

Ecodesign of electronic devices

UNIT 1: Introduction to Ecodesign of electronic devices

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Chapter summary:

- The role of Ecodesign in electronic devices
- Advantages of Ecodesign approaches
- Providing quality of ecological devices



1.1. Introduction

Electronic industry (EI) represents a great share of European economic activities. Increased usage of new technologies and affordability of electronic devices to the end consumers have further encouraged the growth of electronic industry and its influence on the related industries. In many cases, it is questionable whether the expansion of electronic industry has positive or negative effects on people and society. Do electronic devices really improve individual's living standard or benefit the society and environment that we live in? In many cases, we see their positive effects on individuals and society. The evolution of technology has also lead society and individuals to change their habits and living patterns. Another very frequent question are the effects of the electronic industry on the environment. Many electronic devices are made of very specific materials. Their journey from resource to the end product can be equal to a few rounds around the Earth or they can be dangerous to the people and the environment. The production of electronic components and devices often has a negative effect on the environment. These devices need energy in order to function which needs to be produced from different sources. Obtaining energy resources also takes its toll on the environment. Due to these effects, it is reasonable to discuss the design of electronic devices with lower ecological footprint. It is also important to view this issue with the perspective of ecological awareness and the possibilities of sustainable development. To a great extent, new technology enables miniaturization of electronic components as well as reduced consumption of materials and energy. Telecommunication systems play an important role in this, as it is much easier to provide the access to the information and the mutual interaction with lower environmental effects. Lately, the terms smart devices and smart automatization have been enforced. The common goal of these devices is optimal functioning in the sense of operative efficiency as well as the optimal energy consumption. Europe has many directives and guidelines on providing the ecological efficiency and measuring of the ecological footprint of electronic devices. Before we start with the review of Council Directives, we have to quickly take a look at the environment.

Environmental protection is conservation of our own ecosystem that enables our survival. This environment enables us obtaining food, resources, energy resources etc. This means it is vital for quality life. The interest for environmental protection has greatly increased in 1980. This trend was emphasized by non-governmental organizations and governments, which succeeded to confirm certain measures on the global and national level. The colossal problem of environmental protection is thinning of the ozone layer and the greenhouse gases CO_2 and NO_x . Use of resources and water pollution are also important to consider. Many regions with heavy electro-industry have encountered water pollution with poisonous chemicals as well as emissions that cause photochemical smog and acid rain. Environments with living creatures are affected by direct and indirect influences, such as noise, radiation, vibrations. All environmental effects can develop multiple times during product life cycle. Therefore, the manufacturers and the



end consumers are responsible for environmental protection during the full lifecycle of products.

Ecological awareness and Ecodesign are also key to successful business. Lately, the thinking that Ecodesign is only an expense and that it is connected to higher investments has completely changed. Today Ecodesign is a synonym for business success with creative and innovative solutions. The ecological approach strengthens brand reputation, as well as decreases the production costs. Many conscious consumers are aware of the environmental influences of manufacturing and are sometimes ready to even spend more for products with ecological labels. In many cases, the ecological products are more effective, reliable, safer and are a better investment long term. Product design for companies leads to decreased production costs in the sense of lower material consumption due to miniaturization and product optimization. Other implications are a lower material waste due to correct development approaches, lower energy consumption, consideration of resource origin and the supplier origin. All of these positively affect the development of companies, but it also decreases internal risks and influences employee motivation. In Ecodesigning, industrial buyers also have an important role, especially the global companies that can influence suppliers with ecological policies. They can demand from their component or material suppliers to be in compliance with environmental standards and to appreciate the principles of ecological behavior. They often demand a breakdown of all the product's components all the way to the full material declarations. At the same time, Ecodesign is implementing innovative concepts, such as the analysis and synthesis of the device through the whole lifecycle which enables a detailed description of functionalities and device composition. This also included mutual relations in the supply chain. Satisfactory supply chain management leads to quality and efficient ecological products. In the European Union, many standards and directives are in use that evaluate and measure the effects of ecological devices.

Unfortunately, the growing electronic industry and extended use of its products are quickly increasing the amount of e-waste. Electronic waste are all discarded electronic devices. Due to the Council Directive on recycling and reuse of materials, lots of e-waste are still discarded and only around one-third of them is reused. The last evaluations for 2016 show that the quantities of e-waste have increased by 33%, to the total of 65.4 million tons, which is approximately 7kg per European resident [1]. It is interesting that the previous forecasts have predicted only 13 million tons of e-waste per year by 2020 [2].

1.2. Introduction to Ecodesign of electronic devices and their components

Ecodesign is product design that includes environmental protection as well as achieves superior business results in accordance with the policies and directives on environment protection. Ecodesign is a pragmatic approach to design that perceives,



predicts and incorporates key ecological factors into the development process with the intention to minimize environmental effects. Integration of tools for life cycle assessment (LCA) analysis means that designing of a certain device is extended from the ecological perspective to other segments of product life cycle from production to recycling. Determination of environmental influences during life cycle drastically and effectively decreases device's environmental influences at the supply chain, as well as in the product use phase. The life cycle viewpoint enables the designer to have insights into environmental consequences at all design phases and, therefore, attain a glimpse into possible environmental improvements of the product. The conceptual analysis of life cycle means prevention and decreasing of pollution already at the source. This means that we can minimize the quantities of waste, dangerous substances and consumption with a minimal investment of energy and resources. All products have a certain effect on the environment in all life cycle phases, from production to distribution, use, recycling or final discarding.

By incorporating ecological approaches into design, manufacturers can determine direct or indirect environmental influences of products in every life cycle phase. This is essential as more than 80% of environmental influence of every device is defined in the design phase. The methods for evaluating device life cycle are often supported by computer LCA tools which consist of environmental footprint databases for specific processes, materials, and components.

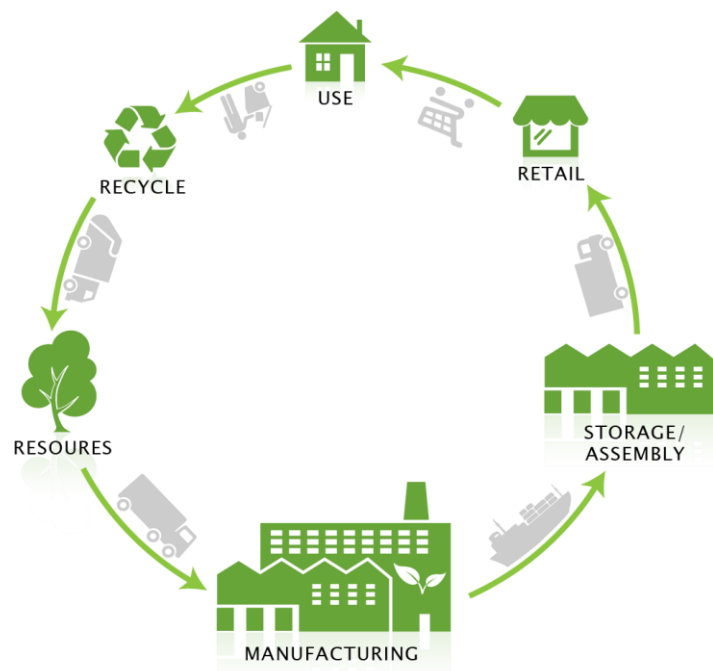


Image 1: Product life cycle.

Ecodesign can be designed and managed in many different stages.

- Strategy – the process of introducing the product to the market
- Research and development – designing innovative products



- Health and security – environmentally friendly production and healthy work environment
- Production – with the intent of increasing efficiency
- Marketing – use of environmental advantages, green sells better
- Supervising quality – ensuring higher product quality

In general, there is high demand for efficient electronic devices with low energy consumption and resources. European legislation and ecological labeling are important tools for improving the energy efficiency of products. It is intended to remove inefficient products from the European market which would essentially benefit Union's goals for European efficiency by 2020. Consequently, industrial competitiveness and innovation with improved environmentally efficient products in the whole EU market are supported.

1.2.1 Legal framework

- Environmental directives determine compliant rules on the EU level for improving the environmental efficiency of products, such as household appliances, information and communication technologies and technical appliances. Directives determine minimal mandatory requirements regarding the energy efficiency of products. This is intended to prevent formation of obstacles for trade, improving product quality and environmental protection.
- Energy labeling directive supplements the requirements with the mandatory labeling of devices which are designed by the Ecodesign principles.

Directive on environmentally suitable design also determines consultative forum for consulting with stakeholders regarding the implementation of this directive. The list of members includes representatives from EU countries, industry and civil society. The group is open to observers from all EFTE (European Free Trade Association) members and candidates as well as organizations with a legitimate interest in the debate.

1.2.2 Regulation of product specifications

- The Ecodesign Directive is implemented through regulation of individual product specifications which are used in EU countries.



1.2.3 Coordinated standards

- Regulations on ecological labeling are supplemented with coordinated European standards. Technical specifications require the product to be in compliance with the given requirements and only then can the manufacturer mark the product with a label CE.

1.2.4 Market supervision

- National market supervision authorities warrant the products, sold in European Union, to meet the requirements determined by the Ecodesign and energy labeling directives.

1.2.5 International perspectives

- Many countries that are not EU members (the USA, Australia, Brasil, China, and Japan) have similar environmental legislation and directives on energy labeling, similar to European Union.

1.3. The complexity of electronic devices

Electronic devices are composed of many different materials. Some of them are dangerous to the environment in the process of acquisition, processing or removal. The process of recycling electronic devices is an important factor in environmental protection. The main goal in handling with electronic waste is increasing quantities of separately collected waste, recycling and reuse of resources for the production of new products. Electrical and electronic equipment and its components contain lead, mercury, cadmium, and chrome, which are dangerous to people and environment, therefore it is necessary to handle them cautiously. Waste management is defined in Council Directive on Waste Electrical and Electronic Equipment – OEEQ.

A few examples of electronic device composition [2]:

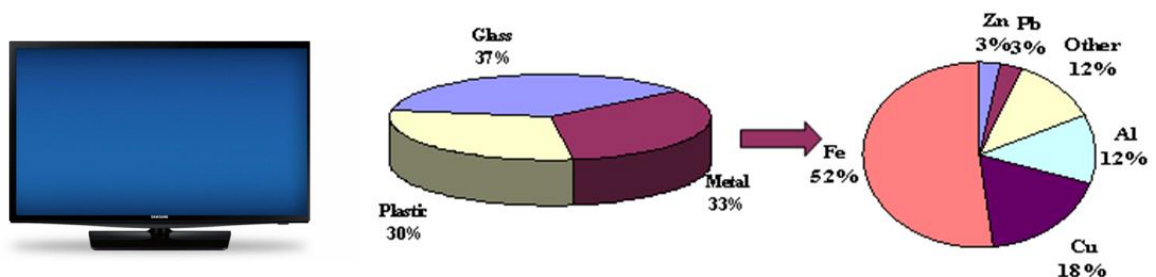


IMAGE 1: TELEVISION COMPOSITION

Slika 2. Sestava televizorja.



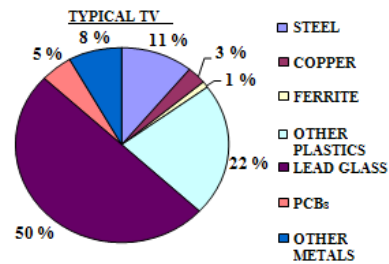


IMAGE 2: PERSONAL COMPUTER COMPOSITION

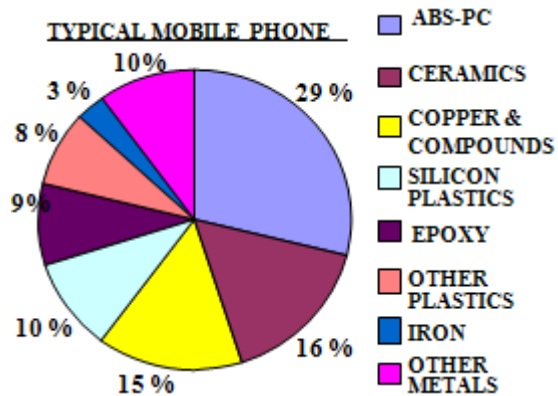


IMAGE 3: MOBILE PHONE COMPOSITION

Environmental efficiency of the device is measured also when is use and in the production process. This measurement is CO₂ footprint assessment. This method is exclusively used for measuring energy consumption in the production process and during device use. Energy consumption depends on different energy resources, such as oil, coal, wood, biomass and renewable resources.

1.4. The most common ecological labels and energy performance certificates for electronic devices

All devices, which are declared as environmentally friendly acquire different ecological labels. These labels are attributed according to the imposed directives.



CE label:



IMAGE 4: CE LABEL

CE label indicated products which are in compliance with the European regulation (CE – European Conformity). Products, labeled with this label, meet high standards of health and environmental protection. This label also enables fair competitiveness as all companies abide by the same rules. With this label, the manufacturer declares that the product meets all regulatory requirements and that it can be sold within European Economic Area – EEA. CE label is also valid for foreign products sold within EEA. It is coordinated with EU regulation, which is managed by Directorate-general for Internal Market in EU and Directorate-general for Environment.

Ecolabel flower:



IMAGE 5: ECOLABEL

European ecolabel flower is a label for products which meet the required ecological criteria. European ecolabel is assigned based on European Council and Parliament Directive EC 66/2010/EEC. It is managed by the European Commission in cooperation with other European Union members and other stakeholders. Ecolabel is a voluntary program which means the manufacturers, retailers, and importers can apply for product evaluation. The label can be assigned to products which meet environmental protection criteria defined by EU directives.

http://ec.europa.eu/environment/ecolabel/index_en.htm

Energy star:



IMAGE 6: ENERGY STAR LABEL

Energy star serves as a benchmark that every environmentally conscious manufacturer wishes to meet. The energy star program was enforced as an agreement between European Union and the USA for coordinated energy labeling of office supplies in 1992. It is used for labeling energy-efficient electronic devices, such as personal computers, screens, optical devices, uninterruptible power supply devices (UPS) and servers. European energy star evaluation is defined by Directive 2014/202/EU.

<https://www.eu-energystar.org/>



Blue angel:



IMAGE 7: BLUE ANGEL LABEL

Blue angel label originates from Germany and is one of the oldest labels for ecological labeling of electronic devices. Though it originates in Germany, it is used throughout Europe. This label confirms that the product is focused on four different environmental criteria, such as health, climate, water, and resources. The label jury is assembled by members of environmental and consumer associations, unions, industry, retail, crafts, local authorities, academics, media, church and federal states. The Blue angel encourages environmental protection and consumer protection. Therefore, it is used to reward products and services which benefit the environment in general and also meet high standards of health protection. The labeling is voluntary and covers predominantly white goods and office appliances.

www.blauer-engel.de

Energy performance certificate:

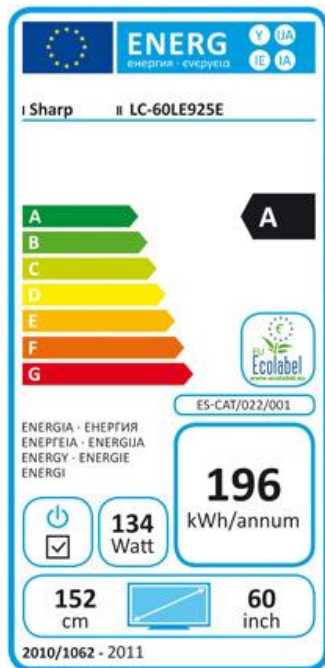


IMAGE 8: ENERGY PERFORMANCE CERTIFICATE

Energy performance certificate is one of the labels for labeling energy efficiency of household appliances and is mandatory for all appliances since 26.9.2015. Energy performance certificate is defined in Council Directive 92/75/EEC. The label ranks household appliances on a scale of G to A+++ based on energy consumption. The label indicates rated power and yearly energy consumption. This data is the basis for classification into energy class G to A+++. The consumers can use this label to compare various appliances and their energy efficiency. Energy performance certificates are mandatory for refrigerators, freezers, washing machines and dryers, dishwashers, ovens, heaters and water heaters, light sources, lamps and air conditioners.



1.5. The influences of Ecodesign on economy

Ecodesign carries many direct and indirect positive influences on the economy and business development. To name a few that lead to development: manufacturing devices with saving materials for device housing and additional components, less electronic component or their minimalization, use of renewable resources all lead to savings and lowering of production costs. If we take a closer look at the production with less dangerous materials, we can see that it does not require additional equipment and processes for health and environmental protection. Contrary, production with dangerous materials leads to more documentation and tracking of dangerous materials. To sum it up, production without dangerous materials is cheaper. The Waste Electrical and Electronic Equipment Directive (WEEE) established an additional fee that device manufacturers have to pay for product recycling. It is calculated by the formula "Product weight * Number of sold products = Market share". Therefore, higher market share equals to higher recycling price. In EU this price is approximately 0.5€ per kilogram. When manufacturers take into account ecological guidelines and design directives, they can decrease product weight and pay lower recycling fee with the same market share, therefore, have lower production costs, lower product price, and higher profit.

The initial approach to Ecodesign is production pricing foresight. Product price depends on many factors, such as the materials used, technological processes, used water resources and the amount of energy used for production. Depending on the given case, economy and social trends it is very difficult to foresee the final product price through the whole supply chain. It is currently assessed that in the manufacturing of printed circuits boards in the electronic industry 20-50% of all costs are related to the material use and energy consumption. Advanced technologies and technological processes contribute similar shares to environmental design. New technologies are closely linked to the correct product design. If we take a closer look at the development of printed matter for new devices. It is essential to take into consideration the shape and appearance of the final product from the beginning. When selecting circuit components it is crucial to know their characteristics, such as size and component type (SMD – surface mounted device, BGA – ball grid array or THT - through-hole technology) and their functional characteristics.

Component types:

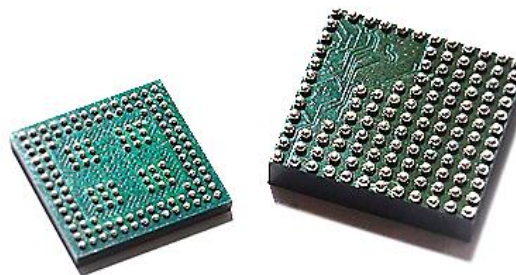


IMAGE 9: BGA BASE





IMAGE 10: SMD BASE



IMAGE 11: TH BASE

The manufacturers can lower some costs while designing, for example, product size, energy efficiency and the choice of technological process for assembling circuit. Most printed matters are composed with mixed soldering processes, such as wave soldering and reflow soldering. With a rational choice of design and printed matter depending on the technological manufacturing processes, it is possible to greatly reduce the product's ecological footprint.

Lately, consumer environmental awareness has increased, meaning ecological products sell better. Strengthening the brands is crucial for environmental awareness, but it also results in advantages to enforcement of new ecological products. Ecological labels on products are intended to provide visibility of ecological products and guarantee that the products were checked by standardization institutes and are therefore safe and reliable. The main organization for standardization of electronic devices is CENELEC (European Committee for Electrotechnical Standardization). CENELEC allows the product to access the European market and controls adoption of other international standards in cooperation with the International Electrotechnical Commission – ICE.

An important aspect of the economy is the evaluation of Life Cycle Cost – LCL. Most manufacturers are only oriented to the product price but other costs also occur during the product life cycle, which the consumer should be familiar with. The life cycle cost analysis includes the off-the-shelf costs meaning it includes the recycling fee and the costs of maintenance, repair, and the average product lifespan. Ecological devices are more reliable and energy efficient and these results are also supported by the life cycle analysis. Onward, we will take a look at the advantages of Ecodesign for companies.



1.6. Innovation

Innovation is what propels the companies and enables easier penetration to the domestic or international market. Ecodesign in many cases changes the methodology and design concepts which generally lead to the established practices. Many of these innovative approaches can be found in different industrial sectors. For example, the dependency on fossil fuels and their negative influences on the atmosphere have led to the development of electric vehicles which have a significantly lower ecological footprint. Lately, the trend of using natural materials is also applied to the production of housing for voltage electronic devices.

1.7. Cost reduction

Ecodesign and systemized approach to management have greatly reduced the costs for companies and end users. Companies can choose between different resource suppliers, optimize their products with lower material usage or change the critical components that raise the production costs. The European legislation strictly observes the manufacturers and the use of ecologically controversial resources. Many times the legislation imposes additional fees for using blacklisted materials. This way, the legislation forces the manufacturers to use ecologically more suitable materials. Substitutions or replacement of controversial materials is often related to innovation, development and technological process.

1.8. Legislation compliance

Environmental criteria and legislation lead the manufacturers and companies to meet the environmental standards. Only this enables systematical accomplishment of environmental criteria. Legislation compliance expands the opportunities for development and the tax relief in the national or European area.

1.9. Higher product quality

The implementation of ecological practices also improves the product quality. Lately, we have seen many device improvements, not only in the industrial setting but also in households. Many devices have improved the quality and lifespan with Ecodesign, for example, the washing machines. Those have benefited from the use of newer technologies, such as the drive type of the washing machine drum with the speed-controlled engine and the mounting of heat pumps both have led to higher



energy efficiency as well as longer lifespan. Similar examples are water storage with digitally controlled temperature etc.

1.10. Improved company reputation

Many indicators and social research have shown that the companies with ecologically compliant products show higher recognition and are viewed as more sincere partners by other companies. Such companies have better abilities to interconnect and rank higher recognition in the business area, as well as amongst the end consumers. After all, the trend of ecological awareness is increasing amongst the consumers.

REFERENCES:

1. http://ec.europa.eu/environment/resource_efficiency/news/up-to-date_news/14012014_en.htm
2. Kuehr, R. et al. 2007. "2008 Review of Directive 2002/96 on Waste Electrical and Electronic Equipment (WEEE) – Final Report". *United Nations University Contract No: 07010401/2006/442493/ETU/G4 ENV.G.4/ETU/2006/0032, Bonn, Germany.*
3. Florin-Constantin Mihai, E-Waste in Transition - From Pollution to Resource, *InTech, Chapters published June 29, 2016 under CC BY 3.0 license, DOI: 10.5772/60487*
4. D. Krajnc, Eko-dizajn, Operativni program čezmejnega sodelovanja Slovenija-Madžarska 2007-2013.

