

# Study on Business Opportunities Extracted From E-Waste A Review

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## Abstract

The country faces a tremendous growth in the electronics industry along with a exponential growth of electronic waste (e-waste). As volume of e-waste continues to grow, the recycling of electronics becomes more important as it sets the stage for the growth of such recycling industries. An upward flow of electronic waste has been reached in recent years due to the enormous growth in the consumer electronics. E-wastes cannot be considered as trash, they are considered as hazards to environment and health. But these e-wastes in return on recycling offer some valuable resources such as noble metals (Copper, Gold, Silver, Lead etc.). The business opportunities which are available through the metals recovery and the methods for better improvement in waste management were the main theme of this study. This work also analyses the role of divergent shareholders and regulatory enrolled in those trade opportunities. A comparison of the state of art of e-waste management in India with the global practices has been performed in order to study the improvement and challenges.

**Keywords:** E-waste management, E-recycling, Hydro-metallurgical recovery, Noble metals.

## 1. Introduction

An impressive Digital Revolution story has been revealed in the growth of the country since liberalization. About 400,000 tons of waste has been generated annually in India, which increases at the rate of 10-15% every year. Government institutions and Business houses mainly contributes around 70% of the share in annual disposal of e-wastes. Some of the unauthorized sectors are involved in detaching rather than reclaiming the products disposed. They contribute about 90% of the e-waste management in India. On the basis of health and safety of the informal recyclers, formal reverse supply chain management of e-waste begins to happen in 2004.

Production of electrical & electronic equipment is one of the fastest growing manufacturing activities. Electronic waste comprises of used/discarded electrical or electronic devices destined for reuse, resale, recycling or disposal. Informal processing of e-waste may leads to adverse human health effects & environmental pollution. Electronic wastes from various sources of industrial & domestic areas should be recycled to avoid environmental pollution. Recycling of e-waste may leads to some of noble metals such as copper, zinc, lead which are used in the fabrication of many industrial and machine parts such as clutch phasing, brake linings etc, and manufacturing of refractory materials in the form of powder. Some of the environmental benefits offered by recycling of e-wastes are

- Energy savings
- Reduction of metals obtained from traditional extractive metallurgical process and
- Reduced CO<sub>2</sub> emissions

Usage of recycled metals compared to virgin metals leads to

energy savings. Table 1 shows the variation of energy savings depending upon the type of metal extracted.

**Table 1.-** Variation of energy savings depending upon the type of metal extracted.

Type of metal	Variation of energy (%)
Copper	85
Steel	74
Lead	65
Zinc	60
Precious metals	>80

The average life of a computer is considered to be 18 to 24 months but the production of a new digital product happens in nanosecond, which shows that the recycling of electronics is one of the fastest growing segments. Due to the processing of 4.4 million tons (approx.) of electronic scraps every year, around \$20 billion has been added to U.S. economy and around 45,000 people were employed. It was seen that the ISRI- the Institute of Recycling Industries represents the interests of only 350 e-recyclers among its 1,600 members around the country.

The statement electronics recycling “is absolutely a growth industry”, is made by the Business Director for e-Stewards during the launch of a recycler certification program in 2010. Recycling of electronics is an exciting business to enter in Roman but due to the regulatory and certification hurdles, e-recyclers struggle to enter the business.

### 1.1. History of E-Recycling

In the past, the business of e-recycling starts with the collection of electronic items and differentiating them in separate bins by material wise. In order to enrich the processes and elaborate the mass of arriving end-of-life electronics, several steps has been

initiated to turn a bigger profit due to the rise in offers for various metals.

A little survey was done to know about the status of materials once they were shipped away. This leads to the fact that in some destinations such as Asia and Africa, electronic items has been dumped offshore in an improper manner and this may leads to landfills where the metal leaching starts.

Based on the above information, two voluntary certification programs have been followed for e-recyclers in the United States. They are listed as

- R2/RIOS Certified Electronics Recycler program, supported by ISRI
- e-Stewards

**1.2. E-Waste Opportunity in India**

A survey from Tata Strategic Analysis shows that India would take part in the list of largest consumer electronic markets in the world by 2012. The assumption is made due to the increase in production of electronic equipments such as mobiles, PCs and Televisions. The gradual increase in these productions has been depicted in the form of graph which is shown in Fig.1. From Fig.1, it is evident that for every 2 years there is around 30% increase in Mobile Subscribers, 1.1% increase in OCs, 0.5% increase in Televisions production. There will be significant rise in e-waste amount due to this production rise which leads to several emergence and growth opportunities in e-waste management.

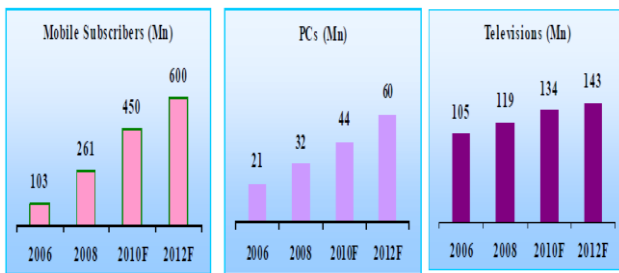


Fig. 1 Year by Electronic equipment Production

The electronic items which have reached end-of-life for their current users are considered to be e-waste and it is seen that the e-waste generation increases due to the reduction in their end-of-life. These e-wastes can't be land filled or incinerated as it can pose environmental risks, so the recycling of these is recommended as they contain some valuable metals.

Table 2 Metals in electronic components

Noble Metals	Hazardous Metals
Gold	Brominated Flame Retardants (BFR)
Silver	Lead, Cadmium
Platinum	Mercury
Aluminum	Phthalate Plasticize

Fig. 2 depicts the potential rise in e-wastes derived from desktops, TVs and mobiles by 2012. It is shown that around 18%, 6% and 33% potential rise in e-waste production of the above products from Fig. 2. This rise may contribute to 1 million ton of e-waste in India.

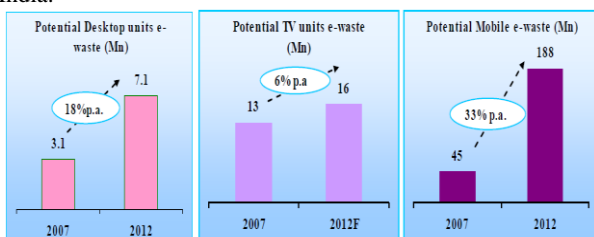


Fig. 2 Increase in Potential e-waste

**2. E-Waste Management- State of Art**

**2.1 Global Impact**

About 1.5 to 3 million tons of e-waste has been produced annually by the advanced countries such as USA, UK, France & Germany. A standardized e-waste management technique has been followed in these countries which has turned this huge pile of junk into a lucrative business opportunity though proper e-waste management, from efficient sourcing and collection right up to extraction and disposal of material as shown in below Fig.

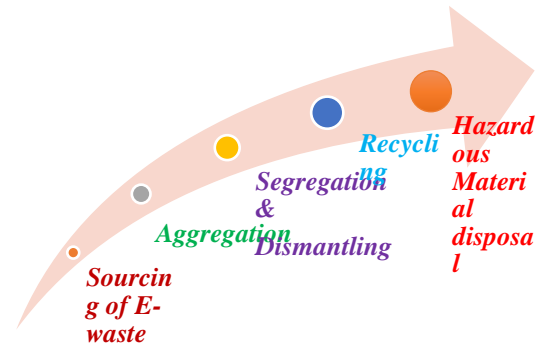


Fig. 4 E-waste Processing

Based on the potential of e-waste, a number of major companies around the world have evolved to cash. Globally, some of the policies has been placed for effective e-waste management.

**2.2. Domestic Scenario**

In India, large number of e-waste has been collected by unorganized players/family workshops, which collect e-waste through bicycle bound scrap collectors. Unsafe and cheapest methods which do not follow standard material disposal procedures has been adopted by these players to recycle e-wastes. Some of the organized players such as InfoTrek, Trishyiraya, e-Parisara, Ultrust Solutions and Ramky can't able to compete with the unorganized players due to their large overhead cost.

The Central Pollution Control Board came with broad guidelines on e-waste handling in India as the country is expected to be one of the largest consumer electronic markets in the world. As the country will be one of the largest electronic consumer, the extended Producer Responsibility model as in the EU is likely to be implemented in India. It is evident that around 1,520 crores can be added to the revenue through E-waste recycling by 2012.

**3. Estimation of E-Waste Generation**

Every year, the amount of e-waste generated can be calculated based on the number of EEE placed in the market and the average life of the equipment. The estimation is calculated by the formula given below:

$$x-y=(x-z)-(y-z) \tag{1}$$

Where, 'x - y' = financial year in which generation is estimated, and z= average life span of EEE.

The electrical and electronic equipment can be classified into two categories:

**Information technology and telecommunication equipment** comprises of Centralized data processing systems: Main frame, Minicomputer; Personal computing: Personal computers, Laptop

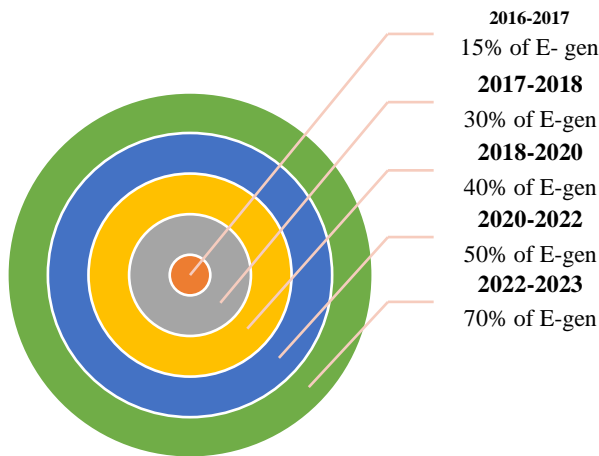
computers, Notebook computers; Printers, Cellular telephones and smart phones.

**Consumer electrical and electronics** comprises of Television sets, Washing Machines, Refrigerator, Air-conditioners

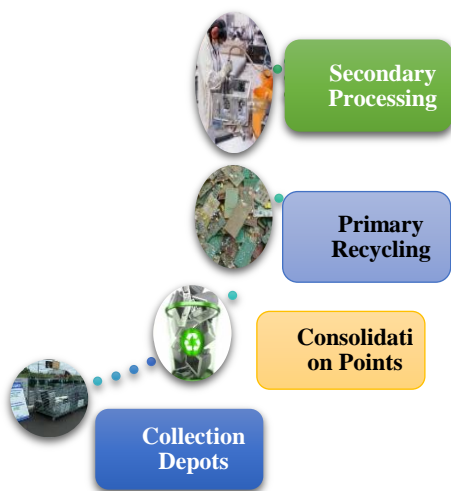
The average life span of Category A is around 6 to 10years and for Category B is 9 to 10 years.

#### 4. Estimation of Target for Collection

For every financial year, the generation of the products listed in Table 1 decides the target for collection of E-Waste. Fig. 7 depicts the target for e-waste collection from 2016 to 2023. From Fig. 7 and Table 1, it is evident that the target for e-waste collection is purely based on the average life span of the products. For example, if a smart phone is introduced in the year 2016 – 2017, it is shown that we can reach around 50% of collection in 2021-2022 as the average life span of a smart phone is 5 years.



#### 4.1. Considerations during E-Waste Processing



Level of Investment	Time and Expense of Certification	Legislation	Health and Safety	Site Security
<ul style="list-style-type: none"> <li>E-waste recycling business includes several operations which requires low level (few million dollar) to high level (\$50 to \$60 million) of investment.</li> <li>Collection, Palletization and shipment of end of life electronics needs low level of investment.</li> <li>Installation of sophisticated shredding and separation technologies requires huge investment.</li> </ul>	<ul style="list-style-type: none"> <li>The expense of certification for each type of operation ranges from \$5000 to \$50,000.</li> <li>It may take atleast 6 months to achieve the certification.</li> <li>Due to the above fact, it is advisable to work towards compliance in early stages to start a enterprise</li> </ul>	<ul style="list-style-type: none"> <li>Several legislations compiled by state and federal impacts the recycling industry and it increases the level of adherence to official rules and formalities.</li> <li>Landfill bans are put into practise for the industries which promotes high recovery rate from e-waste.</li> </ul>	<ul style="list-style-type: none"> <li>Health and safety of the recyclers is another consideration in handling hazardous products.</li> <li>During the process of recycling and due to probable exposure to heavy metals, brominated fire retardants and other concerns, there are some possibilities for adequate dust collection systems, uniform and shower facilities, and other managed safety practices which should be taken care by recyclers.</li> </ul>	<ul style="list-style-type: none"> <li>High level consideration should be given to restricted access and facility monitoring due to the issue of information privacy.</li> <li>These restrictions must be written into contracts between recyclers and customers.</li> </ul>

#### 4.2. Business Opportunities within E-Recycling

##### Collection Depots

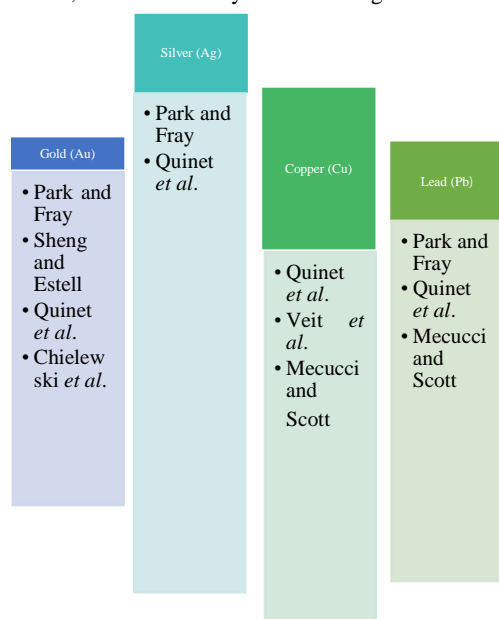
- Over 100 sites in B.C. has been contracted by Encorp in order to palletize the e-waste according to type (computers, televisions etc.) and wrapped them for shipment to a consolidation centre. Bottle and beverage can return centres generate much more business than the collection of e-scrap to the above BC collection centres. This shows that the startup of a collection centre is a low cost activity to enter into e-recycling business if they have appropriate location and available space for the above activity.
- Consolidation Points**
- In B.C. model, consolidation centre is the next stop after collection centre. Consolidation points are used to accumulate full load in order to reduce the transportation difficulties. Such consolidation points has been set up at six contract sites by Encorp. In order to create full uniform loads to send to a recycler, palletized products must be scaled and cross-docked at these locations.
- Collectors are paid for the consolidation of e scraps based on their scaled weight by Encorp. A secure storage area for product accumulation and to facilitate unloading and loading of trailers, dock doors are essential for a company which is interested in this type consolidation business, for example Encorp.
- Primary Recycling**
- A case study on business opportunities available in primary cycling at Intercon Solutions, an Illinois-based e-recycler shows that around 100 were employed. The Intercon Solutions is a

25,000 sq. foot main facility where the removal of incoming scrap from pallets, de-manufacturing (separation of equipment), and material sorting according to the categories has been performed. It is clear that the clean materials are liberated and sent to other approved processors as 100% of incoming material is recovered with zero material sent to the landfill.

- **Secondary Processing**
- Secondary processing includes further processing of obtained clean materials from primary processing. These process categories the materials based on the revenue of the recycler. This is because some materials such as copper may generate revenue for the recycler, while other material, such as glass, the recycler will have to pay for proper processing.
- The materials from the electronic scarp can be teared apart through the usage of shredding machinery. The secondary processing employs various sorting technologies which includes magnets, vibration, optical devices and eddy currents for efficient metals liberation.

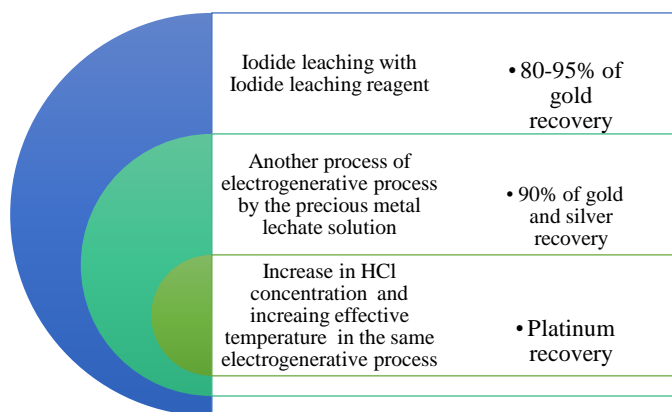
## 5. Summary of Hydrometallurgical Recovery of Pms from E-Waste

Fig. 9 shows some of the investigators who have extracted some of the noble metals such as Au, Ag, Cu and Pb using several leaching agent at various process conditions. Some of the leaching agents used for the recoveries are Aqua regia,  $\text{HNO}_3$ , epoxy resin,  $\text{H}_2\text{SO}_4$ , Chloride, Thiourea and Cyanide leaching etc.



### 5.1. Noble Metal Extraction from PCB's

For an effective extraction of metals and non-metals, a selective process has been selected from the various processes followed by the investigators given in Fig. 2 which is an automatic line process followed by a halide leaching. Halide leaching is considered to be one of the best methods due to its non-corrosive, easy regeneration and fast leaching rate. In order to extract pure noble metals such as gold, silver, platinum from waste PCB's, halide leaching is followed by the electrogenerative process and purification by HCl. In order to recover the precious metals with high rate, eco-friendly leaching process can be used as it will be a energy and cost saving method.



## 6. CONCLUSION

A study of reverse supply chain of e-waste in global and domestic scenario and the scope of improvement was reviewed in the above work. The possibilities of improvement in waste management have been focused in this study. Most of the business opportunities extracted from the e-waste management has been identified in the present paper. The role of different stakeholders and policy making enrolled in those business opportunities was also analyzed in this work. Various metal extraction method from different literatures has been listed. Out of these methods, an Automatic line process followed by a halide leaching is considered to be a best process to extract 90% of noble metals.

## References

- [1] "Recovery of Copper from Printed Circuit Boards Scraps by Mechanical Processing and Electrometallurgy", Veit, H.M.; Bernardes, A.M.; Ferreira, J.Z.; Tenório, J.A.; de Fraga Malfatti, C, Journal of Hazardous Materials, 2006, 137, 1704–1709.
- [2] Article on "E-waste: Opportunity or Burden?" Tata Strategic Management Group, 2012, 1-4.
- [3] "Metal Extraction Processes for Electronic Waste and Existing Industrial Routes: A Review and Australian Perspective", Abdul Khaliq, Muhammad Akbar Rhamdhani , Geoffrey Brooks and Syed Masood, Resources, 2014, 3, 152-179
- [4] "Leaching and Electrochemical recovery of Copper, Lead and Tin from Scrap Printed Circuit Boards", Mecucci, A.; Scott, K., Journal of Chemical Technology, Biotechnology. 2002, 77, 449–457.
- [5] "Recovery of Gold from Computer Circuit Board Scrap using Aqua regia", Sheng, P.P.; Etsell, T.H., Waste Management Resources, 2007, 25, 380–383.
- [6] "Recovery of Precious Metals from Electronic scrap by Hydrometallurgical Processing Routes", Quinet, P.; Proost, J.; Van Lierde, A., Mineral & Metallurgical Process, 2005, 22, 17–22.
- [7] "Separation Technologies for Metals recovery from Industrial Wastes", Chmielewski, A.G.; Urbański, T.S.; Migdał, W., Hydrometallurgy, 1997, 45, 333–344.