

Ecodesign of electronic devices

UNIT 2: European environmental standards and Directives on Electronic Devices

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Chapter summary:

- Integrated product policy
- European standards and perspectives
- RoHS and WEEE directives



2.1. Introduction

European legislation on electronic devices can be divided into two larger parts (see image below):

- Integrated product policy (IPP) includes Ecodesign, Energy Efficiency Directive and Energy Labeling Directive.
- Specific regulations are part of WEEE, such as Waste Electronic Equipment Directive and Restriction of Hazardous Substances Directive (RoHS).

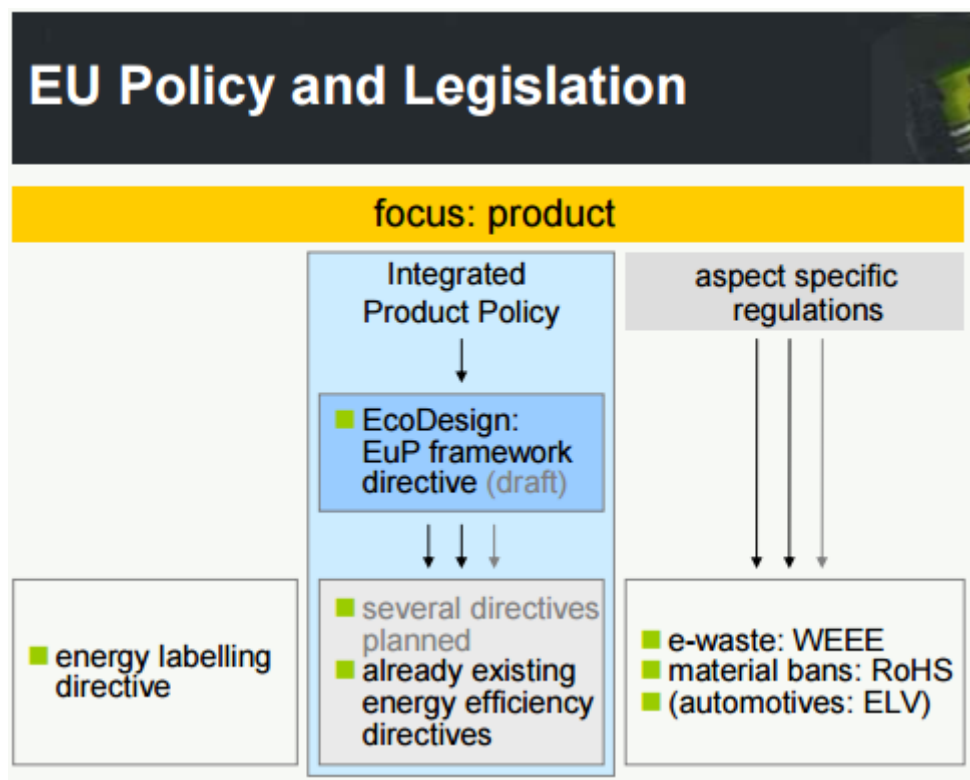


IMAGE 1: LEGISLATION ON ELECTRONIC DEVICES

2.2. Integrated product policy (IPP)

In some ways, all products contaminate the environment with its production, use and as waste at the end of their lifecycle. IPP (integrated product policy) is a European Commission strategy for reducing environmental effects through the product lifecycle. This lifecycle is often long and complex. It includes resource gathering, design, manufacturing process, product assembling, sale, distribution, product use and ends its journey as waste. Therefore, IPP covers all stakeholders from designers, manufacturers,



traders to the users. IPP stimulates all stakeholders to reduce products' environmental effects. Due to many distinctive products the legislation is not reduced to one simple policy that would cover all products. For this reason, many different tools are used for reaching the goals, such as economic instruments, hazardous substance limitations, voluntary agreements, labeling and product design guidelines.

2.2.1 IPP strategy included all sides through product lifecycle:

- Manufacturers have to consider ecodesign and verify that the products are environmentally friendly.
- Traders have to advertise green products and inform the consumers about the existence of these products.
- Consumers have to use green products carefully and discard them at their lifecycle end in an environmentally friendly way.

Political criteria

IPP is focusing on three elements with direct environmental effect in the product lifecycle.

- Product price reflects environmental effects.
- Consumer knowledge.
- Ecodesign.

2.2.2 Environmental effects and product price

The market can play the key role in optimizing environmental effects. Thus, IPP implements lower tax rate for products labeled with ecolabels.

2.2.3 Consumer knowledge and their choice

IPP strategy includes education of consumers and companies which could lead to higher use of ecodesigned products. It is essential to guarantee the consumers comprehensible and credible technical information through product labeling or other sources. For reducing environmental effects, it is necessary to provide the consumers with information on correct product use. Europe is already providing a source of information through ecolabelled products. However, the product range has to be expanded with subsidies on the European and national level. Other instruments for promotion environmentally friendly consumerism are self-declarations and ISO ecolabeling.



Public orders in EU contribute to 12% of BDP and present a potential for purchasing of ecodesigned products. If these purchases were realized, the manufacturers would start producing ecodesigned products.

2.2.4 Ecodesigning products

For the expansion of ecodesign to a broader range, it is important to prepare and disclose product and lifecycle information. This can be done through two instruments, i.e., Live Cycle Inventories (LCI) and Lifecycle Assessments (LCA). More about ecodesign will be presented in the following chapters.

2.3. European environmental standards and electronics directives

As a result of more and more evidence on climate change and energy dependency, the European Union is determined to become energy efficient economy. The trends are moving towards safer, competitive, locally produced and sustainable energy supplies.



Energy politics are promoting merging of energy networks and energy efficiency. It is dealing with energy resources, from fossil fuels, atomic energy to renewable resources (solar and wind power, biomass, geothermal energy, hydropower, tidal power). Article 194. of Treaty on the Functioning of the European Union implements a special legal basis in the energy field which is based on the shared competences between EU and its members. In the following chapters, some directives and strategies on electrical energy will be comprehensively presented, while other energy types will be only mentioned.

2.3.1 European energy politics

European energy politics coordinates balanced production and supply of all energy types. It analyzes prices and develops guidelines for the supply of cost-efficient energy and at the same time considers the competitiveness of European economy.



2.3.2 Internal energy market

The primary goal is the establishment of a framework for supervision of whole energy market. Internal Market in Electrical energy Directive merges the production, transfer, distribution and supply guidelines. Another important directive is Transparency of Gas and Electrical energy Prices Directive which regulates price transparency for the end users.

Smart Grids also take place in the internal energy market. They enable the consumers to supervise their energy consumption and hence contribute to energy production with less produced carbon. European Commission suggests the use of Smart Grids in full scale to reduce primary energy consumption.

In 2011 EU has approved cross-border regulation on the electric energy exchange. This regulation induces rules for energy exchange within European Union which encourages competitiveness and business harmony. The common framework for energy product and electrical energy taxation is also specified, as well as an agreement on minimal taxation of oil, coal, natural gas and electrical energy.

2.3.3 Efficient energy use

In 2007 European leaders have accepted an agreement on lowering energy consumption by 20% by 2020. This saving equals to the closing of 400 power stations. In October 2014 they raised this share to 27% or more by 2030.

Proper energy efficiency of buildings greatly contributes to the goal of reducing energy consumption by 20% by 2020. Buildings in Europe spent about 40% of all produced energy.

Directive on Electrical and Gas Means of Transport (charging stations) sets standard rules on the setup of the charging infrastructure in different European countries. It determines the minimal requirements for buildings which will enable the charging of electrical and natural gas automobiles. Until 2020, the Directive predicts establishment of electrical charging stations in densely populated areas. Until 2025, it foresees the establishment of charging stations on hydrogen and liquefied natural gas (LNG). Efficiency and safety of water heaters – boilers are also defined in this Directive the water heaters have to be designed by ecological criteria. This Directive (92/42/EEC) also refers to new water heaters for liquid and gaseous fuels.

2.3.4 Energy efficiency of office equipment: Energy Star program (EU-USA)

The voluntary program for measuring energy efficiency “Energy Star” has been accepted together with the United States of America. Its function is to stimulate the production of energy efficient office equipment. The Energy Star label enables the consumers to identify equipment with low energy consumption.



European Union and the United States of America have signed the new Energy Star agreement on 28. December 2006. Its goal is that the manufacturers would voluntary use the agreed specifications for evaluating the energy efficiency of office equipment, such as computers, monitors, printers, copy machines, scanners, multifunctional devices, faxes, etc. the previous agreement was only valid until 2007, and it only included computers.

The manufacturers and traders of office equipment can join the Energy Star program and use the label if they meet the required energy specifications. The evaluations can be made by manufacturers or independent laboratories. USA and EU have both their own instruments for supervision energy efficiency of devices labeled with the Energy Star label. In Europe, this is the European Community Energy Star Board (ECESB). ECESB can notify the manufacturer about the incorrect labeling and submit their recommendations. They also prepare a draft plan on program compliance. If the conditions are not met, they can discontinue cooperation with the manufacturer in the program.



3.3.5 Renewable resources

European Union invests a great deal in renewable energy resources. Until 2020 they would like 20% of total energy consumption and 10% of the energy used in transport to come from renewable resources. Renewable resources are:

- Ocean energy has immense potential. Currently, there are many different technologies for using the wave and tide energy, wind power on the sea and the conversion of temperature changes and salinity changes for the electrical energy.
- Wind power is created when wind turbines and generators are used for electrical energy production. In 2011, wind power in EU presented 6,3% share.
- Solar energy is produced with photovoltaic modules. In 2012, the network of all modules equaled to 17,2 GW photovoltaic modules.



2.4. Energy efficient products

In European Union, many everyday products carry ecolabels and are designed to be as energy efficient as possible. The results of ecodesign and labeling are reflected in energy saving, for example until 2020 we will save 175 Mtoe (Mtoe - Million Tonnes of Oil Equivalent) which equals to yearly primary consumption of Italy! For the consumers, this means saving 465 € per year on the electrical energy bill. Industry foresees a saving of 55 billion €.



2.4.1 Energy consumption of products, informing consumers and labeling

Energy labels help consumers to choose energy-efficient products. Labeling requirements for specific product groups are designed in accordance with Directive on energy labeling, which is lead by European Commission. The manufacturers can create their own energy efficiency labels with the tools, prepared by the European Commission [1]. The previous directive on energy efficiency labeling only referred to household appliances. The current directive applies to a broad spectrum of products which have direct or indirect effects on energy efficiency. The Energy Labeling Directive 2010/30/EU and its amendment 2012/27/EU establish a framework for labeling and informing consumers on the energy use of products. The Directive includes products with direct or indirect effects on energy use during product use. It excludes used products and all products related to transport of people or goods.

Which information must be submitted?

Suppliers have to attach data about electrical energy consumption to their products. Technical documentation also has to contain:



- general product description,
- project calculation results,
- testing reports,
- references that enable identification of similar models.

Technical documentation has to be available for five years. The suppliers have to deliver this information to the traders free of charge. The traders have to attach the designations on visible places.

What function do the delegated acts serve?

Delegated acts have to monitor mainly:

- product description,
- measuring methods and standards,
- detailed technical documentation,
- form and content of labels. The product classification on the label has to be marked with a letter from **A to G**. The most energy efficient class is labeled with **A+++**. A scale of seven colors is in use, dark green equals to the highest energy efficiency.
- location where the label has to be attached.

If the products, which are part of the public order, are included in the delegated act as stated in Directive 2004/18/EC then they need to be purchased in accordance with the high energy efficiency, declared in energy classes.

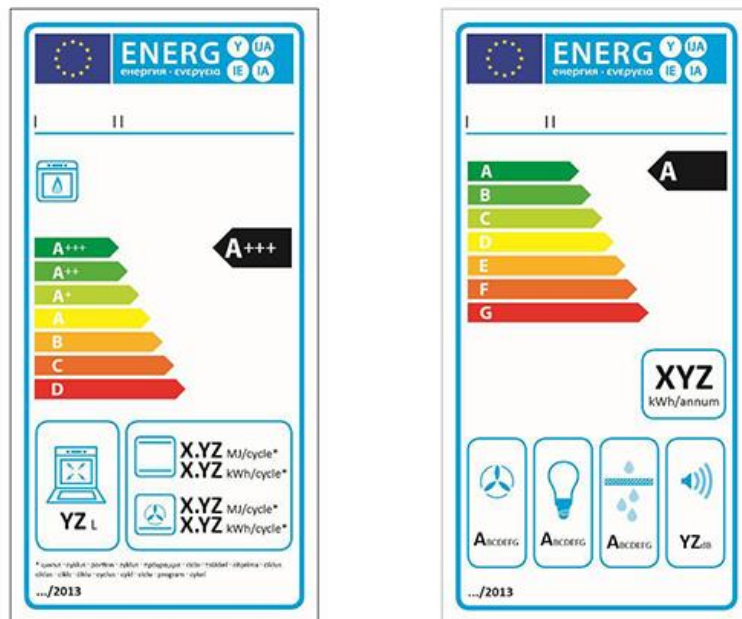


IMAGE 2: ENERGY EFFICIENCY LABEL



In 2015 the European Commission proposed labeling of energy efficiency on the scale of A to G. The previous scale was defined in 1995 and had classes from A+++ to D, but the energy efficiency has improved greatly, so almost all products were in the highest A class. Due to this the new scale from A to G can help consumers to easily single out the most efficient appliances. The European Commission also proposes the establishment of a digital base of all appliances to achieve higher transparency [2]. European household on average saves 45 € per year due to the new measuring of energy efficiency.

What has changed with the January 1. 2015?

New ways of measuring energy efficiency help consumers save energy when cooking, preparing coffee and surfing online. The consumers can also check the energy efficiency of products sold online.

- The energy labels for online retail: traders have to display efficiency labels when selling online. Until now, they only displayed the labels for products within class A, but with the new Directive, they have to display all classes.
- Energy labels are required for gas grills and hoods. Previously, only electric ovens were labeled.
- Automatic standby mode for network-connected: new appliances (modems, routers, printers, etc.) will have the option to switch to the low power mode when the main tasks are not performing.
- Automatic standby mode for coffee machines: new coffee machines will have to automatically switch to standby mode after a certain inactive time.

What are the benefits for consumers?

- Consumers have the same possibility to compare energy efficiency classes when shopping online as they do in physical stores.
- With energy efficient gas stoves (f.e. A+) consumers can save up to 180€ through the product lifetime in comparison to the appliances in a lower energy class (f.e. D). In electrical ovens, this saving can be up to 230€.
- New rules regarding standby mode of network-connected devices can add to the saving 40€ per year for the average household, without affecting product functions.
- New regulation for coffee machines can save up to 45€ through product lifetime.
- All the new rules can lead to the households saving up to 45€ per year.



Environmental effects

These three new measures for labeling cooking appliances and standby mode of network-connected devices are evaluated to save CO₂ emission for 15 million tons per year. This saving equals to the yearly emission of Bucharest. All ecodesigned products and products labeled with energy labels save 166 million TOE (tonne of oil equivalent).

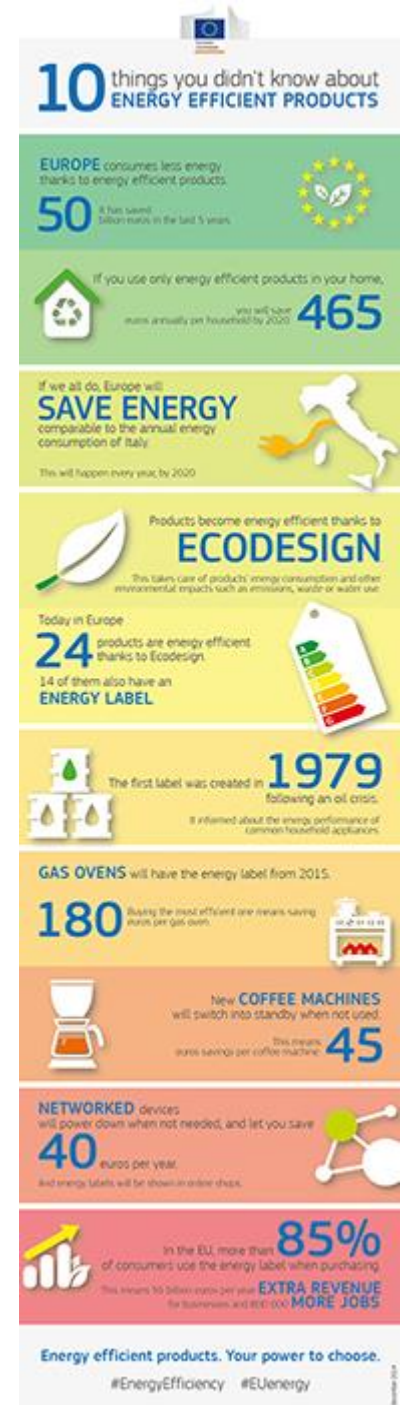
2.5 Ecodesigning products

Directive 2009/125/ES, prepared by the European Parliament and Council on the October 21. 2009 regarding the establishment of a framework for determining energy related requirements on environmentally suitable product design. The Directive establishes a framework of minimal requirements for environmentally suitable design which products that use energy have to meet before they can be used or sold in EU. Directive is not in use for passenger or freight traffic.

Key points:

- Requirements for environmentally suitable design cover all lifecycles of the product, from resources, production, packaging to the use until the end of its lifecycle.
- For each of these cycles the institutes, chosen by EU countries, evaluate different environmental effects. These institutions check effects, such as materials, used energy, predicted emissions and waste, opportunities for reuse, recycling, and processing.
- Manufacturers have to create an ecological profile of their products and take them into account when they consider alternative construction options.

Products that meet the requirements, carry label CE and can be sold anywhere in EU. The requirements for ecodesigning individual products are defined in Directive 2009/125/EC [3]. In addition to the ecodesign regulation, manufacturers can voluntary accept the agreement for scaling down the use of their products.



2.5.1 Television sets

Television sets [4] also fit into the EU regulation and, therefore, have to be labeled with an energy label and design by environmental guidelines. These rules save up to 45 TWh of energy yearly until 2020, which equals to the energy consumption of Czech Republic. This saving also equals to 15 million tons less of CO₂ emissions.

When television sets are not operating, their consumption has to be lower than 0,3W and when in use between 0,5W to 1W, depending on the standby function. Television sets have to automatically switch to standby mode after 4 hours of inactivity.



Energy labels

Television sets have to be labeled with energy classes from A++ (the most efficient) to G (least efficient). From January 2017 the most efficient televisions have label A+++. These energy classes also take into consideration display size. Yearly energy consumption labeled on the television includes 4 hours of use per day.

[EU regulativa za televizijske aparate 1062/2010](#)

All television sets sold in EU have to meet the requirements of ecodesign. These requirements cover energy efficiency, capabilities and sufficient information about the product.

Links:

- [EU ecodesign regulation for televisions 642/2009](#)
- [Amended by regulation 801/2013](#)
- [Manufacturers guide to ecodesign requirements for televisions](#)
- [Manufacturers guide to standby and off mode electric power consumption](#)
- [Transitional measurement methods 2010/C 114/05](#)



2.5.2 Circulator pumps

Circulation pumps [5] are appliances that pump liquids in closed circulation systems. These are cooling and heating systems and are also part of ecodesigning. Until 2020 it is forecasted to save up to 23 TWh of energy per year and reduce CO₂ emissions up to 11 million tons.

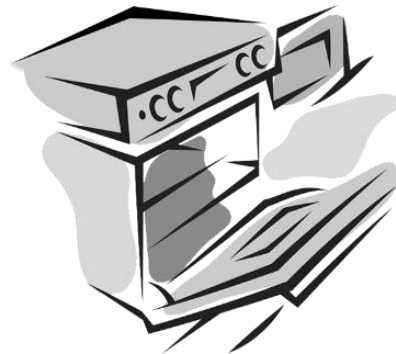
All circulator pumps sold in EU have to meet ecodesigning guidelines. These requirements cover energy efficiency, capabilities and sufficient information about the product.

Links:

- [EU ecodesign regulation for circulators 641/2009](#)
- [Amendment to the Ecodesign regulation for circulators 622/2012](#)
- [Harmonised standards for circulators 2013/C 254/04](#)

2.5.3 Cooking appliances

Cooking appliances [6] are ovens, cooking hobs and hoods which are part of EU ecodesigning since 2015. With replacing old ovens with newer ones in the highest energy class, consumers can save up to 230€ in 15 years. When we are using efficient cooking appliances, we can save approximately 1% of years worth of energy used in European households. CO₂ emissions are reduced to 2,7 million tons yearly by 2030, an equal to emissions of 4 medium-sized power plants. Microwave ovens, outdoor kitchen appliances, and grills are excluded from these requirements.



Energy labels

New cooking appliances have to carry a label with energy class. Classes are ranging from A+++ to G for kitchen hoods and ovens. In ovens, only their energy efficiency is evaluated and for hoods also the efficiency of air suction, integrated lighting fixtures, and fat filtration.

[EU regulativa za označevanje gospodinjskih pečic in nap.](#)

All ovens, cooking appliances and kitchen hoods sold in EU have to meet ecodesigning guidelines. These requirements cover energy efficiency, capabilities and sufficient information about the product.

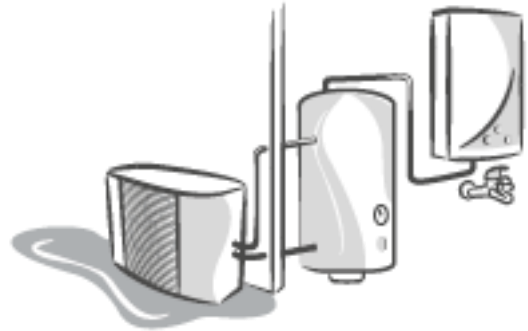


Links:

- [EU ecodesign regulations for domestic ovens, hobs, and range hoods](#)
- [Manufacturers guide for cooking appliances](#)

2.5.4 Heating bodies

Heaters and water heaters [7] (boilers) in households are also part of energy labeling and are part of ecodesigning. Heaters and water heaters can save up to 60 billion € until 2020. For example, if a household is equipped with a standard gas boiler, it uses 20 MWh per year while the new condensing gas boiler saves up to 275€ per year. This investment is paid off in seven years and reduces energy consumption by 20%. Efficient heaters and water heaters can save in total 600 TWh of energy yearly and reduce CO₂ emissions to 135 million tons.



Energy labels

New heaters have to carry a label with energy class. Classes are ranging from G (least efficient) to A++ (most effective). It is also possible to combine the technologies, for example, create a boiler with the solar interface and, therefore, achieve class A+++.

[EU regulativa označevanja za prostorske in kombinirane grelnike 811/2013](#)

[EU regulativa označevanja za vodne kotle – grelnike 812/2013](#)

Ecodesigning guidelines are the same for all manufacturers of heating bodies and all traders who sell in EU. The regulation refers to the energy efficiency, level of nitric oxide emissions, the volume of water boiler and heat losses of hot water boilers.

Links:

- [Manufacturers guide for heaters and water heaters](#)
- [Tool for calculating the energy efficiency of packages of heaters, water, and combination heaters](#)
- [EU ecodesign regulations for heaters and combination heaters 813/2013](#)
- [EU ecodesign regulations for water heaters 814/2013](#)
- [Harmonised standards for heaters 2014/C 207/02](#)
- [Harmonised standards for water heaters 2014/C 207/03](#)

3.5.5 Lighting fixtures



Lighting fixtures [8] are part of EU ecodesigning and energy labeling. When using energy efficient lighting fixtures, households can save up to 25€ per year. If they replace a halogen with LED lamp, this saving can increase to 100€ through product lifetime of 20 years. With saving in lighting fixtures, 11 million households can be supplied, and CO₂ emissions can be reduced by 12 million tons in Europe. Security lighting and some LED lighting fixtures for specific use are excluded from this regulation.



Energy labels

Lighting fixtures carry labels that mark energy classes A++ to E.

[EU regulativa za označevanje svetilnih teles 874/2012](#)

Ecodesigning is obligatory for all standard bulbs, fluorescent bulbs and point light sources in EU. The regulation includes energy efficiency and other factors, such as bulb/lamp lifetime and warm-up time.

Links:

- [EU ecodesign regulation for directional lamps, LED lamps, control gear, and luminaires](#)
- [EU ecodesign regulation for fluorescent lamps without ballast, ballasts, and luminaires](#)

Special Directive 2005/32/EC instructs ecodesign of fluorescent lamps, high-intensity discharge lamps, and associated ballasts. Yearly electric energy consumption of fluorescent bulbs without built-in ballasts is extremely high in EU. It is predicted to reach 260 TWh of electrical energy by 2020. High consumption is also the cause of higher CO₂ emissions, higher light pollution, and higher energy consumption. This Directive instructs ecodesigning of certain lighting fixture types for general use, but especially for:

- Fluorescent lamps without integrated ballasts.
- High-intensity discharge lamps.
- Ballasts that enable the operation of the aforementioned lamps.

The regulation defines ecodesigning in three phases (2009, 2012 and 2017), each phase presents progress in development and range of new subcategories of products. These requirements refer to:



- **Fluorescent bulbs**, which have to achieve certain brightness with a certain energy consumption and have a defined lifetime. The manufacturers have to provide data about power, efficiency, brightness, maintenance factor, mercury content, the color of light and color index.
- **Ballasts** have to provide energy efficiency, and certain information has to be given. During bulb functioning, ballasts have to achieve the minimum efficiency threshold. Additionally, the consumption must not exceed 1W when the device is turned off. Manufacturers also have to provide data on energy efficiency.
- **Lamps** also have to achieve energy efficiency. When in use, fluorescent bulbs must not exceed the power of ballasts. Lamp manufacturers have to provide information on efficiency of all ballasts and bulbs which are sold with the lamp, as well as maintenance and disassembly instructions.



The regulation also includes market controlling carried out by national metrology institutions. Bulb controlling is executed by taking a sample of 20 pieces of the same model that is made by the same manufacturer.

Measured average results must not deviate from the values declared on the product for more than 10%. Ballasts and lamps are also tested, and the measured result also must not exceed the declared values.

Links:

- <http://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficient-products>
- <http://ec.europa.eu/growth/single-market/european-standards/harmonised-standards/ecodesign/>

2.5.6 Electric motors

Electric motors [9] are part of the EU ecodesigning. Electric motors consume almost 50% of all energy in Europe. They are used in machines, such as lifts, cranes and cooling systems. With motors with the higher efficiency, we can save up to 700€ in the motor lifetime of approximately 20 years. On the European level, this adds to 135 TWh of electrical energy by 2020. This equals to CO₂ emission reduction of over 60 million tons. Motors submerged in liquid, such as submersible sewer pumps are excluded.



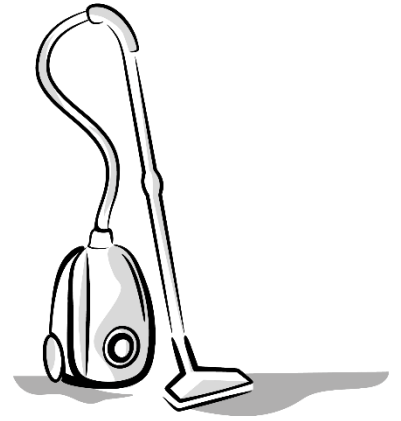
All manufacturers and motor traders have to consider ecodesigning to be able to trade in the EU. These requirements cover motor efficiency.

Links:

- [Manufacturers guide](#)
- [EU ecodesign regulations for motors 640/2009 amended by 4/2014](#)
- [Harmonised standards 2012/C 394/06](#)

2.5.7 Digital receivers

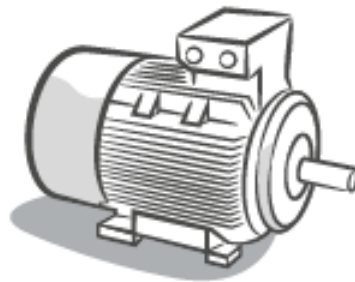
Digital receivers [10] for receiving and decoding digital television signal are part of EU ecodesigning. By the rules, digital receiver must not consume more than 5W during normal functioning and 0,5W during standby mode. This requirement saves up to 9 TWh of energy and reduced CO₂ emissions by 4 million tons. This equals to 1,4 billion € saving in the European households. On the market are different digital receivers, for receiving cable terrain signal, satellite signal or signal from the internet. Digital receivers are used when the television can not decode the signal. Older televisions had cathode ray tube that could decode only analog signal, but since these are coming to an end in Europe, consumers need to buy digital receivers to continue receiving the television channels on the analog television. Due to this, the receivers are part of ecodesign regulation. Digital televisions on the market now enable receiving of terrain and satellite signal to avoid using digital receivers. Ecodesigning is obligatory for all manufacturers and traders of digital receivers in EU. Ecodesigning for simple digital receivers is specified in Commission Regulation 107/2009.



When we receive television signal with conditional access to a specific provider who requires paid registration and has encoded signal the term complex digital receiver is used. These receivers are part of the voluntary agreement and as such save up to 6,5 TWh of energy, 884 million € and 2,6 million tons of CO₂ emissions.

Links:

- [Voluntary agreement for complex set-top boxes version 3.1](#)
- [Commission report on the Voluntary Agreement for complex set-top boxes: COM \(2012\) 684](#)



3.5.8 Vacuum cleaners



Part of the ecodesigning regulation are also vacuum cleaners [11]. Use of the most energy efficient vacuum cleaner saves up to 70€ through product lifetime. In the EU, up to 20 TWh of energy can be saved yearly by 2020. This saving equals to yearly consumption of all Belgian households. It also leads to 6 million tons less CO₂ emissions. Floor polishers, robotic vacuum cleaners, manual and battery vacuum cleaners are excluded from regulation.

Energy labels

New vacuum cleaners have to carry an energy label with a class ranging from A+++ to G. The classes include the total power of the vacuum cleaner and how efficiently this power is used for vacuuming.

All vacuum cleaners sold in EU have to meet ecodesigning regulations. These requirements cover energy efficiency, capabilities and sufficient information about the product.

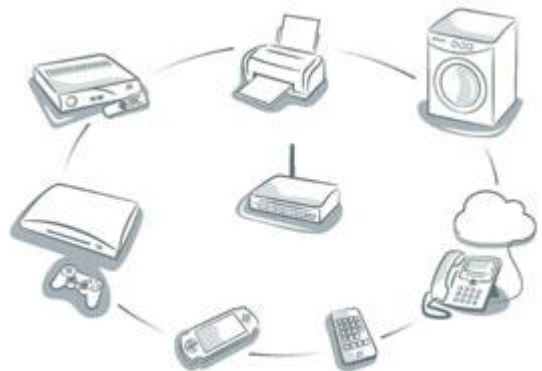
Links:

- [Manufacturers guide](#)
- [EU ecodesign regulation for vacuum cleaners](#)

2.5.9 Standby mode and off-mode

Codesigning is mandatory for all manufacturers and suppliers who want to sell appliances in EU that use electrical energy in standby mode and off-mode. Standby mode can be found in a wide array of devices, such as computers, televisions, audio devices, dishwashers, microwave ovens and electrical toys. From 2009 it is mandatory for these devices to switch into standby mode after a reasonable amount of time. From 2013 these devices must not consume more than 0,5W of electrical power in standby mode. This regulation has to decrease electrical energy consumption by 33,5 TWh yearly, which equals to yearly consumption of Romania. This way approximately 25 billion € per year are saved and CO₂ emissions are decreased for 29 million tons.

More and more modern devices are connected to the internet in the standby mode and due to this consume a lot of energy, for example, omrežne



televizije, digital receivers, printers, gaming consoles, and modems. Special requirements for these devices were presented in 2013. Since January 2017, network devices must not consume more than 3 to 12W, depending on the product. In comparison to the products, sold until 2016 that spent 20 to 80W, this is a saving of additional 36-38 TWh.

Ecodesigning requirement for electrical devices in standby mode are presented in detail in the following documents

Links:

- [Harmonised standards 2012/C 394/05](#)
- [Guidelines accompanying the regulation 1275/2008](#)
- [Amendment to the guidelines 801/2013](#)

2.6 Specific directives: RoHS and WEEE

2.6.1 RoHS1 (Restriction of Hazardous Substances Directive)

Directive on Restriction of Hazardous Substances in electrical and electronic devices was accepted by the European Union in February 2003.

It came into use on 1. June 2006 and is now named RoHS 1. This directive restricts the use of six hazardous substances in manufacturing processes of different types of electronic and electrical equipment. RoHS Directive is closely connected to Directive WEEE (Waste Electrical and Electronic Equipment Directive 2002/96/EC), which defines recycling of electronic devices. This directive will be further presented in later chapters.

RoHS is often equated to the directive on non-use of lead, but RoHS also restricts use of other substances:

1. Lead (Pb)
2. Mercury (Hg)
3. Cadmium (Cd)
4. Hexavalent chromium (Cr6+)
5. Polybrominated diphenyl (PBB)
6. Polybrominated diphenyl ether (PBDE)
7. Di (2-ethylhexyl) phthalate (DEHP)
8. Benzyl butyl phthalate (BBP)



9. Dibutyl phthalate (DBP)
10. Diisobutyl phthalate (DIBP)

The highest allowed mass concentration in homogeneous materials are 0,1% or 1000ppm (particles per million) except for cadmium, which is limited to 0,01%.

For example: Radio contains housing, screws, an electronic circuit, speaker, etc. Screws and housing can be made of homogeneous materials while other components are usually composed of multiple materials. The electronic circuit can be composed of the printed circuit board, integrated circuits, resistors, capacitors, switches. The switch can be composed of contacts, springs, pins, which are made of different materials. Speakers are composed of magnets, copper wires, paper. Everything that can be defined as a homogenous material has to contain the minimal amounts of the above-mentioned materials. If the radio housing is made of plastic with PBB content of 0,23%, this means it is not produced according to the RoHS directive.

2.6.1 RoHS 2

RoHS 2 (2011/65/EU) directive has developed from the previous version and was accepted on July 21. 2011 and applied on January 2. 2013. It restricts the use of the same substances as the original directive while it also improves regulation conditions and the clarity of legislation.

Differences between RoHS1 and RoHS2:

- The gradual introduction of RoHS for all electrical and electronic devices, cables and spare parts by July 22. 2019.
- Clarifies important definitions from RoHS 1.
- RoHS 2 introduces a methodology for evaluating new hazardous substances with the intent to restrict them.
- Gives the EU members the opportunity to suggest new restrictions.
- Clearer and more transparent rules on approving or deleting exceptions.

2.6.1 WEEE (Waste Electrical & Electronic Equipment)

Directive 2002/96/ES prepared by the European Parliament and Council on the January 27. 2003 on waste electrical and electronic equipment was approved with the intention to preserve, protect and improve the environment, protect the health and rational use of natural resources. The mentioned policy is based on the precautionary principle, the principle of preventive action and on the principle that environmental



damages are precedently restored at the source as well as on the principle that the responsible for the pollution covers the costs [12].

Devices such as computers, television sets, refrigerators and mobile phones are the fastest growing waste in EU. In 2005 there was 9 million tons of this waste with the prediction to reach 12 million tons by 2020. Directive WEEE includes a complex mix of materials and components with hazardous substances which are dangerous for the environment if not handled carefully. The production of modern electronic devices requires the use of rare and precious resources, for example, gold. 10% of world stock of gold is used for producing electronic devices. Due to this, the circular economy is important for the more efficient use of rare substances.

For regulation this area, two directives were accepted, specifically WEEE and RoHS which were described in the previous chapter.

2.7 Key terms

Environmentally suitable design: systematic integration of environmental aspects into product design to improve environmental efficiency of products in their lifecycle.

Ecological profile: description of inputs and outputs (for example materials, emissions, and waste) of a product in its lifecycle that are important regarding its environmental effects. These inputs and outputs are declared in measurable physical quantities.

Energy efficiency: lower energy consumption for the same service. Few examples: energy efficient refrigerators and washing machines.

Energy saving: service reduction or its cancellation with the intention to save energy. Example: turning lights off.

Cogeneration: simultaneous production of electrical energy and heat when both are being used.

Remote heating: a heating network that enables the energy that is often lost during production or in industrial processes to be used and supplied to the place of use.

Remote cooling: centralized production and distribution of energy for cooling. Cold water that is pumped around the network for remote cooling is used for cooling air that circulates in ventilation systems. Water is then returned to the production plant where it is cooled again.

Alternative fuels: fuels or energy sources that are at least partially used as substitutes to fossil oil resources. Amongst them are electrical energy, hydrogen, biofuel, compressed natural gas, liquid gas or liquefied petroleum gas.



ENERGY STAR®: registered brand owned by the United States Environmental Protection Agency (EPA).

Renewable resources: energy sources that can not be depleted, for example, wind power, solar power or sustainable biomass. According to the projection from 2014 the three main renewable resources in EU are biomass (47%), water energy (17%) and wind power (11%).

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