TELECOMMUNICATIONS PRODUCTS: A COMPARATIVE ANALYSIS

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ABSTRACT: This study analyzes the impact of obsolete telecommunication devices in particular, cellular phones on both industry and in economy. A background study will be conducted to depict the growing significance of the accumulating waste and potential material resources. Following this, the product structure of various cellular phones will be compared for their bill-of-materials and materials. The study will then propose an efficient end-of-life solution methodology that would provide economic and environmental gain. Related literature review and the gaps in the end-of-life processing solutions will also be included in the study. Solution for design-for-environment including other lessons learned from the research will be provided as a guideline for further progress. This study provides crucial information about calculating in-stock metals, aids in recycling decisions, aids in prioritizing disassembly, bill -of-materials of a cell phone for disassembly sequence, legislation in the Unites Estates, and how changing design will affect the industry.

1. Introduction

Nowadays cellular phone devices are provided not just with new features but also with new complex, hazardous, and valuable materials that on one hand generate an environmental problem but on the other hand generate a profitable possibility. To this end, it is important to propose an efficient end-of-life (EOL) processing solution that provides environmental and economic gain.

In this paper we provide different data and calculations which could catch attention for some players to invest on the cell phone recycling business; consequently an important impact on the environment could be generated by removing cell phones and their material content out of the waste stream.

2. Cell Phone Telecommunication Industry

First generation of cell phones (1G) exploded in the early 80s, when a revolutionary product was able to handle phone calls in either one area or hand them off to other areas. Second generation (2G) was generated in the early 1990s, cell phones were much smaller due to advances in battery and computer chips technology. At the beginning of the last decade the third generation (3G) came to provide text messaging and also provided access internet. Few years later the fourth generation (4G) hit the market bringing many innovations such as radio and TV stream, Wifi, video conferences, high resolution cameras, among others. The fifth generation (5G) seems to be arriving to the market soon with never imagined features and technology; experts forecast retina scan, solar panel, even ultrasonic technology. Figure 1 shows the evolution of cell phones within the years regarding technology, convenience and also esthetic.

Figure 1. Cell phone evolution. (Nokia)

Cell phones have rapidly evolved not only in technology but also in customer demand, today they are considered to be an omnipresent commodity. Figure 2 shows the exponential behavior of subscribers and units sold in the United States which in 2009 were 285.6 and 216.1 respectively.

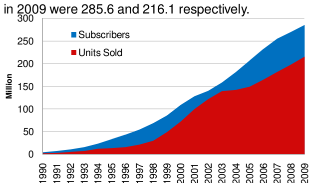

Figure 2. Subscribers and units sold in U.S. (EPA and U.S. Census Bureau)

Cell phone designs vary from model to model; however the basic components remain almost the same. Figure 3 illustrates the bill of materials (BOM) of the unit Nokia 1100 which is the world's best selling cell phone of all times with 250 million handset sold by 2005.

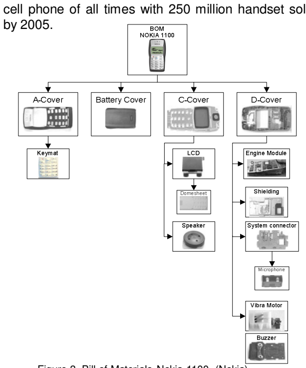

Figure 3. Bill of Materials Nokia 1100. (Nokia)

The cell phone telecommunication industry is a business which obtained a revenue of \$184.4 Billion in 2009. The global handset market share by the end of last year is illustrated in Figure 4.

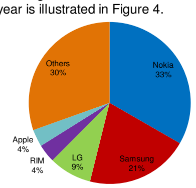

Figure 4. Global handset market share. (Strategy Analytics)

3. EOL Cell Phones Management Options

Disassembly for Reuse: Consists of removing components from assembled units which can then be independently handled and recovered.

Resale and Remanufacturing: Consist on a cell phone lifetime extension where they are collected in developed countries and sent or refurbished for sale in developing economies.

Recycling: Is in essence a process for material recovery. Generally only the materials that generate monetary revenue are recovered

4. E-Waste Cell Phone Legislation in U.S.

Basically there are two different approaches: some states are establishing seller take-back fee of cell phones whereas some states are requesting that manufacturers be in charge for the expenses and the logistics of the procedure.

In general 65% of the states in the United States is nowadays covered by a state e-waste recycling legislation. Figure 5 shows the actual condition of every state.

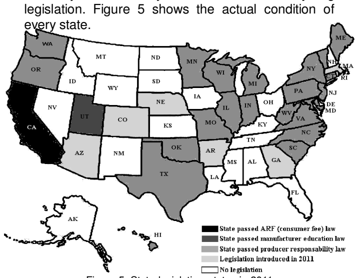

Figure 5. State legislation status in 2011 (Electronic Take Back Coalition)

5. Cell Phone Life Spam

Cell phones become obsolete for many reasons. The prospective life span of a cell phone is above 10 years, however most of the users upgrade their cell phones roughly four times during this period (Osibanjo & Nnorom, 2007); typically cell phones are replaced for the reason that they do not have preferred applications anymore, because their compatibility does not match with the new supplier, or they do not work anymore. Usually the life cycle of cell phones is as shown in the Figure 6.

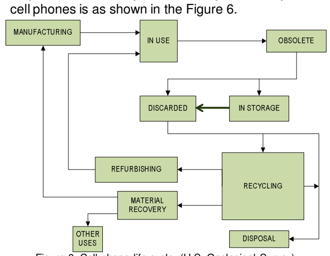

Figure 6. Cell phone life cycle. (U.S. Geological Survey)

EPA calculates that 20% of cell phones are ready for their end-of-life management when they are two years old; 70% of cell phones are ready when they are five years old and the remaining 10% are store up until they are sent for their end-of-life management when they are ten years old.

6. Cell Phone Weight and Material composition

Cell phones have dropped from 1587 grams to 90 grams the last two decades as it is presented in Figure 7, it means the average weight of cell phones has decreased 94.3% in the last twenty years.

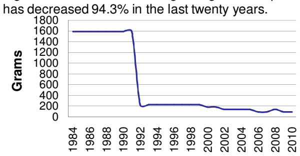

Figure 7. Average weight of cell phones. (EPA)

Even though cell phones may content 500-1000 components depending on their complexity, most of them are made from similar materials; Figure 8 represents the typical composition of a cell phone.

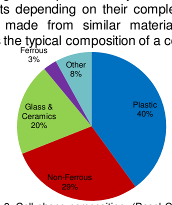

Figure 8. Cell phone composition. (Basel Convention)

Figure 9 shows the weight of the materials that are usually recovered and recycled from cell phones.

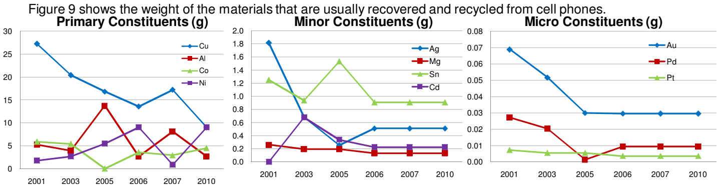

Figure 9. Constituents in a cell phone. (EPA, Basel Convention, BT Cellnet, UNEP, and Nokia)

7. Potential of EOL Cell Phones

Recycling brings great environmental benefits and in the last years it has caught the attention of some players who see a potential business. However, recycling process face a problem in its very first stage: collecting. Figure 10 shows the usual final destination for cell phones.

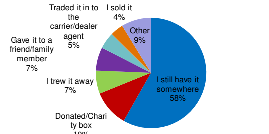

Figure 10. Destination of cell phones in New York. (Nokia)

As shown in Figure 11, the amount of cell phones collected for recycling is just a small portion of the potential amount of units ready for EOL management; in 2010, out of 152 millions, just 17.4 millions of cell phones were collected for recycling.. There is a vast amount of tons of cell phone waste that is not collected every year. Figure 12 represents how the percentage of cell phone tonnage collected has increased from 5.6% in 2000 to 11.5% in 2010; still it is not significant to generate a considerable impact.

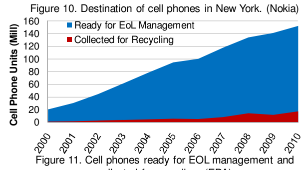

Figure 11. Cell phones ready for EOL management and collected for recycling. (EPA)

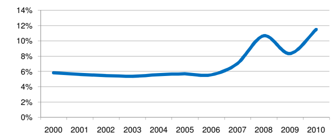

Figure 12. Percentage of cell phones collected relative to tonnage ready for EOL management. (EPA)

To calculate the potential value of the cell phones ready for EOL management and collected for recycling, it is necessary to compute the tonnage values with markets prices, provided in the following table.

	MARKET PRICE (US $/t)										
Year	Copper (Cu)	Silver (Ag)	Gold (Au)	Palladium (Pd)	Platinum (Pt)	Aluminum (Al)	Magnesium (Mg)	Tin (Sn)	Cobalt (Co)	Nickel (Ni)	Cadmium (Cd)
2000	1,940	161,000	9,010,000	22,243,172	17,660,405	1,640	2,790	8,160	29,700	8,640	362
2001	1,690	140,000	8,750,000	19,634,782	17,145,671	1,520	2,740	6,940	23,300	5,950	500
2002	1,670	148,000	10,000,000	10,920,965	17,443,709	1,430	2,560	6,440	17,100	6,770	644
2003	1,880	157,000	11,700,000	6,526,601	22,326,764	1,500	2,500	7,490	20,600	9,630	1,310
2004	2,950	207,000	13,200,000	7,488,873	27,288,267	1,850	3,470	12,100	43,400	13,800	1,200
2005	3,830	236,000	14,300,000	6,543,963	28,919,918	2,010	2,690	7,960	33,600	14,700	3,300
2006	6,940	373,000	19,500,000	10,382,440	36,793,957	2,680	3,090	9,240	30,700	24,200	2,980
2007	7,230	432,000	22,400,000	11,488,748	42,067,322	2,690	4,960	15,000	54,600	37,200	7,610
2008	7,040	483,000	28,100,000	11,417,373	50,742,236	2,660	6,940	19,100	68,400	21,100	5,920
2009	5,320	472,000	31,300,000	8,540,846	38,823,633	1,750	5,070	14,200	34,200	14,600	2,870
2010	7,539	570,676	38,580,895	17,059,507	51,941,459	2,301	5,346	14,021	46,297	21,710	3,902

Table 1. Average market prices of materials recovered from cell phones. (U.S. Geological Survey)

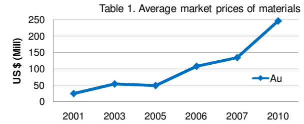

Figure 13. Last year the gold that could be recovered from cell phones that were ready for EOL management in the United States was \$247.7 millions, without accounting for the recovery cost, but still a pretty attractive number.

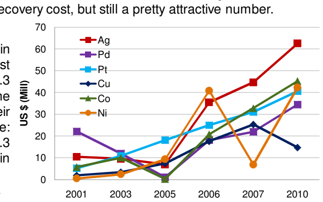

Figure 14. In spite of their minimum amount of material in each unit, the high price make them be very valuable; last year, the potential value were: \$62.5 million for silver, \$34.3 million for palladium, and \$40.5 million for platinum. On the other hand low price constituents are valuable due to their high weight percentage; last year, the potential value were: \$14,7 million for copper, \$45.1 million for cobalt, and \$42.3 million for nickel. All this numbers do not take in consideration the recovery cost.

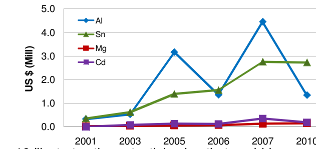

Figure 15. Last year, their potential value in cell phones ready for EOL Management was: \$1.3 million for aluminum, \$2.7 for tin, \$150220 for magnesium, and \$190222 for cadmium. This numbers do not account the recovery cost .

Figure 16 illustrates the potential value that could be recovered from cell phones in the last decade. Just last year the value of the material collected for recycling was \$56,3 million, yet small if compare with \$489.8 million that was ready for EOL management, it represents only 11.5%. In this matter it could be added that usually the recovery rate is calculated to be 99% for copper, 98% for gold, and 90% for silver, palladium and platinum(Neira & Favret, 2006).

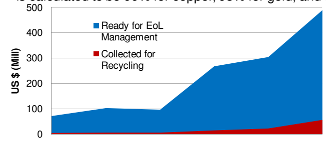

Figure 16. Potential value of materials in cell phones.

8. Conclusions

Over the years they have tried to generate consciousness about recycling and its impact in the environment; nevertheless in this capitalist society if business does not generate profit the environmental benefits are irrelevant. The actual EOL market has been developed by parties which found profitable opportunities, simultaneously generating environmental gain, but they are just a small number.

Even when the cell phones tend to be smaller year by year, it is compensated by the growing number of units sold. The potential value of materials that could be recovered was almost \$490 million last year, without accounting the recovery cost, but still a big and attractive number to generate expectations and incentives.

There could be significant benefits apart from the economical. A new source of raw material would be developed, and it would battle the decreasing access to these materials from domestic mines. In addition, the environmental impact would be significant since recycling includes taking care of different materials which are hazardous for human being and the environment in general. They could develop effective programs that collect used cell phones to keep them out of the waste stream. Concurrently they could create incentives for eco-friendly cell phones design to facilitate reuse and recycling and reduce or even eliminate hazardous substances from the product.

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