MAKING A VICIOUS CYCLE VIRTUOUS: RARE EARTHS AS AN E-WASTE CASE STUDY

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Master of Environmental Studies, 2011
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ABSTRACT

Electronic waste (computers, cell phones, appliances, etc), is the fastest growing waste stream in the US and EU. In the US, 82% of e-waste is landfilled, while 18% goes to recyclers. (USEPA 2008) However, due to market forces and regulation gaps, most of that 18% is exported for resale or informal recycling overseas. (GAO 2008) This results in economic and environmental injustices as well as transboundary movement of valuable materials including ferrous, precious, and rare earth metals.

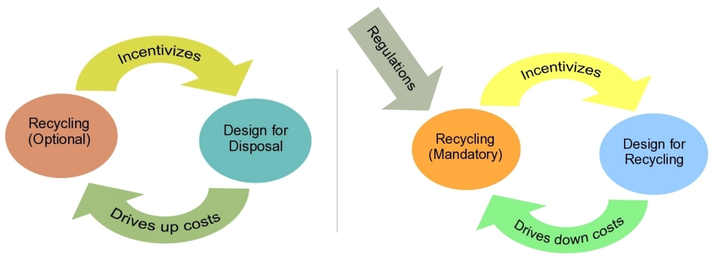
A rare earth embargo in 2010 highlighted extreme homogenization in that market. Subsequent media coverage focused on development of new mines requiring 15 years and $500M-1B of infrastructure investments.. This paper argues that regulations requiring domestic recycling and manufacturer take-back would drive down recycling costs, facilitating aggregation of "anthropogenic ore", or waste that could be mined for valuable materials. This would mediate environmental injustice and damage, but also provide a buffer against volatile commodities markets.

EXTERNALIZED COSTS

Along with valuable materials like gold, steel, and rare earths, electronics contain toxins such as lead, mercury, and flame retardants which make it difficult and expensive to recycle in the US. Brokers in developing nations offer competitive prices because lax environmental laws and worker protections in the importing nations lead to inexpensive, but dangerous, waste processing. Local economics in places like Guiyu, China (right, Courtesy Basel Action Network) incentivize workers to use hazardous methods like acid baths and open burn pits to extract resellable commodities like gold and copper. This results in air, water, and soil pollution, with devastating effects on human health and the environment. Such damages that occur outside of the formal economy are termed *externalized costs.*

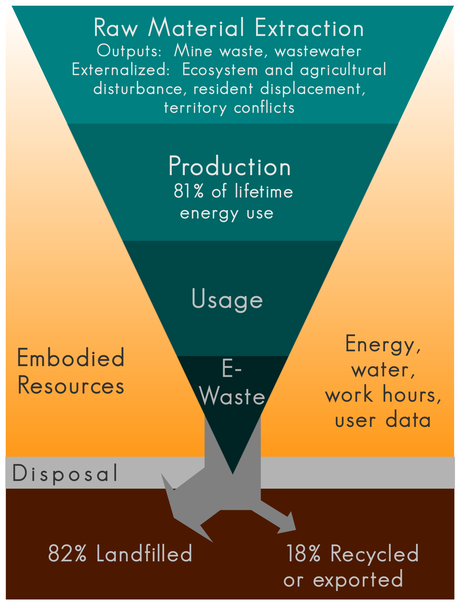
However, externalization begins at the raw material phase, with ecosystem degradation, loss of agricultural land, resident displacement, etc. Mineral resources are also at the center of violent land conflicts, as with extraction of "conflict coltan" from the Democratic Republic of Congo and black market rare earths from southern China. Besides the human toll, these damages lead to the loss of economically valuable ecosystem services. Because they are not financially codified, they too become externalized costs.

CREATING A VIRTUOUS CYCLE



Market forces lead to a vicious e-waste cycle: Recycling rates are low, because recycling is expensive, because products are not designed for recycling, because recycling rates are low.. Well-designed regulations can induce virtuous cycles. They can create markets from externalized costs and foster an even playing field valued by industry. By requiring manufacturers to take back old electronics, regulations could trigger changes in life cycle assessment and product design, leading to higher recycling rates.

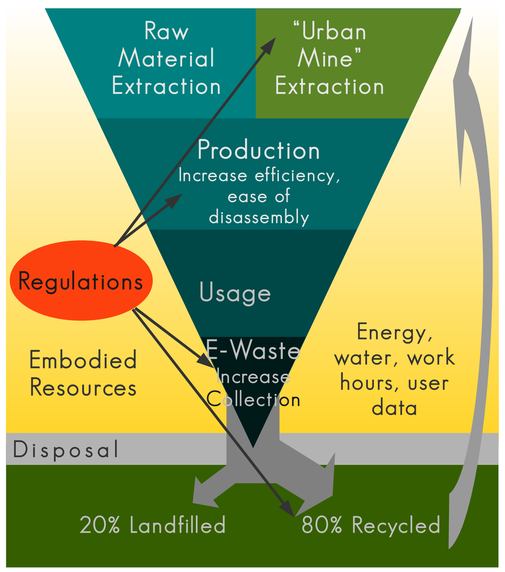
ELECTRONICS LIFE CYCLE



This illustration, though not to scale, expresses that electronics manufacturing is deceptively resource intensive. The materials, water, and energy used to make electronics are not reflected in the size of the finished product. UNEP and USGS reports estimate that the waste-to-product ratio for mining of aluminum is about 52:1; for gold it is about 682,000:1. Williams calculated that manufacture of a memory chip required 630 times its weight in fuel and chemicals (2002), and that 81% of the energy used during the life of a desktop computer was expended during the manufacturing stage (2004). The graphic shows some externalized costs as well as materials, energy, and labor that are "embodied" through a product's life. When e-waste is landfilled at end-of-life, all of its embodied resources follow a linear path that stops at the disposal phase.

POTENTIAL IMPACTS OF REGULATION

In this illustration, e-waste is considered an "urban mine". Recycling conserves resources embodied in e-waste and reduces demand for mineral extraction. Since 2003, EU regulations have required manufacturers to design for the environment and take their products back for recycling (WEEE Directive), while they replace toxic materials with safer alternatives as advances in materials science allow (RoHS Directive). Even with incomplete compliance, the directives have induced significant changes in the electronics supply chain. Product design that considers end-of-life disassembly, drives down the cost and hazards of recycling. The US Government Accountability Office has urged the US to widen the scope of e-waste regulation. Many groups such as the Silicon Valley Toxics Coalition have called for mandated manufacturer take-back.

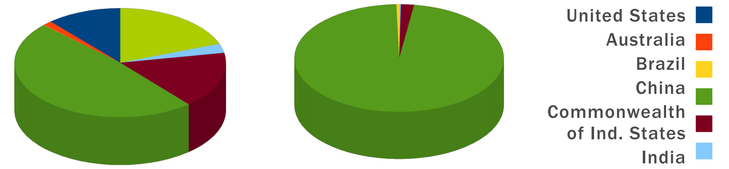


RARE EARTH EMBARGO, 2010

Rare earth elements (REEs) are 19 chemically similar metals with properties that make them indispensable in electronics and many clean energy products. In 2010, reports by the US Government Accountability Office and Department of Energy highlighted their importance to industry and national defense. The People's Republic of China currently produces about 97% of the world's rare earths. In late 2010, China ceased rare earth shipments to Japan for over a month, then briefly extended the embargo to the US and EU. The market responded with violent price spikes, and a vigorous discussion about the monopolized rare earth market ensued.

However, Chinese market dominance had been building since the 1980s with increased REE development. Price competition among Chinese producers drove down worldwide prices and eliminated most global producers by the late 1990s. In 2002, the only active mine in the US at Mountain Pass, CA, ceased operations following permitting problems and EPA concerns about radioactive tailings.

China has reduced REE export quotas since 2005, but post-embargo the market has reacted even more strongly to the biannual quota announcements. The Chinese government argues that reducing exports is in its own industrial and environmental best interest, but also acknowledges that the quotas help bring manufacturing to China since REE prices are much lower inside the country.



Rare Earth Oxide Reserves, 2011 (Million Metric Tons)

Rare Earth Oxide Production, 2010 (Metric Tons).

Source: USGS

"ANTHROPOGENIC ORE"

In the wake of the 2010 embargo, there has been a rush to develop non-Chinese rare earth mining and refining capacity. However, the necessary infrastructure could take 15 years to develop and $500M-1B per site. Intellectual resources are also at a premium. The US suffers from a lack of expertise and patents for producing rare earth products for industry. Most discussion about the rare earth monopoly focuses on mining, but there is a need to develop recycling infrastructure instead of, or in addition to, extraction infrastructure. The UN Environment Programme refers to stockpiles of discarded electronic as "urban mines" or "anthropogenic ore" and urges industry to develop the tools needed to extract valuable materials from waste. (Graedel, 2010) Researchers in Japan have already begun working on the problem, realizing that their economic well-being may depend on it.

CONCLUSION

Anthropogenic ore like stockpiled e-waste is many times richer in several valuable metals than geologic ore. Effective regulation could provide incentives to develop this resource while decreasing the environmental and human burden imposed by traditional mining. The rare earth embargo in late 2010 made it clear that investing in the industrial and intellectual infrastructure to make e-waste recycling viable, is not only good for people and the environment, but could be a crucial component of a healthy information-based economy.

SELECTED REFERENCES

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