The Missing Links of Battery Waste Management

A situation analysis in India perspective

MANJUSHA MUKHERJEE,
Toxics Link, New Delhi
Small batteries
A GLOBAL BUSINESS

- Small/pencil/household/dry-cell batteries: Primary or non-rechargeable & Secondary or rechargeable
- Use: remotes, toys, watches, flashlights, cameras, radio, calculator, smoke detectors, various medical & electronic devices

Business: 120 billion US$ by 2019; 15 billion pieces sold

Business: 8.6 billion US$ by 2022; Consumption: 2.7 billion pieces
<table>
<thead>
<tr>
<th>Battery types</th>
<th>Common Usages</th>
<th>Electrodes</th>
<th>Electrolyte</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkaline</td>
<td>CD, MP3 players, toys, camera, flash lights, remote controls</td>
<td>Manganese dioxide + zinc</td>
<td>Potassium Hydroxide</td>
</tr>
<tr>
<td>Carbon Zinc</td>
<td>Clocks, radios, smoke alarm</td>
<td>Manganese dioxide + zinc</td>
<td>Zinc chloride</td>
</tr>
<tr>
<td>Lithium Coin</td>
<td>Calculators, electronic organizers</td>
<td>Metallic Li + MnO2/Carbon Monofluoride</td>
<td>Mixture of Organic Materials</td>
</tr>
<tr>
<td>Lithium Photo</td>
<td>Cameras</td>
<td>Metallic Li + MnO2/Carbon Monofluoride</td>
<td>Mixture of Organic Materials</td>
</tr>
<tr>
<td>Silver Oxide</td>
<td>Watches</td>
<td>Silver Oxide + Zinc</td>
<td>KOH/NaOH</td>
</tr>
<tr>
<td>Zinc Air</td>
<td>Hearing aids</td>
<td>Zinc + Oxygen</td>
<td>KOH</td>
</tr>
</tbody>
</table>
## Types, Usage & Composition

<table>
<thead>
<tr>
<th>Battery Types</th>
<th>Common Usages</th>
<th>Electrodes</th>
<th>Electrolyte</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rechargeable</td>
<td>CD/MD/MP3 players, toys, camera, flash light, remote controls, solar lighting</td>
<td>MnO&lt;sub&gt;2&lt;/sub&gt; + Zinc</td>
<td>KOH</td>
</tr>
<tr>
<td>Alkaline</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nickel metal hydride</td>
<td>Digital cameras, remote controlled racing toy cars</td>
<td>Nickelic/Nickelous Hydroxide + Metallic rare earth alloys</td>
<td>KOH</td>
</tr>
<tr>
<td>Nickel Cadmium</td>
<td>Power Tools</td>
<td>Nickelic/Nickelous Hydroxide + Metallic Cd or Cd(OH)&lt;sub&gt;2&lt;/sub&gt;</td>
<td>KOH</td>
</tr>
<tr>
<td>Lithium (Li) ion</td>
<td>Notebook computers, PDAs, mobile phones, camcorders, digital cameras</td>
<td>Compounds containing Li ions + Carbon materials</td>
<td>Mixture of organic material</td>
</tr>
<tr>
<td>Lead Acid</td>
<td>Car starter battery, lift trucks, golf charts, marine, standby power</td>
<td>Lead or Lead compounds</td>
<td>Sulphuric acid</td>
</tr>
<tr>
<td>Steel, aluminium, copper and zinc are most widely used metals of all globally</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>India imports Zn for domestic consumption</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recovery reduces: mining requirement, landfill load, emission and waste generation in primary production,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saves non-renewable resources, energy, water and cost consumption of primary production</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Composed of heavy metals, like, Cadmium, nickel, lead, mercury, copper, zinc, lithium, manganese
- Some chemicals are extremely toxic & harmful to human & environment
- Differs in shape, size, chemistry - complex & expensive to sort & reprocess
- Needs skills & knowledge to event sort
The Case of India

Usage to disposal: 97% non-rechargeable zinc-carbon cells

Highest battery usage:
- remote controls (TV, AC)
- clocks/watches, toys
- torches, camera
AWARENESS & DISPOSAL IN HOUSEHOLDS

86.5%
Unaware of the hazards associated with batteries

92.5%
Throw batteries in common household dustbins
The Informal Ways
VALUE CHAIN OF SPENT BATTERIES

Consumers

Waste pickers (from household bins)

Small kabaddiwalas

Big kabaddiwalas

Landfill

Ragpicker

Dismantler

Recycler
## Economics of the Informal Ways

<table>
<thead>
<tr>
<th>Seller</th>
<th>Buyer</th>
<th>Product</th>
<th>Price (INR per kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Households, Waste Pickers, Rag Pickers, Small Kabadis</td>
<td>BigKabadis</td>
<td>Used battery along with other household waste</td>
<td>1-1.5</td>
</tr>
<tr>
<td>Big Kabadis</td>
<td>Recyclers</td>
<td>Segregated discarded batteries (depends on the price of zinc in the market)</td>
<td>2.5-3</td>
</tr>
<tr>
<td>Recycler</td>
<td>Scrap market</td>
<td>Steel (tin-plated) contents recovered from discarded batteries</td>
<td>5-6</td>
</tr>
<tr>
<td>Recyclers</td>
<td>Industry</td>
<td>Carbon rods recovered from discarded batteries</td>
<td>10</td>
</tr>
<tr>
<td>Recyclers</td>
<td>Industry</td>
<td>Zinc recovered &amp; smelted from discarded batteries (20% less)</td>
<td>120</td>
</tr>
</tbody>
</table>

### Resource Recovery (%)

- **Waste**: 36%
- **Steel (tin-plated)**: 5%
- **Carbon powder**: 50%
- **Carbon Rod**: 3%
- **Zinc**: 6%
Dead & Buried

INFORMAL BATTERY DISMANTLING UNITS NO-LONGER OPERATE IN DELHI

1. Infrastructural challenges, unavailability of space
2. Increased labour charges
3. Inefficient recovery leading to lowering profit margin
4. Old stocks are stored and new wastes go directly to landfills

- CURRENT INFORMAL RECYCLE NEGLIGIBLE;
- NO FORMAL RECYCLING;
- 2.4 BILLION PIECE ANNUAL LANDFILL LOAD;
- LINEAR LIFECYCLE - FROM MINED TO LANDFILLED
Resource Landfilled

Materials Recoverable in one ton of AA batteries: a comparison of formal & informal ways

<table>
<thead>
<tr>
<th></th>
<th>Formal Recovery in kgs</th>
<th>Informal Recovery in kgs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials Recovered</td>
<td>Zinc 258</td>
<td>Zinc 50</td>
</tr>
<tr>
<td></td>
<td>Steel 200</td>
<td>Steel 60</td>
</tr>
<tr>
<td></td>
<td>Manganese 217</td>
<td>Manganese 0</td>
</tr>
<tr>
<td>Remaining (carbon powder etc.)</td>
<td>326 Carbon powder &amp; rod</td>
<td>530</td>
</tr>
</tbody>
</table>

WHAT COULD HAVE BEEN SAVED!
For 2.7 billion battery consumption every year:

- 15025 tonnes of Zn,
- 15258 tonnes of Mn
- 10848 tonnes of Steel
- Carbon rods
IMPACT OF BATTERY WASTE LANDFILLING

- **Air Pollution**
  - Landfill decomposition, municipal waste combustion
  - Emission of volatile compounds
  - Human consumption
    - Food contamination
    - Surface water contamination
    - Groundwater & Surface Water Pollution

- **Soil Pollution**
  - Heavy metal leaching: Cd, Zn, Pb, Mn, Ni, Hg, Li
  - Permeation to ground water
  - Uptake by plants

- **IMPACTS**
  - Carcinogenic
  - Neurotoxin
  - Developmental toxicity
  - Renal (kidney) toxicity
  - Birth defects
90% DROP IN OVERALL ENVIRONMENTAL LOAD WHEN 100% RECYCLED ZINC IS USED

<table>
<thead>
<tr>
<th>Metal</th>
<th>Energy Saving in Terajoules/100,000 T</th>
<th>Percentage of Energy Savings</th>
<th>Carbon footprint Saving in Kilotonnes of CO2/100,000 tonnes</th>
<th>Percentage savings of CO₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc</td>
<td>600</td>
<td>25</td>
<td>180</td>
<td>76</td>
</tr>
<tr>
<td>Copper</td>
<td>1060</td>
<td>63</td>
<td>81</td>
<td>65</td>
</tr>
<tr>
<td>Nickel</td>
<td>1878</td>
<td>91</td>
<td>190</td>
<td>90</td>
</tr>
<tr>
<td>Aluminium</td>
<td>4460</td>
<td>95</td>
<td>354</td>
<td>92</td>
</tr>
</tbody>
</table>
Are they regulated in India?

Batteries (Management and Handling) Rules, 2001 & 2010 amendment

- Applies to lead acid batteries
- Not applicable to small batteries

Solid Waste Management Rules, 2016

- Defined ‘used batteries’ as ‘domestic hazardous waste’.
- Source segregation mandated
- Waste deposition centres, safe storage, transport to HW disposal facility, public awareness and management of HW as per the HW rules recommended for the lot.
- Landfilling suggested
- No recycling. No specific mention. No EPR for small batteries

Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2015

- Do not restrict waste batteries (excluding those containing lead, cadmium & mercury) import and export.
- Only mentioned as recyclable hazardous waste
Best practices in battery collection & recycling

- Battery take-back legislations regulating manufacture, collection, storage, transportation, recycling and disposal with phase wise collection targets – most effective – mandated in EU, US, Canada, Japan, Taiwan, etc.
- Upstream regulation: environmental consideration in product Design, Labeling requirements
- Downstream regulation: producer responsibility, public education program, PPP battery recycling programs, drop-off collection sites/networks, industrial stewardship
- State Fund model: managed by govt. organization, funded by producers
- Single organization model, Competing organization model, No-organization model (producer and authorized agencies)
KEY RECOMMENDATIONS

- A SEPARATE REGULATORY FRAMEWORK FOR SMALL BATTERIES MANAGEMENT
- TARGET BASED EXTENDED PRODUCER RESPONSIBILITY AS THE KEY PRINCIPLE
- SETTING UP OF ROBUST COLLECTION MECHANISM FOR CONSUMERS
- SUPPORT FOR BATTERY RECYCLING INFRASTRUCTURE
- CONSUMER AWARENESS.