



ECOSIGN

Ecodesign of Electronic Devices

UNIT 7: Recycling of electronic devices



Recycling of electronic devices

- In the last two decades, the volume of consumer and business electronic equipment has drastically increased. At the same time, the fast changes in information and communication technologies, the concurrently increased versatility of electronic devices and low prices drastically lower device's lifetime and long-term usefulness.
- EU directive defines e-waste as outdated equipment that needs electric current or magnetic field for operating. E-waste are also measuring instruments for measuring electrical units.
- The electronic product becomes waste when its structure and condition cannot provide the predefined purpose
- WEEE-'Wast Electrical and Electronic Equipment'

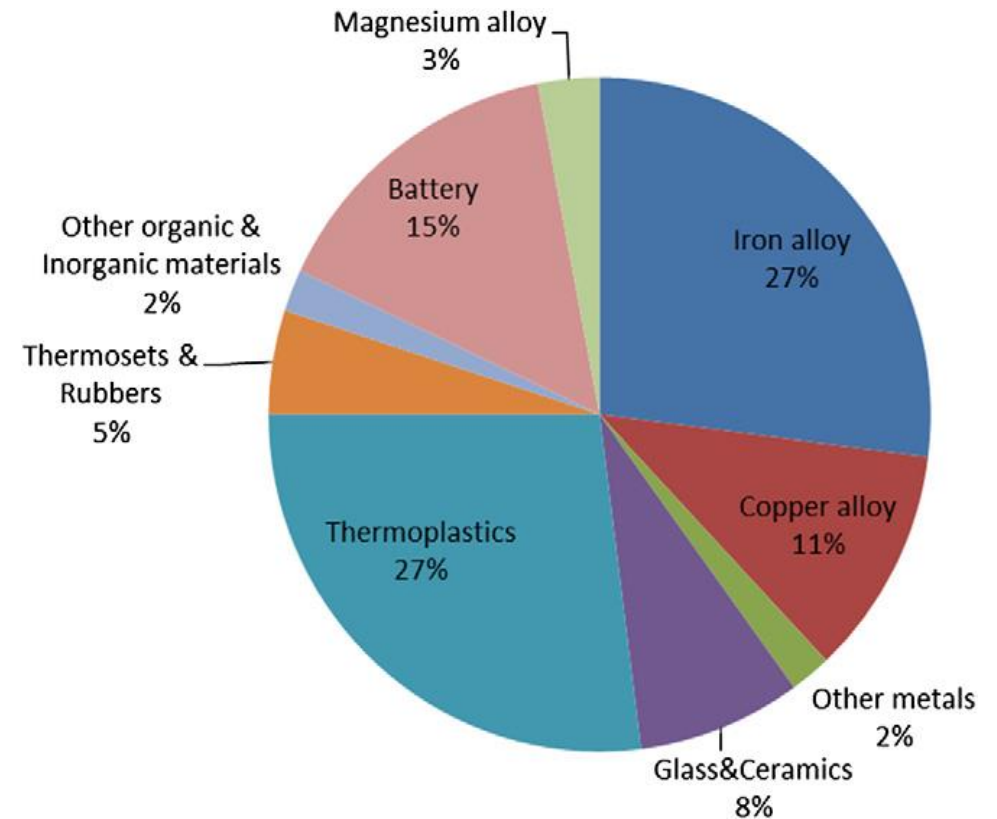
Recycling of electronic devices

- Reasons, why an electronic product is no longer useful, can be several. Most often the electronic device is not functional due to damage. It is also possible that the used technology is outdated or the design is no longer in trend.
- Within the WEEE research, some components in electronic devices contain dangerous substances such as mercury and cadmium.
- Control over large and even growing quantities of e-waste, recycling and processing of materials for reuse are the key questions from the ecological, as well as the economic perspective.

Type of WEEE	Arising	Collected	% Recycled
Television set	8000	4000	50
Video/sound	72000	3200	4
Copmuters/IT	357000	94600	26
Household appliances	392000	345300	88

Recycling of electronic devices

- The composition of e-waste varies by product type and the same applies to the composition of materials
- This is related to ambiguities about recycling of mobile phones which have enormously expanded until now
- A mobile phone can have plastic or metal covering parts. Interior parts that are needed for main functionalities can also be similar; these are display, printed circuits, and battery. One example of materials in a mobile phone is presented on right image.



Recycling of electronic devices

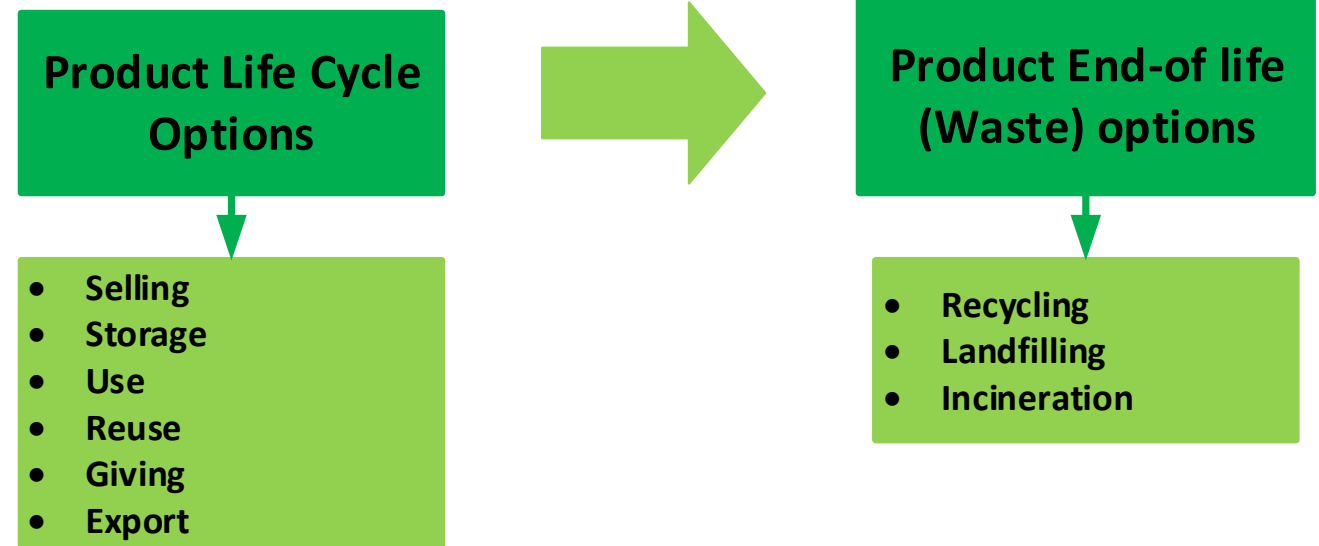
- Recycling of WEEE can be profitable if the materials in the devices can be recovered during this process
- E-waste contains relatively large quantities of precious materials, such as iron, aluminum, and copper.
- They also contain special materials, such as indium, gallium and rare earths.
- Recycling processes must also be economically sustainable, which means that the separation and processing of various materials is only possible if they can be profitable, as secondary material for reuse in new products.

Recycling of electronic devices

- Some components of electronic devices contain hazardous substances that can be harmful to the environment if processed and disposed inadequately. The studies show that most mercury and cadmium in the landfills in the USA and EU come from e-waste.
- Uncontrolled processing of e-waste, such as incineration outside can also cause negative effects to the environment and people who are directly or indirectly in contact with the incinerator.
- To slow down the increase of e-waste, the main principles in e-waste management are:
 - **Reduce the number of devices:** Fewer products on the market and the current ones need to be maintained.
 - **Device reuse:** By donating or selling we can give the device for reuse.
 - **Recycling:** Products that are not functioning or useful.

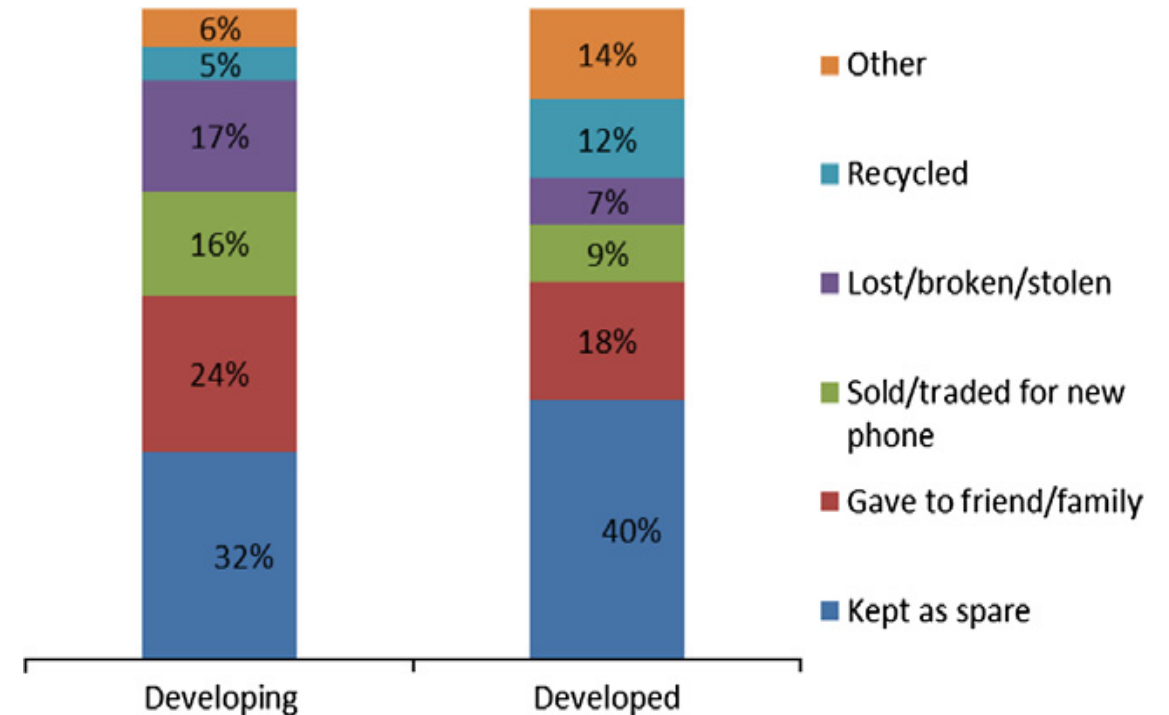
Recycling of electronic devices

- The image presents different possibilities for a typical electronic device when it has reached the end of the lifecycle. In each of the options are also possible bad practices that are related to the following facts. For example, recycling at the end of lifetime can be executed in a correct or incorrect manner. During product's lifetime, several users can use the product that could go through a phase of upgrade or repair. The product can be sold directly from the user to the user or through different mediums. With today's growing technology, the electronic products are quickly losing their value.



Recycling of electronic devices

- In image, we can see results of the last study on discarded electronic devices. The study included a limited number of electronic devices, such as phones, tablets, music players, etc. In the developed countries, almost 40% of discarded devices stay at home, and only 12% are given to the recycling process. The ratio between recycled and preserved devices at home is an indicator of general awareness of consumer on recycling and its importance.



Electronic waste management policy

- The general goal in planning the national policy for e-waste management is creating a sustainable society for recycling. This includes the establishment of reliable models and infrastructure for collecting and recycling, but also efforts for increasing awareness and changing consumer behavior. All the new practices will need time to develop.
- Important steps towards sustainable development and responsibility for the environment and public health have been made with the restrictions on the use of hazardous substances in electronic devices. The restriction of hazardous substances is defined in Directive 2002/95/EC and RoHS.
- Other directives have also been adopted that have involved the recycling processes, for example, Directive 2002/96/EC.



Electronic waste management policy

- The scheme of e-waste collection was first established in Europe. It is based on the principle that the users can hand over the device to the recycling process anytime without any additional payments. The goal of this scheme is increasing awareness amongst users and promoting the increase of recycling capacities.
- Directive RoHS demands that all heavy metals in electronic devices, such as lead, mercury, cadmium, hexavalent chromium and flame retardants, such as polybrominated biphenyls or polybrominated diphenyl ether should be substituted by less hazardous materials.
- To achieve higher efficiency and related savings at costs were established organizations PROs (Producer responsibility organization) which are managed separately to respect the given responsibilities regarding management of discarded devices in the name of the larger electronic equipment manufacturers.



Electronic waste management policy

- For an efficient solution of e-waste management problem, the countries have in the last decade accepted regulation on the extended producer responsibility EPR.
- EPR requires that manufacturers of electrical and electronic equipment take back the user's equipment and recycle their products when they reach the end of the lifecycle.
- EPR is based on the assumption that the manufacturer's responsibility to recycling own products will force and encourage them to design new devices to have lower recycling and disposal costs.
- An important aspect of EPR is that the rate of returned resources would be higher which would decrease environmental effects and lower the production of electronic devices.



Electronic waste management policy

- Currently are in the European Union in use different models for estimating quotas for financing certain costs in the recycling chain. Quota models are differentiated by what will be financed and how to estimate the costs for different product categories and their collection.
- Costs of product category evaluation and collection are based on the manufacturers who are in the same scheme and produce different electronic devices.
- Usually, the establishment of e-waste collection systems is the most efficient if it is organized in a collective way, meaning several manufacturers share the same collection system and the costs. In Europe, this has been achieved with the establishment of PROs



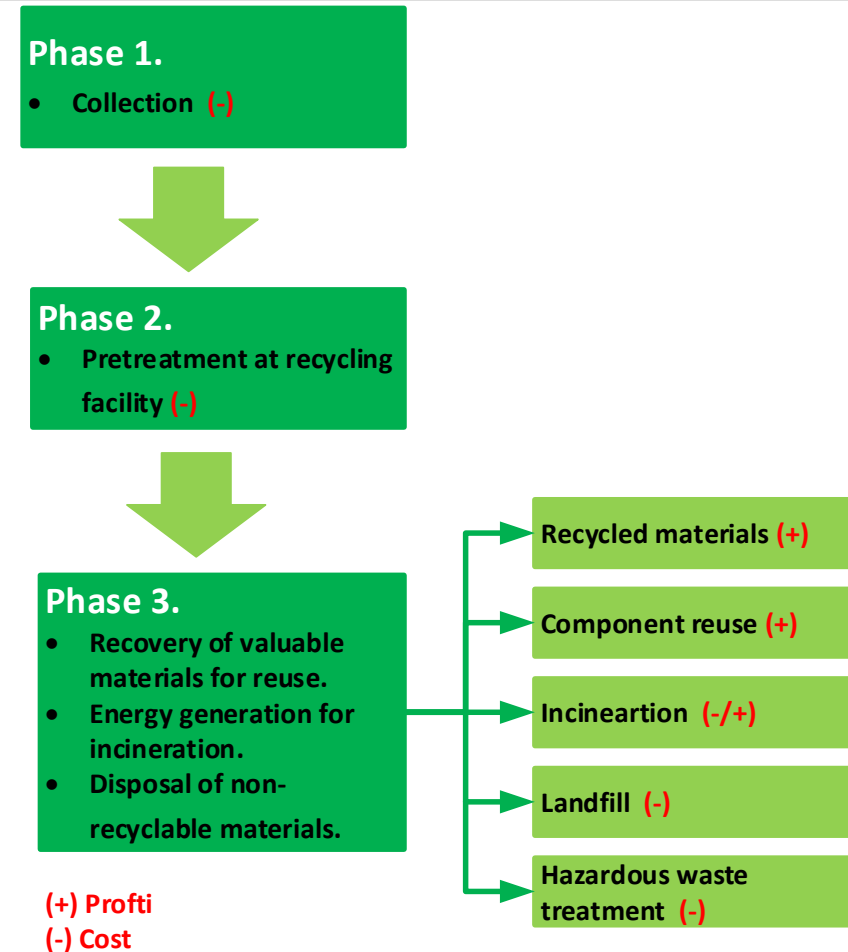
Recycling of electronic components

- The end of product's lifecycle can be divided into several subprocesses which are intended to recover the used materials and energy. Optimization of the whole recycling process chain is key for achieving efficient recycling for the environment, as well as for the economy.
- The efficiency of e-waste recycling does not only depend on the technical capacities, but also on other factors.
- There are challenges related to the politics, legislation, economy, society, and culture.
- One of the main obstacles in recycling is still the lack of consumer awareness on possibilities for recycling electronic waste and their positive impact on the environment and creation of a society that is focused on sustainable development.



Recycling of electronic components

- At the end of product's lifecycle, the recycling process can be divided into three phases that need different management methods and different technical approach.
 - The first step is collection and consolidation of waste, called »take back«. This is mainly a logistic challenge that requires a high level of awareness and consumer's readiness to return outdated electronic devices for recycling.
 - In the second step before waste processing, the waste is taken over by specialized recycling companies.
 - Recycling process.



Collection points and infrastructure

- Collection and transport of electronic waste present the main cost of the whole recycling process. Collection costs can enormously increase if the costs for increasing user awareness through different public media are added to the costs.
- Optimization of the collection process, together with the establishment of cost-efficient ways of communication and increasing awareness of the existing programs for recycling is crucial for efficient WEEE recycling.
- Many collector schemes that enable the consumer to return outdated electronic equipment anytime cause accumulation of electronic waste which leads to lots of expensive additional sorting.

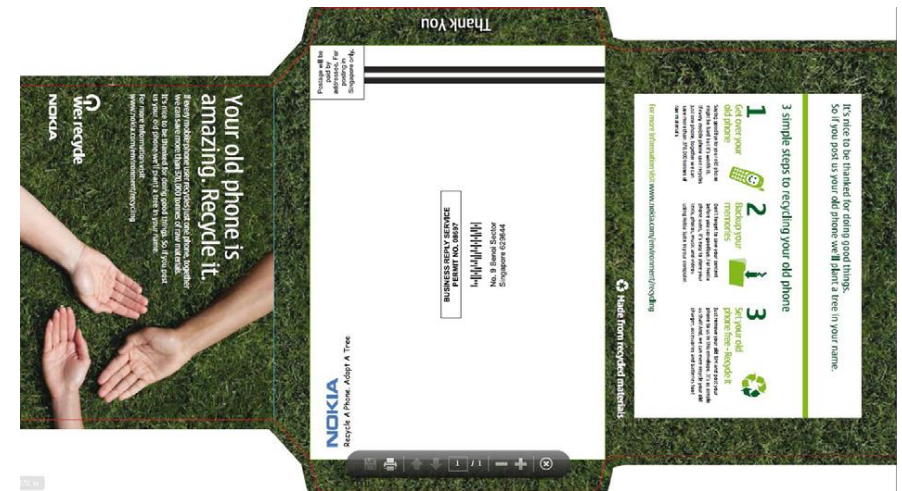
Collection points and infrastructure

- The introduction of a recycling program and the construction of the necessary infrastructure are the first steps in the creation of a collection system for e-waste.
- Producers responsible organisations have been established in the European Union countries, which have established a permanent aggregate e-waste infrastructure on behalf of manufacturers. Thus, the requirements set out in the European WEEE Directive have been met.
- Visible collection points, which at the same time effectively communicate to the user a message about the possibility of recycling the device, are located at various kiosks and other collection points.



Collection points and infrastructure

- For the consumer, one of the easiest ways to return a small obsolete electronic recycling machine is to use postal services.
- Prepaid postal items and titles can be downloaded and printed from the Internet, while envelopes can be sent directly to consumers distributed to retailers or in the sales package of the new product on request. Envelopes provide a simple return procedure, but they are expensive in terms of return logistics.



The electronic waste recycling process

- Recycling of a variety of different metals, such as black alloys and aluminum have a long history in the metal processing industry. The recycling technology is well developed and very efficient. The recycling technology for electronic waste and metal processing is different as it is a source of secondary resources.
- The processes have a short history and less established technologies. The electronic products have a complex composition and contain different materials. These materials are integrated among themselves. Usually, they are present in small quantities and are built in thin layers.
- Separation of materials on different groups makes the recycling process different. Also, there is a mass of different electronic devices that have different structure and components.
- Most recycling companies pay a lot of attention to the process before recycling. This means that e-waste are sorted on different materials that are prepared for final processing.

The electronic waste recycling process

- Due to this, the recycling processes vary between devices and can be summed up in some main steps of the electronic devices recycling process:
 - Sorting by components.
 - Decomposition and disassembly. Removal of hazardous elements and batteries.
 - Preparation of material for further processing. Metallurgical or mechanical processes.
 - Recycling. Return of materials to reuse.
 - Incineration. Use of energy.
 - Removal of materials that cannot be recycled.

The electronic waste recycling process

- Before processing, different technological processes for separation of materials are used. Different material fractions can be involved in suitable recycling processes.
- The separation process is shown in the image. Disassembly of complex electronic equipment is done only if the device contains precious parts.
- Those usually cannot be diluted with less precious ones. Just like in separated recycling, the printed matter (PCB) which contain hazardous substances require special handling.

