Current trend in domestic production of India and the E-waste generation potential

Dr. Sandip Chatterjee
Director,
Ministry of Electronics Information Technology
Government of India
sandip@meity.gov.in
Electronics Industry in India: A Snapshot

- India’s share in global electronics manufacturing grew from 1.3% (2012) to 3.5% (2010)
- Rapid growth in exports lately: 38% Y-o-Y in 2018-19
### Growth in Mobile Manufacturing

<table>
<thead>
<tr>
<th></th>
<th>2014</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile manufacturing units</td>
<td>2</td>
<td>&gt; 200</td>
</tr>
<tr>
<td>Number of Mobile handsets produced*</td>
<td>60 million</td>
<td>330 million</td>
</tr>
<tr>
<td>Value of mobile handsets produced*</td>
<td>$3 billion</td>
<td>$30 billion</td>
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*Data refers to the financial year

**India has emerged as the second largest manufacturer of mobile handsets in the world**
New Schemes for Electronics Manufacturing

Production Linked Incentive Scheme (PLI) → Large Scale Mobile Manufacturing

Scheme for Promotion of Manufacturing of Components and Semiconductors (SPECS) → Domestic Electronics Supply Chain of Components

Electronics Manufacturing Cluster Scheme (EMC 2.0) → Infrastructure and Common Facilities

<table>
<thead>
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<th>5 Year Outcomes</th>
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<tbody>
<tr>
<td>Production</td>
</tr>
<tr>
<td>INR 8.0 Lakh Cr (USD 106 Bn)</td>
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<tr>
<td>Exports</td>
</tr>
<tr>
<td>INR 5.8 Lakh Cr (USD 77 Bn)</td>
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<tr>
<td>Employment</td>
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<td>10 Lakh</td>
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Total incentives of up to INR 50,000 Crore (~ $6.7 Bn)
Top E-waste Generating in 2019

Global Generation: 53.4Mn T

India at 3rd Position in the world in E-waste Generation

Source: United Nation University, ITU 2020
Present Challenges

- All the EEE used in India not included in Schedule-I *(presently only 21 Nos. products)*
- Choice of products are not either based on CRM or Toxicity presence
- Mass balancing system to audit the materials leakages
- Capacity, infrastructure and technical capability auditing for 407 authorised recyclers
- Process audit for PROs/ Dismantlers/ Recyclers to set a benchmark
- Citizen Awareness and skilled manpower
- Affordable infrastructure: machine & equipment to extract the materials
- Affordable process technology: machine and equipment to extract the materials
MeitY’s Initiatives on Sustainable E-Waste Management

1. Effective Awareness to stakeholders
2. Low cost processing technology
3. Affordable Machine and equipment
4. Promote start-ups and entrepreneurship
5. Creating Skilled manpower
.............sensitising citizens.....
E-waste Awareness Programme (2015-2020)

website: www.greene.gov.in

Green electronics for a sustainable future
Manage E-WASTE responsibly

End of track for E-WASTE

GreenE: Footprint created…
Awareness Programme: Salient Achievements

Resources Created

• Stakeholder specific contents

• Training manual, short films, posters etc. created for ATL/BTL Activities

• Online/ Social Media Engagement

• Freely available in GreenE website for citizen

• eLearning Content for 7th to 9th std. students developed for DIKSHA Platform

• Standard protocol to carry out e-waste inventory study developed for MoEF&CC, CPCB

Source: https://greene.gov.in/
Outreach

- **31 States and UTs** covered
- **1923 Activity/ Workshop**
- **Total Participants**: 16,52,031

- **Mass Awareness**: 2813 cinema: 20,11,62,090
- **GreenE Champions created**: 1247
............. ... Creating technology.... .....
Recycling Technology - low cost

Printed Circuit Board

1. PCB Processing technology physical separation methods and upscaled
   
   - Pulverization, physical separation, chemical leaching etc.
   - Pilot Plant level demonstration done to recover precious metal from 1 Metric Tonnes of e-waste with a recovery rate of 95%.
   - Commercialization **NML, Jamshedpur**

2. Printed circuit boards processing technology was successfully developed & demonstrated
   
   - Depopulation, pyrolysis, calciner, chemical leaching etc.
   
   **CMET, Hyderabad & E-parisara, Bangalore**

*Accomplished during 2007-2010*
Recycling Technology- low cost

C-MET Hyderabad

Status: Technology Transferred to M/s Namo Recycling
End user: Copper smelters, E-waste recyclers
Capacity: 30 TPA
100Kg PCB (3.5MT e-waste) /batch

EPPL Bangalore

Capacity: 300 TPA
1000Kg PCB (35MT e-waste) /day
Accomplished during 2010-2014
Recycling Technology - low cost

**WEEE Plastics**

Collection, segregation/identification of plastics

Blending with additives & fillers for properties optimization

- Grinding, washing mechanical recycling

7 categories of plastics: (ABS, HIPS, PC, PP, PVC, nylons, Epoxy, phenolic, Polyesters etc.)

- **Homogenous type Type 1**: (76%): housing, mouse etc. Processing technology developed to convert these plastic to Master batch for value added product, gained virgin properties, Process patented.
- **Heterogeneous type**: Type 2 (20.5%): connectors, cartridge, etc., & Type 3 (3.5%): Thermoset plastics containing BFR, fillers & heavy metals

**Status**: Technology Transferred Neel Plast Pvt. Ltd. Bhubaneswar

**Accomplished during 2009-2012**

CIPET, Bhubaneswar
Centre of Excellence on E-Waste Management

Vision
• Self-sustaining ecosystem capable of managing India’s e-waste

Mission
• To lead transformations by creating a conducive e-waste management environment which nurtures innovation, entrepreneurship and capacity building

Goal
• Complete recycling solutions for spent PCBs, Li-Ion Batteries, Phosphors, Permanent Magnets and PV modules
• Design & fabrication of cost effective and energy efficient process equipment for E-waste recycling
• Create Indian Intellectual Property

Participatory Funding
• MeitY: GoI (40%) + State Govt. Of Telangana (40%) + Industry (20%)

Academic Collaborations
• National: IIT Hyderabad, CIPET, Bhubaneswar
• International: National Institute for Environmental Studies (NIES), Japan

Created on September 2019, for 5 yrs
Target Delivery

Affordable Recycling Process Technology & Machines: IP Generation

• PCB, Li-ion Batteries, phosphors, permanent magnets and PV modules

Technology transfer

• Dismantling & Training: 50 SMEs
• E-waste Recycling: 12 start-ups
• Empowerment of Informal Sectors: 10

Training/ Skill Development and Capacity building

• RoHS practices: 100 SMEs
• Collaboration with academic institutions 4 Ph. Ds & 20 M. Techs

Dedicated Infrastructure

• 500 Kg PCB/day E-waste processing facility at Telangana Govt. Site
Achievements

- Spent PCB recycling technology augmented to 300 Kg/day capacity
- Recycling services to 5 industries for recovery of precious metals
- Completed design augmentation of recycling process equipment: 1000 kg/day.
- Designed the dismantling system for small, medium and large equipment.
- IP created
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Selective metal recovery process from waste Li-ion batteries: Hydrometallurgical route

**Achievement**
- 100 % extraction of Lithium achieved
- 90 % Co extraction and 100 % Mn extraction achieved using selective solvent
- IP under preparation
Achievement
• High metal recovery with less burning loss
• IP created

Technology Offerings
Achievement
• IP created

Technology Offerings

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NdFeB Powder
RE precipitate
RE oxide

Rare Earth elements extraction from Spent Permanent Magnets

Spent permanent magnet

Thermal demagnetization
Pulverization
Size reduction
NdFeB magnet concentrates

Leaching
Controlled crystallization
S/L Separation
Precipitation (S)
Oxalate conversion
Calcination

Ni Layer residue
RE Oxide
Fe rich residue (L)
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**Red Phosphor:**
$Y_2O_3 : Eu^{3+}$
Y-67.2%, Eu-6.5%

**Green Phosphor:**
$CeMgAl_{10}O_{17}:Tb^{3+}$
Ce-9.5% Tb-5.3%,
Mg-5.7%, Al-31.3%

**Blue Phosphor:**
$BaMgAl_{10}O_{17}:Eu^{2+}$
Eu-1.9%,
Ba-12.4%, Mg-2.7%,
Al-32.4%

- IP created

**Technology Offerings**

**Solvent Extraction**

**Calcination**

**Mixed Rare Earth Oxides**

**Rare Earth nitrates**

**Y, Eu, Tb, Ce (Organic phase)**

**Mg, Al, Ba (Aqueous phase)**

**Rare Earth Oxides**

**Waste Phosphors**

**Acid leaching**

**Rare Earths & other metals as impurities**

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**Rare Earth Oxides**

**Waste FLs**

**Crushing FLs using Bulb eater**

**Removal of Mercury (Hg)**

**Spent Phosphors**

**Acid Leaching ($H_2SO_4$)**

**Sulfate solution of Eu, Y, Ce & Tb and other metals as impurities**

**Solvent Extraction**

**Rare Earth elements extraction from Fluorescent Lamp (FL) Phosphors**

**Rare Earth Oxides**
Recovery of valuable materials from end-of-life silicon solar cells

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Discarded solar cell panel

Physical dismantling and separation of Si solar cells

Thermal treatment

Chemical processing (dissolution and extraction)

Removal of anti reflection layer and other metals

Recovery of solar grade Si

Treatment of waste chemicals

Thermal treatment of solar cell

Hot air oven at ~400 °C  Waste solar cells sample after 7 h heating (~400 °C) a) Front & b) Back View

Technology Offerings
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Industry Engagement: PCB Recycling
Technology transferred to M/s NAMO eWaste, Faridabad
Interested for Technology roll out
Sadbhavana Seva samasthe

Industry Engagement: Lithium ion batteries Recycling
Interested for Technology Partnership
Sadbhavana Seva samasthe
Centre of Excellence on E-Waste Management

2 Years M.Tech. programme in E-waste Resource Engineering & Management

PCB recycling training

RoHS training
skilled manpower and entrepreneurship
Capacity building, skill & entrepreneurship development for youth at NE states

Target
• Skilled manpower & entrepreneurship development dismantling & segregation
• Training & demonstration facility at NE states
• Generate employment and business for the skilled youth at recycling industry

Goal
(i) Master Trainers: 20 nos
(ii) Trained skilled entrepreneurs: 240 nos. (30 from each 8 States)

Achievements
• Industry/ training agencies for training and hand-holding engaged
• Training materials/ Basic course curriculum, SoP etc. designed and developed
• 8 State Govt. agreed for handholding/ implementing supports
• Smart classroom, LMS with VC & white board software created online training
• Dedicated site www.ewasteskills.nielit.gov.in developed
• Creating industry eco-system for start ups being explored with MSME, Sikkim

Created on February 2020, for 2 yrs
.......... towards circular economy....
Global Scenario to ensure Circular Economy

- **R2R - legislation** intends to allow consumers the ability to repair and modify their own consumer electronic devices, where otherwise the manufacturers forces consumers to only use their services
  - **USA**: South Dakota, New York, Minnesota, & Massachusetts—introduced "R2R" laws (2014-2016) to mandate OEMs to provide the required info. & documentation for consumers & 3rd party repairer for the job. **25 States** introduced similar legislation in 2019. EU’s legislation, 2019 says manufacturers mandates to supply replacement parts for 10 years since 2021
  - **Against**: OEM considers this as breach of IP, threat to people safety, argues hackers could insert vulnerabilities in repaired devices to affect a user's privacy & security
  - **For**: slowing the rate of recycling, reduce energy consumption for recycling as well as fresh production, hence environment protection

- **Recycling standards**: CENELEC, Global Recycled Standard (GRS), ISO, R2 Standards

- **Eco-labels and Green Stickers** for sustainability: energy consumption/ creating pollution

- **Circular Economy Indicator**: Raw material consumption, CRM, Life cycle analysis, EoL recycling rate, Recycling rates, Recyclability benefit rate, Energy recoverability benefit rate, Trade in SRM, Waste generation, WEEE management etc.

- **Green Public Procurement** to ensure more resource-efficient economy, critical mass of demand for sustainable goods and services, stimulus for eco-innovation.
Circular Economy Challenges: *Design for Environment (DfE)*

- **Design Requirements:** Products designed for obsolescence rather than longevity or repair or upgrade or remanufacture

- **Fundamental legal barriers** preventing accessible repair: IPR infringements,

- **Non-legal barriers**: Lack of awareness, knowledge, tools, manuals or spare parts, costs of repair, time and convenience, lack of trust, risk of poor quality & availability of cheap new products makes repair a less competitive option

- **Consumer preferences and attitudes not favoring repair**: Cultural aspects that make repair less desirable independent of costs and other barriers

- **Fair Repair-bills**: OEMs to provide repair service, service documentation, diagnostics, tools, firmware & service parts available, on fair and reasonable terms, to their customers and to independent repair technicians
Circular Economy Barriers: Repairing Sector

- Design lifetimes/ Planned obsolescence prevents repair
- **End-user license agreement**/ sales contracts **forbids** repair, modification of software-enabled products, use non-OEM parts. Violation extends to breach of contract IP laws
- Dissembling **proprietary screws**/ slim, compact & sleek make products **non-removable batteries** is difficult, so repair become impossible
- OEM refuse to provide spare parts/ software support to other repairers
- Unauthorized distribution of software, restoration of operation of disks is unlawful, breaking technical software locks is against Copyright law
- Design measures: **Software doping** prevents products work with 3rd party parts/ Equipment compatibility issue (e.g. printers ink cartridges/ electronics battery chargers)
- **Technical lock on software** incl. **Digital Rights Management (DRM)** and **Technical Protection Measures (TPM)**
- Software repair/ **copying codes** is infringement. Updated embedded software makes repaired device less functional, pose security risks, or loses the ability to retrieve data
- **Lack of awareness:** consumer rights/ legality of warranty prevents R2R
Way Forward: Circular Economy in India

- Products to design longevity or repair
- Design for Environment (DfE) to Reuse/ refurbished/ minimize e-waste
- RE to consider during manufacturing process. To create awareness on RE & CE benefits
- To track SRM (secondary raw materials) or CRM (critical raw materials)
- Motivation or incentive for Green design and innovation
- Legislative and regulatory framework: Right to Repair, Echo-level to promote circular economy
- Standards for refurbishments, Dismantling, Segregation & Recycling
- E-waste Management Rules 2016 allows refurbished electronics products. CRO (compulsory registration obligations) to provide appropriate standards
- Consumers to provide choice for safety/ quality std. for refurbished products