Environmental Imperative of Responsible E-waste Disposal: Science, Impacts, and Savings

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For: TechTurn

Executive Summary

As the number of computers in use globally nears 2 billion[1], and as knowledge of technology's harmful impacts on the environment spreads, electronic waste ("e-waste") is becoming one of the corporate world's most critical environmental issues. Computers, servers, and other common information technology ("IT") hardware contain toxic substances such as mercury, lead, and cadmium. And the quantities of these substances are significant. Unless companies take specific precautions to properly handle e-waste, these substances may end up harming the environment, damaging human health, and subjecting the company to public relations and legal liabilities.

Proper e-waste disposal is an issue for every company.

- E-waste is a critical environmental issue for corporations
- Computers contain dangerous toxic metals
- Many "recyclers" use methods that harm the environment
- Clear best practices exist for e-waste handling
- TechTurn's process assures safety and environmental benefits

Unfortunately, e-waste disposal methods are haphazard today. Many companies do not have clear plans for assuring proper disposal of old computers, monitors, and other "retired" pieces of IT hardware. In a commissioned study conducted by Forrester Consulting on behalf of TechTurn Ltd, Sept 2008, it was found that 25% of IT assets either sit in storage or are thrown in the trash.[2] And many e-waste handlers use poor or improper methods.[3] A large portion of "recycled" e-waste ends up being shipped to the developing world where it is handled in an environmentally disastrous manner. Against this backdrop, a clear set of best practices has emerged that can assure proper handling of e-waste.

With the assistance of a conscientious Information Technology Sustainability Services (ITSS) provider that employs a consistent, science-based methodology, the responsible disposition of e-waste can be simple—and even profitable. Moreover, using an ITSS provider can help a company firmly establish its own sustainability credentials. TechTurn, Inc., a leading ITSS provider, has the systems and capabilities to help companies manage their e-waste. At the heart of TechTurn's value proposition lies an automated diagnostics system that enables TechTurn to analyze every computer it handles. These diagnostics assure each asset is assigned its highest and best use along a spectrum from full reuse to recycled parts to recycled materials—guaranteeing that no e-waste is shipped to the developing world or any other improper endpoint. Companies that take steps to safely and responsibly maximize the utility of their discarded IT hardware can rightfully take credit for the environmental savings from these proactive steps and environmental gains.

In this white paper, Esty Environmental Partners (EEP) describes the harms that e-waste can cause, why e-waste should matter to a company, and what companies can do to mitigate the environmental impact of their e-waste.

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[i] This white paper was developed by Esty Environmental Partners (EEP) in close consultation with TechTurn, Inc. In addition to composing this paper, EEP is connected to TechTurn through its chairman, Dan Esty, who sits on the board of TechTurn, Inc.

E-waste is a serious environmental issue

> *"E-waste is one of the most serious environmental threats that remains currently unmanaged by companies."*
>
> —Dan Esty, Director of the Center for Business and Environment at Yale and author of *Green to Gold*.

Though businesses often pay a great deal of attention to their environmental footprint and to the performance impact of IT assets when they are in use, relatively little attention is paid to the environmental impact of IT assets after their useful life has come to an end. Given the alarming environmental impact of e-waste, this inattention is a potential public relations liability and a mistake for companies that care about protecting the environment. E-waste represents over 90% of the long-lived toxic material disposed of by a typical white collar firm (see analysis on page 3). Unregulated and improper e-waste recycling has been linked to massive fish die-offs and other ecological catastrophes.[4]

Toxics in a Computer

Computers contain notable amounts of toxic metals. The lamps that light flat-panel displays require mercury. A typical desktop computer system has 57 grams of lead, 2.5 grams barium, 0.01 grams of arsenic, 0.8 grams of antimony, and various amounts of other toxic metals.[5] Cathode ray tube (CRT) monitors contain four pounds of lead.[6]

These toxics are dangerous to the health of humans and the environment. If ingested, there are enough toxic metals in 10 computers to kill 14 adults.[7] *Most of the heavy metals used in computers are persistent toxics that will not break down in a landfill. If incinerated, they produce volatilized heavy metals that present a significant public health hazard. If not properly disposed of, computers can end up causing serious and long-lasting ecological and human health problems.*

> "[Most e-waste] ends up being shipped abroad to developing nations, where unprotected workers are exposed to a machine's toxic guts while they extract reusable parts. What cannot be salvaged is often dumped in or near water sources, a practice that environmental groups say has contributed to polluted soil and drinking water for poor populations."[8] —*The New York Times*, December 9, 2007

Toxic elements in a typical computer	Quantity per computer [9]
Lead (Pb)	57 g
Barium (Ba)	2.5 g
Arsenic (As)	0.01 g
Antimony (Sb)	0.8 g
Mercury (Hg)	0.05 g
Selenium (Se)	trace
Cadmium (Cd)	trace

Not confined to an environmental fringe, academic and government scientists from the Government Accountability Office (GAO), China, Germany, and Switzerland have investigated this issue and determined

that unregulated e-waste recycling in the developing world is an environmental and human health disaster. Peer-reviewed scientific research shows significant environmental degradation, particularly with regard to toxic metal contamination, in e-waste recycling towns.[10] Lead, arsenic, cadmium, lithium, molybdenum, selenium, beryllium, cobalt, copper, and nickel have been found in the water, soil, and breast milk at e-waste recycling hubs in the developing world. The contamination has been clearly linked to e-waste recycling. [11]

> "Dust from roads next to e-waste workshops had ***370 times more lead*** than samples from roads 30 kilometers away"
>
> —*New Scientist*, April 5, 2008

E-waste not shipped to the developing world is typically discarded in landfills. *Newsweek* notes that: "Most consumers will eventually send their old, obsolete gear to landfills, where decaying circuit boards and PC screens could leak toxic substances like mercury, lead, and chromium."[12]

Why e-waste matters to companies:

E-waste is a significant contributor to the average knowledge-worker company's impact on the environment. To help quantify the relative environmental impact of information technology, EEP

Environmental impacts of a typical 10,000-person knowledge-worker company:
E-waste accounts for more the 90% of persistent toxics

Office Input	Toxic Impact	Persistent Toxic Impact*	Carbon Impact**	Water Impact
Improper E-waste Disposal	**8%**	**91%**	**1.5%**	**6%**
Paper	--	--	4.5%	67%
Toner	0.1%	0.1%	--	--
Heating	--	--	26%	--
Electricity	--	9%	68%	--
Cleaning materials	91.9%	--	--	1.5%
Bathrooms	--	--	--	25%
TOTALS (%)	100%	100%	100%	100%
TOTALS	1,790 Kilograms	43 Kilograms	34,830 Tons	44 Mil Liters
Definitions	Materials that can cause death to humans if ingested in usable form	Toxic materials that maintain harmfulness over time	Greenhouse gases for which a business is responsible	Water used by the business

*Toxics from cleaning products are significantly less persistent in the environment than the heavy metals in computers
**Includes bought energy, own emissions and GHGs required to produce equipment used by the company

Sources: See endnote 13

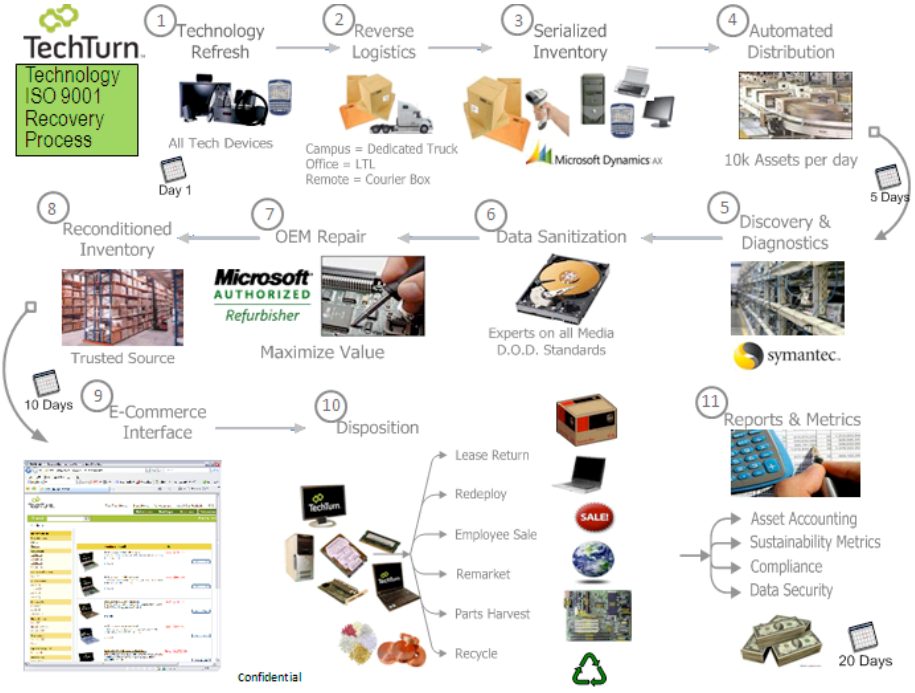
modeled the complete set of major environmental impacts of a typical 10,000 employee knowledge-worker firm.[13] In addition to e-waste, EEP considered lighting, heating/air conditioning, bathrooms, cleaning products, paper use, and toner use. The model charted four types of impacts: total toxic impacts (e.g., bleach, ammonia, and heavy metals); persistent toxic impacts (e.g., mercury, cadmium, and lead); carbon impact; and water impact. EEP's research determined that an average service company with 10,000 employees[14] will use its computers for approximately 3 years, meaning the company retires about 3,000 computers each year.

Those 3,000 computers contain more than 18,000 lethal doses of toxic metal. If those computers are recycled irresponsibly in a developing country, lethal doses can seep into the environment and harm thousands of people. By using a responsible IT disposition partner such as TechTurn, a firm can significantly decrease its environmental impacts. For an average professional services firm, proper e-waste disposal can reduce the firm's overall water impact by 8.5%, its greenhouse gas impact by 1.5%, its total toxics amount by 8%, and its burden of long-lived, persistent toxics by more than 90%.

What is "Responsible Disposal"?

Responsible disposal of e-waste assures:

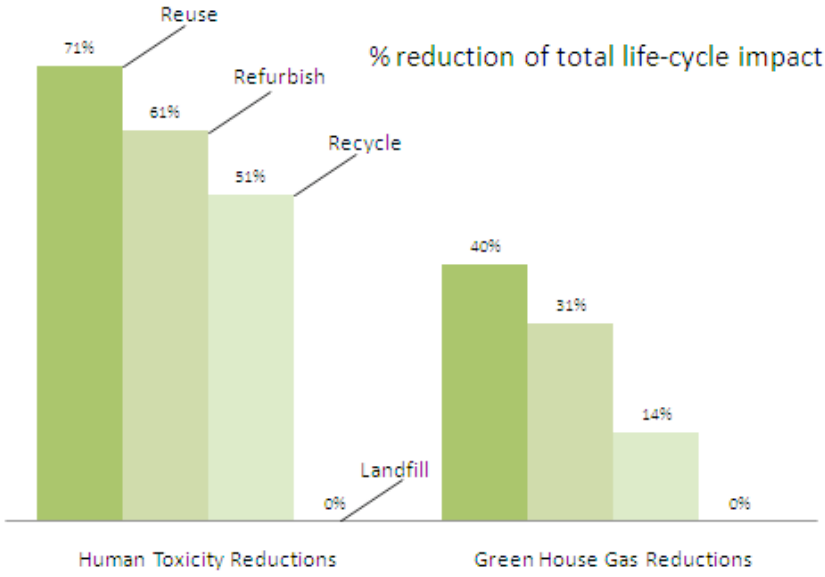
- IT assets are put to their highest and best use to lighten the burden on the environment
- Toxics in e-waste never go to the developing world to harm the environment



ITSS companies like TechTurn engaged in responsible disposal practices with multiple dimensions. TechTurn, for example, puts e-waste through a comprehensive 11-step, 20-day process that incorporates diagnostics, disassembly, data sanitization, repair and reconditioning, and a final "disposition" that is individually appropriate for each IT asset. Unlike simple recyclers that break down all computers into their raw materials (e.g., plastics, glass, copper, and gold) and sell them as commodities, ITSS providers like TechTurn

and their high-quality e-waste recycling partners perform individual analysis on each computer to assure that the maximum life, value, and environmental benefit are extracted.

TechTurn's methodology assigns assets to their highest use—creating major environmental benefits over landfilling and simple recycling



ITSS companies like TechTurn assure that the environmental toxics within each IT asset are managed in a safe and responsible manner. Through a proven and certified process that complies with US and EU regulations, TechTurn ensures the safety of workers and the environment. In addition, TechTurn recycles or reuses all packaging, saving cardboard, paper, plastic, and foam from the landfill.

Methods of Disposal:

Once a computer is no longer wanted by a business, there are several paths it can take to its "end-of-life." Reuse or refurbishment—both forms of giving the asset a second life—are the preferred environmental options. Both of these options help to avoid the manufacture of new computers—creating significant environmental savings. [15]

Reuse: The best computer for the environment is one that is never built. Responsible e-waste handlers recognize this. Companies like TechTurn identify any computer that could be of value to another user (such as a student, family, or a small business) and designate it for reuse.

Refurbishment/Upgrade: Many machines discarded as "e-waste" are still functional, but out of date. By replacing a few parts

Annual environmental savings that a company reaps by using TechTurn (versus landfilling)

with new ones (e.g., upgrading the memory), a computer can be given a second life, instead of being scrapped for its raw materials. While this path requires the manufacture of a few new components, it is, on average, 61% less harmful to humans and 31% less harmful to the climate than making a new computer.[16]

To manufacture the 3,000 computers discarded by a typical 10,000-person firm each year requires more than 7,000,000 liters of water, 1.3 million kilograms of fossil fuel, and 74,000 kilograms of industrial chemicals. How much is that? Those impacts translate to: enough water to fill 2.5 half-liter water bottles per employee every work day of the year, enough fuel to power 11 compact fluorescent light bulbs at each employee's desk during every work hour for a year, and a two brick's worth (8 pounds) of industrial chemicals for every employee in the company.

A company's ability to give its computers useful second lives will depend on the age of those computers. Best-practice e-waste processors like TechTurn can reuse or refurbish between 70% and 95% of the computers they receive that are less than six years old. Reusing and refurbishing computers instead of producing new ones greatly benefits the environment by preventing harmful impacts from manufacturing raw material extraction.[17]

Benefits of properly handling e-waste are significant

Using a responsible and high-quality e-waste handler can help a company significantly reduce its harmful impact on human and environmental health. TechTurn can also support a company's sustainability and reporting efforts through the production of robust, easily comprehensible metrics. The TechTurn Environmental Savings Calculator, developed by

TechTurn

TechTurn Environmental Benefits Calculator

Customer:	Company X
Date:	2/10/2010

Customer Inputs to Calculator			
	0-3 y/o	3-5 y/o	6 and older
Desktops	634	238	128
Laptops	1486	284	230
2U Servers	56	2	4
4U servers	33	11	3
HDDs (GB)	1000	200	100
Network Switches	7	4	1

Environmental Benefits with TechTurn

Impact Type	Quantity Used to Make Your Equipment	Reductions through Reuse and Responsible Recycling with TechTurn	
Water	Liters of water	% Reduced	Liters of water reduced
	6,950,768	34%	2,393,876
Fossil Fuel	Kilograms of fossil fuel	% Reduced	Kilograms of fossil fuel reduced
	1,277,630	35%	441,288
Industrial Chemicals	Kilograms of chemicals	% Reduced	Kilograms of chemicals reduced
	76,550	51%	38,891
Toxic Metals	Lethal doses of toxic metal	% Reduced	Number of lethal doses avoided
	30,395	62%	18,757

www.techturn.com/calculator

Esty Environmental Partners (shown above and available at www.techturn.com/calculator), generates environmental savings calculations customized to any business based on its unique mix of IT asset categories and ages designated for disposal. The calculator shows the savings from properly disposed e-waste in terms of water, fossil fuel, industrial chemicals, and toxic metals. This example, using the yearly inventory of a typical 10,000-person knowledge worker firm, the company would save about 2.3 million liters of water, half a million kilograms of fossil fuel, 39,000 kilograms of industrial chemicals, and 19,000 lethal doses of toxic chemicals.

Conclusion:

- Improper disposal of e-waste is a moral and PR liability
- Proper disposal generates environmental benefits
- TechTurn assures responsible e-waste handling
- TechTurn can quantifying your environmental savings

The manufacture and improper disposal of computers and other IT assets can significantly harm the environment. Computers put toxic substances in the environment when they are disposed of—and they release greenhouse gases and dirty water during their production. Information Technology Sustainability Services (ITSS) providers such as TechTurn can assure you and your company that your e-waste will be handled in accordance with the highest levels of environmental stewardship.

An environmentally responsible program of reuse, refurbishment, and responsible recycling can make a major difference in a company's overall environmental impact and can significantly boost its sustainability program. TechTurn can help put your company on the path to sustainability by helping launch such a program. TechTurn can help you reduce the persistent toxics you release into the environment by maximizing the useful life of your IT assets.

TechTurn will also generate an individualized environmental scorecard that converts raw data into metrics that form the cornerstone of responsible environmental management and can easily be translated into environmental or sustainability reports. TechTurn can guarantee and certify that your e-waste is responsibly recycled. And TechTurn can quantify your environmental savings in easy-to-understand terms—making it easier for you to tell the world about your efforts to green your IT assets and spelling out the financial gain from "greening" the IT department.

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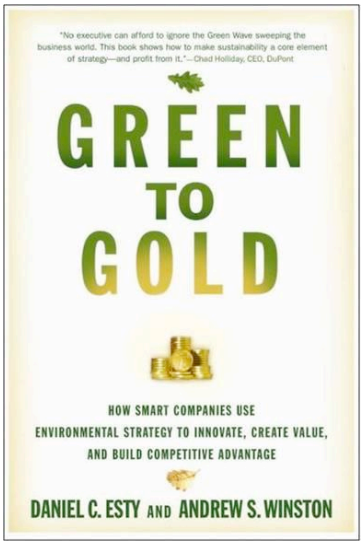
Profile of Esty Environmental Partners



Esty Environmental Partners (EEP) is a management consulting firm that works with its clients to develop and implement environmental strategies that provide business advantage. Our advice and methods are built on the 20-year career of Dan Esty, Director of both the Center for Environment and Business at Yale and the Yale Center for Environmental Law and Policy. These Centers have focused on how environmental challenges create evolving opportunities for companies to innovate and lead. Dan's most recent book, ***Green to Gold***, presents several of the EEP frameworks and provides cutting-edge guidance for executives on how to face environmental challenges and seize environmental leadership. Dan Esty and George Favaloro (a former McKinsey consultant and corporate executive) founded EEP in the summer of 2006 to apply this set of frameworks and help companies achieve positive results from their environmental initiatives. In the spring of 2007, Amy Longsworth joined EEP as a Partner, adding an additional 20 years of experience in environmental strategy, marketing, and communications to the team.

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End Notes:

[1] Forrester Research projects world PC use to be more than 2 billion by 2015. "Computers sold in the world this year." Worldometers: World Statistics Updated in Real Time. http://www.worldometers.info/computers/ 15 August 2008.

[2] Forrester Consulting. 2008. "The state of green IT adoption." September.

[3] GAO, 2008. "Electronic waste: EPA needs to better control harmful U.S. exports through stronger enforcement and more comprehensive regulation." August. GAO-08-1044

[4] Iles, A. 2004. "Mapping environmental justice in technology flows: Computer waste impacts in Asia." *Global Environmental Politics* 4:4 Pp. 76-107.

[5] Industrial Economics Inc.'s 2007 paper commissioned by the EPA: "Management of electronic waste in the United States: approach two. Draft Final Report." EPA530-R-07-004b

[6] GAO, 2008.

[7] Data from the Center for Disease Control and Prevention (CDC)'s National Institute for Occupational Safety and Health (NIOSH) about compounds that demonstrate Imminent Danger to Life and Health (IDLH) (www.cdc.gov/niosh). These NIOSH reports summarize the relevant studies on the lethal dose for toxic materials.

[8] From "Time to deal with e-Waste" in the December, 9, 2007 edition of *The New York Times*.

[9] Industrial Economics Inc., 2007; Hazardous Material Laboratory (California Department of Toxic Substances Control). 2004; "SB20 report determination of regulated elements in discarded laptop computers, LCD monitors, plasma TVs and LCD TVs."; EEP analysis

[10] Wong C.S.C., Wu, Duzgoren-Aydin, N.S., Aydin, A, and M.H. Wong. 2007. "Trace metal contamination of sediments in an e-waste processing village of China." *Environmental Pollution*. 145(2) 434-442; Hicks, C., Dietmar, R, and M. Eugster. 2005. "The recycling and disposal of electrical and electronic waste in China—legislative and market responses." *Environmental Impact Assessment Review* 25 459–471.

[11] Wong C.S.C., Wu, Duzgoren-Aydin, N.S., Aydin, A, and M.H. Wong. 2007. "Evidence of excessive releases of metal from primitive e-waste processing in Guiyu, China." *Environmental Pollution*. 148(1) 62-72; Wong et al, 2007; Leung et al, 2008.

[12] Newsweek. "Recycling: tech trash, e-waste: by any name, it's an Issue" (December 13, 2005)

[13] EEP analysis using sources including: US EPA's 2007 document "National Action Plan for Energy Efficiency: Sector Collaborative accomplishments and Next Steps"; EPA Green Cleaning Pollution Prevention Calculator, and Environmental Defense Fund Paper Calculator (www.papercalculator.org); Lee et al. 2001."Characterization of VOCs, ozone, and PM_{10} emissions from office equipment in an environmental chamber." Building and Environment. 36: 837-843.

[14] EEP used a "10,000 person knowledge worker company" because through collaboration with TechTurn, this was determined to be the average size of a corporate customer in need of a responsible e-waste solution. 10,000-person knowledge-worker firms could include banks, brokerages, insurance companies, law firms, or any other company with large office and computing needs.

[15] Scientists studying the total impacts of computers have determined that the majority of the environmental impacts are concentrated in the raw material extraction and component fabrication stage (sometimes called "pre-manufacturing"). Several processes account for the damaging upstream impacts, including the mining of gold, palladium, copper, and tantalum (to make complex parts like circuit boards), component manufacturing (Erik Williams, a widely-acclaimed expert on the life cycle impacts of computers, claims that it takes 435 kg of fossil fuels, 2340 liters of water, and 25 kg of chemicals to produce one laptop).

[16] Keuhr and Williams 2003. Choi et al. 2006. EEP analysis.

[17] Horvath A. and Masanet E., 2007. "An analysis of measures to reduce the life-cycle energy consumption and greenhouse gas emissions of California's personal computers." University of California Energy Institute; Choi et al. 2006; Kuehr and Williams 2003.