

MOVING TOWARD SUSTAINABLE CONSUMPTION IN ELECTRONICS DESIGN, PRODUCTION, AND RECYCLING

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We live in a world of limited resources. Humanity is overshooting Earth's ecological limits, consuming resources and generating waste at an unsustainable rate. If everyone on Earth lived the lifestyle of the average American it would require five planets, according to Global Footprint Network.¹

Business has the knowledge and skills to retool its operations to live within the ecological limits of the planet. But to achieve this lifestyle, according to a recent assessment by the World Business Council for Sustainable Development, huge changes will be needed in business practices, consumer behavior, and government policies to achieve it.²

The path towards sustainable production and consumption for business was sketched broadly in the seminal 1999 book *Natural Capitalism*. It called on business to develop design innovations to make far more efficient use of natural resources, recast industrial systems to more closely mimic nature, and to reinvest in Earth's "natural capital" to sustain and restore its resources.³ One important incremental step to promote more efficient use of resources is for companies to move towards greater responsibility for the full life cycle of products; this is especially important with complex high-technology goods that contain both valuable and toxic components.

Extended Producer Responsibility (EPR) is a policy that shifts responsibility for collection and recycling of post-consumer goods from governments to producers. Since companies have the greatest influence over product design and marketing decisions, they have the greatest ability to reduce the overall environmental impact of their products. EPR provides an incentive for companies to make smarter product design choices since they know they will be responsible for end-of-life management costs. Simpler, less toxic products should be cheaper and easier to reclaim for recycling and reuse.

As You Sow is a non-profit dedicated to promoting corporate social responsibility through shareholder advocacy. We press public companies to adopt stronger social and environmental policies using the power of share ownership. We

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¹ *Footprint Basics*, FOOTPRINTNETWORK.ORG, http://www.footprintnetwork.org/en/index.php/GFN/page/basics_introduction (last updated Nov. 3, 2010).

² WORLD BUSINESS COUNCIL FOR SUSTAINABLE DEVELOPMENT, VISION 2050 (2010), available at <http://www.wbcd.org/templates/TemplateWBCSD5/layout.asp?type=p&MenuId=MTYxNg&doOpen=1&ClickMenu=LeftMenu>.

³ PAUL HAWKEN, AMORY LOVINS & L. HUNTER LOVINS, *NATURAL CAPITALISM, CREATING THE NEXT INDUSTRIAL REVOLUTION passim* (Little, Brown, Boston 1999).

engage in dialogue, file shareholder resolutions, build coalitions, and conduct shareholder education initiatives to raise awareness and promote more responsible corporate behavior. We collaborate with other concerned investors including socially responsible investment firms and funds, faith-based investors, and other institutional investors.

A cornerstone of our work is that companies must do a better job of taking responsibility for factoring the environmental impact of their products into the overall costs of doing business. Our Sustainability Program encourages companies to do more to design products considering environmental and social impact, including using recycled materials, reducing toxic components, and taking responsibility for products at the end of their life.

Among the many blue chip companies whose policies and practices have been improved by engagement with As You Sow are Apple, Best Buy, Coca-Cola, Dell, Disney, Gap, Home Depot, Hewlett Packard, Nike, Starbucks, and Time-Warner. This Article discusses our success in moving several key electronics companies toward more sustainable practices through adoption of electronic waste recycling policies.

I. THE E-WASTE PROBLEM

The technological revolution driven by faster, cheaper microchip technology has resulted in an explosion of electronic consumer goods. Yet the incredible technological innovation responsible for swift advances in design and production of electronics has not yet extended to adequate responsibility for environmental life cycle impacts—especially safe, effective end-of-life policies.

Over the past decade, electronic waste has become a major environmental toxics and recycling issue. E-waste is the fastest growing category of waste in the U.S. municipal waste stream. An estimated 65 million computers, 42 million monitors, and 130 million cell phones are discarded in the U.S. annually.⁴ The International Association of Electronics Recyclers estimates 3 billion units of consumer electronics, including computers, DVD players, VCRs, music players, etc. will be scrapped worldwide before the end of the decade or about 400 million units per year—more than 100,000 per day.⁵ But, according to the U.S. Environmental Protection Agency, only 13 percent of this tidal wave of waste is recycled, with the rest going to landfills or incinerators.⁶

Electronics sales were expected to top \$165 billion in the U.S. and \$700 billion worldwide in 2009.⁷ As developing countries begin to purchase more

⁴ *Statistics on the Management of Used and End-of-Life Electronics*, EPA, <http://www.epa.gov/epawaste/conservematerials/ecycling/manage.htm> (last updated Mar. 1, 2010).

⁵ *Electronics Recycling*, ISRI, http://www.isri.org/imis15_prod/ISRI/Issues/Electronics_Recycling/ISRI/Navigation/Electronics/Electronics_Recycling.aspx?hkey=c35e177a-9c4b-4daa-959d-462996ec52ab (last visited Nov. 10, 2010).

⁶ ENV'T'L PROT. AGENCY, *MUNICIPAL SOLID WASTE IN THE UNITED STATES* (2008).

⁷ *CE Industry Forecast*, CONSUMER ELECTRONICS ASS'N, <http://www.ce.org/Research>

electronics, the waste problem spreads further around the globe. According to a recent report by the UN Environmental Program, South African and Chinese e-waste will increase by up to 400 percent from 2007 levels by 2020.⁸

Improper disposal, especially in developing countries, harms human health and the environment. The manufacture of one computer workstation can involve scores of chemical compounds as well as heavy metals, many of which are hazardous, including lead, mercury, cadmium, brominated flame-retardants, hexavalent chromium, and beryllium.

Lead, which has long been banned from many products, was used in solder and cathode ray tubes in older TVs and monitors. Cathode ray tubes have been designated as hazardous waste and banned from landfills in several states.⁹ Approximately 40 percent of lead in U.S. landfills is estimated to come from discarded electronic equipment.¹⁰ Mercury is used in flat panel monitor switches, cadmium is found in some batteries, and flame retardants are contained in plastic computer housings as well as cables, connectors and circuit boards.¹¹ Of special concern are bromine- and chlorine-based compounds widely used as flame retardants in plastic resins, which are persistent in the environment and have been linked to disruption of human endocrine and neurological systems.¹²

Thirty years after the Love Canal hazardous waste dumping led to landmark laws requiring polluters to pay for clean up of industrial chemical wastes, most companies continue to externalize pollution and product end-of-life costs. For

/Sales_Stats/Forecasts.asp (last visited Nov. 10, 2010).

⁸ U.N. ENV'T PROG., RECYCLING - FROM E-WASTE TO RESOURCES, FINAL REPORT 59-66 (2009), available at http://www.unep.org/PDF/PressReleases/E-Waste_publication_screen_FINALVERSION-sml.pdf.

⁹ See Hazardous Waste Management System; Modification of the Hazardous Waste Program; Cathode Ray Tubes and Mercury-Containing Equipment; Proposed Rule, 67 Fed. Reg. 40510-511 (proposed June 12, 2002) (to be codified at 40 C.F.R. pt. 260) (explains that California and Massachusetts have banned CRTs from landfills); *Wastes Banned from the Trash*, CALRECYCLE, <http://www.calrecycle.ca.gov/HomeHazWaste/info/> (last updated Feb. 20, 2008) (showing California's policy).

¹⁰ *The Facts: Recycling Electronics*, NATURAL RESOURCE DEFENSE COUNCIL, <http://www.nrdc.org/cities/recycling/nycelectronics.pdf> (last visited Nov. 26, 2010).

¹¹ *The Problem with Electronics: Toxic Materials in Electronic Products*, ELECTRONICS TAKE BACK COALITION, <http://www.electronicstakeback.com/toxics-in-electronics> (last visited Dec. 21, 2010); see also POISON PCs AND TOXIC TVs, SILICON VALLEY TOXICS COALITION (2004), available at <http://svtc.org/wp-content/uploads/ppc-ttv1.pdf>.

¹² THE GREEN SCREEN FOR SAFE CHEMICALS, EVALUATING FLAME RETARDANTS FOR TV ENCLOSURES, CLEAN PRODUCTION ACTION (2007), available at http://cleanproduction.org/library/Green_Screen_Report.pdf; see also SICK OF DUST: CHEMICAL IN COMMON PRODUCTS - A NEEDLESS HEALTH RISK IN OUR HOMES, CLEAN PRODUCTION ACTION (2005), available at <http://cleanproduction.org/library/Dust%20Report%20with%20Appendices.pdf>; BROMINATED FLAME RETARDANTS ON DUST IN COMPUTERS: THE CASE FOR SAFER CHEMICALS AND BETTER COMPUTER DESIGN, CLEAN PRODUCTION ACTION (2004), available at <http://cleanproduction.org/library/BFR%20Dust%20on%20Computers.pdf>.

example, dioxins are halogenated compounds which are a byproduct of the manufacture of chlorinated solvents. They are a potent human carcinogen and among the most toxic chemicals known. Dioxins contaminated entire communities like Love Canal in Niagara Falls, N.Y., and Times Beach, Mo. in the 1970s. Public outrage led to passage of the federal superfund law in 1980, which held that companies could be held liable for improper disposal of hazardous wastes such as dioxins. Today, when computer components are incinerated rather than responsibly recycled, the combustion can cause the formation of dioxins.

Ironically, the greatest concentration of superfund hazardous waste cleanup sites in one county in the U.S. is not in the Rust Belt but in Silicon Valley, home to what was believed to be the environmentally benign computer industry. There are twenty-nine superfund sites in Santa Clara County, California, home to information and communications technology giants like Apple, HP, Google and Intel. Nineteen of the sites were contaminated by computer chip manufacturers in the 1970s which used toxic solvents like trichloroethylene and trichloroethane that leaked into local groundwater, which is now undrinkable.¹³ Remediation may involve 100 years of pumping and treating groundwater.

Most component production has moved from Silicon Valley to developing global markets, transferring pollution to these areas. A coalition of thirty-four mainland China environmental groups led by the Institute for Public and Environmental Affairs recently identified several component producers for major Western electronics brands as sources of heavy metal contamination.¹⁴ The groups believe lead, cadmium and other heavy metals dumped by suppliers can be linked to high levels of metals found in thousands of Chinese citizens.¹⁵ The report asks big Western brands to disclose how they are monitoring suppliers to ensure that wastes are not being dumped into rivers in violation of Chinese law.¹⁶

As important as keeping production wastes and discarded electronic equipment from leaching toxics into the environment is the need to safely reclaim used materials. Computers and mobile phones contain valuable metals such as gold, silver and copper with significant market value that can be reclaimed for reuse under safe working conditions. A clear challenge for electronics companies is how to dramatically increase levels of take back, ensure that electronics are properly recycled, capture and reuse materials, and encourage increasingly less toxic generations of future electronics.

¹³ *Silicon Valley Toxic Tour*, SILICON VALLEY TOXICS COALITION, http://www.svtc.org/site/PageServer?pagename=svtc_silicon_valley_toxic_tour (last visited Nov. 10, 2010).

¹⁴ Ina Pozon, *Engaging IT's Elusive Giants*, THE ASIA WATER PROJECT: CHINA (June 2010), <http://www.asiawaterproject.org/more-editorial/4893/>.

¹⁵ INSTITUTE OF PUBLIC AND ENVIRONMENTAL AFFAIRS, 2010 STUDY OF HEAVY METAL POLLUTION BY IT BRAND SUPPLY CHAIN 1 (Apr. 24, 2010), *available at* <http://www.asiawaterproject.org/wp-content/uploads/2010/06/Initial-Study-of-Heavy-Metal-Pollution-by-IT-Brand-Supply-Chain-English-Final.pdf>.

¹⁶ Jonathan Watts, *Global IT Brands Urged To Be More Accountable for Pollution in China Supply Chain*, GUARDIAN.CO.UK, (May 6, 2010), <http://www.guardian.co.uk/environment/2010/may/06/global-it-brands-china-pollution>.

One of the reasons for the high volume of discarded electronics is the industry marketing strategy of planned obsolescence. Moore's law is a famous prediction made by Gordon Moore, founder of Intel Corp. that the number of transistors that can be placed on an integrated circuit will double approximately every two years.¹⁷ Moore's law has generally proved to be accurate, contributing to technological progress but also to the phenomenon of planned obsolescence that drives the industry. Rapid improvements in computing speed allows engineers and marketers to constantly develop more powerful and advanced models of electronic equipment, tempting consumers to discard working electronics for more advanced models often after only a year or two of use. The need to upgrade is reinforced by pervasive advertising about more advanced models with more sophisticated features and our increasing dependence on faster internet speeds for education and communication.

These rapid technological advances have resulted in premature retirement for millions of units of working electronics, sometimes because they can't be upgraded without being replaced. A classic example is the Apple iPod and iPhone, which offer no consumer access to their batteries.

II. ACTIVISTS PRESS FOR CHANGE

About eight years ago, activist groups led by the Electronics Take Back Coalition began to press leading computer brands to take responsibility for their products not only at end-of-life but throughout the entire lifecycle. A major catalyst towards action was mandated recycling for electronics imposed by the European Union. The Waste Electrical and Electronic Equipment (WEEE) Directive became law in 2003 and basically imposed producer responsibility on companies, making them financially responsible for recycling electronic waste.¹⁸ At about the same time, the EU enacted the Restriction on Hazardous Substance (ROHS) Directive calling for the phase out of six problematic materials used in electronics: lead, mercury, cadmium, hexavalent chromium and flame retardants known as PBB and PBDE.¹⁹ This combination of pressing companies to take responsibility for e-waste take back and to phase out key toxics was a concerted effort by activists to move companies towards EPR. The European actions provided great leverage for stakeholders in the U.S. When stakeholders learned U.S. companies would have to comply with the WEEE Directive, they were able to confront the companies about why they weren't being proactive to offer e-waste solutions in the U.S. market when they were being forced to in Europe.

¹⁷ *Moore's Law and Intel Innovation*, INTEL, http://www.intel.com/about/company_info/museum/exhibits/moore.htm (last visited Dec. 21, 2010).

¹⁸ *Recast of the WEEE and RoHS Directives Proposed*, EUROPEAN COMM'N ENVIRONMENT, http://ec.europa.eu/environment/waste/weee/index_en.htm (last updated Mar. 6, 2010).

¹⁹ Directive 2002/95/EC of the European Commission, Directorate-General Environment, on the Restriction of the Use of certain Hazardous Substances in Electrical and Electronic Equipment (RoHS).

III. SHAREHOLDER ACTIONS

In 2002, As You Sow and its shareholder colleagues began to engage management and file shareholder proposals with Apple, Dell, HP and IBM to take responsibility for e-waste and reduce toxic components.²⁰

After As You Sow engaged with Dell, it agreed to develop a strong take back program and today will recycle any product it has sold for free, a policy few other companies will match. (Most companies will still not recycle a product for free unless a new purchase is involved). Dell also worked with As You Sow and other investors to set a take back goal. In 2004, Dell agreed to a goal of recovering 50 percent more waste in fiscal 2005 than it collected in 2004. It worked with us to develop a take back metric, estimating the average life of a computer as seven years. Take back was measured as the number of systems recycled as a factor of total units sold during the previous seven years. Apple has also adopted this metric. Dell met and exceeded its goal. It also went on to develop a profitable asset recovery program for business clients. The company said clients will pay for the assurance of total destruction of hard disk drives and recycling in a responsible manner.

We then turned our attention to Apple, which lagged behind both HP and Dell on take back. After filing a shareholder proposal in 2006 and securing a meeting with Apple CEO Steve Jobs in 2007, the company took dramatic action. In a May 2007 letter entitled “A Greener Apple,” posted on the Apple web site, Jobs made strong commitments to both computer recycling and toxics reduction. The normally blunt Jobs made a rare apology about the company’s lack of communication on environmental commitments stating, “[w]e apologize for leaving you in the dark for this long.”²¹ On recycling, he agreed to triple the company’s recycling rate for old computers from about 9 percent in 2006 to 32 percent in 2010. Apple has greatly exceeded this goal, achieving a 41 percent recycling rate in 2008 (based on the take back metric described above) and appears to be on track to reach 50 percent this year. In response to a Greenpeace campaign seeking the phase out of polyvinyl chloride and brominated flame retardants from its products, Jobs promised to eliminate them by the end of 2008. Apple met its goal before the end of 2008 with the exception of PVC in power cords, which was achieved a year later.

We also believe there need to be multiple options for return; consumers are more likely to take back electronics if they can be dropped off conveniently somewhere near their home. In 2008, we began to engage Best Buy, the largest electronics retailer in the U.S. As You Sow filed a shareholder proposal asking the

²⁰ Our shareholder colleagues included Calvert Group, Green Century Funds, F+C Asset Management, Pax World Fund, Trillium Asset Management and Walden Asset Management, representing \$50 billion in invested assets.

²¹ Steve Jobs, *A Greener Apple*, APPLE, http://images.apple.com/hotnews/agreener/apple/docs/A_Greener_Apple.pdf (last visited Nov. 10, 2010).

company to research the feasibility of in-store take back. To its credit, Best Buy readily agreed, undertaking a hundred-store pilot that the company described as a great success. It expanded the program to all one-thousand US stores in February 2009. In its first year, Best Buy collected 60 million pounds, representing about 1 million units of e-waste. In April 2010, the company announced a new commitment to capturing 1 billion pounds over the next several years. The Best Buy system represents a potential model of convenient take back for the US consumer. While most items can be dropped off for free, it charges \$10 for old TVs and CRT monitors because of the extra cost associated with disposal. This cost is partially offset by giving customers a ten dollar gift card. We are now in dialogue with Wal-Mart, the second largest U.S. electronics retailer, to match Best Buy's commitment.

E-waste activists have also pressed states to adopt e-waste take back laws and now twenty-three states have such laws.²² This provides another take back option for consumers and businesses that keeps electronics out of landfills. All of the laws, except for California's, require producers to pay for collection and recycling (California imposes a recycling fee on consumers when they buy a covered unit). These laws represent a striking success for implementation of an EPR model at the state level and serve as ongoing experiments in what kinds of systems work best for collection of e-waste. Early feedback suggests that states like Minnesota that mandate high recovery goals are getting the highest per capita rates of return. Washington State has high takeback rates because its law emphasized consumer convenience; there are more than 200 collection sites around the state and more than 90 percent of residents have a drop off site within ten miles of home.

IV. EXPORT OF E-WASTE

While initial attention was focused on collecting e-waste, there is now concern about how and where it gets recycled. Activist groups have demonstrated much of the waste is not being responsibly recycled domestically but shipped to developing countries with cheap labor and being dismantled under primitive conditions that pose a threat to human health and the environment.

Basel Action Network has issued two wrenching reports exposing this problem. In 2002, *Exporting Harm: The High-Tech Trashing of Asia* caused a sensation that forced electronics brands to strengthen oversight of the recyclers they contract with.²³ The report focused on Guiyu in Guangdong Province, China, where approximately 100,000 poor migrant workers were employed breaking apart and processing old computers imported mostly from the U.S. Workers use nineteenth century technologies to clean up wastes of the twenty-first century.

²² *State Legislation*, ELECTRONICS TAKE BACK COALITION. For more details on each of these state laws, see http://www.electronicstakeback.com/legislation/state_legislation.htm (last visited Nov. 10, 2010).

²³ *High-Tech Toxic Trash from USA Found to be Flooding Asia*, BASEL ACTION NETWORK, http://www.ban.org/ban_news/ewastepr.html (last visited Nov. 10, 2010).

Generally unaware of health and environmental hazards, workers openly burn plastics and wires, and melt toxic soldered circuit boards to extract gold, silver and copper. The burning of plastics can cause formation of dioxins, threatening worker health and polluting nearby rivers. Tons of waste not deemed to have an economic value lay strewn about the countryside.

Three years later, BAN exposed similar conditions in Africa, with *The Digital Dump: Exporting High-Tech Re-use and Abuse to Africa*, focusing on Lagos, Nigeria.²⁴ An estimated fifty large shipping containers per month arrive in Lagos under the official guise of reuse and repair of working units. In reality about 75 percent of the units are not marketable or reusable, resulting in open air burning of components to extract metals and dumping the remainder in roadsides and swamps creating health and environmental contamination from the toxic leachate and smoke.

Following these reports, major recyclers and the IT brands that use them to collect end of life units made pledges that their policy is to bar exports of hazardous components. However, the economic pressure to export is too tempting to resist for many recyclers. In November 2008, TV newsmagazine *60 Minutes* chronicled how waste collected by recyclers who pledged no export still ended up on a ship to China.²⁵ As with previous stakeholder engagement over sustainable harvesting of forests and fair treatment of supply chain workers, it is clear that enforceable codes of conduct and supplier auditing are needed to verify responsible behavior.

One limitation of state take back laws is that they do not have the authority to bar export of hazardous e-waste, a function reserved for the federal government. E-waste activists are now seeking such federal legislation.

Responsible recycling of e-waste could theoretically be a potential economic boon to livelihoods of people in developing countries. However, we know from a decade of research on labor rights in developing countries that (a) many countries have not developed civil society systems adequate to protect workers, and (b) Western companies using contract labor in developing countries are often not proactive about protecting workers or paying a sustainable living wage. Most U.S. companies sourcing globally had to be pressed by activist and shareholder groups into developing and enforcing codes of conduct in the 1990s. Most are still not transparent about how workers are treated in the global supply chain. Until systems are developed to ensure that exported waste can be responsibly managed, in most cases it is more socially responsible to develop cost-effective domestic recycling systems that protect worker health and the environment.

There are now competing e-waste recycler certification and auditing systems being developed to audit e-waste recyclers. Such systems have been in use for

²⁴ *High-Tech Toxic Trash Exported to Africa*, BASEL ACTION NETWORK (Oct. 24, 2005), <http://www.ban.org/BANreports/10-24-05/documents/PressRelease.pdf>.

²⁵ *Following the Trail of Toxic E-Waste*, 60 MINUTES (Aug. 30, 2009), <http://www.cbsnews.com/stories/2008/11/06/60minutes/main4579229.shtml?tag=mncol;lst;10>.

some time in other sectors. For example, the Forest Stewardship Council is a widely respected international group that promotes responsible management of world forests, discouraging clear-cutting and enforcing sustainable forestry practices, and certifies whether specific forests are being managed in alignment with its criteria.

In April 2010, Basel Action Network (BAN) and a group of recyclers unveiled an E-Stewards certification process.²⁶ Accredited certifying bodies will seek to independently assure conformity to an E-Stewards standard, and perform supplier audits to check for compliance with the standard's stringent environmental and social justice criteria for electronics recyclers. These criteria include no toxic e-waste dumped in landfills or incinerators, exported to developing countries, or sent to prison labor operations, and accountability for the entire recycling chain of toxic materials.

A competing e-waste standard is known as R2 for Responsible Recycling. It originated at the EPA through a joint stakeholder process. However, after some e-waste activist groups were unable to secure agreement on what they viewed as stringent standards, BAN left the R2 process and started E-Stewards. BAN contends the R2 process is weaker in several fundamental areas, which could allow for continued export of hazardous e-waste. The Institute of Scrap Recycling Industries, a trade association of commodities recyclers is a major supporter of R2. Critics contend R2 has major loopholes, allowing disposal of e-waste in landfills and incinerators in "circumstances beyond the recycler's control" and allowing export "to countries that legally accept them" but relying on recyclers to determine that legality.²⁷ R2 would allow incineration for "energy recovery" when recycling is not economically feasible, suggesting that a significant amount of plastic computer housings could be incinerated domestically.

Keeping toxic e-waste from being exported is only half the challenge. If e-waste activists succeed in restricting exports of electronic waste, there will need to be concerted efforts by electronics brands and recyclers to put their considerable skills of innovation into developing a better North American infrastructure for recycling and stronger markets for recovered materials. There needs to be a dramatic increase in our ability to efficiently recover valuable materials for reuse or there will be irresistible economic pressure for cheaper foreign disposal options. We need the equivalent of a Moore's law for e-waste recovery where the technology and recycling industries commit to using their technological prowess to rapidly develop more advanced and cost-effective processes for reclaiming materials from end of life electronics.

²⁶ E-STEWARDS, <http://e-stewards.org> (last visited Nov. 10, 2010).

²⁷ Robert Houghton, *The E-Stewards vs. R2 Debate: Make the Choice to Stop E-Waste Exports*, REBLOG (Feb. 18, 2010), <http://blog.redemtech.com/2010/02/the-stewards-vs-r2-debate-make-the-choice-to-stop-ewaste-exports.html>; *see also* Robert Houghton, *What Is and What Isn't Responsible Electronics Recycling*, GREENBIZ (Feb. 17, 2010), <http://www.greenbiz.com/blog/2010/02/17/what-and-what-isnt-responsible-electronics-recycling#ixzz0wp76O9cf>.

V. GREEN DESIGN

Some major companies have made impressive advances in green design, removing brominated flame retardants and polyvinyl chloride from their products. IT companies will need to accelerate efforts to phase out toxic substances so that electronic devices will be easier to recycle. Apple has shown leadership in this area, committing to eventual phase-out of bromine and chlorine compounds from all of its product lines.

EPEAT (Electronic Product Environmental Assessment Tool) is a useful product evaluation system developed by EPA, the electronics industry, and stakeholders to help purchasers evaluate the environmental attributes of hundreds of mainstream computer systems.²⁸ Systems are rated as bronze, silver or gold after evaluations of performance in areas like reduced toxics, use of recycled plastic, life extension and energy conservation. If EPEAT standards were considerably strengthened, it could also be a driving force for reduced toxics and longer electronic product life. Another useful resource is Greenpeace's Guide to Greener Electronics, which ranks major manufacturers on a range of sustainability criteria.²⁹

One hopeful note in terms of moving towards sustainability is that information technology products can play a role in reduction of energy use and greenhouse gases. A 2008 industry funded study, *Smart 2020: Enabling the Low Carbon Economy in the Information Age*, demonstrated how industry products can deliver a range of services and products that can reduce carbon emissions. Electronic motor systems improve industrial efficiency; smart logistics systems increase the efficiency of transport and storage systems; electronic building controls and sensors can provide significant energy savings. Cloud computing can reduce the number of servers companies need by consolidating them on large remote systems. Smart energy grids provide better monitoring and management of electricity grids. The report concluded that as much as 15 percent of projected 2020 GHG emissions could be shaved through aggressive application of IT systems.

VI. CONCLUSION

There is important work that must occur simultaneously on several fronts to move the industry from a few symbolic improvements to a viable system for the evolution of sustainable production of electronics.

The European WEEE and ROHS initiatives mentioned earlier need to be strengthened. ROHS needs to close loopholes that allow some of the banned substances to continue to be used. Companies need to increase their R&D budgets to develop acceptable alternatives.

²⁸ EPEAT, <http://www.epeat.net> (last visited Nov. 10, 2010).

²⁹ *Guide to Greener Electronics*, GREENPEACE, <http://www.greenpeace.org/international/en/campaigns/toxics/electronics/> (last visited Dec. 21, 2010).

Electronic brands need to place a higher priority on designing materials that have the fewest toxics possible and that utilize high levels of recovered metals and plastics, reducing reliance on virgin raw materials. Until companies accept total financial responsibility for end of life processing, they will lack sufficient incentives to reduce those costs through smarter design.

Companies must prioritize research dollars to develop technological breakthroughs in more efficient ways to recover gold, silver, copper and other valuable metals from end of life units, making recovery more cost effective.

Companies who claim materials as proprietary under the Toxic Substances Control Act need to provide full disclosure so workers dismantling electronics know what risks they are dealing with.

Finally, we need to reform a financial system that values maximized short term profits above all else. It will be difficult to seriously confront inefficient production practices and over-consumption until ways are developed to derive a fair return on investment from slower economic growth, until companies develop systems of production that employ radical shifts towards sustainable design and maximized reuse of previously processed materials, and until both investors and producers place serious economic value on Earth's natural systems.