India: Including the Existing Informal Sector in a Clean e-Waste Channel

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St Gallen/ Switzerland

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India’s booming economy generated 330'000 tons of e-waste in 2007
50’000 tons were imported (illegally)
95 % of it is recycled by the so-called informal sector
  + allows collection rates close to 100 %
  + provides a living to thousands of people
  - induces hazardous operations
  - the recycling chain is difficult to control
e-Waste Channels in India
Initial Situation (Bangalore)

Product → Waste

Consume → Collect → Recover → Dispose

- **Importers**
- **Manufacturers**
- **Retailer**
- **Private Consumer**
- **Corporate Consumer**
- **Donations (Import)**
- **Scrap Dealers**
- **Middlemen (Auctions)**
- **Rag Pickers**
- **Repair & Refurbish**

1. **End-of-life equipment from corporate consumer:**
   - Often sold to an "authorised" dealer, the pro-

2. **Material Recovery:**
   - Manual dismantling of hazardous components
   - Wires & cable burning
   - Precious metal recovery (e.g. gold leaching)

3. **Informal Dumping:**
   - Emissions from dumped residues / non-Valuable parts
   - Emissions from informal burning sites

**Informal sector**

Informal Dumping & Burning

Landfill

**Undesirable Operations:**

- Manual dismantling of hazardous components
- Wires & cable burning
- Precious metal recovery (e.g. gold leaching)
- Emissions from informal burning sites
The Need to Solve a Problem
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Soil analysis in Delhi

- Dioxin $> 350$ ng/kg TS
- Copper $> 7'500$ mg/kg TS
- Lead $> 50'000$ mg/kg TS
- Zinc $> 4'500$ mg/kg TS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Measured Value [mg/kgTS]</th>
<th>Indicative Value [mg/kgTS]</th>
<th>Investigation Value [mg/kgTS]</th>
<th>Alert Value [mg/kgTS]</th>
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<tbody>
<tr>
<td>Gold</td>
<td>&lt; 5.0</td>
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<tr>
<td>Copper</td>
<td>7'740.0</td>
<td>40.0</td>
<td>150.0</td>
<td>1'000.0</td>
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<td>50.0</td>
<td>200.0</td>
<td>2'000.0</td>
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<td>Zinc</td>
<td>4'730.0</td>
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<td></td>
<td>2'000.0</td>
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<td>Mercury</td>
<td>&lt; 1.0</td>
<td>0.5</td>
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<tr>
<td>Cadmium</td>
<td>1.6</td>
<td>0.8</td>
<td>2.0</td>
<td>30.0</td>
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</table>
EMPA’s objective in this context is to:

- reduce the risks to the population and the pollution of the environment resulting from unsafe e-waste handling.
- focus on knowledge transfer to and skills upgrade of all involved stakeholders through trainings and seminars.
- target mainly the existing informal recyclers allowing for their maximum but safe participation in future e-waste management by facilitating their evolution and integration in formal structures.
The Indian Clean e-Waste Channel
Aimed long term situation

Product ▶ Waste

Consume

Collect

Recover Function Material Energy

Dispose

Intervention & Control:

Importers

Manufacturers

Retailer

Corporate Consumer

Private Consumer

Donations (Import)

Authorized Dealers

Middlemen (Auction)

Rag Pickers

Repair & Refurbish

Smelter / Refinery

Larger Recyclers

Entrepreneurs

Landfill

Informal Dumping & Burning

Private Consumer

Middlemen (Auction)

Entrepreneurs

Authorized Dealers

Smelter / Refinery

Larger Recyclers

Informal Dumping & Burning
The Indian Clean e-Waste Channel
Aimed long term situation

Product ➔ Waste

Consume ➔ Collect ➔ Function ➔ Recover ➔ Energy ➔ Dispose

- Importers
- Manufacture
- Retailer
- Collectors
- Collector
- Private Consumer
- Consumer
- Donations (Import)
- Repair & Refurbish
- Authorized Dealers
- Smelter / Refinery
- Landfill
- Informal Dumping & Burning
- Authorized Dealers
- Midlamer (Auctions)
- Rag Pickers
- Larger Recyclers
- Entrepreneurs
- Smelter / Refinery
- Control through authorization with licenses
- Control through authorization with contracts
- Formalizing of the informal sector by substantial upgrade of skills & technology; promotion of new business models

Intervention & Control:
- Policy & Legislation
- Business & Finance
- Technology & Skill
Precious metal recovery from PWBs
Mass Flow Analysis – Wet Chemical Process

- PWEs: 1000 kg, 200 kg PWE, 100 kg Gold
- Dismantling:
  - Node PWE: 680 kg, 116 g
  - Duct: 50 kg
  - Disposal
- Connectors: 370 kg, 74 g
- Gold Extraction:
  - Scrap Metal: 367 kg, 11 kg
  - Gas & Liquid Emissions: 3 kg, 12 g
  - Disposal
- Chemicals & Energy: 1000 kg
- Gold: 51 g, 1000 kg
Alternative scenario: precious metal smelting and refining
Smelting / Refining Scenario

Flowchart showing the process of smelting and refining, including the movement of materials and emissions.
Proposed Business Model

The challenge:
• how to connect small family businesses to large industrial smelters?
• how to ensure homogeneous quality of the material?
• does the inherent value of the material pay for itself?
Proposed Business Model (2)

The buffer can be:
- a cooperative
- a medium / large formal recycler
- a dealer / middleman
- …
3 categories of PWBs

<table>
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<tr>
<th>Categories</th>
<th>Gold</th>
<th>Silver</th>
<th>Palladium</th>
<th>Platinum</th>
<th>Copper</th>
<th>Penalty</th>
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<td>50 ppm</td>
<td>500 ppm</td>
<td>20 ppm</td>
<td>1 ppm</td>
<td>15%</td>
<td>1% Cd</td>
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<tr>
<td>Medium grade</td>
<td>100 ppm</td>
<td>1000 ppm</td>
<td>40 ppm</td>
<td>1 ppm</td>
<td>15%</td>
<td>1% Cd</td>
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<tr>
<td>High grade</td>
<td>150 ppm</td>
<td>1500 ppm</td>
<td>60 ppm</td>
<td>1 ppm</td>
<td>15%</td>
<td>1% Cd</td>
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<td></td>
<td>200 ppm</td>
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<td>80 ppm</td>
<td>1 ppm</td>
<td>15%</td>
<td>1% Cd</td>
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<td></td>
<td>300 ppm</td>
<td>3000 ppm</td>
<td>120 ppm</td>
<td>1 ppm</td>
<td>15%</td>
<td>1% Cd</td>
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<table>
<thead>
<tr>
<th>Category</th>
<th>ppm Gold</th>
<th>Gross Value @ UPMR</th>
<th>Deductions</th>
<th>Deduction -%</th>
<th>Variable cost-%</th>
<th>fix cost-%</th>
<th>Net Value @ UPMR</th>
<th>Net Profit Alternate Business Model</th>
<th>Net Profit Baseline Scenario</th>
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<tr>
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<td>50</td>
<td>3107.53</td>
<td>2577.59</td>
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<td>38.97%</td>
<td>63.03%</td>
<td>561.32</td>
<td>140</td>
<td>760</td>
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<tr>
<td></td>
<td>100</td>
<td>5098.40</td>
<td>2634.07</td>
<td>52.21%</td>
<td>38.33%</td>
<td>61.67%</td>
<td>2462.33</td>
<td>2040</td>
<td>1190</td>
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<tr>
<td>Medium grade</td>
<td>150</td>
<td>7053.89</td>
<td>2718.28</td>
<td>38.83%</td>
<td>40.24%</td>
<td>58.76%</td>
<td>4335.81</td>
<td>3920</td>
<td>2860</td>
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<td></td>
<td>200</td>
<td>9011.37</td>
<td>2830.22</td>
<td>31.72%</td>
<td>42.60%</td>
<td>57.40%</td>
<td>6181.16</td>
<td>5760</td>
<td>3570</td>
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<tr>
<td>High grade</td>
<td>250</td>
<td>10368.86</td>
<td>2954.70</td>
<td>27.21%</td>
<td>45.02%</td>
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<td>8014.16</td>
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<tr>
<td></td>
<td>300</td>
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<td>52.76%</td>
<td>9847.17</td>
<td>9430</td>
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Batch of mixed low grade boards
Au 30 ppm / Ag 300 ppm / Cu 16%

Baseline scenario:
Benefit = 8 INR / kg (0.2 US$/kg)

Smelting / refining:
Net value of about 4.5 INR/kg
(or 0.12 US$/kg)

NOT WORTH TO EXPORTING! Cannot compete with local selling price!
Upgrade of Basic Cluster

Sold separately -> total of 14 INR / kg (or 0.35 US$/kg) !!!
Added value of 6 INR/kg (or 0.15 US$/kg)
Conclusions

- Informal waste recycling exists in all (developing) countries
- Wet chemical leaching of precious metals generalised in India and China only, but can appear very rapidly where e-waste accumulates if no proper system is implemented

This alternate business model presents:

Opportunities:
- Strong economic incentive to integrate the informal sector into the global economy
- Win-win model: increased material (and value) recovery / minimised environmental damage by avoiding inefficient hazardous processes
- Recycling of valuable parts could allow to finance the safe recycling of non-valuable fractions
- Regulated, legalized and controlled system
Conclusions

Challenges:
■ Functioning of the “buffer”: important starting capital, knowledge of the market, important payment delays, etc…
■ Authorisations: Basel Convention, local environmental legislation, taxes, export license, etc…
■ Gain trust from the informal sector: -> social impact?
■ Market prices of metals must remain high!

Further Research:
■ Extend similar studies to other fractions
■ Better understanding of process costs: which impact on the final balance?
THANK YOU FOR YOUR ATTENTION!

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QUESTIONS?