"Revolutionizing E-Waste Management: Unlocking the Untapped Value of Discarded Electronics"

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Imagine if i told you that we discard hundreds of millions of dollars into landfills every year. Take a moment to look around the room you're in right now – chances are, you'll spot numerous electronic devices. Our dependence on electronic devices is escalating, and with rapid technological advancements, newer models flood the market, leading to more discarded devices than ever before.

Electronic devices consist of various base and precious metals in their essential components. These metals boast recyclable and reusable properties. However, studies indicate that only 1 5-20% of electronic devices undergo recycling, leaving a significant reservoir of valuable metals untapped.

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E-Waste Recycling: Streamlining Physical Sorting

E-waste recycling kicks off with device disassembly, now enhanced by autonomous solutions like Apple's robots. Physical processing uses shredding and grinding to break components into manageable fractions.

Methods for sorting metal and non-metal fractions include:

- Shredding/Pulverization: Shapes metals and non-metals for separation based on malleability and gravity.
- Liquid-Based Sorting: Relies on specific gravity differences but faces efficiency challenges.
- Electrostatic Separation: Separates materials by conductivity, limited to small particle sizes.
- Magnetic Separation: Recovers ferrous metals like copper before crushing.

Despite advancements, challenges persist—potential

emew clean technologies

metal loss, purity issues, and high operational costs hinder widespread use.

Metal Extraction Options for PCBs

Smelting + Electrorefining

Smelting, currently a prevalent method treating up to 70% of PCBs, involves incinerating crushed PCBs in furnaces, creating a low-concentration PGM alloy with impurities. Base metals removal is necessary before processing PGMs. Integrated smelters mostly recover copper, as iron and aluminum concentrate in the produced slag. PCBs' ceramics and glass contribute to higher slag formation, causing a significant loss of precious and base metals. Apart from high energy consumption, smelting poses a risk of dioxin and other hazardous toxins release, addressed by advanced pollution abatement processes.

For additional metal processing, electrorefining is essential. In this process, anodes are cast from molten alloy, leading to the production of pure copper cathodes in electro-refining cells. During electrolysis, copper dissolves into the solution, plates as a pure copper cathode, while noble metals like gold and PGMs fall to the bottom, generating anode slime every 15-20 days. Less noble metals dissolve at the anode, causing impurity build-up and electrolyte contamination, necessitating bleeding to maintain copper cathode quality.

Outsource Processing (Smelting)

Some E-Waste recyclers opt to delegate additional feed processing to third-party facilities to sidestep the capital investment and operational complexities of refining. While smelting processes excel in handling large material volumes, determining the precise composition of varied lots processed in a smelting line is challenging, especially if materials lack homogeneity. This complexity extends to accurate pre-sampling.

Disadvantages of outsource processing:

- Lower value realized
- High shipping costs
- Prolonged payment terms
- Locked working capital
- High carbon footprint

On-Site Processing (Smelting)

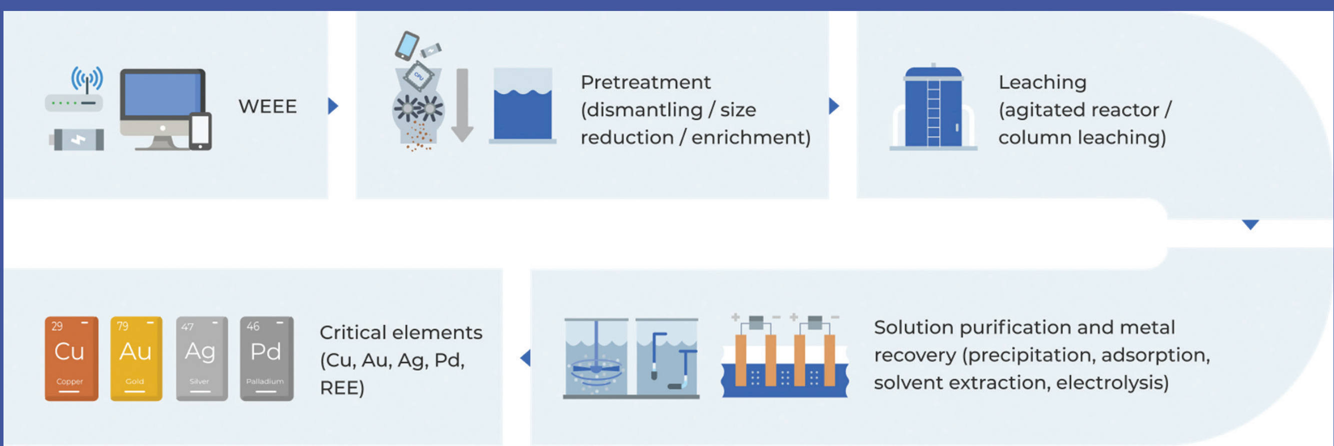
In certain instances, recyclers establish their own smelting facilities, resembling third-party smelters but typically on a smaller scale. While they encounter comparable environmental and operational challenges, they effectively extract the inherent value of metals and avoid shipping costs.

Downsides of on-site processing:

- Smelting permits are hard to obtain and highly capital intensive
- Requires additional processing steps
- Higher working capital in the precious metals
- High carbon footprint

Digestion + Electrowinning

E-waste recyclers often opt for digestion coupled with various purification technologies. This method involves caustic or acid leaching followed by



purification techniques like cementation, ion exchange, solvent extraction, activated carbon adsorption, and electrowinning.

In the digestion stage, PCBs are preprocessed into non-ferrous particles containing metals like gold, silver, copper, and PGMs. During digestion, copper is dissolved, while gold, silver, and PGMs emerge as a residue in less than 24 hours, ready for further recycling into pure metal or sale to precious metal refineries.

Digestion + Electrowinning in E-Waste recycling: Post-digestion, a direct current is applied, electro-depositing copper onto the cathode. Although conventional electrowinning has limitations like low selectivity, high operating costs, and safety concerns, the emew electrowinning system overcomes these issues. Its cylindrical cells enhance mass transfer, producing high-purity copper cathodes even at lower concentrations.

The emew system utilizes a closed system, rapidly circulating electrolyte across the cathode, reducing overall acid consumption and waste generation. It ensures a safer working environment by eliminating issues like acid mist and noxious gases. With auto-stripping of cathode tubes, the emew system doesn't require additional stripping equipment, distinguishing it from conventional electrowinning cells.

Inadequate management of e-waste not only results in missed financial opportunities but also contributes to global warming. Failing to recycle metals from e-waste necessitates investments in mining and refining operations for primary metals, which may become more expensive due to declining metal grades in ores.

Consider that the global value of raw materials in e-waste generated in 2019 amounted to about $57 billion USD. Unfortunately, only a small fraction of this sum was recovered.

Positive changes are underway. Europe and the US already recycle nearly 40% of electronic waste, with other countries following suit. Since 2014, the number of countries with some form of e-waste regulation has increased from 61 to 78. However, enforcement remains lacking in many cases, leading to improper recycling practices.