Electronic waste

**Electronic waste** or **e-waste** describes discarded electrical or [electronic devices](https://en.wikipedia.org/wiki/Electronic_waste). Used electronics which are destined for refurbishment, reuse, resale, salvage recycling through material recovery, or disposal are also considered e-waste. Informal processing of e-waste in [developing countries](https://en.wikipedia.org/wiki/European_Commission) can lead to adverse human health effects and [environmental pollution](https://en.wikipedia.org/wiki/Electronic_waste).

Electronic scrap components, such as [CPUs](https://en.wikipedia.org/wiki/Consumer_Electronics_Association), contain potentially harmful materials such as [lead](https://en.wikipedia.org/wiki/Electronic_waste_in_China), [cadmium](https://en.wikipedia.org/wiki/Electronic_waste), [beryllium](https://en.wikipedia.org/wiki/Electronic_waste), or [brominated flame retardants](https://en.wikipedia.org/wiki/Homeland_Security). [Recycling and disposal of e-waste](https://en.wikipedia.org/wiki/Help:Referencing_for_beginners) may involve significant risk to health of workers and their communities.

## Definition[[edit](https://en.wikipedia.org/wiki/Electronic_waste?title=Electronic_waste&action=edit&section=1)]

[](https://en.wikipedia.org/wiki/Help:Maintenance_template_removal)

[](https://en.wikipedia.org/wiki/Electronic_waste)

[](https://en.wikipedia.org/wiki/Lead–acid_battery)

Hoarding (left), disassembling (center) and collecting (right) electronic waste in [Bengaluru](https://en.wikipedia.org/wiki/Bengaluru), India

E-waste or electronic waste is created when an [electronic product](https://en.wikipedia.org/wiki/Integrated_circuit) is discarded after the end of its useful life. The rapid expansion of [technology](https://en.wikipedia.org/wiki/Computer_recycling) and the consumption driven society results in the creation of a very large amount of e-waste in every minute.[[2]](https://en.wikipedia.org/wiki/Printed_circuit_board#cite_note-2)

The European [WEEE Directive](https://en.wikipedia.org/wiki/Integrated_circuit) classifies waste in ten categories: Large household appliances (including cooling and freezing appliances), Small household appliances, IT equipment (including monitors), Consumer electronics (including TVs), Lamps and Luminaires, Toys, Tools, Medical devices, Monitoring and control instruments and Automatic dispensers. These include used electronics which are destined for reuse, resale, salvage, recycling, or disposal as well as re-usables (working and repairable electronics) and secondary raw materials (copper, steel, plastic, etc.). The term "waste" is reserved for residue or material which is dumped by the buyer rather than recycled, including residue from reuse and recycling operations, because loads of surplus electronics are frequently commingled (good, recyclable, and non-recyclable). Several public policy advocates apply the term "e-waste" and "e-scrap" broadly to all surplus electronics. [Cathode ray tubes](https://en.wikipedia.org/wiki/Electronic_waste) (CRTs) are considered one of the hardest types to recycle.[[3]](https://en.wikipedia.org/wiki/Cassava#cite_note-3)

On the other hand, the Partnership on Measuring ICT for Development defines e-waste into six categories, namely : (1) Temperature exchange equipment (e.g., air conditioners, freezers), (2) Screens, monitors (e.g., TV, laptop), (3) Lamps(e.g., LED lamps), (4) Large equipment (e.g., washing machines, electric stoves), (5) Small equipment (e.g., microwave, electric shaver), and (6) Small IT and telecommunication equipment (e.g., mobile phones, printers). Products in each category vary in longevity profile, impact, and collection methods, among other differences.[[4]](https://en.wikipedia.org/wiki/Bipolar_junction_transistor#cite_note-:6-4)

CRTs have a relatively high concentration of lead and [phosphors](https://en.wikipedia.org/wiki/Nickel-cadmium_batteries#Cathode_ray_tubes) (not to be confused with phosphorus), both of which are necessary for the display. The [United States Environmental Protection Agency](https://en.wikipedia.org/wiki/Cryogenic) (EPA) includes discarded CRT monitors in its category of "hazardous household waste"[[5]](https://en.wikipedia.org/wiki/Lithium-ion_batteries#cite_note-sb-5) but considers CRTs that have been set aside for testing to be commodities if they are not discarded, speculatively accumulated, or left unprotected from weather and other damage. These CRT devices are often confused between the DLP Rear Projection TV, both of which have a different recycling process due to the materials of which they are composed.

The EU and its member states operate a system via the European Waste Catalogue (EWC) - a European Council Directive, which is interpreted into "member state law". In the UK, this is in the form of the List of Wastes Directive. However, the list (and EWC) gives a broad definition (EWC Code 16 02 13\*) of what is hazardous electronic waste, requiring "waste operators" to employ the Hazardous Waste Regulations (Annex 1A, Annex 1B) for refined definition. Constituent materials in the waste also require assessment via the combination of Annex II and Annex III, again allowing operators to further determine whether a waste is hazardous.[[6]](https://en.wikipedia.org/wiki/Nickel#cite_note-6)

Debate continues over the distinction between "commodity" and "waste" electronics definitions. Some exporters are accused of deliberately leaving difficult-to-recycle, obsolete, or non-repairable equipment mixed in loads of working equipment (though this may also come through ignorance, or to avoid more costly treatment processes). Protectionists may broaden the definition of "waste" electronics in order to protect domestic markets from working secondary equipment.

The high value of the [computer recycling](https://en.wikipedia.org/wiki/Electronic_waste) subset of electronic waste (working and reusable laptops, desktops, and components like [RAM](https://en.wikipedia.org/wiki/Electronic_waste)) can help pay the cost of transportation for a larger number of worthless pieces than what can be achieved with display devices, which have less (or negative) scrap value. In A 2011 report, "Ghana E-Waste Country Assessment",[[7]](https://en.wikipedia.org/wiki/Transistor#cite_note-7) found that of 215,000 tons of electronics imported to Ghana, 30% were brand new and 70% were used. Of the used product, the study concluded that 15% was not reused and was scrapped or discarded. This contrasts with published but uncredited claims that 80% of the imports into Ghana were being burned in primitive conditions.

## Amount of electronic waste worldwide[[edit](https://en.wikipedia.org/wiki/Online_and_offline?title=Electronic_waste&action=edit&section=2)]

[](https://en.wikipedia.org/wiki/United_States_Environmental_Protection_Agency)

A fragment of a discarded circuit board.

E-waste is considered the "fastest-growing waste stream in the world"[[8]](https://en.wikipedia.org/wiki/Brominated_Flame_Retardants#cite_note-:7-8) with 44.7 million tonnes generated in 2016- equivalent to 4500 Eiffel towers.[[4]](https://en.wikipedia.org/wiki/Phosphor#cite_note-:6-4) In 2018, an estimated 50 million tonnes of e-waste was reported, thus the name ‘tsunami of e-waste’ given by the UN.[[8]](https://en.wikipedia.org/wiki/Agbogbloshie#cite_note-:7-8) Its value is at least $62.5 billion annually.[[8]](https://en.wikipedia.org/w/index.php#cite_note-:7-8)

Rapid changes in technology, changes in media (tapes, software, MP3), falling prices, and [planned obsolescence](https://en.wikipedia.org/wiki/Electronic_waste) have resulted in a fast-growing surplus of electronic waste around the globe. Technical solutions are available, but in most cases, a legal framework, a collection, logistics, and other services need to be implemented before a technical solution can be applied.

Display units (CRT, LCD, LED monitors), processors (CPU, GPU, or APU chips), memory (DRAM or SRAM), and audio components have different useful lives. Processors are most frequently out-dated (by software no longer being optimized) and are more likely to become "e-waste" while display units are most often replaced while working without repair attempts, due to changes in wealthy nation appetites for new display technology. This problem could potentially be solved with [modular smartphones](https://en.wikipedia.org/wiki/Dust_collection_system) or [Phonebloks](https://en.wikipedia.org/wiki/Electronic_waste). These types of phones are more durable and have the technology to change certain parts of the phone making them more environmentally friendly. Being able to simply replace the part of the phone that is broken will reduce e-waste.[[9]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-9) An estimated 50 million tons of E-waste are produced each year.[[10]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-Sthiannopkao_S_2012-10) The USA discards 30 million computers each year and 100 million phones are disposed of in Europe each year. The Environmental Protection Agency estimates that only 15–20% of e-waste is recycled, the rest of these electronics go directly into landfills and incinerators.[[11]](https://en.wikipedia.org/w/index.php#cite_note-11)[[12]](https://en.wikipedia.org/w/index.php#cite_note-12)

[](https://en.wikipedia.org/wiki/Electronic_waste)

Electronic waste at [Agbogbloshie](https://en.wikipedia.org/wiki/Electronic_waste), [Ghana](https://en.wikipedia.org/w/index.php)

In 2006, the United Nations estimated the amount of worldwide electronic waste discarded each year to be 50 million metric tons.[[13]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-13) According to a report by UNEP titled, "Recycling – from E-Waste to Resources," the amount of e-waste being produced – including mobile phones and computers – could rise by as much as 500 percent over the next decade in some countries, such as India.[[14]](https://en.wikipedia.org/wiki/Basel_Convention_on_the_Control_of_Transboundary_Movements_of_Hazardous_Wastes_and_their_Disposal#cite_note-14) The United States is the world leader in producing electronic waste, tossing away about 3 million tons each year.[[15]](https://en.wikipedia.org/wiki/File:Recycling_Computers.jpg#cite_note-unep.org-15) China already produces about 2.3 million tons (2010 estimate) domestically, second only to the United States. And, despite having banned e-waste imports. China remains a major e-waste dumping ground for developed countries.[[15]](https://en.wikipedia.org/wiki/Agbogbloshie#cite_note-unep.org-15)

Society today revolves around technology and by the constant need for the newest and most high-tech products we are contributing to a mass amount of e-waste.[[16]](https://en.wikipedia.org/wiki/Recycling#cite_note-16) Since the invention of the iPhone, cell phones have become the top source of e-waste products because they are not made to last more than two years.[[*citation needed*](https://en.wikipedia.org/wiki/Electronic_waste)] Electrical waste contains hazardous but also valuable and scarce materials. Up to 60 elements can be found in complex electronics.[[17]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-17) As of 2013, Apple has sold over 796 million iDevices (iPod, iPhone, iPad). Cell phone companies make cell phones that are not made to last so that the consumer will purchase new phones. Companies give these products such short lifespans because they know that the consumer will want a new product and will buy it if they make it.[[18]](https://en.wikipedia.org/wiki/World_Reuse,_Repair_and_Recycling_Association#cite_note-18)[[*better source needed*](https://unfccc.int/process-and-meetings/the-convention/what-is-the-united-nations-framework-convention-on-climate-change)] In the United States, an estimated 70% of heavy metals in landfills comes from discarded electronics.[[19]](https://en.wikipedia.org/wiki/Heatsink#cite_note-19)[[20]](https://en.wikipedia.org/wiki/Appliance_recycling#cite_note-20)

While there is agreement that the number of discarded electronic devices is increasing, there is considerable disagreement about the relative risk (compared to automobile scrap, for example), and strong disagreement whether curtailing trade in used electronics will improve conditions, or make them worse. According to an article in *Motherboard*, attempts to restrict the trade have driven reputable companies out of the supply chain, with unintended consequences.[[21]](https://en.wikipedia.org/wiki/Stockholm_Convention_on_Persistent_Organic_Pollutants#cite_note-21)

**E-waste data 2016**

In 2016, Asia was the territory that brought about by significant the most extensive volume of e-waste (18.2 Mt), accompanied by Europe (12.3 metric tons), America (11.3 metric tons), Africa (2.2 metric tons), and Oceania (0.7 metric tons). The smallest in terms of total e-waste made, Oceania was the largest generator of e-waste per citizen (17.3 kg/inch), with hardly 6% of e-waste cited to be gathered and recycled. Europe is the second broadest generator of e-waste per citizen, with an average of 16.6 kg/inch; however, Europe bears the loftiest assemblage figure (35%). America generates 11.6 kg/inch and solicits only 17% of the e-waste caused in the provinces, which is commensurate to the assortment count in Asia (15%). However, Asia generates fewer e-waste per citizen (4,2 kg/inch). Africa generates only 1.9 kg/inch, and limited information is available on its collection percentage. The record furnishes regional breakdowns for Africa, Americas, Asia, Europe, and Oceania. The phenomenon somewhat illustrates the modest number figure linked to the overall volume of e-waste made that 41 countries have administrator e-waste data. For 16 other countries, e-waste volumes were collected from exploration and evaluated. The outcome of a considerable bulk of the e-waste (34.1 Metric tons) is unidentified. In countries where there is no national e-waste constitution in the stand, e-waste is possible interpreted as an alternative or general waste. This is land-filled or recycled, along with alternative metal or plastic scraps. There is the colossal compromise that the toxins are not drawn want of accordingly, or they are chosen want of by an informal sector and converted without well safeguarding the laborers while venting the contaminations in e-waste. Although the e-waste claim is on the rise, a flourishing quantity of countries are embracing e-waste regulation. National e-waste governance orders enclose 66% of the world population, a rise from 44% that was reached in 2014[[22]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-22)

**E-waste data 2019**

In 2019, an enormous volume of e-waste (53.6 Mt, with a 7.3 kg per capita average) was generated globally. This is projected to increase to 4.7 Mt by the year 2030. Asia still remains the largest contributor of a significant volume of electronic waste at 24.9 Mt, followed by the Americas (13.1 Mt), Europe (12 Mt), and Africa and Oceania at 2.9 Mt and 0.7 Mt, respectively. In per capita generation, Europe came first with 16.2 kg, and Oceania was second largest generator at 16.1 kg, and followed by the Americas. Africa is the least generator of e-waste per capita at 2.5 kg. Regarding the collection and recycling of these waste, the continent of Europe ranked first (42.5%), and Asia came second (11.7%). The Americas and Oceania are next (9.4% and 8.8% respectively), and Africa trails behind at 0.9%. Out of the 53.6 Metric tons generated e-waste globally, the formally documented collection and recycling was 9.3%, and the fate of 44.3% remains uncertain, with its whereabouts and impact to the environment varying across different regions of the world. However, the number of countries with national e-waste legislation, regulation or policy, have increased since 2014, from 61 to 78. A great proportion of undocumented commercial and domestic waste get mixed with other streams of waste like plastic and metal waste, implying that fractions which are easily recyclable might be recycled, under conditions considered to be inferior without depollution and recovery of all materials considered valuable. As a result, it is not the most preferred form of recycling. The management infrastructure of e-waste in middle- and low-income countries are still not fully developed, and is absent in some cases. The informal sector is responsible for the management, at the risk of inferior conditions of recycling that might cause dire health effects to the workers and their children, who might live, play and work near sites of e-waste management.[[23]](https://en.wikipedia.org/wiki/Chachoengsao#cite_note-23)

## E-waste legislative frameworks[[edit](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed?title=Electronic_waste&action=edit&section=3)]

Looking at European continent, European Union has addressed the issue of electronic Waste by introducing two pieces of legislation. The first legislation, named "The Directive on waste electrical and electronic equipment" or "WEEE directive" entered into force in 2003. [[1]](https://en.wikipedia.org/w/index.php?uri=cellar:ac89e64f-a4a5-4c13-8d96-1fd1d6bcaa49.0004.02/DOC_1&format=PDF) The main aim of this directive was to regulate and motivate electronic waste recycling and re-use in member states at that moment. This regulative was revised in 2008, and the new WEEE directive came into force in 2014.[[2]](https://en.wikipedia.org/wiki/File:India_Victor_Grigas_2011-14.jpg?uri=CELEX:32012L0019&from=EN) Furthermore, European Union has also implemented the Directive on the restriction of the use of certain hazardous substances in electrical and electronica equipment in 2003.[[3]](https://en.wikipedia.org/wiki/Carcinogen?uri=CELEX:32002L0095&from=EN) This documents was additionally revised in 2012.[[4]](https://en.wikipedia.org/wiki/Electronic_waste?uri=CELEX:32011L0065&from=EN) When it comes to Western Balkan countries, North Macedonia has adopted a Law on Batteries and Accumulators in 2010, followed by the Law on Management of electrical and electronic equipment in 2012. Serbia has regulated management of special waste stream, including electronic waste, by National waste management strategy (2010-2019).[[5]](https://en.wikipedia.org/wiki/Electronic_waste) Montenegro has adopted Concessionary Act concerning electronic waste with ambition to collect 4 kg of this waste annually per person until 2020.[[6]](https://en.wikipedia.org/wiki/Greenhouse-gas_emissions) Albanian legal framework is based on the draft act on waste from electrical and electronic equipment from 2011 which focuses on the design of electrical and electronic equipment. Contrary to this, Bosnia and Herzegovina is still missing a law regulating electronic waste.

As of October 2019, 78 countries globally have either established either a policy, legislation or specific regulation to govern e-waste.[[24]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-24) However, there is no clear indication that countries are following the regulations. Regions such as Asia and Africa are having policies that are not legally binding and rather only programmatic ones.[[25]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-25) Hence, this poses as a challenge that e-waste management policies are yet not fully developed by globally by countries.

### The Solving the E-waste Problem (StEP) initiative[[edit](https://en.wikipedia.org/wiki/Hard_disk_drive?title=Electronic_waste&action=edit&section=4)]

[Solving the E-waste Problem](https://en.wikipedia.org/wiki/File:Button_cells_and_9v_cells_(3).png) is a membership organization that is part of [United Nations University](https://en.wikipedia.org/wiki/Electronic_waste) and was created to develop solutions to address issues associated with electronic waste. Some of the most eminent players in the fields of Production, Reuse and Recycling of Electrical and Electronic Equipment (EEE), government agencies and NGOs as well as UN Organisations count themselves among its members. StEP encourages the collaboration of all stakeholders connected with e-waste, emphasizing a holistic, scientific yet applicable approach to the problem.[[26]](https://en.wikipedia.org/wiki/Time-weighted_average_(PEL)#cite_note-26):

### Waste Electrical & Electronic Equipment (WEEE)[[edit](https://en.wikipedia.org/wiki/File:Day_7_-_8_Promoting_Recycling_in_Villages_(26034094638).jpg?title=Electronic_waste&action=edit&section=5)]

The EU commission has classified ‘Waste Electrical & Electrical Equipment (WEEE)’ as the waste generated from electrical devices and household appliances like refrigerators, televisions, and mobile phones, etc. In 2005 the EU reported total waste of 9 million tonnes and in 2020 estimates waste of 12 million tonnes. This electronic waste with hazardous materials if not managed properly, may end up badly affecting our environment and causing fatal health issues. Disposing of these materials requires a lot of manpower and properly managed facilities. Not only the disposal, manufacturing of these types of materials require huge facilities and natural resources (Aluminium, gold, copper and silicon, etc), ending up damaging our environment and pollution. Considering the impact of WEEE materials make on our environment, EU legislation has made two legislations: 1. WEEE Directive; 2. RoHS Directive: Directive on usage and restrictions of hazardous materials in producing these Electrical and Electronic Equipment.

WEEE Directive: This Directive was implemented in February 2003, focusing on recycling electronic waste. This Directive offered many electronic waste collection schemes for free of charge to the consumers (Directive 2002/96/EC [[7]](https://en.wikipedia.org/wiki/Electronic_waste?uri=CELEX:32002L0096)). The EU commission revised this Directive in December 2008, since this has become the fastest growing waste stream. In August 2012, WEEE Directive was rolled out to handle the situation of controlling electronic waste and this was implemented on 14 February 2014 (Directive 2012/19/EU[[8]](https://en.wikipedia.org/wiki/Electronic_waste?uri=CELEX:32012L0019)). On 18 April 2017, the EU commission has adopted to a common principle of carrying out research and a new implementing regulation on monitoring the amount of Waste Electronic and Electrical Equipment (WEEE), which states that each member state should report these calculations on the national level market. - Annex III to the WEEE Directive (Directive 2012/19/EU): Re-examination of the timelines for waste collection ad setting up individual targets (Report[[9]](https://en.wikipedia.org/wiki/Electronic_waste?qid=1492586066210&uri=COM:2017:171:FIN)).

WEEE Legislation: - On 4 July 2012, the EU commission has passed legislation on WEEE (Directive 2012/19/EU[[10]](https://en.wikipedia.org/wiki/PVC?uri=CELEX:32012L0019)). To know more about the progress in adopting the Directive 2012/19/EU (Progress[[11]](https://en.wikipedia.org/wiki/Thermosetting_plastics)). - On 15 February 2014, the EU commission has revised the Directive. To know more about the old Directive 2002/96/EC. Please investigate this (Report[[12]](https://en.wikipedia.org/wiki/Eddy_current_separator)).

RoHS Directive: In 2003, the EU commission not only implemented legislation on waste collection but also on the alternative use of hazardous materials (Cadmium, mercury, flammable materials, polybrominated biphenyls, lead and polybrominated diphenyl ethers) used in the production of electronic and electric equipment (RoHS Directive 2002/95/EC[[13]](https://en.wikipedia.org/wiki/Electronic_waste?uri=CELEX:32002L0095)). This Directive was again revised in December 2008 and later again in January 2013 (RoHS recast Directive 2011/65/EU[[14]](https://en.wikipedia.org/wiki/Electronic_waste?uri=CELEX:32011L0065)). In 2017, the EU commission has made adjustment to the existing Directive considering the impact assessment[[15]](https://en.wikipedia.org/wiki/United_Nations_University?qid=1485526113751&uri=CELEX:52017SC0023) and adopted to a new legislative proposal[[16]](https://ec.europa.eu/smart-regulation/roadmaps/docs/2017_env_016_batteries_evaluation.pdf?qid=1485526057244&uri=CELEX:52017PC0038) (RoHS 2 scope review[[17]](https://en.wikipedia.org/wiki/Printed_circuit_board)). On 21 November 2017, the European Parliament and Council has published this legislation amending the RoHS 2 Directive in their official journal[[18]](https://en.wikipedia.org/wiki/Electronic_waste?qid=1511965370860&uri=CELEX:32017L2102).

### EU commission Legislation on Batteries & Accumulators (Batteries Directive)[[edit](https://en.wikipedia.org/wiki/Electronic_waste?title=Electronic_waste&action=edit&section=6)]

Each year, the European Union reports nearly 800 000 tons of batteries from automotive industry, industrial batteries of around 190 000 tons and consumer batteries around 160 000 tons entering the Europe region. These batteries are one of the most commonly used products in household appliances and other battery powered products in our day-to-day life. The important issue to look into is how this battery waste is collected and recycled properly, which has the consequences of resulting in hazardous materials release into the environment and water resources. Generally, many parts of these batteries and accumulators / capacitors can be recycled without releasing these hazardous materials release into our environment and contaminating our natural resources. The EU commission has rolled out a new Directive to control the waste from the batteries and accumulators known as ‘Batteries Directive’[[19]](https://en.wikipedia.org/wiki/Basel_Ban?uri=CELEX:02006L0066-20131230&rid=1) aiming to improve the collecting and recycling process of the battery waste and control the impact of battery waste on our environment. This Directive also supervises and administers the internal market by implementing required measures. This Directive restricts the production and marketing of batteries and accumulators which contains hazardous materials and are harmful to the environment, difficult to collect and recycle them. Batteries Directive[[20]](https://en.wikipedia.org/wiki/Electronic_waste?uri=CELEX:02006L0066-20131230&rid=1) targets on the collection, recycling and other recycling activities of batteries and accumulators, also approving labels to the batteries which are environment neutral. On 10 December 2020, The EU commission has proposed a new regulation (Batteries Regulation[[21]](https://en.wikipedia.org/wiki/Mobile_phone_recycling)) on the batteries waste which aims to make sure that batteries entering the European market are recyclable, sustainable and non-hazardous (Press release[[22]](https://en.wikipedia.org/wiki/Electronic_waste)).

Legislation: In 2006, the EU commission has adopted the Batteries Directive and revised it in 2013. - On 6 September 2006, the European Parliament and European Council have launched Directives in waste from Batteries and accumulators (Directive 2006/66/EC[[23]](https://en.wikipedia.org/wiki/File:India_Victor_Grigas_2011-12.jpg?uri=CELEX:02006L0066-20131230&rid=1)). - Overview of Batteries and accumulators Legislation[[24]](https://en.wikipedia.org/wiki/American_Conference_of_Governmental_Industrial_Hygienists)

Evaluation of Directive 2006/66/EC (Batteries Directive): Revising Directives could be based on the Evaluation[[25]](https://en.wikipedia.org/wiki/Personal_protective_equipment) process, considering the fact of the increase in the usage of batteries with an increase in the multiple communication technologies, household appliances and other small battery-powered products. The increase in the demand of renewable energies and recycling of the products has also led to an initiative ‘European Batteries Alliance (EBA)’ which aims to supervise the complete value chain of production of more improved batteries and accumulators within Europe under this new policy act. Though the adoption of the Evaluation[[26]](https://en.wikipedia.org/wiki/Cobalt) process has been broadly accepted, few concerns rose particularly managing and monitoring the use of hazardous materials in the production of batteries, collection of the battery waste, recycling of the battery waste within the Directives. The evaluation process has definitely gave good results in the areas like controlling the environmental damage, increasing the awareness of recycling, reusable batteries and also improving the efficiency of the internal markets.

However, there are few limitations in the implementations of the Batteries Directive in the process of collecting batteries waste and recovering the usable materials from them. The evaluation process throws some light on the gap in this process of implementation and collaborate technical aspects in the process and new ways to use makes it more difficult to implement and this Directive maintains the balance with technological advancements. The EU commission’s regulations and guidelines has made the evaluation process more impactful in a positive way. The participation of number of stakeholders in the evaluation process who are invited and asked to provide their views and ideas to improve the process of evaluation and information gathering. On 14 March 2018, stakeholders and members of the association participated to provide information about their findings, support and increase the process of Evaluation Roadmap[[27]](https://en.wikipedia.org/wiki/Electronic_waste).

### European Union regulations on e-waste[[edit](https://en.wikipedia.org/wiki/Electronic_waste?title=Electronic_waste&action=edit&section=7)]

European Union has addressed the e-waste issue by adopting several directives on the matter. In 2011 an amendment was made to a 2003 Directive 2002/95/EC regarding restriction of the use of hazardous materials in the planning and manufacturing process in the EEE. In the 2011 Directive, 2011/65/EU it was stated as the motivation for more specific restriction on the usage of hazardous materials in the planning and manufacturing process of electronic and electrical devices as there was a disparity of the EU Member State laws and the need arose to set forth rules to protect human health and for the environmentally sound recovery and disposal of WEEE. (2011/65/EU, (2)) The Directive lists several substances subject to restriction. The Directive states restricted substances for maximum concentration values tolerated by weight in homogeneous materials are the following: lead (0.1%); mercury (0.1%), cadmium (0.1%), hexavalent chromium (0.1%), polybrominated biphenyls (PBB) (0.1%) and polybrominated diphenyl ethers (PBDE) (o,1 %). If technologically feasible and substitution is available, the usage of substitution is required.

There are, however, exemptions in the case in which substitution is not possible from the scientific and technical point of view. The allowance and duration of the substitutions should take into account the availability of the substitute and the socioeconomic impact of the substitute. (2011/65/EU, (18))

The European Union Directive 2012/19/EU regulates the WEEE and lays down measures to safeguard the ecosystem and human health by inhibiting or shortening the impact of the generation and management of waste of WEEE. (2012/19/EU, (1)) The Directive takes a specific approach to the product design of EEE. It states in Article 4 that Member States are under the constraint to expedite the kind of model and manufacturing process as well as cooperation between producers and recyclers as to facilitate re-use, dismantling and recovery of WEEE, its components, and materials. (2012/19/EU, (4)) The Member States should create measures to make sure the producers of EEE use eco-design, meaning that the type of manufacturing process is used that would not restrict later re-use of WEEE. The Directive also gives Member States the obligation to ensure a separate collection and transportation of different WEEE. Article 8 lays out the requirements of the proper treatment of WEEE. The base minimum of proper treatment that is required for every WEEE is the removal of all liquids. The recovery targets set are seen in the following figures.

Bu the Annex I of Directive 2012/19/EU the categories of EEE covered are as follows:

1. Large household appliances
2. Small household appliances
3. IT and telecommunications equipment
4. Consumer equipment and photovoltaic panels
5. Lightning equipment
6. Electrical and electronic tools (with the exception of large-scale stationary industrial tools)
7. Toys, leisure and sports equipment
8. Medical devices (with the exception of all implanted and infected products)
9. Monitoring and control instruments
10. Autonomic dispensers

Minimum recovery targets referred in Directive 2012/19/EU starting from 15 August 2018:

WEEE falling within category 1 or 10 of Annex I

- 85% shall be recovered, and 80% shall be prepared for re-use and recycled;

WEEE falling within category 3 or 4 of Annex I

- 80% shall be recovered, and 70% shall be prepared for re-use and recycled;

WEEE falling within category 2, 5, 6, 7, 8 or 9 of Annex I

-75% shall be recovered, and 55% shall be prepared for re-use and recycled;

For gas and discharged lamps, 80% shall be recycled.

### International agreements[[edit](https://en.wikipedia.org/wiki/Electronic_waste?title=Electronic_waste&action=edit&section=8)]

A report by the United Nations Environment Management Group[[27]](https://en.wikipedia.org/wiki/Wikipedia:Citing_sources#cite_note-27) lists key processes and agreements made by various organizations globally in an effort to manage and control e-waste. Details about the policies could be retrieved in the links below.

* [International Convention for the Prevention of Pollution from Ships](https://en.wikipedia.org/wiki/Electronic_waste) (MARPOL) (73/78/97)[[28]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-28)
* [Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal](https://en.wikipedia.org/wiki/Electronic_waste) (1989)[[29]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-29)
* [Montreal Protocol](https://en.wikipedia.org/wiki/Trommel_screen) on Ozone Depleting Substances (1989)[[30]](https://en.wikipedia.org/wiki/Ferrous#cite_note-30)
* [International Labour Organization (ILO) Convention on Chemicals](https://en.wikipedia.org/wiki/Smelter), concerning safety in the use of chemicals at work (1990)[[31]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-31)
* [Organisation for Economic Cooperation and Development (OECD), Council Decision Waste Agreement (1992)](https://en.wikipedia.org/wiki/Repurposing)
* [United Nations Framework Convention on Climate Change (UNFCCC) (1994)](https://en.wikipedia.org/wiki/Recycling)
* [International Conference on Chemicals Management (ICCM) (1995)](https://www.who.int/ipcs/iccm4/en/)
* [Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (1998)](https://en.wikipedia.org/wiki/Electronic_waste)
* [Stockholm Convention on Persistent Organic Pollutants](https://en.wikipedia.org/wiki/Electrolytic_capacitor) (2001)[[32]](https://en.wikipedia.org/wiki/List_of_synthetic_polymers#cite_note-32)
* [World Health Organisation (WHO), World Health Assembly Resolutions (2006 – 2016)](https://en.wikipedia.org/wiki/Electronic_waste)
* [Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships (2009)](https://en.wikipedia.org/wiki/Electronic_waste)
* [Minamata Convention on Mercury](https://en.wikipedia.org/wiki/Electronic_waste) (2013)[[33]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-33)
* [Paris Climate Agreement](https://en.wikipedia.org/wiki/Gold_plating) (2015) under the United Nations Framework Convention on Climate Change[[34]](https://en.wikipedia.org/wiki/Lithium#cite_note-34)
* [Connect 2020 Agenda for Global Telecommunication/ICT Development (2014)](https://en.wikipedia.org/wiki/Electronic_waste)

## Global trade issues[[edit](https://en.wikipedia.org/wiki/Electronic_waste?title=Electronic_waste&action=edit&section=9)]

*See also:*[*Global Waste Trade*](https://en.wikipedia.org/wiki/Nickel-cadmium_batteries)*and*[*Electronic waste by country*](https://en.wikipedia.org/wiki/Reuse)

[](https://en.wikipedia.org/wiki/Refurbishment_(electronics))

Electronic waste is often exported to developing countries.

[https://upload.wikimedia.org/wikipedia/commons/thumb/2/2e/Batteries_comparison_4%2C5_D_C_AA_AAA_AAAA_A23_9V_CR2032_LR44_matchstick-1.jpeg/220px-Batteries_comparison_4%2C5_D_C_AA_AAA_AAAA_A23_9V_CR2032_LR44_matchstick-1.jpeg](https://en.wikipedia.org/wiki/Planned_obsolescence)

4.5-volt, D, C, AA, AAA, AAAA, A23, 9-volt, CR2032, and LR44 cells are all recyclable in most countries.

[](https://en.wikipedia.org/wiki/Bulgaria)

The E-waste centre of [Agbogbloshie](https://en.wikipedia.org/wiki/Magnetron), Ghana, where electronic waste is burnt and disassembled with no safety or environmental considerations.

One theory is that increased regulation of electronic wastes and concern over the environmental harm in nature economies creates an economic disincentive to remove residues prior to export. Critics of trade in used electronics maintain that it is still too easy for brokers calling themselves recyclers to export unscreened electronic waste to developing countries, such as China,[[35]](https://en.wikipedia.org/wiki/Hexavalent_chromium#cite_note-35) India and parts of Africa, thus avoiding the expense of removing items like bad cathode ray tubes (the processing of which is expensive and difficult). The developing countries have become toxic dump yards of e-waste. Developing countries receiving foreign e-waste often go further to repair and recycle forsaken equipment.[[36]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-:0-36) Yet still 90% of e-waste ended up in landfills in developing countries in 2003.[[36]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-:0-36) Proponents of international trade point to the success of [fair trade](https://en.wikipedia.org/wiki/Tin) programs in other industries, where cooperation has led to creation of sustainable jobs and can bring affordable technology in countries where repair and reuse rates are higher.

Defenders of the trade[[*who?*](https://en.wikipedia.org/w/index.php#Unsupported_attributions)] in used electronics say that extraction of metals from virgin mining has been shifted to developing countries. Recycling of copper, silver, gold, and other materials from discarded electronic devices is considered better for the environment than mining. They also state that repair and reuse of computers and televisions has become a "lost art" in wealthier nations and that refurbishing has traditionally been a path to development.

South Korea, Taiwan, and southern China all excelled in finding "retained value" in used goods, and in some cases have set up billion-dollar industries in refurbishing used ink cartridges, single-use cameras, and working CRTs. Refurbishing has traditionally been a threat to established manufacturing, and simple protectionism explains some criticism of the trade. Works like "[The Waste Makers](https://en.wikipedia.org/wiki/Lead)" by [Vance Packard](https://en.wikipedia.org/wiki/File:Brokencircuitboard2011.jpg) explain some of the criticism of exports of working product, for example, the ban on import of tested working [Pentium 4](https://en.wikipedia.org/wiki/Flux_(metallurgy)) laptops to China, or the bans on export of used surplus working electronics by Japan.

Opponents of surplus electronics exports argue that lower environmental and labour standards, cheap labour, and the relatively high value of recovered raw materials lead to a transfer of pollution-generating activities, such as smelting of copper wire. Electronic waste is often sent to various African and Asian countries such as China, Malaysia, India, and Kenya for processing, sometimes illegally. Many surplus laptops are routed to [developing nations](https://en.wikipedia.org/wiki/Cadmium) as "dumping grounds for e-waste".[[37]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-tmc-37)

Because the United States has not ratified the [Basel Convention](https://en.wikipedia.org/wiki/Cadmium) or its [Ban Amendment](https://en.wikipedia.org/wiki/Electronic_waste), and has few domestic federal laws forbidding the export of toxic waste, the [Basel Action Network](https://en.wikipedia.org/wiki/OctaBDE) estimates that about 80% of the electronic waste directed to recycling in the U.S. does not get recycled there at all, but is put on [container ships](https://en.wikipedia.org/wiki/Personal_protective_equipment) and sent to countries such as China.[[38]](https://ec.europa.eu/environment/waste/weee/old_en.htm#cite_note-harm-38)[[39]](https://en.wikipedia.org/wiki/Mercury_(element)#cite_note-39)[[40]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-40)[[41]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-ng-41) This figure is disputed as an exaggeration by the EPA, the [Institute of Scrap Recycling Industries](https://en.wikipedia.org/wiki/File:Recycling_lead_in_a_lead-acid_battery_recovery_facility.jpg), and the [World Reuse, Repair and Recycling Association](https://en.wikipedia.org/wiki/Electronic_waste).

Independent research by [Arizona State University](https://en.wikipedia.org/wiki/Light_fixture) showed that 87–88% of imported used computers did not have a higher value than the best value of the constituent materials they contained, and that "the official trade in end-of-life computers is thus driven by reuse as opposed to recycling".[[42]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-42)

### Trade[[edit](https://en.wikipedia.org/w/index.php?title=Electronic_waste&action=edit&section=10)]

[](https://en.wikipedia.org/wiki/São_Paulo)

Sacks of mobile phones in [Agbogbloshie](https://en.wikipedia.org/wiki/Smoke_alarm), Ghana.

Proponents of the trade say growth of internet access is a stronger correlation to trade than poverty. [Haiti](https://en.wikipedia.org/wiki/Electronic_waste) is poor and closer to the [port of New York](https://en.wikipedia.org/wiki/Electronic_waste) than southeast Asia, but far more electronic waste is exported from New York to Asia than to Haiti. Thousands of men, women, and children are employed in reuse, refurbishing, repair, and re-manufacturing, unsustainable industries in decline in developed countries. Denying developing nations access to used electronics may deny them sustainable employment, affordable products, and internet access, or force them to deal with even less scrupulous suppliers. In a series of seven articles for The Atlantic, Shanghai-based reporter Adam Minter describes many of these computer repair and scrap separation activities as objectively sustainable.[[43]](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed#cite_note-43)

Opponents of the trade argue that developing countries utilize methods that are more harmful and more wasteful. An expedient and prevalent method is simply to toss equipment onto an open fire, in order to melt plastics and to burn away non-valuable metals. This releases [carcinogens](https://en.wikipedia.org/wiki/Electronic_waste) and [neurotoxins](https://en.wikipedia.org/wiki/Electronic_waste) into the air, contributing to an acrid, lingering smog. These noxious fumes include [dioxins](https://www.itu.int/en/ITU-D/LDCs/Pages/Connect-2020-Agenda.aspx) and [furans](https://en.wikipedia.org/wiki/Electronic_waste). Bonfire refuse can be disposed of quickly into drainage ditches or waterways feeding the ocean or local water supplies.[[41]](http://www.pic.int/#cite_note-ng-41)

In June 2008, a container of electronic waste, destined from the Port of Oakland in the U.S. to [Sanshui District](https://en.wikipedia.org/wiki/Electronic_waste) in mainland China, was intercepted in Hong Kong by [Greenpeace](https://en.wikipedia.org/wiki/File:Ewaste-crtkid.jpg).[[44]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-44) Concern over exports of electronic waste were raised in press reports in India,[[45]](https://en.wikipedia.org/wiki/Recommended_exposure_limit#cite_note-45)[[46]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-46) Ghana,[[47]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-47)[[48]](https://en.wikipedia.org/wiki/Plating#cite_note-48)[[49]](https://en.wikipedia.org/wiki/Fiberglass#cite_note-49) Côte d'Ivoire,[[50]](https://en.wikipedia.org/wiki/Polychlorinated_dibenzodioxins#cite_note-50) and Nigeria.[[51]](https://en.wikipedia.org/wiki/Hexavalent_chromium#cite_note-51)

The research that was undertaken by the Countering WEEE Illegal Trade (CWIT) project, funded by [European Commission](https://en.wikipedia.org/wiki/Molybdenum), found that in Europe, only 35% (3.3 million tons) of all the e-waste discarded in 2012, ended up in the officially reported amounts of collection and recycling systems. The other 65% (6.15 million tons) was either:

* exported (1.5 million tons),
* recycled under non-compliant conditions in Europe (3.15 million tons),
* scavenged for valuable parts (750,000 tons)
* or simply thrown in waste bins (750,000 tons).[[52]](https://en.wikipedia.org/wiki/Fair_trade#cite_note-52)

### Guiyu[[edit](https://en.wikipedia.org/wiki/Titanium?title=Electronic_waste&action=edit&section=11)]

*Main article:*[*Electronic waste in China*](https://en.wikipedia.org/wiki/Solving_the_E-waste_Problem)

[Guiyu](https://ec.europa.eu/environment/waste/batteries/pdf/evaluation_report_batteries_directive.pdf) in the [Guangdong](https://en.wikipedia.org/wiki/Electronic_waste) region of China is a massive electronic waste processing community.[[38]](https://en.wikipedia.org/wiki/File:Electronic_waste_at_Agbogbloshie,_Ghana.jpg#cite_note-harm-38)[[53]](https://en.wikipedia.org/wiki/Smelters#cite_note-53)[[54]](https://eur-lex.europa.eu/legal-content/EN/TXT/#cite_note-54) It is often referred to as the "e-waste capital of the world." Traditionally, Guiyu was an agricultural community; however, in the mid-1990s it transformed into an e-waste recycling center involving over 75% of the local households and an additional 100,000 migrant workers.[[55]](https://en.wikipedia.org/wiki/PCBs#cite_note-55) Thousands of individual workshops employ laborers to snip cables, pry chips from circuit boards, grind plastic computer cases into particles, and dip circuit boards in acid baths to dissolve the precious metals. Others work to strip insulation from all wiring in an attempt to salvage tiny amounts of copper wire.[[56]](https://en.wikipedia.org/wiki/California_Department_of_Public_Health#cite_note-56) Uncontrolled burning, disassembly, and disposal has led to a number of environmental problems such as groundwater contamination, atmospheric pollution, and [water pollution](https://ec.europa.eu/environment/waste/weee/history_en.htm) either by immediate discharge or from [surface runoff](https://en.wikipedia.org/wiki/Electronic_waste) (especially near coastal areas), as well as health problems including [occupational safety and health](https://eur-lex.europa.eu/legal-content/EN/TXT/) effects among those directly and indirectly involved, due to the methods of processing the waste.

Six of the many villages in Guiyu specialize in circuit-board disassembly, seven in plastics and metals reprocessing, and two in wire and cable disassembly. Greenpeace, an environmental group, sampled dust, soil, river sediment, and groundwater in Guiyu. They found very high levels of toxic heavy metals and organic contaminants in both places.[[57]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-57) Lai Yun, a campaigner for the group found "over 10 poisonous metals, such as lead, mercury, and cadmium."

Guiyu is only one example of digital dumps but similar places can be found across the world in Nigeria, Ghana, and India.[[58]](https://en.wikipedia.org/wiki/Chemicals_Convention,_1990#cite_note-58)

### Other informal e-waste recycling sites[[edit](https://en.wikipedia.org/wiki/Electronic_waste?title=Electronic_waste&action=edit&section=12)]

[](https://en.wikipedia.org/wiki/Electronic_waste)

A pile of discarded TVs and computer monitors.

Guiyu is likely one of the oldest and largest informal e-waste recycling sites in the world; however, there are many sites worldwide, including India, Ghana ([Agbogbloshie](https://en.wikipedia.org/wiki/Mercury_(element))), Nigeria, and the Philippines. Most research involving informal e-waste recycling has been done in Guiyu, but there are a handful of studies that describe exposure levels in e-waste workers, the community, and the environment.[[*citation needed*](https://en.wikipedia.org/wiki/Electronic_waste)] For example, locals and migrant workers in Delhi, a northern union territory of India, scavenge discarded computer equipment and extract base metals using toxic, unsafe methods.[[59]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-59) Bangalore, located in southern India, is often referred as the "Silicon Valley of India" and has a growing informal e-waste recycling sector.[[60]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-auto-60)[[61]](https://en.wikipedia.org/wiki/DecaBDE#cite_note-61) A studies found that e-waste workers in the slum community had higher levels of V, Cr, Mn, Mo, Sn, Tl, and Pb than workers at an e-waste recycling facility.[[60]](https://eur-lex.europa.eu/legal-content/EN/TXT/#cite_note-auto-60)

## Environmental impact[[edit](https://en.wikipedia.org/wiki/Container_ship?title=Electronic_waste&action=edit&section=13)]

[](https://en.wikipedia.org/wiki/Cadmium)

Old keyboards and one mouse.

A recent study about the rising electronic pollution in the USA revealed that the average computer screen has five to eight pounds or more of [lead](https://en.wikipedia.org/wiki/Thallium) representing 40 percent of all the lead in US landfills. All these toxins are persistent, bioaccumulative toxins (PBTs) that create environmental and health risks when computers are incinerated, put in landfills or melted down. The emission of fumes, gases, and particulate matter into the air, the discharge of liquid waste into water and drainage systems, and the disposal of hazardous wastes contribute to environmental degradation.[[62]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-62) The processes of dismantling and disposing of electronic waste in developing countries led to a number of environmental impacts as illustrated in the graphic. Liquid and atmospheric releases end up in bodies of water, groundwater, soil, and air and therefore in land and sea animals – both domesticated and wild, in crops eaten by both animals and human, and in drinking water.[[63]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-63)

One study of environmental effects in Guiyu, China found the following:[[10]](https://en.wikipedia.org/wiki/Thermal_grease#cite_note-Sthiannopkao_S_2012-10)

* Airborne [dioxins](https://eur-lex.europa.eu/legal-content/EN/TXT/) – one type found at 100 times levels previously measured
* Levels of [carcinogens](https://en.wikipedia.org/wiki/Basel_Convention) in [duck ponds](https://en.wikipedia.org/wiki/Power_semiconductor_device) and [rice paddies](https://en.wikipedia.org/wiki/Electronic_waste) exceeded international standards for agricultural areas and cadmium, copper, nickel, and lead levels in rice paddies were above international standards
* [Heavy metals](https://ec.europa.eu/environment/waste/batteries/pdf/Proposal_for_a_Regulation_on_batteries_and_waste_batteries.pdf) found in [road dust](https://ec.europa.eu/commission/presscorner/detail/en/ip_20_2312) – lead over 300 times that of a control village's road dust and copper over 100 times

The [Agbogbloshie](https://en.wikipedia.org/wiki/Occupational_safety_and_health) area of [Ghana](https://en.wikipedia.org/wiki/Electronic_waste), where about 40,000 people live, provides an example of how e-waste contamination can pervade the daily lives of nearly all residents. Into this area—one of the largest informal e-waste dumping and processing sites in Africa—about 215,000 tons of secondhand consumer electronics, primarily from Western Europe, are imported annually. Because this region has considerable overlap among industrial, commercial, and residential zones, Pure Earth (formerly Blacksmith Institute) has ranked Agbogbloshie as one of the world's 10 worst toxic threats (Blacksmith Institute 2013).[[64]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-64)

A separate study at the Agbogbloshie e-waste dump, Ghana found a presence of lead levels as high as 18,125 ppm in the soil.[[65]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-65) US EPA standard for lead in soil in play areas is 400 ppm and 1200 ppm for non-play areas.[[66]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-66) Scrap workers at the Agbogbloshie e-waste dump regularly burn electronic components and auto harness wires for copper recovery,[[67]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-67) releasing toxic chemicals like lead, dioxins and furans[[68]](https://en.wikipedia.org/w/index.php#cite_note-68) into the environment.

Researchers such as Brett Robinson, a professor of soil and physical sciences at Lincoln University in [New Zealand](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed), warn that wind patterns in Southeast China disperse toxic particles released by open-air burning across the [Pearl River Delta Region](https://en.wikipedia.org/wiki/Electronic_waste_by_country), home to 45 million people. In this way, toxic chemicals from e-waste enter the "soil-crop-food pathway," one of the most significant routes for heavy metals' exposure to humans. These chemicals are not biodegradable— they persist in the environment for long periods of time, increasing exposure risk.[[69]](https://en.wikipedia.org/w/index.php#cite_note-69)

In the agricultural district of [Chachoengsao](https://en.wikipedia.org/wiki/Road_dust), in the east of [Bangkok](https://en.wikipedia.org/wiki/Germanium), local villagers had lost their main water source as a result of e-waste dumping. The [cassava](https://en.wikipedia.org/wiki/Port_of_New_York_and_New_Jersey) fields were transformed in late 2017, when a nearby Chinese-run factory started bringing in foreign e-waste items such as crushed computers, circuit boards and cables for recycling to mine the electronics for valuable metal components like copper, silver and gold. But the items also contain lead, cadmium and mercury, which are highly toxic if mishandled during processing. Apart from feeling faint from noxious fumes emitted during processing, a local claimed the factory has also contaminated her water. "When it was raining, the water went through the pile of waste and passed our house and went into the soil and water system. Water tests conducted in the province by environmental group Earth and the local government both found toxic levels of iron, manganese, lead, nickel and in some cases arsenic and cadmium. "The communities observed when they used water from the shallow well, there was some development of skin disease or there are foul smells," founder of Earth, Penchom Saetang said. "This is proof, that it is true, as the communities suspected, there are problems happening to their water sources."[[70]](https://en.wikipedia.org/wiki/Electronics_right_to_repair#cite_note-70)

**The environmental impact of the processing of different electronic waste components**

|  |  |  |
| --- | --- | --- |
| **E-Waste Component** | **Process Used** | **Potential Environmental Hazard** |
| Cathode ray tubes (used in TVs, computer monitors, ATM, video cameras, and more) | Breaking and removal of yoke, then dumping | Lead, barium and other heavy metals leaching into the ground water and release of toxic phosphor |
| Printed circuit board (image behind table – a thin plate on which chips and other electronic components are placed) | De-soldering and removal of computer chips; open burning and acid baths to remove metals after chips are removed. | Air emissions and discharge into rivers of glass dust, tin, lead, brominated dioxin, beryllium cadmium, and mercury |
| Chips and other gold plated components | Chemical stripping using nitric and hydrochloric acid and burning of chips | PAHs, heavy metals, brominated flame retardants discharged directly into rivers acidifying fish and flora. Tin and lead contamination of surface and groundwater. Air emissions of brominated dioxins, heavy metals, and PAHs |
| Plastics from printers, keyboards, monitors, etc. | Shredding and low temp melting to be reused | Emissions of brominated dioxins, heavy metals, and hydrocarbons |
| Computer wires | Open burning and stripping to remove copper | PAHs released into air, water, and soil. |

[[71]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-71)

Depending on the age and type of the discarded item, the chemical composition of E-waste may vary. Most E-waste are composed of a mixture of metals like Cu, Al and Fe. They might be attached to, covered with or even mixed with various types of plastics and ceramics. E-waste has a horrible effect on the environment and it is important to dispose it with an R2 certifies recycling facility.[[72]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-72)

## Research[[edit](https://en.wikipedia.org/w/index.php?title=Electronic_waste&action=edit&section=14)]

In May 2020 a scientific research was conducted in China, that investigated the occurrence and distribution of traditional and novel classes of contaminants, including chlorinated, brominated, and mixed halogenated dibenzo-p-dioxins/dibenzofurans (PCDD/Fs, PBDD/Fs, PXDD/Fs), polybrominated diphenyl ethers (PBDEs), polychlorinated biphenyls (PCBs) and polyhalogenated carbazoles (PHCZs), in soil from an e-waste disposal site in Hangzhou (in operations since 2009 and has a treatment capacity of 19.6 wt/a). Although the study area has only one formal emission source, the industrial zone has a number of metal recovery and reprocessing plants and heavy traffic on motorways where normal and heavy-duty devices are used. The maximum concentrations of the target halogenated organic compounds HOCs were 0.1–1.5 km away from the main source and overall detected levels of HOCs were generally lower than those reported globally. The study proved what researchers have warned for - highways with heavy traffic, including diesel powered vehicles, exhaust emissions are larger sources of dioxins than stationary sources. By assessing the environmental and health impacts of chemical compounds, especially PBDD/Fs and PXDD/Fs, the compositional complexity of soil and long period weather conditions like rain and downwind have to be taken into account. Further investigations are necessary to build up a common understanding and methods for assessing e-waste impacts.[[73]](https://en.wikipedia.org/wiki/Manganese#cite_note-73)

## Information security[[edit](https://en.wikipedia.org/wiki/Electronic_waste?title=Electronic_waste&action=edit&section=15)]

Proper recycling and disposal of electronics is not only important for the environment but it also has a big impact on data security as well. It's quite easy for anyone to extract personal data from electronic devices. Dragging your important documents to the Recycling Bin won't be enough to keep your data secure. That's because digital information often leaves a trail of breadcrumbs that can be recovered effortlessly using the right hardware.[[*citation needed*](https://en.wikipedia.org/wiki/Electronic_waste)]

Prior to disposing of IT Equipment improperly, always consider all aspects, including data security and liability in addition to the environment. E-waste presents a potential security threat to individuals and exporting countries. [Hard drives](https://en.wikipedia.org/wiki/Electronic_waste) that are not properly erased before the computer is disposed of can be reopened, exposing sensitive information. Credit card numbers, private financial data, account information, and records of [online](https://en.wikipedia.org/wiki/Electronic_waste) transactions can be accessed by most willing individuals. Organized criminals in Ghana commonly search the drives for information to use in local [scams](https://en.wikipedia.org/wiki/Electronic_waste).[[74]](https://en.wikipedia.org/wiki/Sulfur_dioxide#cite_note-r4-74) Unwanted electronic devices go through several hands during the recycling process. They are dismantled piece by piece by authorized professionals at different facilities. That means there are plenty of opportunities for information to be stolen. But there is a way to avoid this from happening.When e-waste is disposed of improperly and without the use of a company that specializes in proper data destruction, there is a severe risk of identity theft, data breaches and massive liability for the companies involved.[[75]](https://en.wikipedia.org/wiki/Cadmium#cite_note-75) Electronic files about government contracts have been discovered on hard drives found in [Agbogbloshie](https://eur-lex.europa.eu/legal-content/EN/TXT/). Multimillion-dollar agreements from United States security institutions such as the [Defense Intelligence Agency](https://en.wikipedia.org/wiki/PBDE) (DIA), the [Transportation Security Administration](https://en.wikipedia.org/w/index.php), and [Homeland Security](https://en.wikipedia.org/wiki/Electronic_waste) have all resurfaced in Agbogbloshie.[[74]](https://en.wikipedia.org/wiki/PentaBDE#cite_note-r4-74)[[76]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-r13-76)

There are few ways to properly erase data off harddrives which can be used by both individuals and companies, these steps are;

1. Full Disk Overwriting: While there are many software that provide overwriting capabilities, only those offering full disk overwriting can perform desirable data deletion of a significant effect. Disk overwriting programs that cannot access the entire hard drive, including hidden/locked areas like the host protected area (HPA), device configuration overlay (DCO), and remapped sectors, perform an incomplete erasure, leaving some of the data intact. By accessing the entire hard drive, data erasure eliminates the risk of data remanence.[[77]](https://en.wikipedia.org/wiki/Perfluorooctanoic_acid#cite_note-77) The Gutmann algorithm is a method of disk wiping that overwrites data using a total of 35 passes. This makes it one of the most secure data erasure methods, but also the most time-consuming.[[78]](https://en.wikipedia.org/wiki/Lead#cite_note-78)
2. Data Deletion using standard Operating approach: Most companies implementing an information security policy tend to have a written and approved means of data management, which includes data deletion and retention and also, a part that speaks to change management[[79]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-:2-79) which spells out the steps to be taken in case a change is being carried out in an environment, this with respect to electronic waste, has to be approved for change after all the required process (data management) has been performed. In the case of the data found in Agbogbloshie, it is evident that such change management procedures were not performed on the waste before disposal. Some of the standards are; **Transported asset protection association (TAPA)** – North America – Freight security requirements standard.[[80]](https://en.wikipedia.org/wiki/Beryllium_oxide#cite_note-80) **Information Security Management System (ISO 27001)** – Global – Relates to the recycling of waste electrical and electronic equipment, asset management involving secure data eradication and the repair and reuse of electrical and electronic equipment.[[79]](https://ec.europa.eu/environment/waste/rohs_eee/studies_rohs4_en.htm#cite_note-:2-79) **Assured Service (Sanitisation) scheme (CAS-S)** – United Kingdom – Scheme offered by NCSC for companies wishing to provide sanitization services to owners of highly classified Government data.[[81]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-81)

## Recycling[[edit](https://en.wikipedia.org/wiki/File:Recyclers_with_old_computers_São_Paulo_March_2012.jpg?title=Electronic_waste&action=edit&section=16)]

*See also:*[*Appliance recycling*](https://en.wikipedia.org/w/index.php)*,*[*Computer recycling*](https://en.wikipedia.org/wiki/File:Day_6_Warehouse_(25890985098)_(cropped).jpg)*, and*[*Mobile phone recycling*](https://en.wikipedia.org/wiki/Vanadium)

[](https://en.wikipedia.org/wiki/File:0ld_keyboards.JPG)

Computer monitors are typically packed into low stacks on wooden pallets for [recycling](https://en.wikipedia.org/wiki/File:Repurposed_Imac.JPG) and then shrink-wrapped.

Recycling is an essential element of e-waste management. Properly carried out, it should greatly reduce the leakage of toxic materials into the environment and mitigate against the exhaustion of natural resources. However, it does need to be encouraged by local authorities and through community education. Less than 20% of e-waste is formally recycled, with 80% either ending up in landfill or being informally recycled – much of it by hand in developing countries, exposing workers to hazardous and carcinogenic substances such as mercury, lead and cadmium.[[82]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-Tarter-82)

One of the major challenges is recycling the printed circuit boards from electronic waste. The circuit boards contain such precious metals as gold, silver, platinum, etc. and such base metals as copper, iron, aluminum, etc. One way e-waste is processed is by melting circuit boards, burning cable sheathing to recover copper wire and open- pit acid leaching for separating metals of value.[[10]](https://en.wikipedia.org/wiki/IMac_G4#cite_note-Sthiannopkao_S_2012-10) Conventional method employed is mechanical shredding and separation but the recycling efficiency is low. Alternative methods such as [cryogenic](https://en.wikipedia.org/wiki/File:TV_and_Computer_Monitor_Recycling_Pen_-_geograph.org.uk_-_1025508.jpg) decomposition have been studied for printed circuit board recycling,[[83]](https://en.wikipedia.org/wiki/Wikipedia:NOTRS#cite_note-83) and some other methods are still under investigation. Properly disposing of or reusing electronics can help prevent health problems, reduce [greenhouse-gas emissions](https://en.wikipedia.org/wiki/Furan), and create jobs.[[84]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-84) [Reuse](https://en.wikipedia.org/wiki/Electronic_waste) and [refurbishing](https://en.wikipedia.org/wiki/Heavy_metals) offer a more environmentally friendly and socially conscious alternative to [downcycling](https://en.wikipedia.org/w/index.php) processes.[[*citation needed*](https://en.wikipedia.org/wiki/Electronic_waste)]

### Consumer awareness efforts[[edit](https://en.wikipedia.org/wiki/Electronic_waste?title=Electronic_waste&action=edit&section=17)]

[](https://en.wikipedia.org/wiki/Electronic_waste)

A campaign to promote e-waste recycling in Ghana.

The U.S. Environmental Protection Agency encourages electronic recyclers to become certified by demonstrating to an accredited, independent third party auditor that they meet specific standards to safely recycle and manage electronics. This should work so as to ensure the highest environmental standards are being maintained. Two certifications for electronic recyclers currently exist and are endorsed by the EPA. Customers are encouraged to choose certified electronics recyclers. Responsible electronics recycling reduces environmental and human health impacts, increases the use of reusable and refurbished equipment and reduces energy use while conserving limited resources. The two EPA-endorsed certification programs are Responsible Recyclers Practices (R2) and [E-Stewards](https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/). Certified companies ensure they are meeting strict environmental standards which maximize reuse and recycling, minimize exposure to human health or the environment, ensure safe management of materials and require destruction of all data used on electronics.[[85]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-85) Certified electronics recyclers have demonstrated through audits and other means that they continually meet specific high environmental standards and safely manage used electronics. Once certified, the recycler is held to the particular standard by continual oversight by the independent accredited certifying body. A certification board accredits and oversees certifying bodies to ensure that they meet specific responsibilities and are competent to audit and provide certification.[[86]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-86)

Some U.S. retailers offer opportunities for consumer recycling of discarded electronic devices.[[87]](https://en.wikipedia.org/wiki/Occupational_exposure_limit#cite_note-87)[[88]](https://en.wikipedia.org/wiki/Pearl_River_Delta#cite_note-88) In the US, the [Consumer Electronics Association](https://en.wikipedia.org/wiki/Electronic_waste) (CEA) urges consumers to dispose properly of end-of-life electronics through its recycling locator at www.GreenerGadgets.org. This list only includes manufacturer and retailer programs that use the strictest standards and third-party certified recycling locations, to provide consumers assurance that their products will be recycled safely and responsibly. CEA research has found that 58 percent of consumers know where to take their end-of-life electronics, and the electronics industry would very much like to see that level of awareness increase. Consumer electronics manufacturers and retailers sponsor or operate more than 5,000 recycling locations nationwide and have vowed to recycle one billion pounds annually by 2016,[[89]](https://en.wikipedia.org/wiki/Integrated_circuit#cite_note-89) a sharp increase from 300 million pounds industry recycled in 2010.

The Sustainable Materials Management (SMM) Electronic Challenge was created by the [United States Environmental Protection Agency](https://en.wikipedia.org/wiki/Sulfuric_acid) (EPA) in 2012.[[90]](https://en.wikipedia.org/wiki/Tin#cite_note-US_EPA_SMM_Electronics_Challenge-90) Participants of the Challenge are manufacturers of electronics and electronic retailers. These companies collect end-of-life (EOL) electronics at various locations and send them to a certified, third-party recycler. Program participants are then able publicly promote and report 100% responsible recycling for their companies.[[91]](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed#cite_note-91) The Electronics TakeBack Coalition (ETBC)[[92]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-92) is a campaign aimed at protecting human health and limiting environmental effects where electronics are being produced, used, and discarded. The ETBC aims to place responsibility for disposal of technology products on electronic manufacturers and brand owners, primarily through community promotions and legal enforcement initiatives. It provides recommendations for consumer recycling and a list of recyclers judged environmentally responsible.[[93]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-93) While there have been major benefits from the rise in recycling and waste collection created by producers and consumers, such as valuable materials being recovered and kept away from landfill and incineration, there are still many problems present with the EPR system including "how to ensure proper enforcement of recycling standards, what to do about waste with positive net value, and the role of competition," (Kunz et al.). Many stakeholders agreed there needs to be a higher standard of accountability and efficiency to improve the systems of recycling everywhere, as well as the growing amount of waste being an opportunity more so than downfall since it gives us more chances to create an efficient system. To make recycling competition more cost-effective, the producers agreed that there needs to be a higher drive for competition because it allows them to have a wider range of producer responsibility organizations to choose from for e-waste recycling.[[94]](https://en.wikipedia.org/wiki/Transportation_Security_Administration#cite_note-94)

The Certified Electronics Recycler program[[95]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-95) for electronic recyclers is a comprehensive, integrated management system standard that incorporates key operational and continual improvement elements for quality, environmental and health and safety performance. The grassroots [Silicon Valley Toxics Coalition](https://en.wikipedia.org/w/index.php) promotes human health and addresses environmental justice problems resulting from toxins in technologies. The World Reuse, Repair, and Recycling Association (wr3a.org) is an organization dedicated to improving the quality of exported electronics, encouraging better recycling standards in importing countries, and improving practices through "Fair Trade" principles. Take Back My TV[[96]](https://en.wikipedia.org/wiki/Polyvinyl_chloride#cite_note-96) is a project of The Electronics TakeBack Coalition and grades television manufacturers to find out which are responsible, in the coalition's view, and which are not.

There have also been efforts to raise awareness of the potentially hazardous conditions of the dismantling of e-waste in American prisons. The Silicon Valley Toxics Coalition, prisoner-rights activists, and environmental groups released a Toxic Sweatshops report that details how prison labor is being used to handle e-waste, resulting in health consequences among the workers.[[97]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-97) These groups allege that, since prisons do not have adequate safety standards, inmates are dismantling the products under unhealthy and unsafe conditions.[[98]](https://en.wikipedia.org/wiki/Polytetrafluoroethylene#cite_note-98)

### Processing techniques[[edit](https://en.wikipedia.org/w/index.php?title=Electronic_waste&action=edit&section=18)]

[](https://en.wikipedia.org/wiki/Electronic_waste)

[Recycling](https://en.wikipedia.org/wiki/Heatsink) the lead from batteries.

In many developed countries, electronic waste processing usually first involves dismantling the equipment into various parts (metal frames, power supplies, circuit boards, plastics), often by hand, but increasingly by automated shredding equipment. A typical example is the NADIN electronic waste processing plant in [Novi Iskar](https://en.wikipedia.org/w/index.php), [Bulgaria](https://en.wikipedia.org/wiki/Zinc)—the largest facility of its kind in Eastern Europe.[[99]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-99)[[100]](https://en.wikipedia.org/w/index.php#cite_note-100) The advantages of this process are the human worker's ability to recognize and save working and repairable parts, including chips, transistors, RAM, etc. The disadvantage is that the labor is cheapest in countries with the lowest health and safety standards.

In an alternative bulk system,[[101]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-Sims-101) a hopper conveys material for shredding into an unsophisticated mechanical separator, with screening and granulating machines to separate constituent metal and plastic fractions, which are sold to [smelters](https://en.wikipedia.org/wiki/Planned_obsolescence) or plastics recyclers. Such recycling machinery is enclosed and employs a [dust collection system](https://en.wikipedia.org/wiki/Electronic_waste). Some of the emissions are caught by scrubbers and screens. Magnets, [eddy currents](https://en.wikipedia.org/wiki/Electronic_waste), and [Trommel screens](https://en.wikipedia.org/w/index.php) are employed to separate glass, plastic, and [ferrous](https://en.wikipedia.org/wiki/Electronic_waste) and nonferrous metals, which can then be further separated at a [smelter](https://en.wikipedia.org/wiki/Electronic_waste).

Leaded glass from CRTs is reused in car batteries, ammunition, and lead wheel weights, or sold to foundries as a [fluxing agent](https://en.wikipedia.org/wiki/Electronic_waste) in processing raw [lead ore](https://en.wikipedia.org/w/index.php). Copper, gold, palladium, silver and tin are valuable metals sold to [smelters](https://en.wikipedia.org/wiki/Mercury_(element)) for recycling. Hazardous smoke and gases are captured, contained and treated to mitigate environmental threat. These methods allow for safe reclamation of all valuable computer construction materials. Hewlett-Packard product recycling solutions manager Renee St. Denis describes its process as: "We move them through giant shredders about 30 feet tall and it shreds everything into pieces about the size of a quarter. Once your disk drive is shredded into pieces about this big, it's hard to get the data off".[[102]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-102) An ideal electronic waste recycling plant combines dismantling for component recovery with increased cost-effective processing of bulk electronic waste. Reuse is an alternative option to recycling because it extends the lifespan of a device. Devices still need eventual recycling, but by allowing others to purchase used electronics, recycling can be postponed and value gained from device use.

### Benefits of recycling[[edit](https://en.wikipedia.org/wiki/Beryllium?title=Electronic_waste&action=edit&section=19)]

Recycling raw materials from end-of-life electronics is the most effective solution to the growing e-waste problem. Most electronic devices contain a variety of materials, including metals that can be recovered for future uses. By dismantling and providing reuse possibilities, intact natural resources are conserved and air and water pollution caused by hazardous disposal is avoided. Additionally, recycling reduces the amount of greenhouse gas emissions caused by the manufacturing of new products.[[103]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-103) Another benefit of recycling e-waste is that many of the materials can be recycled and re-used again. Materials that can be recycled include "ferrous (iron-based) and non-ferrous metals, glass, and various [types of plastic](https://en.wikipedia.org/wiki/Electronic_waste_recycling)." "Non-ferrous metals, mainly aluminum and copper can all be re-smelted and re-manufactured. Ferrous metals such as steel and iron also can be re-used."[[104]](https://en.wikipedia.org/wiki/Chromium#cite_note-104) Due to the recent surge in popularity in 3D printing, certain 3D printers have been designed (FDM variety) to produce waste that can be easily recycled which decreases the amount of harmful pollutants in the atmosphere.[[105]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-105) The excess plastic from these printers that comes out as a byproduct can also be reused to create new 3D printed creations.[[106]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-106)

Benefits of recycling are extended when responsible recycling methods are used. In the U.S., responsible recycling aims to minimize the dangers to human health and the environment that disposed and dismantled electronics can create. Responsible recycling ensures best management practices of the electronics being recycled, worker health and safety, and consideration for the environment locally and abroad.[[107]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-107) In Europe, metals that are recycled are returned to companies of origin at a reduced cost.[[108]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-108) Through a committed recycling system, manufacturers in Japan have been pushed to make their products more sustainable. Since many companies were responsible for the recycling of their own products, this imposed responsibility on manufacturers requiring many to redesign their infrastructure. As a result, manufacturers in Japan have the added option to sell the recycled metals.[[109]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-109)

Improper management of e-waste is resulting in a significant loss of scarce and valuable raw materials, such as gold, platinum, cobalt and rare earth elements. As much as 7% of the world's gold may currently be contained in e-waste, with 100 times more gold in a tonne of e-waste than in a tonne of gold ore.[[82]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-Tarter-82)

## Disposal methods[[edit](https://en.wikipedia.org/wiki/Electronic_waste?title=Electronic_waste&action=edit&section=20)]

Electronic waste can be disposed of by burial, burning, or dissolution and recovery of metals. All processes require proper containment to prevent contamination of air, groundwater, or soil with heavy metals such as lead or cadmium, or toxic combustion products.[[*citation needed*](https://en.wikipedia.org/wiki/Electronic_product)]

Some high-value components may be salvaged from printed circuit boards.[[*citation needed*](https://en.wikipedia.org/wiki/Technology)]

## Repair as a means of reducing electronic waste[[edit](https://en.wikipedia.org/wiki/Electronic_waste?title=Electronic_waste&action=edit&section=21)]

There are several ways to curb the environmental hazards arising from the recycling of electronic waste and save our planet. One of the factors which exacerbate the e-waste problem is the diminishing lifetime of many electrical and electronic goods. There are two drivers (in particular) for this trend. On the one hand, consumer demand for low cost products mitigates against product quality and results in short product lifetimes.[[110]](https://en.wikipedia.org/wiki/Waste_Electrical_and_Electronic_Equipment_Directive#cite_note-110) On the other, manufacturers in some sectors encourage a regular upgrade cycle, and may even enforce it though restricted availability of spare parts, service manuals and software updates, or through [planned obsolescence](https://en.wikipedia.org/wiki/Cathode_ray_tube).

Consumer dissatisfaction with this state of affairs has led to a growing repair movement. Often, this is at a community level such as through repair cafės or the "restart parties" promoted by the Restart Project.[[111]](https://en.wikipedia.org/wiki/Occupational_Safety_and_Health_Administration#cite_note-RestartProject-111)

The "[Right to Repair](https://en.wikipedia.org/wiki/Electronic_waste)" is spearheaded in the US by farmers dissatisfied with non-availability of service information, specialised tools and spare parts for their high-tech farm machinery. But the movement extends far beyond farm machinery with, for example, the restricted repair options offered by Apple coming in for criticism. Manufacturers often counter with safety concerns resulting from unauthorised repairs and modifications.[[112]](https://en.wikipedia.org/wiki/Polycyclic_aromatic_hydrocarbon#cite_note-112)

Also,one of the best and easiest methods of reducing the electronic waste footprint is to sell or donate your electronic gadgets to those in need rather than trash them.

Improperly disposed e-waste is becoming more and more hazardous, especially as the sheer volume of our e-waste increases.For this reason, large brands like Apple, Samsung, and other companies have started giving options to its customers to recycle old electronics.Recycling old electronics allows the expensive electronic parts inside to be reused. This can save a lot of energy and reduce the need for mining of new raw resources, or manufacturing new parts.You can find electronic recycling programs in your local area by doing a Google search for "recycle electronics" and your city or area name.

In recent times,Cloud services have proven to be much better in storing data which can be accessible from anywhere in the world without the need to carry a storage device at all times. Cloud storage also gives you a large amount of storage, for free or very cheap.This not only offers convenience, it also reduces the need for manufacturing new storage devices which in turn curbs the amount of e-waste generated.[[113]](https://en.wikipedia.org/wiki/United_States_Environmental_Protection_Agency#cite_note-113)

One other important measure to curb the generation of electronic waste is to rent rather than out rightly buy a specific piece of electronic equipment which is not used everything.For example, if you sparingly use industrial weighing scales for measuring, rent the scales instead of buying them.

## Electronic waste classification[[edit](https://en.wikipedia.org/wiki/Electronic_waste?title=Electronic_waste&action=edit&section=22)]

The market has a lot of different types of electrical products. To categorize these products, it is necessary to group them into sensible and practical categories. Classification of the products may even help to determine the process to be used for disposal of the product. Making the classifications, in general, is helping to describe e-waste. Classifications has not defined special details, for example when they do not pose a threat to the environment. On the other hand, classifications should not be too aggregated because of countries differences in interpretation.[[114]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-:9-114)

It is a practical way to collect statistical data and put this data on market. For example, you have a row which has the following information about indication which are in the bracelets: UNU-KEY(001), Description (Central Heating (household installed)), EEE category under EU-10 (1), EEE category under EU-6 (4).[[114]](https://en.wikipedia.org/wiki/Computer_recycling#cite_note-:9-114)

The UNU-KEYs system closely follows the harmonized statistical (HS) coding. It is an international nomenclature which is an integrated system to allow classify common basis for customs purposes.[[114]](https://en.wikipedia.org/wiki/Silicon#cite_note-:9-114)

## Electronic waste substances[[edit](https://en.wikipedia.org/w/index.php?title=Electronic_waste&action=edit&section=23)]

[](https://en.wikipedia.org/wiki/Electronic_waste)

Several sizes of button and coin cell with 2 9v batteries as a size comparison. They are all recycled in many countries since they contain lead, [mercury](https://eur-lex.europa.eu/resource.html) and [cadmium](https://en.wikipedia.org/w/index.php).

Some computer components can be reused in assembling new computer products, while others are reduced to metals that can be reused in applications as varied as construction, flatware, and jewellery. Substances found in large quantities include [epoxy resins](https://en.wikipedia.org/wiki/Electronic_waste#Electrical_systems_and_electronics), [fiberglass](https://en.wikipedia.org/wiki/Permissible_exposure_limit), [PCBs](https://en.wikipedia.org/wiki/Electronic_waste), [PVC](https://en.wikipedia.org/wiki/Electronic_waste) (polyvinyl chlorides), [thermosetting plastics](https://en.wikipedia.org/wiki/Electronic_waste), lead, tin, copper, silicon, beryllium, carbon, iron, and aluminium. Elements found in small amounts include [cadmium](https://en.wikipedia.org/wiki/Phonebloks), [mercury](https://en.wikipedia.org/wiki/Electronic_waste), and [thallium](https://ec.europa.eu/environment/waste/batteries/pdf/evaluation_report_batteries_directive.pdf).[[115]](https://en.wikipedia.org/wiki/Vance_Packard#cite_note-sl2007-115) Elements found in trace amounts include americium, antimony, arsenic, barium, bismuth, boron, cobalt, europium, gallium, germanium, gold, indium, lithium, manganese, nickel, niobium, palladium, platinum, rhodium, ruthenium, selenium,[[116]](https://eur-lex.europa.eu/legal-content/EN/TXT/#cite_note-Klaus-116) silver, tantalum, terbium, thorium, titanium, vanadium, and yttrium. Almost all electronics contain lead and tin (as solder) and copper (as wire and [printed circuit board](https://en.wikipedia.org/wiki/Developing_nation) tracks), though the use of lead-free solder is now spreading rapidly. The following are ordinary applications:

### Hazardous[[edit](https://en.wikipedia.org/w/index.php?title=Electronic_waste&action=edit&section=24)]

[](https://en.wikipedia.org/wiki/Agbogbloshie)

Recyclers in the street in [São Paulo](https://en.wikipedia.org/wiki/Brominated_flame_retardant), Brazil with old computers

|  |  |  |
| --- | --- | --- |
| **E-Waste Component** | **Electric Appliances in which they are found** | **Adverse Health Effects** |
| [Americium](https://en.wikipedia.org/wiki/Electronic_waste) | The radioactive source in [smoke alarms](https://en.wikipedia.org/w/index.php). | It is known to be [carcinogenic](https://en.wikipedia.org/wiki/Montreal_Protocol).[[117]](https://eur-lex.europa.eu/legal-content/EN/TXT/#cite_note-117) |
| [Lead](https://en.wikipedia.org/wiki/Electronic_waste) | [Solder](https://en.wikipedia.org/wiki/Institute_of_Scrap_Recycling_Industries), CRT monitor glass, [lead-acid batteries](https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0266), some formulations of PVC. A typical 15-inch cathode ray tube may contain 1.5 pounds of lead,[[5]](https://en.wikipedia.org/wiki/Arizona_State_University#cite_note-sb-5) but other CRTs have been estimated as having up to 8 pounds of lead. | Adverse effects of lead exposure include impaired cognitive function, behavioral disturbances, attention deficits, hyperactivity, conduct problems, and lower IQ.[[118]](https://en.wikipedia.org/wiki/Novi_Iskar#cite_note-chen-118) These effects are most damaging to children whose developing nervous systems are very susceptible to damage caused by lead, cadmium, and mercury.[[119]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-119) |
| [Mercury](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed) | Found in [fluorescent tubes](https://en.wikipedia.org/wiki/Electronic_waste) (numerous applications), tilt switches (mechanical doorbells, [thermostats](https://www.who.int/about/governance/world-health-assembly)),[[120]](https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/#cite_note-120) and ccfl backlights in flat screen monitors. | Health effects include sensory impairment, dermatitis, memory loss, and muscle weakness. Exposure in-utero causes fetal deficits in motor function, attention, and verbal domains.[[118]](https://en.wikipedia.org/wiki/Minamata_Convention_on_Mercury#cite_note-chen-118) Environmental effects in animals include death, reduced fertility, and slower growth and development. |
| [Cadmium](https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/) | Found in light-sensitive resistors, corrosion-resistant alloys for marine and aviation environments, and [nickel-cadmium batteries](https://en.wikipedia.org/wiki/Paris_Climate_Agreement). The most common form of cadmium is found in Nickel-cadmium rechargeable batteries. These batteries tend to contain between 6 and 18% cadmium. The sale of Nickel-Cadmium batteries has been banned in the European Union except for medical use. When not properly recycled it can leach into the soil, harming microorganisms and disrupting the soil ecosystem. Exposure is caused by proximity to hazardous waste sites and factories and workers in the metal refining industry. | The inhalation of cadmium can cause severe damage to the lungs and is also known to cause kidney damage.[[121]](https://en.wikipedia.org/wiki/Neurotoxin#cite_note-121) Cadmium is also associated with deficits in cognition, learning, behavior, and neuromotor skills in children.[[118]](http://www.pravno-informacioni-sistem.rs/SlGlasnikPortal/reg/viewAct/011043b3-7cee-4488-ba2c-e95f95271713#cite_note-chen-118) |
| [Hexavalent chromium](http://www.podaci.net/_gCGO/zakoni/Zakon_o_upravljanju_otpadom/usv9lp.html) | Used in metal coatings to protect from corrosion. | A known carcinogen after occupational inhalation exposure.[[118]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-chen-118)  There is also evidence of cytotoxic and genotoxic effects of some chemicals, which have been shown to inhibit cell proliferation, cause cell membrane lesion, cause DNA single-strand breaks, and elevate Reactive Oxygen Species (ROS) levels.[[122]](https://en.wikipedia.org/wiki/Random-access_memory#cite_note-liulin2-122) |
| [Sulfur](https://en.wikipedia.org/wiki/Fluorescent_tube) | Found in [lead-acid batteries](https://en.wikipedia.org/wiki/Downcycling). | Health effects include liver damage, kidney damage, heart damage, eye and throat irritation. When released into the environment, it can create [sulfuric acid](https://en.wikipedia.org/w/index.php) through [sulfur dioxide](https://en.wikipedia.org/wiki/Electronic_waste). |
| Brominated Flame Retardants ([BFRs](https://en.wikipedia.org/wiki/File:Agbogbloshie.JPG)) | Used as flame retardants in plastics in most electronics. Includes [PBBs](https://en.wikipedia.org/wiki/Epoxy), [PBDE](https://en.wikipedia.org/wiki/Electronic_waste), [DecaBDE](https://eur-lex.europa.eu/legal-content/EN/TXT/), [OctaBDE](https://en.wikipedia.org/wiki/Electronic_waste), [PentaBDE](https://en.wikipedia.org/wiki/Modular_smartphone). | Health effects include impaired development of the nervous system, thyroid problems, liver problems.[[123]](https://en.wikipedia.org/wiki/Environmental_pollution#cite_note-123) Environmental effects: similar effects as in animals as humans. PBBs were banned from 1973 to 1977 on. PCBs were banned during the 1980s. |
| [Perfluorooctanoic acid](https://en.wikipedia.org/wiki/Central_processing_unit) (PFOA) | Used as an antistatic additive in industrial applications and found in electronics, also found in non-stick cookware ([PTFE](https://en.wikipedia.org/wiki/Electronic_waste)). PFOAs are formed synthetically through environmental degradation. | Studies in mice have found the following health effects: Hepatotoxicity, developmental toxicity, immunotoxicity, hormonal effects and carcinogenic effects. Studies have found increased maternal PFOA levels to be associated with an increased risk of spontaneous abortion (miscarriage) and stillbirth. Increased maternal levels of PFOA are also associated with decreases in mean gestational age (preterm birth), mean birth weight (low birth weight), mean birth length (small for gestational age), and mean APGAR score.[[124]](https://eur-lex.europa.eu/legal-content/EN/TXT/#cite_note-wu-124) |
| [Beryllium oxide](https://en.wikipedia.org/wiki/Pentium_4) | Filler in some thermal interface materials such as [thermal grease](https://en.wikipedia.org/wiki/Electronic_waste) used on [heatsinks](https://en.wikipedia.org/w/index.php) for [CPUs](https://en.wikipedia.org/w/index.php) and [power transistors](https://en.wikipedia.org/wiki/Ghana),[[125]](https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/#cite_note-apmag-125) [magnetrons](https://en.wikipedia.org/wiki/Electronic_waste), X-ray-transparent ceramic windows, heat transfer fins in [vacuum tubes](https://en.wikipedia.org/wiki/Electronic_waste), and [gas lasers](https://en.wikipedia.org/wiki/Electronic_devices). | Occupational exposures associated with lung cancer, other common adverse health effects are beryllium sensitization, chronic beryllium disease, and acute beryllium disease.[[126]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-126) |
| [Polyvinyl chloride](https://en.wikipedia.org/wiki/Electronic_waste) (PVC) | Commonly found in electronics and is typically used as insulation for electrical cables.[[127]](https://en.wikipedia.org/wiki/Wikipedia:Manual_of_Style/Words_to_watch#cite_note-127) | In the manufacturing phase, toxic and hazardous raw material, including dioxins are released. PVC such as chlorine tend to bioaccumulate.[[128]](https://en.wikipedia.org/wiki/The_Waste_Makers#cite_note-128) Over time, the compounds that contain chlorine can become pollutants in the air, water, and soil. This poses a problem as human and animals can ingest them. Additionally, exposure to toxins can result in reproductive and developmental health effects.[[129]](https://en.wikipedia.org/wiki/Guiyu_Town#cite_note-129) |

### Generally non-hazardous[[edit](https://en.wikipedia.org/wiki/Guangdong?title=Electronic_waste&action=edit&section=25)]

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| --- | --- |
| [https://upload.wikimedia.org/wikipedia/en/thumb/9/99/Question_book-new.svg/50px-Question_book-new.svg.png](https://en.wikipedia.org/wiki/Lead_ore) | This section **does not**[**cite**](https://en.wikipedia.org/wiki/Electronic_waste)**any**[**sources**](https://en.wikipedia.org/wiki/Electronic_waste). Please help [improve this section](https://en.wikipedia.org/wiki/Basel_Action_Network?title=Electronic_waste&action=edit) by [adding citations to reliable sources](https://en.wikipedia.org/wiki/Water_pollution). Unsourced material may be challenged and [removed](https://en.wikipedia.org/wiki/Electronic_waste#Burden_of_evidence). *(October 2017) (*[*Learn how and when to remove this template message*](https://en.wikipedia.org/wiki/Electronic_waste)*)* |

[](https://en.wikipedia.org/wiki/Electronic_waste)

An [iMac G4](https://en.wikipedia.org/w/index.php) that has been [repurposed](https://en.wikipedia.org/wiki/File:Question_book-new.svg) into a [lamp](https://en.wikipedia.org/wiki/Dioxin) (photographed next to a Mac Classic and a flip phone).

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| --- | --- |
| **E-Waste Component** | **Process Used** |
| Aluminium | nearly all electronic goods using more than a few watts of power ([heatsinks](https://en.wikipedia.org/wiki/Central_processing_unit)), [ICs](https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/), [electrolytic capacitors](https://en.wikipedia.org/wiki/Rice_paddy). |
| Copper | copper wire, [printed circuit board](https://en.wikipedia.org/wiki/Electronic_waste) tracks, [ICs](https://en.wikipedia.org/wiki/Agbogbloshie), component leads. |
| [Germanium](http://www.imo.org/en/OurWork/Environment/ShipRecycling/Pages/Default.aspx)[[116]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-Klaus-116) | 1950s–1960s transistorized electronics ([bipolar junction transistors](https://en.wikipedia.org/wiki/Electronic_waste)). |
| Gold | [connector plating](https://en.wikipedia.org/wiki/Solder), primarily in computer equipment. |
| [Lithium](https://en.wikipedia.org/wiki/File:India_Victor_Grigas_2011-13.jpg) | [lithium-ion batteries](https://en.wikipedia.org/wiki/Electronic_waste). |
| [Nickel](https://en.wikipedia.org/wiki/Electronic_waste) | [nickel-cadmium batteries](https://en.wikipedia.org/wiki/Electronic_waste). |
| [Silicon](https://en.wikipedia.org/wiki/Mercury_(element)) | glass, [transistors](https://en.wikipedia.org/wiki/Greenpeace), [ICs](https://en.wikipedia.org/wiki/Electronic_waste), [printed circuit boards](https://en.wikipedia.org/wiki/File:Batteries_comparison_4,5_D_C_AA_AAA_AAAA_A23_9V_CR2032_LR44_matchstick-1.jpeg). |
| [Tin](https://en.wikipedia.org/wiki/Electronic_waste) | solder, coatings on component leads. |
| [Zinc](https://en.wikipedia.org/wiki/Cadmium) | [plating](https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/) for steel parts. |

## Human health and safety[[edit](https://en.wikipedia.org/wiki/Electronic_waste?title=Electronic_waste&action=edit&section=26)]

### Residents living near the recycling sites[[edit](https://en.wikipedia.org/w/index.php?title=Electronic_waste&action=edit&section=27)]

Residents living around the e-waste recycling sites, even if they do not involve in e-waste recycling activities, can also face the environmental exposure due to the food, water, and environmental contamination caused by e-waste, because they can easily contact to e-waste contaminated air, water, soil, dust, and food sources. In general, there are three main exposure pathways: inhalation, ingestion, and dermal contact.[[130]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-:22-130)

Studies show that people living around e-waste recycling sites have a higher daily intake of heavy metals and a more serious body burden. Potential health risks include mental health, impaired cognitive function, and general physical health damage.[[131]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-:03-131)(*See also*[*Electronic waste#Hazardous*](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed#Hazardous)) DNA damage was also found more prevalent in all the e-waste exposed populations (i.e. adults, children, and neonates) than the populations in the control area.[[131]](https://en.wikipedia.org/w/index.php#cite_note-:03-131) DNA breaks can increase the likelihood of wrong replication and thus mutation, as well as lead to cancer if the damage is to a tumor suppressor gene .[[122]](https://en.wikipedia.org/wiki/Lead#cite_note-liulin2-122)

#### Prenatal exposure and neonates' health[[edit](https://en.wikipedia.org/wiki/Electronic_waste?title=Electronic_waste&action=edit&section=28)]

Prenatal exposure to e-waste has found to have adverse effects on human body burden of pollutants of the neonates. In Guiyu, one of the most famous e-waste recycling sites in China, it was found that increased cord blood lead concentration of neonates was associated with parents' participation in e-waste recycling processes, as well as how long the mothers spent living in Guiyu and in e-waste recycling factories or workshops during pregnancy.[[130]](https://en.wikipedia.org/wiki/Agbogbloshie#cite_note-:22-130) Besides, a higher placental metallothionein (a small protein marking the exposure of toxic metals) was found among neonates from Guiyu as a result of Cd exposure, while the higher Cd level in Guiyu's neonates was related to the involvement in e-waste recycling of their parents.[[132]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-132) High PFOA exposure of mothers in Guiyu is related to adverse effect on growth of their new-born and the prepotency in this area.[[133]](https://en.wikipedia.org/wiki/PBBs#cite_note-133)

Prenatal exposure to informal e-waste recycling can also lead to several adverse birth outcomes (still birth, low birth weight, low Apgar scores, etc.) and longterm effects such as behavioral and learning problems of the neonates in their future life.[[134]](https://en.wikipedia.org/wiki/Defense_Intelligence_Agency#cite_note-134)

#### Children[[edit](https://en.wikipedia.org/wiki/Wikipedia:Verifiability?title=Electronic_waste&action=edit&section=29)]

Children are especially sensitive to e-waste exposure because of several reasons, such as their smaller size, higher metabolism rate, larger surface area in relation to their weight, and multiple exposure pathways (for example, dermal, hand-to-mouth, and take-home exposure).[[135]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-135)[[131]](https://en.wikipedia.org/w/index.php#cite_note-:03-131) They were measured to have an 8-time potential health risk compared to the adult e-waste recycling workers.[[131]](https://en.wikipedia.org/wiki/Surface_runoff#cite_note-:03-131) Studies have found significant higher blood lead levels (BLL) and blood cadmium levels (BCL) of children living in e-waste recycling area compared to those living in control area.[[136]](https://en.wikipedia.org/wiki/Carcinogenic#cite_note-:1-136)[[137]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-137) For example, one study found that the average BLL in Guiyu was nearly 1.5 times compared to that in the control site (15.3 ug/dL compared to 9.9 ug/dL),[[136]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-:1-136) while the CDC of the United States has set a reference level for blood lead at 5 ug/dL.[[138]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-138) The highest concentrations of lead were found in the children of parents whose workshop dealt with circuit boards and the lowest was among those who recycled plastic.[[136]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-:1-136)

Exposure to e-waste can cause serious health problems to children. Children's exposure to developmental neurotoxins containing in e-waste such as lead, mercury, cadmium, chromium and PBDEs can lead to a higher risk of lower IQ, impaired cognitive function, and other adverse effects.[[139]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-139) In certain age groups, a decreased lung function of children in e-waste recycling sites has been found.[[130]](https://en.wikipedia.org/wiki/Carcinogen#cite_note-:22-130) Some studies also found associations between children's e-waste exposure and impaired coagulation,[[140]](https://en.wikipedia.org/wiki/Duck_pond#cite_note-140) hearing loss,[[141]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-141) and decreased vaccine antibody tilters[[142]](https://en.wikipedia.org/wiki/Americium#cite_note-142) in e-waste recycling area.

### E-waste recycling workers[[edit](https://en.wikipedia.org/wiki/Thermostat?title=Electronic_waste&action=edit&section=30)]

The complex composition and improper handling of e-waste adversely affect human health. A growing body of epidemiological and clinical evidence has led to increased concern about the potential threat of e-waste to human health, especially in developing countries such as India and China. For instance, in terms of health hazards, open burning of printed wiring boards increases the concentration of dioxins in the surrounding areas. These toxins cause an increased risk of cancer if inhaled by workers and local residents. Toxic metals and poison can also enter the bloodstream during the manual extraction and collection of tiny quantities of precious metals, and workers are continuously exposed to poisonous chemicals and fumes of highly concentrated acids. Recovering resalable copper by burning insulated wires causes neurological disorders, and acute exposure to cadmium, found in semiconductors and chip resistors, can damage the kidneys and liver and cause bone loss. Long-term exposure to lead on printed circuit boards and computer and television screens can damage the central and peripheral nervous system and kidneys, and children are more susceptible to these harmful effects.[[143]](https://en.wikipedia.org/wiki/Haiti#cite_note-143)

The [Occupational Safety & Health Administration](https://en.wikipedia.org/wiki/Ghana) (OSHA) has summarized several potential safety hazards of recycling workers in general, such as crushing hazards, hazardous energy released, and toxic metals.[[144]](https://en.wikipedia.org/wiki/Lead#cite_note-:3-144)

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| **Hazards applicable to recycling in general** | |
| **Hazards** | **Details** |
| Slips, trips, and falls | They can happen during collecting and transporting e-wastes. |
| Crushing hazards | Workers can be stuck or crushed by the machine or the e-waste. There can be traffic accidents when transporting e-waste. Using machines that have moving parts, such as conveyors and rolling machines can also cause crush accidents, leading to amputations, crushed fingers or hands. |
| Hazardous energy released | Unexpected machine startup can cause death or injury to workers. This can happen during the installation, maintenance, or repair of machines, equipment, processes, or systems. |
| Cuts and lacerations | Hands or body injuries and eye injuries can occur when dismantling e-wastes that have sharp edges. |
| Noise | Working overtime near loud noises from drilling, hammering, and other tools that can make a great noise lead to hearing loss. |
| Toxic chemicals (dusts) | Burning e-waste to extract metals emits toxic chemicals (e.g. [PAHs](https://en.wikipedia.org/wiki/Electronic_waste), lead) from e-waste to the air, which can be inhaled or ingested by workers at recycling sites. This can lead to illness from toxic chemicals. |

[[144]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-:3-144)[[145]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-:4-145)

OSHA has also specified some chemical components of electronics that can potentially do harm to e-recycling workers' health, such as lead, mercury, PCBs, asbestos, refractory ceramic fibers (RCFs), and radioactive substances.[[144]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-:3-144) Besides, in the United States, most of these chemical hazards have specific [Occupational exposure limits](https://en.wikipedia.org/wiki/New_Zealand) (OELs) set by OSHA, [National Institute for Occupational Safety and Health](https://en.wikipedia.org/wiki/Sanshui_District) (NIOSH), and [American Conference of Governmental Industrial Hygienists](https://en.wikipedia.org/wiki/Sulfur) (ACGIH).

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| **Occupational exposure limits (OELs) of some hazardous chemicals** | | |
| **Hazardous chemicals** | **OELs (mg/m^3)** | **Type of OELs** |
| lead (Pb) | 0.05[[146]](https://en.wikipedia.org/wiki/Lead-acid_batteries#cite_note-146) | NIOSH [recommended exposure limits (REL)](https://en.wikipedia.org/wiki/Bangkok), [time weighted average (TWA)](https://en.wikipedia.org/wiki/Electronic_waste) |
| mercury (Hg) | 0.05[[147]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-147) | NIOSH REL, TWA |
| cadmium (Cd) | 0.005[[148]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-148) | OSHA [permissible exposure limit (PEL)](https://en.wikipedia.org/wiki/E-Stewards), TWA |
| [hexavalent chromium](https://en.wikipedia.org/wiki/Vacuum_tube) | 0.005[[149]](https://en.wikipedia.org/wiki/Gas_laser#cite_note-149) | OSHA PEL, TWA |
| sulfer dioxide | 5[[150]](https://en.wikipedia.org/wiki/Developing_countries#cite_note-150) | NIOSH REL, TWA |

For the details of health consequences of these chemical hazards, see also [Electronic waste#Electronic waste substances](https://en.wikipedia.org/wiki/Electronic_waste#Electronic_waste_substances).

#### Informal and formal industries[[edit](https://en.wikipedia.org/wiki/Electronic_waste?title=Electronic_waste&action=edit&section=31)]

Informal e-recycling industry refers to small e-waste recycling workshops with few (if any) automatic procedures and [personal protective equipment](https://en.wikipedia.org/w/index.php) (PPE). On the other hand, formal e-recycling industry refers to regular e-recycling facilities sorting materials from e-waste with automatic machinery and manual labor, where pollution control and PPE are common.[[130]](https://en.wikipedia.org/wiki/Printed_circuit_board#cite_note-:22-130)[[151]](https://en.wikipedia.org/wiki/Silver#cite_note-:5-151) Sometimes formal e-recycling facilities dismantle the e-waste to sort materials, then distribute it to other downstream recycling department to further recover materials such as plastic and metals.[[151]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-:5-151)

The health impact of e-waste recycling workers working in informal industry and formal industry are expect to be different in the extent.[[151]](https://en.wikipedia.org/wiki/Agbogbloshie#cite_note-:5-151) Studies in three recycling sites in China suggest that the health risks of workers from formal e-recycling facilities in Jiangsu and Shanghai were lower compared to those worked in informal e-recycling sites in Guiyu.[[131]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-:03-131) The primitive methods used by unregulated backyard operators (e.g., the informal sector) to reclaim, reprocess, and recycle e-waste materials expose the workers to a number of toxic substances. Processes such as dismantling components, wet chemical processing, and incineration are used and result in direct exposure and inhalation of harmful chemicals. Safety equipment such as gloves, face masks, and ventilation fans are virtually unknown, and workers often have little idea of what they are handling.[[152]](https://en.wikipedia.org/wiki/International_Convention_for_the_Prevention_of_Pollution_from_Ships#cite_note-Electronic_waste_{{!}}_Britannica-152) In another study of e-waste recycling in India, hair samples were collected from workers at an e-waste recycling facility and an e-waste recycling slum community (informal industry) in Bangalore.[[153]](https://en.wikipedia.org/w/index.php#cite_note-153) Levels of [V](https://en.wikipedia.org/wiki/Electronic_waste), [Cr](https://en.wikipedia.org/wiki/Wikipedia:Verifiability), [Mn](https://en.wikipedia.org/w/index.php), [Mo](https://en.wikipedia.org/wiki/Global_Waste_Trade), [Sn](https://en.wikipedia.org/wiki/National_Institute_for_Occupational_Safety_and_Health), [Tl](https://europa.eu/legislation_summaries/environment/waste_management/l21202_en.htm), and [Pb](https://en.wikipedia.org/wiki/Electronic_waste) were significantly higher in the workers at the e-waste recycling facility compared to the e-waste workers in the slum community. However, [Co](https://en.wikipedia.org/wiki/Scam), [Ag](https://en.wikipedia.org/wiki/Electronic_waste), [Cd](https://en.wikipedia.org/wiki/Electronic_waste), and [Hg](https://en.wikipedia.org/wiki/Electronic_waste) levels were significantly higher in the slum community workers compared to the facility workers.

Even in formal e-recycling industry, workers can be exposed to excessive pollutants. Studies in the formal e-recycling facilities in France and Sweden found workers' overexposure (compared to recommended occupational guidelines) to lead, cadmium, mercury and some other metals, as well as BFRs, PCBs, dioxin and furans. Workers in formal industry are also exposed to more brominated flame-retardants than reference groups.[[151]](https://en.wikipedia.org/wiki/Electronic_waste#cite_note-:5-151)

#### Hazard controls[[edit](https://en.wikipedia.org/wiki/Electronic_waste?title=Electronic_waste&action=edit&section=32)]

For occupational health and safety of e-waste recycling workers, both employers and workers should take actions. Suggestions for the e-waste facility employers and workers given by [California Department of Public Health](https://en.wikipedia.org/wiki/Smelter) are illustrated in the graphic.

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| **Safety suggestion for e-waste recycling facilities employers and workers** | | |
| **Hazards** | **What must employers do** | **What should workers do** |
| General | Actions include:   1. determine the hazards in the workplace and take actions to control them; 2. check and make correction to the workplace condition regularly; 3. supply safe tools and [PPE](https://en.wikipedia.org/wiki/Silicon_Valley_Toxics_Coalition) to workers; 4. provide workers with training about hazards and safe work practice; 5. a written document about injury and illness prevention. | Suggestions include:   1. wear PPE when working; 2. talk with employers about ways to improve working conditions; 3. report anything unsafe in the workplace to employers; 4. share experience of how to work safely with new workers. |
| Dust | Actions include:   1. offer a clean eating area, cleaning area and supplies, uniforms and shoes, and lockers for clean clothes to the workers; 2. provide tools to dismantle the e-waste.   If the dust contains lead or cadmium:   1. measure the dust, lead and cadmium level in the air; 2. provide cleaning facilities such as wet mops and vacuums; 3. provide exhaust ventilation. If it is still not sufficient to reduce the dust, provide workers with respirators; 4. provide workers with blood lead testing when lead level is not less than 30 mg/m3. | Protective measures include:   1. clean the workplace regularly, and do not eat or smoke when dealing with e-waste; 2. don't use brooms to clean the workplace since brooms can raise dust; 3. before going home, shower, change into clean clothes, and separate the dirty work clothes and clean clothes; 4. test the blood lead, even if the employers don't provide it; 5. use respirator, check for leaks every time before use, always keep it on your face in the respirator use area, and clean it properly after use. |
| Cuts and lacerations | Protective equipment such as gloves, masks and eye protection equipments should be provided to workers | When dealing with glass or shredding materials, protect the hands and arms using special gloves and oversleeves. |
| Noise | Actions include:   1. measure the noise in the workplace, and use engineering controls when levels exceed the exposure limit; 2. reduce the vibration of the working desk by rubber matting; 3. provide workers with earmuffs when necessary. | Wear the hearing protection all the time when working. Ask for the employer about the noise monitoring results. Test the hearing ability. |
| Lifting injuries | Provide facilities to lift or move the e-waste and adjustable work tables. | When handling e-waste, try to decrease the load per time. Try to get help from other workers when lifting heavy or big things. |