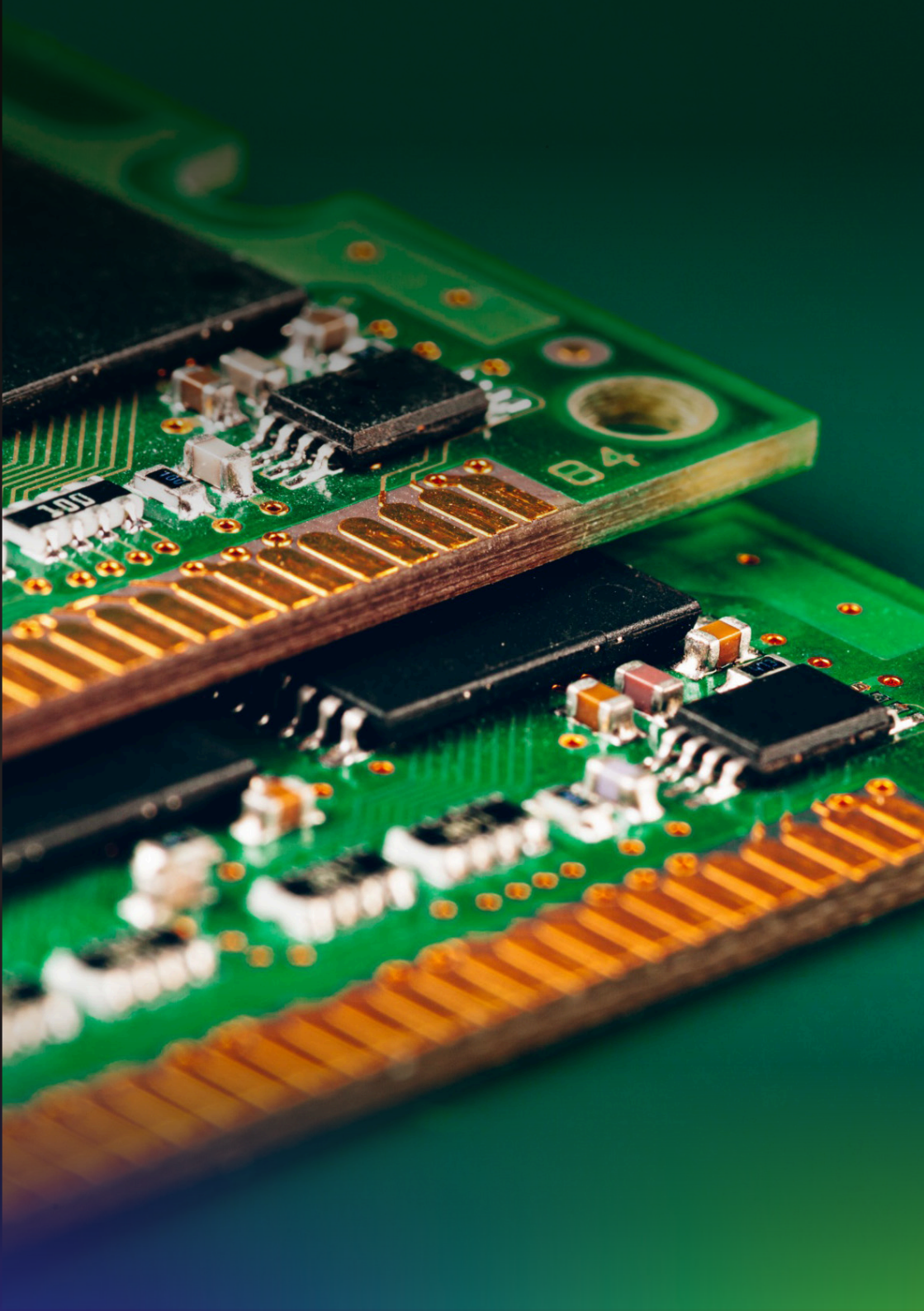
## The Second-Life Advantage

Refurbishing and reusing electronics extends product lifespans, reduces demand for virgin materials, and offers affordable access to technology.

- The global refurbished electronics market was valued at USD 85 billion in 2023 and is projected to grow at 12% CAGR through 2030.
- Refurbishment can cut lifecycle carbon emissions by up to 80% compared to manufacturing new devices.
- Devcices like laptop saves 300 kgs of CO2 per unit, 190000ltrs of water and smartphones and save 55 kgs of CO2 per unit and 13000 ltrs of water.

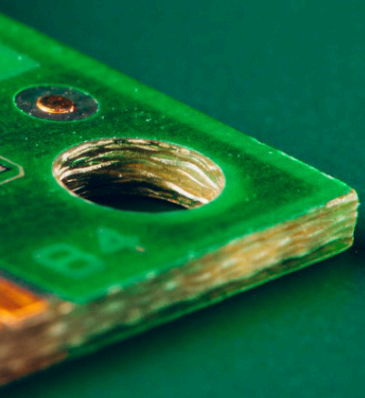
### Core Components of a Refurbishment Ecosystem

- Device Collection & Assessment – Sourcing from trade-ins, lease returns, corporate IT upgrades.
- Certified Repair Facilities – OEM-certified centers ensuring quality and compliance.
- Resale Platforms – Marketplaces like Back Market, Amazon Renewed, Cashify.


B4

# Build today and lead tomorrow with a greater vision.

That's tremendous, aint it leaders?
It's great to see the **$3.7Tn** electronics industry's shift to Green Electronics, driven by ESG and circular mandates. We saw that the market is set for **14.1% CAGR growth**, emphasized by the rising importance of the refurbishment market.
But, who's shifting this growth? Lets Read.



# Key Players and Leaders

## Dr. Lisa Jackson

**VP, Environment, Policy, and Social Initiatives, Apple Inc.**

Dr. Jackson spearheaded Apple's goal to achieve carbon neutrality in its supply chain by 2030, including using 100% recycled rare earth elements in key products. Her work has cut operational emissions by 70% since 2015 and transitioned over 200 suppliers to renewable energy.

## Jensen Huang

**CEO, NVIDIA**

Mr. Huang advocates for using AI to boost energy efficiency in semiconductor design and data centers, lowering the electronics lifecycle's carbon footprint. NVIDIA's AI frameworks have

optimized energy consumption in 500+ global manufacturing plants, leading to up to 30% power savings.

## Dr. Venkatesh Narayanamurti

### Harvard University

Dr. Narayanamurti leads academic research on substituting critical minerals and developing energy-efficient nanodevices, forging a vital link between academia and industry. His rare earth alternatives roadmap has been adopted into the national electronics strategies of three G20 countries.

## Sunita Narain

### Director General, Centre for Science and Environment (CSE), India

Ms. Narain is central to enforcing India's Extended Producer Resp onsibility (EPR) for e-waste and promoting equitable recycling models. Her direct influence was key to shaping India's 2022 E-Waste Rules, which now affect more than 12,000 registered manufacturers.

# Green Innovation Hubs

## Startups and Accelerators in Eco-Tech

### Types of Innovation Hubs

- Startup Accelerators – Providing mentorship, capital, and market access for green electronics startups.
- Corporate Innovation Labs – In-house R&D units focused on sustainable materials, energy efficiency, and recycling.
- Public-Private Partnerships (PPPs) – Government-backed initiatives to scale eco-tech.

### Key Global Players

- Greentown Labs (USA) – Supports over 200 clean tech startups, including electronics recycling ventures.
- Circular Electronics Initiative (EU) – Collaboration between OEMs, universities, and policy bodies to promote circular design.

### India's Ecosystem

- The green electronics startup segment in India is expected to grow at >15% CAGR through 2030, driven by regulatory mandates, corporate ESG goals, and rising consumer awareness.
- T-Hub in Hyderabad hosting ESG electronics startups.
- Electronics Sector Skill Council of India (ESSCI) incubation for eco-design startups.

You are halfway there when you define what you want.
And Leaders! I guess these players have paved this great way for us to build the next transformations.
Now let us deep dive into learning about more Industrial trends and Tech-novations!


Great minds build
technology that drives
a societal change.

02

# Insights and Thought Leadership

# Latest Technology Trends

## Green Materials and Alternatives

### Shifting Material Choices

Traditional electronics rely heavily on petroleum-based plastics, leaded solder, and brominated flame retardants—all of which carry high environmental risks. Manufacturers are transitioning to eco-friendly alternatives without compromising performance.

### Notable Green Alternatives

- Bio-Plastics – Derived from corn starch, sugarcane, or algae; biodegradable and compostable.
- Non-Toxic Solder – Tin-silver-copper (SAC) alloys replacing lead-based solders.
- Halogen-Free Laminates – Reduces toxic emissions during disposal.
- Recycled Aluminium & Steel – Cuts energy use in production by 95% and 60%, respectively.

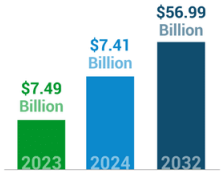
### Comparison of Conventional vs Green Materials

| Material Type | Conventional | Green Alternative | Emission Reduction (%) |
|---|---|---|---|
| Plastic | ABS, PVC | Bio-PLA, PHA | 30–60 |
| Solder | Lead-tin | Tin-silver-copper | 100 (lead elimination) |
| Laminate | Brominated FR4 | Halogen-free FR4 | 25–35 |

# BIOPLASTICS MARKET

FORTUNE BUSINESS INSIGHTS

Bioplastics Market to grow at **29.0%** CAGR by 2024-2032




## INDUSTRY DEVELOPMENT

NatureWorksLLC announced to launch the new biopolymer-based product named Ingeo 6500D.

## EUROPE

$3.68 Billion (2022)
$3.64 Billion (2023)

Asia Pacific | South America
North America | Middle East & Africa

## DRIVERS

Increasing Demand for Eco-friendly Plastics from the Packaging Industry

## TRENDS

Growth in Demand from the Automotive Industry

**GERMANY, BY TYPE**

Biodegradable
Non-Biodegradable

**BY APPLICATION**

Automotive & Transportation
Rigid Packaging | Textiles
Agriculture & Horticulture
Flexible Packaging
Consumer Goods
Others

Source. fortunebusinessinsights.com

# Sustainable Manufacturing

## Energy Efficiency in Production

Transitioning to renewable-powered facilities can cut the carbon footprint of manufacturing, which accounts for 24% of sectoral GHG emissions, by up to 50%.

## Water Neutrality Measures

Companies use closed-loop systems to recycle 90–95% of process water and implement rainwater harvesting; Intel has replenished 13 billion gallons globally since 2000.

## Lean Manufacturing for Waste Reduction

Implementing methodologies like Six Sigma reduces production defects by up to 35%, while digital twins enable real-time process optimization.

## Energy and Water Savings in Sustainable Manufacturing

| Measure | Typical Savings (%) | Industry Example |
|---|---|---|
| Renewable Energy Integration | 40–50 | Apple's 100% renewable operations |
| Closed-Loop Water | 90–95 | Samsung semiconductor fabs |
| Lean Process Implementation | 20–35 | Dell assembly lines |

# Supply Chain and ESG Reporting Standards

## Why It Matters

Transparent electronics supply chains spanning high-risk sourcing regions are critical for regulatory compliance, investor confidence, and brand reputation. Digital tools like Blockchain for traceability and AI for risk assessment enable real-time tracking and transparency.

## Key Reporting Standards

- Global Reporting Initiative – Covers sustainability disclosures across environmental, social, and governance metrics.
- Sustainability Accounting Standards Board – Industry-specific ESG metrics for investor decision-making.
- Task Force on Climate-Related Financial Disclosures – Framework for assessing climate-related risks and opportunities.

## Digital Tools for Transparency

- Blockchain-based traceability for conflict minerals.
- AI-driven supplier risk assessment.
- Cloud platforms for real-time ESG performance tracking.

## Global Adoption of ESG Standards

| Standard | Adoption Rate (%) | Typical Use Case |
|---|---|---|
| GRI | 78 | Sustainability reporting for stakeholders |
| SASB | 62 | Investor-focused disclosures |
| TCFD | 54 | Climate risk reporting |

# Rare Earth & Conflict Minerals

## The Critical Minerals Challenge

Electronics manufacturing depends on rare earth elements (REEs) and conflict minerals such as tantalum, tin, tungsten, and gold (3TG), which are often sourced from politically unstable regions.

- The global rare earth market is valued at USD 9.2 billion (2023) and expected to grow at 10% CAGR till 2030.
- Over 60% of rare earth production is concentrated in China, posing supply chain risks.

### Traceability Measures

- OECD Due Diligence Guidance – Framework for responsible mineral supply chains.
- Blockchain-based Tracking – Immutable, end-to-end visibility from mine to factory.
- RMI (Responsible Minerals Initiative) – 400+ member companies implementing smelter audits.

### Substitution & Recycling Strategies

- Material Substitution – Using ferrite magnets in place of neodymium magnets in some applications.
- Urban Mining – Recovering REEs from e-waste with yields up to 95% purity.
- Design Innovation – Modular products allowing easy retrieval of rare components. Energy and Water Savings in Sustainable Manufacturing

# WHERE IN THE WORLD ARE ALL THE RARE EARTHS?

**Rare earth elements (REEs) are a group of 17 elements whose importance is critical in high technology. Their use has exploded as electronics and renewable technologies increasingly have become part of everyone's daily lives.**

Rare earths are abundant in the Earth's crust but mineable concentrations are less common, making reserves potential very valuable and strategic.

*The USGS tracked the world's reserves in tons (imperial).

**World Total**
**115,820,000t***
Reserve data

**China**
**44,000,000t**
37.9%

China tops the list for reserves and mine production.

While the U.S. has 1.5 million tons in reserves, it still depends on China for refined rare earths.

Other Countries 310,000t
Australia 4,100,000t
South Africa 790,000t
Tanzania 890,000t
Greenland 1,500,000t

3.5%
0.7%
1.3%


**Russia**
**12,000,000t**
10.3%

**Vietnam**
**22,000,000t**
18.9%

Although Vietnam and Brazil have the second and third most reserves, their mine production is among the lowest at only 1,000 tons per year each.

Canada 830,000t
U.S. 1,500,000t
0.7%
1.3%

**Brazil**
**21,000,000t**
18.1%

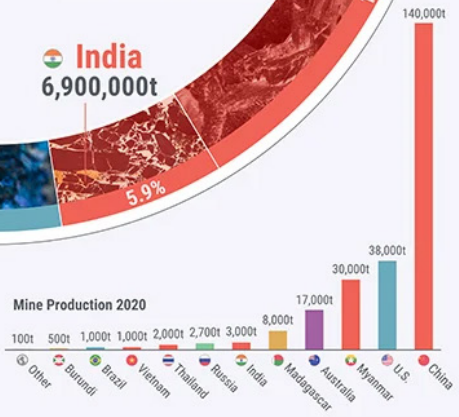
**India**
**6,900,000t**
5.9%

After mine production, rare earths must be refined and separated into their individual metals for their particular uses.

**Uses:**

Magnets · Lights · Screens · Glass · Catalysts · Batteries · Steel Alloys

**Mine Production 2020**




**Source:** USGS Mineral Commodity Summaries, Rare Earths

# Energy-Efficient Product Designs

## Designing for Efficiency

Energy-efficient electronics reduce lifecycle energy consumption, directly lowering carbon footprints. For example:

- Standby power accounts for 5–10% of total residential electricity use globally.
- Integrating power management ICs can reduce device energy use by 30–40%.

### Key Strategies

- Smart Chips – ARM-based processors with ultra-low-power modes.
- Dynamic Voltage & Frequency Scaling (DVFS) – Optimizes performance vs. energy use.
- Sleep & Hibernate Modes – Reduces idle power to as low as 0.5W in consumer devices.
- Energy Harvesting Modules – Solar-powered sensors, kinetic energy chargers.

### Energy Efficiency Gains in Modern Electronics

| Feature | Energy Saving (%) | Example |
|---|---|---|
| Low-Power Chipsets | 40–60 | ARM Cortex-M0+ |
| Sleep Modes | 80–95 (idle) | Laptops, smartphones |
| DVFS | Data center servers | Climate risk reporting |

# Sustainable Packaging Innovations

Packaging contributes up to 15% of a product's total environmental impact, with plastics dominating at 40% of material volume. Shifting to sustainable alternatives can cut emissions significantly.

## Innovative Solutions

Molded Pulp Packaging – Replaces EPS foam; 100% recyclable.
Compostable Films – Derived from polylactic acid (PLA).
Water-Based Inks – Eliminates VOC emissions from printing.
Minimalist Design – Reduces overall material use by 20–30%.

## Comparison of Conventional vs Sustainable Packaging

| Packaging Type | Carbon Emissions (kg $CO_2e$/unit) | Decomposition Time | Recyclability (%) |
|---|---|---|---|
| EPS Foam | 1.2 | 500+ years | 90 |
| Molded Pulp | 0.5 | 6 months | 100 |
| PLA Film | 0.3 | 3–6 months | 90 |

# AI, IoT & Blockchain for Green SCM

Emerging technologies enable real-time monitoring, predictive optimization, and traceability in electronics supply chains.

## Applications

- AI – Predictive maintenance to reduce downtime and waste; demand forecasting to avoid overproduction.
- IoT – Sensors for real-time energy and emissions tracking in factories.
- Blockchain – Immutable ledgers for tracking conflict-free minerals and carbon credits.

## Technology-Driven ESG Benefits

| Technology | Key Benefit | Impact Metric |
|---|---|---|
| AI | Predictive demand planning | 20% inventory waste reduction |
| IoT | Energy consumption monitoring | 15–25% facility energy savings |
| Blockchain | Traceable mineral sourcing | 100% verification compliance |

# GREEN SUPPLY CHAIN

The adoption of sustainable practices in the supply chain is crucial to ensure a sustainable future for our planet and the green supply chain is an important step towards a more responsible economy

### WHAT IS IT

The green supply chain is a set of sustainable practices that aim to educe the environmental impact of the entire supply chain, from the acquisition of materials to the delivery of finished products.

### THE MAIN ACTORS

The main actors involved in the green supply chain are suppliers, manufacturers, transporters, and distributors all responsible for adopting sustainable practices in their part of the chain.

### SUSTAINABLE PRACTICES

Sustainable practices used in the green supply chain include the use of recycled materials, low-carbon production, sustainable transport, and waste reduction.

### ENVIRONMENTAL IMPACT

The green supply chain helps to reduce CO2 emissions, increase the use of renewable energy, reduce waste, and conserve natural resources, improving long-term environmental sustainability.

Infographic by DeltalogiX

deltalogix.blog

# Green Finance

## ESG Investing Trends and Clean Tech Funds

### The Rise of Green Finance in Electronics

The transition to sustainable electronics manufacturing is increasingly backed by ESG-focused capital flows. Global ESG assets reached USD 30 trillion in 2022 and are projected to exceed USD 50 trillion by 2030 (Bloomberg Intelligence), accounting for over one-third of total assets under management.

### Key Financing Mechanisms for Electronics

- Green Bonds – Used by tech firms to fund renewable energy use, eco-design R&D, and recycling facilities. Example: Apple's USD 4.7 billion green bond program.
- Sustainability-Linked Loans (SLLs) – Loan interest rates tied to ESG performance metrics.
- Venture Capital for Clean Tech Startups – Growing investments in e-waste recycling and biodegradable materials.

### Top 5 ESG & Clean Tech Funds Relevant to Electronics

| Fund Name | AUM (USD Bn) | Focus Area | Annualized 5Y Return |
|---|---|---|---|
| iShares Global Clean Energy ETF | 15.6 | Renewable energy & efficiency | 12.4% |
| Parnassus Core Equity Fund | 28.0 | ESG leaders in tech & industry | 11.8% |

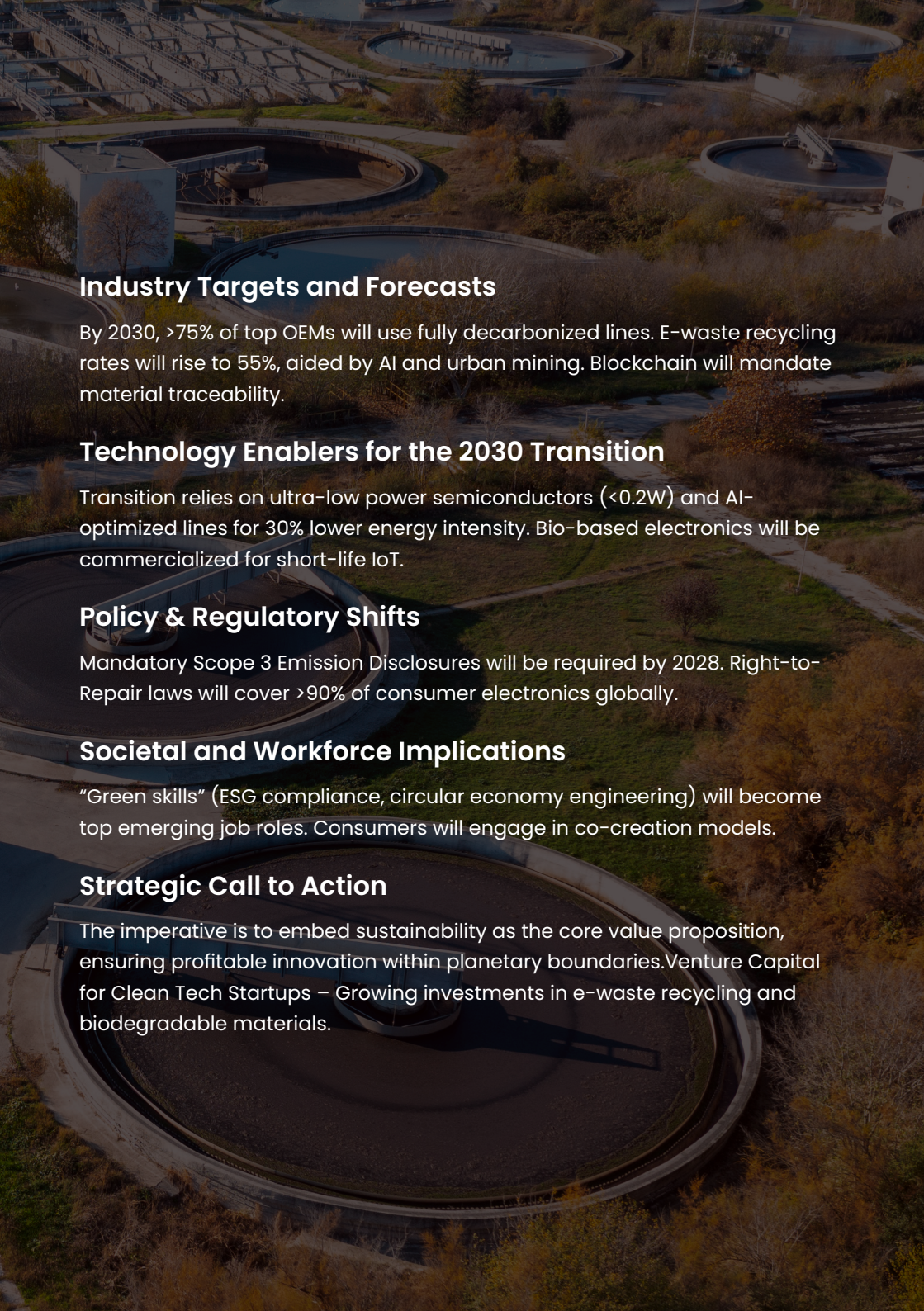
| Fund Name | AUM (USD Bn) | Focus Area | Annualized 5Y Return |
|---|---|---|---|
| SPDR S&P Kensho Clean Power ETF | 4.9 | Battery tech, renewables | 10.2% |
| Impax Environmental Markets | 3.4 | Circular economy, recycling | 13.1% |
| BNP Paribas Easy ECPI Circular Economy Leaders | 1.8 | Circular supply chains | 9.7% |

## India's ESG Finance Push

Introduction of green bond guidelines by SEBI (2023).
Indian green bond issuance crossed USD 7.5 billion in 2023, with electronics OEMs beginning to tap this market.

# 2030 Vision for Green Tech

The next decade is decisive for the industry's environmental trajectory, unifying policy, technology, market, and societal shifts.



## Industry Targets and Forecasts

By 2030, >75% of top OEMs will use fully decarbonized lines. E-waste recycling rates will rise to 55%, aided by AI and urban mining. Blockchain will mandate material traceability.

## Technology Enablers for the 2030 Transition

Transition relies on ultra-low power semiconductors (<0.2W) and AI-optimized lines for 30% lower energy intensity. Bio-based electronics will be commercialized for short-life IoT.

## Policy & Regulatory Shifts

Mandatory Scope 3 Emission Disclosures will be required by 2028. Right-to-Repair laws will cover >90% of consumer electronics globally.

## Societal and Workforce Implications

“Green skills” (ESG compliance, circular economy engineering) will become top emerging job roles. Consumers will engage in co-creation models.

## Strategic Call to Action

The imperative is to embed sustainability as the core value proposition, ensuring profitable innovation within planetary boundaries.Venture Capital for Clean Tech Startups – Growing investments in e-waste recycling and biodegradable materials.

# Interactions with Other Tech

## Cybersecurity and Data Protection in ESG

As manufacturers integrate ESG, cybersecurity is crucial for sustainability credibility. ESG-compliant devices use connected sensors, blockchain, and AI for carbon measurement and transparency. This creates high-value digital assets—datasets—whose compromise risks severe legal and reputational damage.

### Why Cybersecurity is Integral to ESG in Electronics

- Integrity of ESG Metrics: Carbon and sourcing data must be authentic and tamper-proof for disclosures (CDP, GRI, SEC).
- Prevention of Greenwashing Risk: Data manipulation invalidates claims, leading to penalties and stakeholder trust erosion.
- Protection of Innovation: Eco-friendly designs and energy-efficient architectures are valuable IP targets for theft.

### Major Threat Vectors

- IoT Endpoint Vulnerabilities: Exploiting unsecured smart sensors to alter emissions data.
- Supply Chain Data Breaches: Infiltrating ESG reporting systems via poorly secured vendor portals.
- Data Integrity Attacks: Manipulating blockchain-based traceability to hide non-compliant minerals.

## Best Practices for Securing ESG Data

- End-to-End Encryption for device-to-cloud data.
- Blockchain-Enabled Immutable Ledgers for material verification.
- AI-Based Behavioral Analytics for real-time metric change detection.
- Zero Trust Network Architecture (ZTNA) across green facilities.Top 5 ESG & Clean Tech Funds Relevant to Electronics

# Tech-Enabled Recycling

## Reverse Logistics, Smart Bins, Urban Mining

### The Recycling Imperative

Electronics waste is the fastest-growing waste stream globally, with 62 million tonnes generated in 2022, projected to reach 82 million tonnes by 2030. Less than 20% is formally collected and recycled, resulting in loss of valuable metals and hazardous material leakage.

### Technology-Driven Recycling Solutions

**Reverse Logistics Platforms**

AI-driven routing to optimize pickup of e-waste from consumers and businesses.

Partnerships between OEMs and logistics providers for product take-back programs.

**Smart Collection Systems**

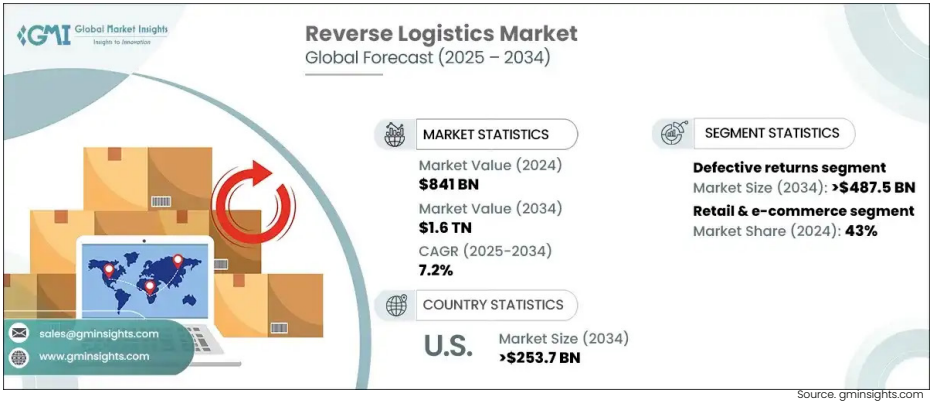
IoT-enabled smart bins detect fill levels, sort waste by type, and issue collection alerts.

AI vision systems identify material composition for pre-sorting.

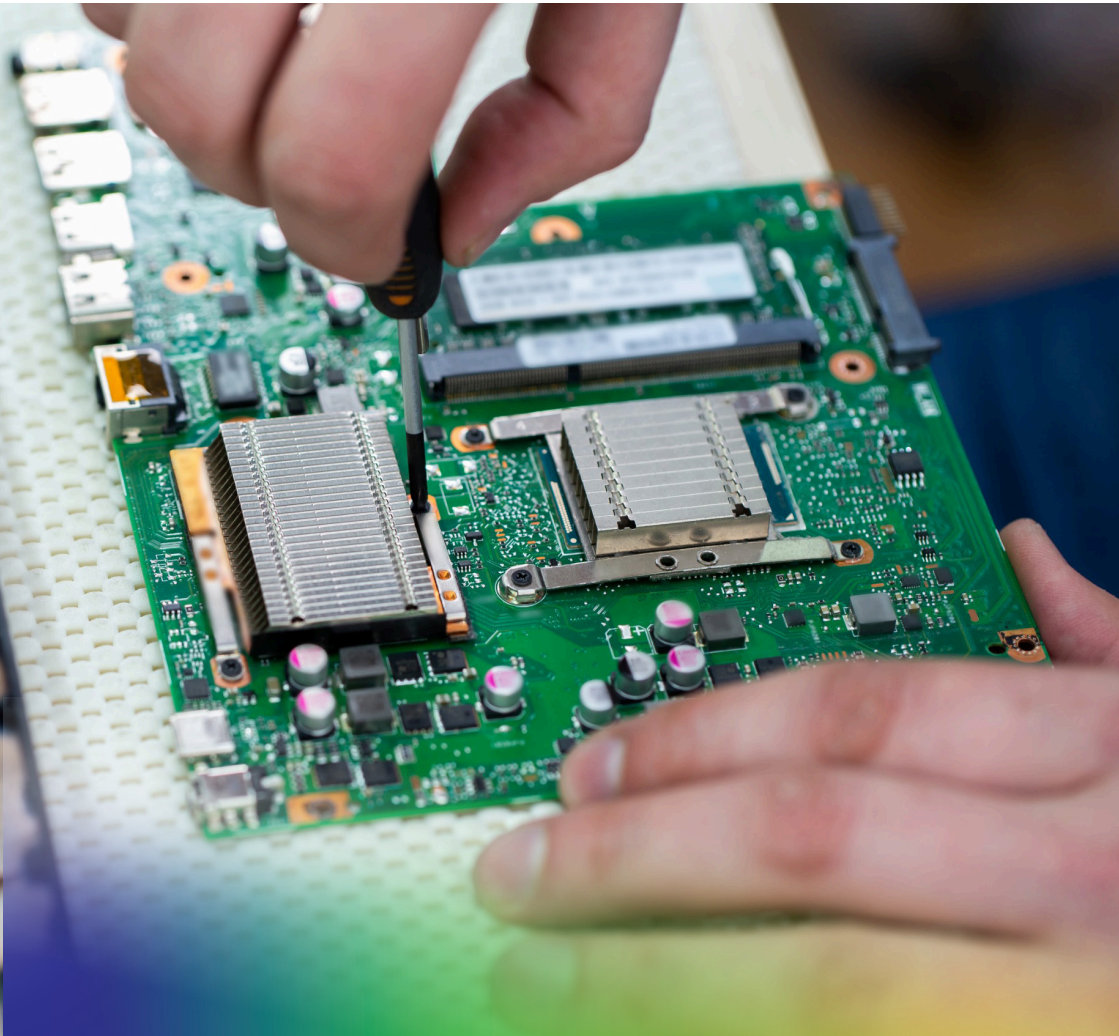
**Urban Mining**

Recovering gold, silver, palladium, and rare earths from circuit boards at yields of 95–98% purity.

Example: Umicore's recycling facility in Belgium processes 500,000 tonnes/year of e-waste.




Source: gminsights.com



# Workforce Transition

## Emerging Skill Areas

- Green Manufacturing Engineering – Low-energy processes, lean waste reduction.
- Sustainable Supply Chain Management – Traceability, ESG audits, blockchain applications.
- Environmental Data Analytics – Carbon accounting, lifecycle analysis.
- ESG Compliance & Reporting – GRI, SASB, TCFD frameworks.

## Reskilling & Upskilling Models

- Government Programs – Skill India Green Jobs initiative targeting 1 million workers by 2030.
- Corporate Training – Dell's "ESG Academy" trains 10,000+ employees annually.
- University Partnerships – ESG-focused engineering curriculums.

## High-Demand ESG Roles in Electronics

| Role | Core Competency | Avg. Annual Salary (India) |
|---|---|---|
| ESG Data Analyst | Carbon footprint modeling | ₹9–12 lakh |
| Circular Design Engineer | Modular, repairable product design | ₹10–14 lakh |
| Supply Chain ESG Auditor | Compliance verification | ₹8–10 lakh |

# NON-GREEN SKILLS SUPPORTING TRANSITION TO SUSTAINABLE JOBS

## STEM SKILLS

- Science & Technology
- Engineering
- Problem-solving
- Logical Mathematics skills
- Critical thinking
- Creativity
- Coding skills

## DIGITAL SKILLS

- Product Designing
- Data Analysis
- Block chain Technology
- AI and Machine Learning
- Graphics Designing and Animating
- Cloud Computing

## EXPERTISE IN INDUSTRIES

- Construction
- Utilities
- Mining
- Agriculture
- Manufacturing
- Professional Services

**Source:** TeamLease, YourStory research

# Ecosystem Leadership

## ESG Reporting in Global Tech Giants

### Why ESG Reporting Matters

Transparent ESG disclosures influence investor confidence, regulatory compliance, and brand equity. Electronics giants have set ambitious environmental targets aligned with UN SDGs.

### Case Studies

**Apple**

- Achieved 100% renewable energy across operations since 2020.
- Recycled rare earth magnets in 100% of iPhone 12+ models.

**Dell Technologies**

- Goal: Reuse or recycle 1 device for every device sold by 2030.
- Reduced scope 1 & 2 GHG emissions by 62% (2011–2022).

**Samsung Electronics**

- Targeting net zero carbon in Device eXperience Division by 2030.
- Introduced solar-powered remote controls with 100% recycled plastic casings.

**HP Inc**

- Over 40% of HP personal systems now use post-consumer recycled plastics.
- Achieved 95% zero-deforestation for HP paper and packaging.
- High-Demand ESG Roles in Electronics

# India's Green Electronics Push

## Policy Landscape

India's green electronics initiatives are driven by a mix of manufacturing incentives, environmental regulations, and digital transformation goals.

### Key Government Actions

- PLI Scheme for IT Hardware (2021) – INR 7,350 crore incentive pool to promote domestic manufacturing of laptops, tablets, servers, with ESG-compliant production encouraged.
- E-Waste (Management) Rules, 2022 – Mandates Extended Producer Responsibility (EPR) with targets up to 70% collection by 2025.
- NITI Aayog's Circular Economy Roadmap – Recommends repairability scoring, recycled material mandates, and product longevity standards.

### Market Opportunity

- India's electronics market expected to reach USD 400 billion by 2030.
- Potential to generate USD 20 billion in revenue from organized e-waste recycling.

# Social Responsibility in Electronics

## Labour, Inclusion, and Digital Equity

Sustainability in electronics goes beyond environmental goals — it includes ethical labor practices, diversity, and equitable technology access.

### Key Areas of Social Responsibility

**Labour Practices**

- Elimination of child and forced labor in supply chains.
- Fair wages and safe working environments in assembly plants.

**Diversity & Inclusion (D&I)**

- Women comprise only 32% of the electronics manufacturing workforce globally; targeted hiring programs aim to raise this to 40%+ by 2030.

**Digital Equity**

- Bridging the digital divide by making refurbished devices and affordable internet available in underserved regions.
- Example: HP's "Digital Equity for 150 Million People by 2030" program.

## Global Social ESG Benchmarks in Electronics

| Metric | 2023 Average | Leading Practice Target |
|---|---|---|
| Women in Workforce (%) | 32 | ≥ 40 |
| Supply Chain Audits Conducted | 68% | 100% |
| Employee Training Hours/Year | 22 | ≥ 40 |

## India-Specific Initiatives

- NASSCOM's FutureSkills Prime program integrates ESG skill training for electronics workers.
- Digital literacy drives in rural areas supported by OEMs under CSR mandates.

# Compliance and Carbon Footprinting Tools

Compliance now demands continuous monitoring, transparent disclosures, and verifiable third-party audits. Global buyers require ESG adherence across the full product lifecycle, from raw material extraction to post-consumer recovery.

## Core ESG Compliance Domains in Electronics

- Material Compliance: Adhering to standards like RoHS (restricting hazardous substances) and REACH (controlling chemical use).
- End-of-Life Management: Mandates like WEEE (EU) set e-waste collection targets, and India's 2022 E-Waste Rules require EPR plans.
- Carbon Emission Disclosure: Using frameworks like CDP and GHG Protocol to report accurate Scope 1, 2, and 3 emissions.

## India's Green Electronics Regulatory Timeline

| Year | Regulation/Policy | Key Impact |
|---|---|---|
| 2016 | E-Waste Rules | EPR introduced |
| 2021 | PLI IT Hardware | ESG manufacturing push |
| 2022 | E-Waste Rules Update | Stricter collection targets |
| 2023 | CE Roadmap | Circular economy integration |

## Carbon Footprinting and LCA Tools

| Tool Name | Key Functionality | Relevance to Electronics |
|---|---|---|
| SimaPro | Full LCA modeling | Measures environmental impact of chipsets, batteries |
| GaBi | Supply chain simulation | Models trade-offs of material substitutions |
| Carbon Trust Calculator | Simplified carbon footprint | Suitable for SMEs |

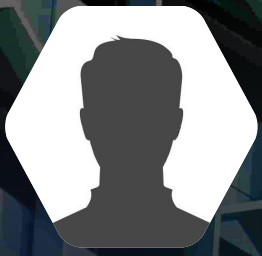
Leaders!
I bet we are going to make it big with the new set of innovations and regulations in the place.
Now let's fill in our popcorn buckets and brace ourselves for some insightful discussions!

# Healthy Leadership builds healthier tech

03

# IMC 2024 Discussions and Engagements

**Panelists**



**Rashim Kapoor**
EVP, Network Mobility,
Bharti Airtel

**P. Mittal**
Deputy General Manager,
MTNL; Research Scholar in
Green Energy Technologies

Panel Title

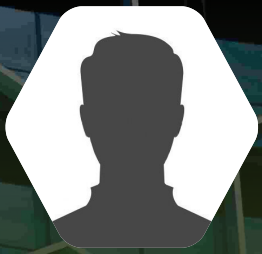
# Decarbonizing for a Sustainable Digital Future

**Namrata Rana**
**National Head of ESG**

Moderator

Panelists

**Magnus Ewerbring**
CTO, APAC, Ericsson



**Dodu Sam**
Technical Director,
PROSE Technologies

# Here is what was discussed in the panel

**Rashim Kapoor**
Mr. Kapoor stated that Airtel is committed to reducing its carbon footprint by $100\%$ by 2050 ($50\%$ by 2030), deploying $5\text{x}$ more power-efficient 5G radios, and pursuing RE100 for data centers, despite the challenge of tripled data consumption.

**P. Mittal**
Ms. Mittal discussed that while equipment is efficient, $5\text{G}'s$ high throughput increases overall energy consumption, emphasizing the need for dynamic energy control and renewable adoption. She later viewed that the greatest challenge is the e-waste generated from technology upgrades.

**Magnus Ewerbring**
Mr. Ewerbring affirmed that Ericsson has carbon net zero goals for 2040, achieved via sustainable operations, efficient products, and enabling other industries to cut emissions, citing a case where IoT sensors lowered mining ventilation energy use.

**Dodu Sam**
Mr. Sam outlined that existing antenna systems waste $30$-$35\%$ of input power, discussing innovations that reduced this wastage to $10\%$, incorporated recyclable materials, and proposed integrating direct solar power into hardware.

**Namrata Rana**

Ms. Rana concluded that decarbonization is about balance—growth versus emissions, utilization versus waste—stressing that a systems approach covering emissions, e-waste, and telecom-enabled sustainability is critical for long-term environmental goals.

**Conclusion**

The speakers agreed that achieving decarbonization requires balancing rapidly increasing data demand with technological innovation, managing e-waste, and implementing systems-level efficiency, guided by science-based targets and renewable energy adoption

# IMC 2025 Discussions and Engagements

**Panelists**

**Dr. M. P. Tangirala**
Member, TRAI

**Sh. Sanjeev Banzal**
Director General,
ERNET India

**Sh. Pushpender Gaur**
Regional Controller of Mines, IBM (Indian Bureau of Mines)

Panel Title

# Green Telecom: Green Premium or Green Savings?

## Sh. Manoj Kumar Singh

**Director General, DIPA (Digital. Infrastructure Providers Association)**

**Moderator**

Panelists

**Ms. Harini Malik**
Senior Director, WW Strategic Business Development Lead, AMD

**Sh. Ashwini Kumar**
Head of Standards, Nokia Solutions & Networks Pvt. Ltd.

**Sh. Deval Sood**
AVP – Regulatory, Bharti Airtel

# Here is what was discussed in the panel

**Dr. M. P. Tangirala**
Dr. Tangirala asserted that India's regulatory trajectory pushes operators toward energy-efficient networks and better ESG reporting, aiming to align sustainability with long-term cost efficiency using spectrum policy and clear carbon disclosures.

**Sh. Sanjeev Banzal**
Mr. Banzal affirmed that research networks are early testbeds for green technologies, highlighting that ERNET's pilots show advanced traffic engineering and server consolidation can meaningfully cut energy bills and provide a scalable blueprint for commercial operators.

**Sh. Pushpender Gaur**
Mr. Gaur described that "green telecom" is inseparable from "green electronics," underlining the importance of responsible mining, traceability of critical minerals, and circularity to reduce the embedded carbon in telecom equipment supply chains.

**Ms. Harini Malik**
Ms. Malik spoke on how modern chip design can dramatically cut power per bit, showcasing how energy-efficient processors combined with AI-based power management can reduce Total Cost of Ownership, proving green silicon delivers performance and savings.

**Sh. Ashwini Kumar**
Mr. Kumar outlined that global standards bodies are embedding energy-efficiency metrics—like sleep modes and power-saving features—into $5\text{G}$ and $6\text{G}$ specifications, arguing that interoperable standards turn ESG targets into measurable engineering goals.

**Sh. Deval Sood**
Mr. Sood discussed that although short-term capital expenditure is a pressure point, lifecycle economics favor green networks, stressing that regulatory incentives and green finance can accelerate the point where "green" clearly becomes "green savings."

**Conclusion**
The consensus was that regulatory alignment and standards are crucial for making green telecom profitable. By leveraging efficient silicon, circular supply chains, and AI-driven optimization, operators can transform green investments into a powerful Opex reduction strategy.

**Interesting and exciting!**
Those are the only words I could think of after going through the conversations of these leaders at these conferences.
Buddie's, charge your batteries and brace yourself for our next fun and learn segment.

# 04 Learning with Fun

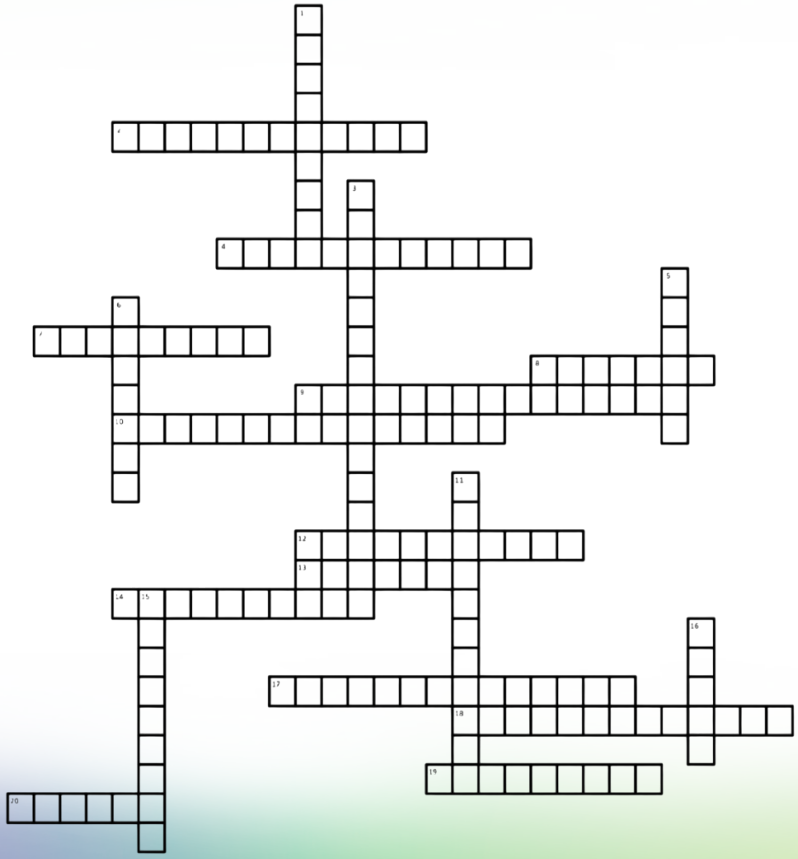
# Crossword

Across

3. Combination for account access
4. Network security barrier
7. Process of confirming identity
10. Computer virus, spyware, etc
12. Unsolicited email or messages
13. Data scrambling for protection
14. Virtual private network for secure online browsing
17. Scam email targeting personal information
18. Unauthorized access to sensitive information
19. Malicious activity on a computer system
20. Software to protect against viruses and malware

Down

1. Criminal activity in cyberspace
2. Malicious software disguised as legitimate
5. Malware that demands payment for data return
6. Unique physical characteristics used for identification
8. Device connected to a network
9. Collection of hacked computers controlled remotely
11. Trial-and-error method to obtain passwords
15. Update to fix security vulnerabilities
16. Unauthorized access to a computer system



# Find the Words

E I R U W N M A R E W A S T E E U T I S E
B L O A C I R C U L A R E C O N O M Y U N
T N N U E S G L A O H I R E N B S A D S V
I A R H L O R G A N I C F A R M I N G T I
E N A C S R I N O T U R M I G P B U C A R
D O H W I N D T U R B I N E N F R P Y I O
C T O R E N L R S D B A T E Y A O C R N N
K E B E U T M E A E O C N W T I I Y H A M
G C B N B E O C C D R V A I T R F C M B E
E H I E I D N Y O U S T A Y N T O L R L N
O N O W O C E C S N T M T O C R S I I E T
T O D A F Y G L E N O I U V L A I N R D A
H L I B U E N I Y T L S I A L D C G E E L
E O V L E P D N T I G M I N E E C T F V I
R G E E L U R G B N A O D P I L F O F E M
M Y R C V A T A I I O E B H G D I M I L P
A N S T F S N T R A N L U F B Y I S C O A
L E I W U I S D O I A F B W P I E O I P C
U A T L A O R B E I A P S O H C N T E M T
A O Y T P L D I R E M I S S I O N S N E N
S H S M U H Y D R O E L E C T R I C C N C
E U O L I D G N F P W A S I B V E A Y T N
S C P Z I S A U C O R I G A U H E C S A R
C A R B O N F O O T P R I N T I E G N T L

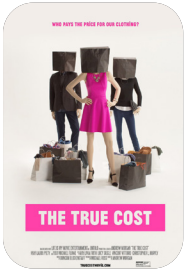
# Electronics in Movies


## Wall-E (2008)

Pixar's dystopian vision of Earth abandoned due to environmental neglect prominently features mountains of discarded electronics, symbolizing the dangers of overconsumption without recycling systems.

## Welcome to Sodom (2018)

A raw, documentary portrayal of Ghana's Agbogbloshie scrapyard, one of the largest e-waste dumping grounds in the world, exposing toxic dismantling methods, child labor, and health hazards linked to unregulated electronics recycling.

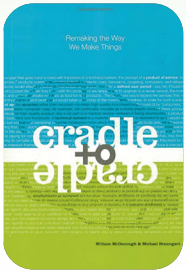

## The True Cost (2015)

While centered on fast fashion, it mirrors electronics industry issues such as hazardous waste disposal and exploitative labor practices, illustrating that ESG failures cross sector boundaries.

## Erin Brockovich (2000)

Based on a real case of corporate chemical contamination, this film indirectly relates to electronics manufacturing's use of toxic solvents and heavy metals, emphasizing the human cost of poor waste management.

# Literature in Electronics

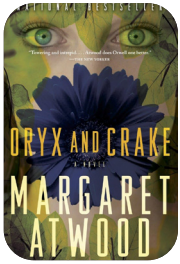


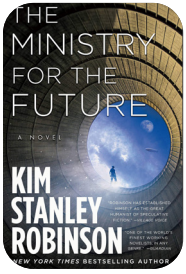

## Cradle (William McDonough & Michael Braungart, 2002)

Pioneers the closed-loop design approach, advocating for electronics to be designed with full material recovery in mind.

## Oryx and Crake (Margaret Atwood, 2003)

Explores corporate bioengineering excesses, serving as a cautionary parallel to unchecked electronics innovation without sustainability safeguards.



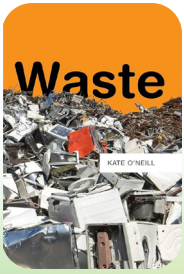




## The Ministry for the Future (Kim Stanley Robinson, 2020)

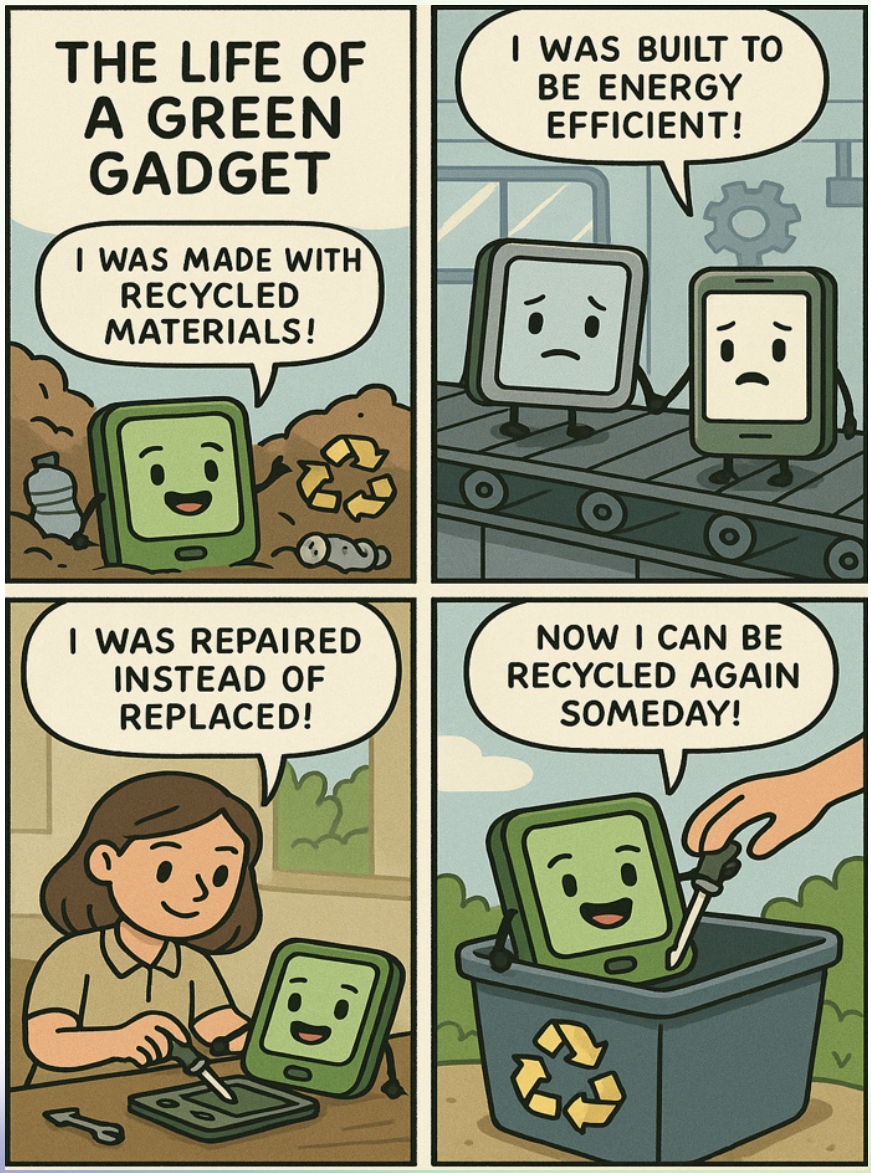
Depicts near-future climate governance structures, including carbon budgets, electronic product lifecycle controls, and circular manufacturing mandates.Cradle to

## Waste: An Unequal World (Kate O'Neill, 2019)

Investigates the global e-waste trade, highlighting how developing nations bear the brunt of hazardous electronics disposal and informal recycling.

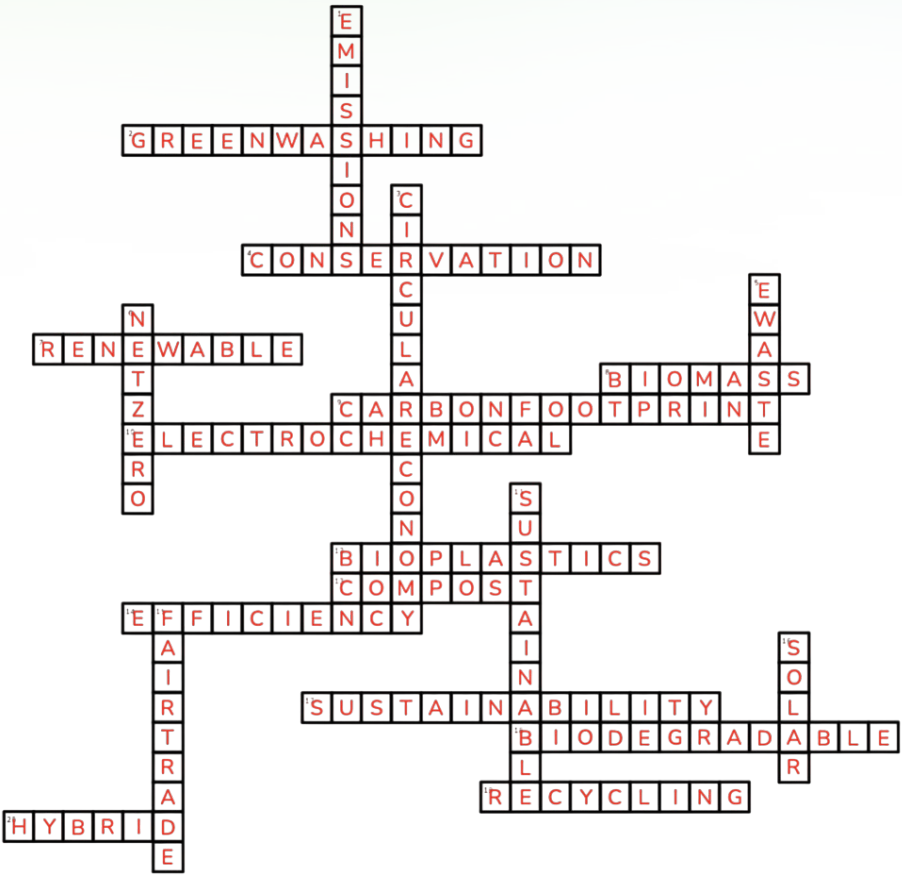


# Comic Strip


THE LIFE OF A GREEN GADGET
I WAS MADE WITH RECYCLED MATERIALS!
I WAS BUILT TO BE ENERGY EFFICIENT!
I WAS REPAIRED INSTEAD OF REPLACED!
NOW I CAN BE RECYCLED AGAIN SOMEDAY!

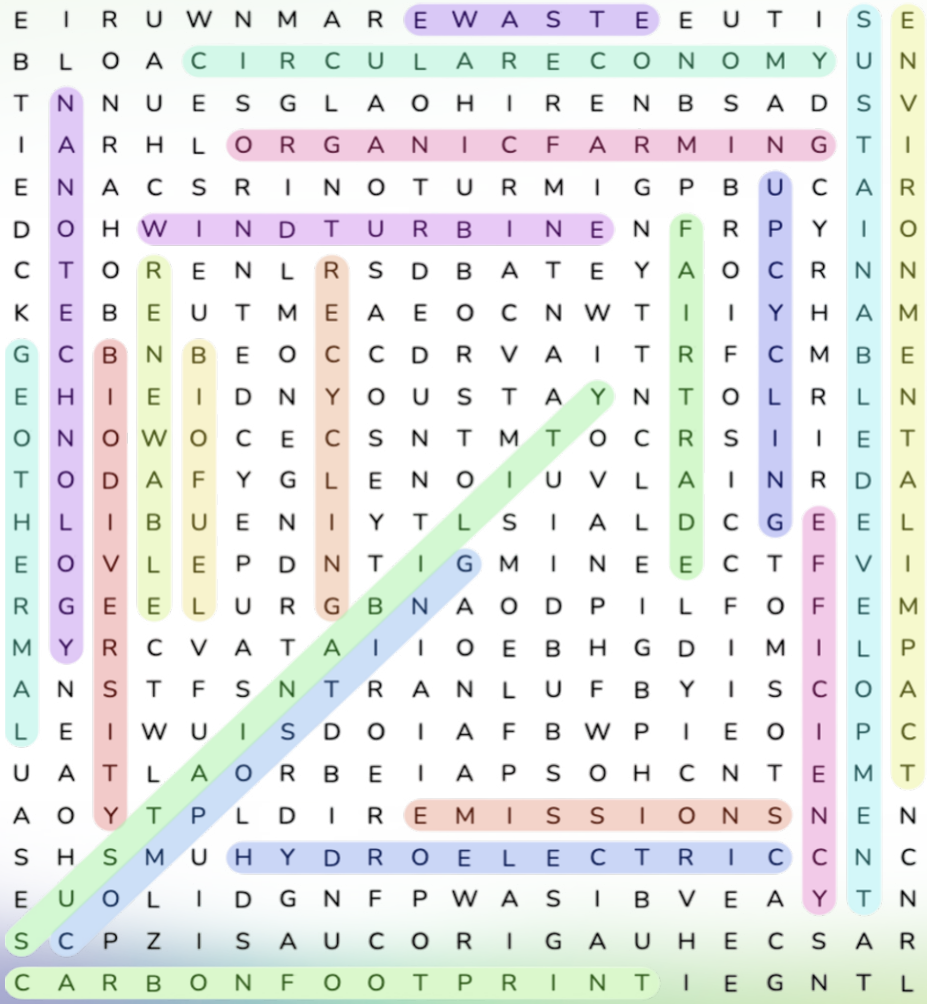
# Solutions

## Crossword



# Find the Words

Biodiversity
Biofuel
Carbon footprint
Circular economy
Composting
E-waste
Efficiency
Emissions
Environmental impact
Fair trade
Geothermal
Hydroelectric
Nanotechnology
Organic farming
Recycling
Renewable
Sustainability
Sustainable development
Upcycling
Wind turbine



# Bibliography


1. https://www.dreamstime.com/comparison-linear-circular-economy-infographic-scheme-product-life-cycle-raw-material-to-production-consumption-image263539021
2. https://www.statista.com/chart/32690/estimated-life-cycle-greenhouse-gas-emissions-of-electronic-devices/
3. https://www.behance.net/gallery/4960665/E-waste-Infographic/modules/39215633
4. https://www.coherentmarketinsights.com/industry-reports/active-electronic-components-market
5. https://www.fortunebusinessinsights.com/industry-reports/bioplastics-market-101940
6. https://www.yahoo.com/lifestyle/why-rare-earth-elements-rare-090000083.html
7. https://deltalogix.blog/en/2023/02/01/green-supply-chain-the-sustainable-supply-chain-management-challenge/
8. https://www.gminsights.com/industry-analysis/reverse-logistics-market
9. https://yourstory.com/2024/10/green-jobs-market-awaits-skilled-talent-amid-ripe-opportunities-sustainability

IMC 25

Discover how the tech world is coding its future green! Learn how market growth by 2030 is powered by innovative companies achieving net-zero goals, tackling the 62 million-tonne e-waste crisis, and embracing refurbishment. We explore key leaders, AI-driven supply chain transparency, and the crucial role of ESG compliance and global regulations like RoHS and WEEE. This book offers the definitive roadmap for navigating the sustainable technology imperative.


Scan to get the Digital Book

www.indiamobilecongress.com
www.zamun.com