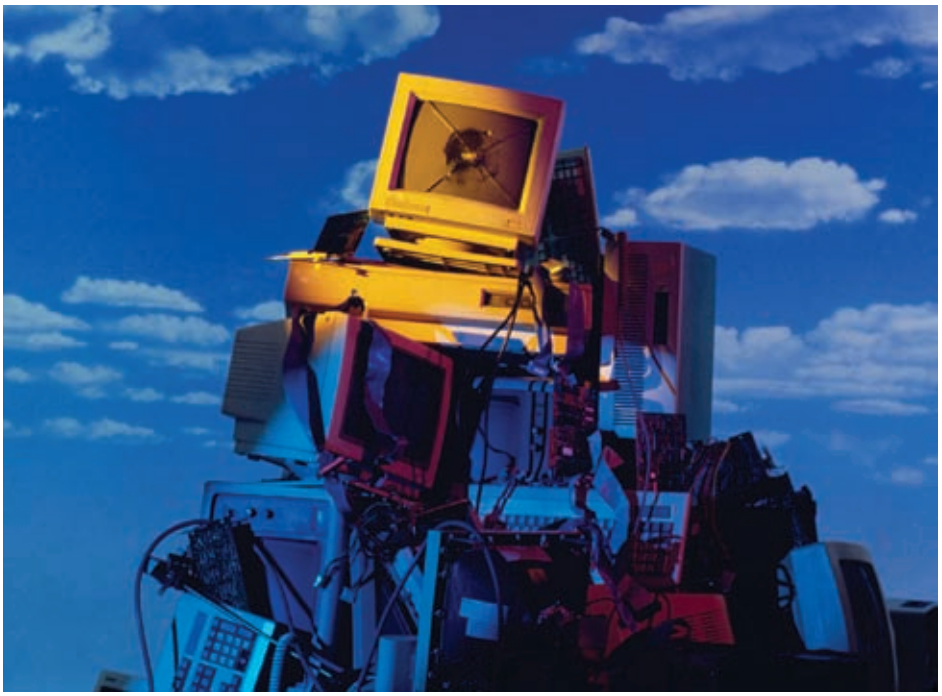
Electronic Waste: A Public Health Issue

The management of electronic waste (e-waste) at the end of its useful life has presented serious challenges to the existing solid waste and hazardous waste management structures, resulting in widespread contamination of the environment[1]. What is less well known are the public health impacts of production, use and end of life management of electronic products.



Current electronic waste management contributes to increasing levels of toxic chemicals building up in our bodies

The chemical body burden of the human population has been steadily increasing; based on a study by the CDC, each of us now carries an average of 150 chemicals in our body, residues of our industrial lifestyle.[2] And this is only for the chemicals that have been tested – many tens of thousands more are used in the marketplace today. According to studies performed by the Environmental Working Group, of the 171 residues tested in 9 volunteers, on average 56 were known carcinogens.[3]

Dangerous chemicals are released when electronic products are manufactured, used, and disposed at end of life. Some of these chemicals are toxic in small amounts and have the ability to accumulate in our fatty tissues through the food we eat and the dust in the air we breathe. These toxins also become more highly concentrated as they move up the food chain and can be passed on to our children.

Chemicals of high concern are known variously as PBTs (Persistent, Bioaccumulative and Toxic) or POPs (Persistent Organic Pollutants.) PBTs are defined by the U.S. EPA as chemicals that are toxic, persist in the environment and bioaccumulate in food chains and, thus, pose risks to human health and ecosystems.[4] The POPs are twelve chemicals (the Dirty Dozen) targeted for global elimination by the Stockholm Convention on Persistent Organic Pollutants.[5] The original Dirty Dozen POPS chemicals are mostly organochlorine pesticides such as chlordane, dieldrin and DDT, but the list also includes toxic by-products of electronics manufacturing and disposal such as dioxins and furans. Other chemicals, including a class of brominated flame retardants commonly used in consumer electronics, are being considered for adoption to the POPS list.

Health advocates are becoming very concerned as studies continue to show high concentrations of PBTs and POPs in human blood across the globe. Many POPs are also endocrine disruptors, known to disrupt the hormone system. These chemicals are particularly hazardous to the developing fetus and young children whose reproductive systems are still forming.

Some of these toxic chemicals are the by-products of electronics manufacturing, while others are found in electronic products themselves. When electronics are not properly recycled, their plastic casings are often burned, releasing PBTs and POPs that can reach people thousands of miles away. Even small amounts of these extremely dangerous toxins can injure human health. This is one reason why e-waste should not be incinerated, even in "waste to energy" facilities. Often e-waste – much of it exported from the US – is sorted, disassembled and burned in the open in villages in Asia creating severe local pollution as well as contributing to the global build up of POPs.

People and the environment are exposed throughout the lifecycle of electronic products

Workers, consumers and communities are exposed to the chemicals contained in consumer electronics throughout their life cycle, from manufacture through use and

disposal. Responsible recycling of electronics reduces some of their health and environmental impacts, but many current recycling practices still need to be improved.

Workers:

Electronics workers have been shown to have high exposure to carcinogens and reproductive toxicants, including solvents, heavy metals and epoxy resins, during production.[6] Women working in semiconductor fabrication showed increased rates of spontaneous abortion and birth defects.[7] In addition, several studies over the past two decades have shown that electronic workers have a significantly elevated risk of lung, pharyngeal, nasal, breast, bladder, and brain cancers.[8]

Recycling workers are exposed to heavy metals and toxic flame retardant chemicals during the shredding and disposal of e-waste.[9] Household hazardous waste collection workers take protective precautions during e-waste collection events; similar precautions should be put in place for those workers handling electronics.

Consumers

Consumers are exposed to an enormous variety of chemicals from products, some of which may originate in the increasing number of consumer electronics in our homes. The Computer Take Back Campaign and Clean Production Action did the first nationwide test for flame retardants in dust on computers in 2004. The study's findings show that dust on computers clearly contain flame retardants used in the computer casings.[10] Subsequent studies show that these flame retardants are ubiquitous in house dust and indoor and outdoor air.[11]

Communities

Some communities located near semiconductor manufacturing have suffered from the direct contamination of their environment, with drastic results for human health. Solvents and other chemicals that leaked from IBM and Fairchild Semiconductor manufacturing plants in San Jose, California, for example, caused increased rates of spontaneous abortions and congenital malformations among infants exposed during pregnancy.[12]

Communities can also suffer from indirect environmental contamination. The incineration, land-filling, and illegal dumping of electronic wastes all contribute toxic chemicals to the environment. For example, common pollutants from municipal waste incinerators include dioxins and furans, which are created when vinyl plastics, such as PVC cables, are burned. Many of the heavy metals found in electronics, including lead, mercury, cadmium and chromium are also detected in incinerator stacks.[13] The U.S. food supply is increasingly contaminated with flame retardant chemicals used in electronics,[14] and these chemicals can potentially leach from electronic products discarded in landfills.[15]

Electronics recycling workers have been shown to have higher levels of flame retardants in their blood, potentially from exposure to contaminated indoor air. Similar exposures are likely for communities where recycling plants are located, especially if these plants are not adequately regulated.[16] Much of the electronics industry in the U.S. has out-sourced manufacturing and disposal to less economically developed countries such as China, India, and the countries of South East Asia. The devastating effect on local communities of uncontrolled management of these wastes is well-documented.[17]

What are we being exposed to?

Toxics in Electronics

Just one computer or television can contain hundreds of chemicals, including lead, mercury, cadmium, brominated flame retardants (BFRs), and polyvinyl chloride (PVC). Many of these chemicals are known to cause cancer, respiratory illness, and reproductive problems. They are especially dangerous because of their ability to travel long distances through air and water and accumulate in our bodies and the environment.

Lead. Many older TV and computer monitors with cathode ray tubes can contain up between four to eight pounds of lead. Lead is also used in the soldering on the circuit boards.[18] Exposure can cause brain damage, nervous damage, blood disorders, kidney damage, and developmental damage to a fetus. Children are especially vulnerable. Acute exposure can cause vomiting, diarrhea, convulsions, coma, or death.[19]

Mercury. Light bulbs in flat panel displays, LCD screens, switches, & printed wiring boards all contain mercury.[20] High levels of exposure to mercury contribute to brain & kidney damage, harm the developing fetus & can be passed down through breast milk and fish consumption. In a 2000 report, the National Academy of Sciences estimated that over 60,000 babies are born each year at risk for neurodevelopmental defects associated with high exposure to methylmercury in the womb.[21]

Plastics and Polyvinyl Chloride (PVC). The average computer contains up to 14 pounds of plastics, including high-impact polystyrene (HIPS), acrylonitrile-butadiene-styrene (ABS) and polycarbonate (PC)/ABS alloys as well as PVC in wire and cable insulation.[22] Combinations of plastics which are difficult to separate and recycle are used in printed circuit boards, in components such as connectors, plastic covers & cables. At end of life, hazardous chemical additives can leach when PVC products are landfilled, and dioxins are emitted when PVC is incinerated. The U.S. EPA estimates that levels of dioxin contamination in the general population is at or near the level at which adverse health effects can be observed in both humans and animals. PVC manufacture and disposal adds to both the phthalate and dioxin body burden in all of us.[23]

Brominated Flame Retardants (BFRs). Used in plastic casings, BFRs are released when electronics are dumped or incinerated. BFRs are considered to be likely endocrine disrupters, causing neurological damage, through thyroid hormone disruption, in the developing fetus with subsequent effects on memory, learning

and motor skills. Levels in humans and other animals high on the food chain have now reached levels that have shown damaging effects in laboratory animals.[24] Incineration of plastics containing BFRs generate brominated dioxins and furans that are chemically similar to the chlorinated dioxins and furans produced by the incineration of PVC.[25]

Dioxins and Furans. These substances are released when electronics containing chlorinated plastics or plastics treated with brominated flame retardants are incinerated (see PVC and BFRs above.) Dioxins and furans may also be created when electronic products in landfills contribute to landfill fires.[26]

Additional Heavy Metals

Cadmium. Surface mounted chip resistors, infrared detectors, semiconductors, older types of cathode ray tubes, and some plastics contain cadmium.[27] Cadmium concentrates in the body and can cause kidney damage and harm to fragile bones. Long term exposure can cause kidney damage and damage to the bone structure. Cadmium is also a known cancer-causing substance.[28]

Beryllium. This is found on motherboards and connectors and is a human carcinogen.[29]

Hexavalent Chromium. This is used for corrosion protection of untreated & galvanized steel plates & as a hardener for steel housing. Hexavalent chromium can cause DNA damage & asthmatic bronchitis.[30]

What's the Answer?

Encourage **responsible recycling, producer takeback, and product re-design** by asking electronic manufacturers to:

- **Commit to product eco-design.** Along with designing in green chemistry, product designers must also design products for disassembly into component parts that can be reused, recycled or composted (in the case of bio-based plastics).
- **Take responsibility for products** for their entire life cycle. Along with addressing the upstream issues of using safer chemicals based on green chemistry principles, take responsibility for the product at the end of its useful life.

Extended Producer Responsibility (EPR), often referred to as product take-back, ensures that manufacturers are responsible for the re-use and recycling of their own brand name products at end of life. Legislation requiring this has now been enacted within the 25 countries of the European Union as well as Japan, South Korea and some regions in the U.S. and Canada. EPR will continue to be adopted as governments realize it is the only responsible solution to e-waste management.

- **Develop a corporate chemical policy** that includes the precautionary principle and an ongoing commitment to continually improve products with the safest chemicals and materials.
- **Demand accountability throughout the supply chain**. Require suppliers to: a) disclose the chemicals used in all components (down to 100 ppm) and the material content of their products; and, b) provide comprehensive safety data for all chemicals used in products.
- **Target highly hazardous chemicals** for elimination, especially PBTs, endocrine disrupting chemicals and OSPAR (Oslo Paris Convention for the Protection of the Marine Environment of the North-East Atlantic) Priority Chemicals.[31]
- **Publicly support government reforms** that promote green chemistry, eliminate highly hazardous chemicals and require manufacturers to provide comprehensive safety data for all chemicals on the market. Europe has recently overhauled its entire chemicals policy to demand more accountability from the chemical industry to supply missing data on all chemicals while encouraging the substitution of hazardous chemicals with safer alternatives. At a minimum, we must demand the same from chemical producers and users in the U.S..[32]

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