# 22 Green ICT: An actual big challenge for the Information and Communication Technology

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The paper presents the new challenges established by the tremendous increase of ICT devices and applications used in all our activity. Starting from the benefits given to our work by the new developments of Information and Communication Technologies, it has been seen a huge increase of the raw materials used for producing those devices, of the materials used for making use of the devices, of the consumables used to print/store data produced by those devices, but mainly of the energy used to make those devices work.
The main question is whether the way we use those devices is correct or we need to change something in our behaviour towards technology?
At the same time, we need to check if the technological improvements are not able to decrease the level of damages produced to the nature.

## 22.1 Introduction

The term *Green ICT* is a quite recent one, being one of the first to praise the third millennium.
Green is a term applied to all areas where energy is saved and resources are preserved and / or reused. The *Green* level is appreciated by the LEED assessments, done by the US Green Building Council (USGBC) or by the "Energy Star" ratings, done by the Environmental Protection Agency (EPA).
The need for introducing the concept of *Green ICT* has emerged in the context of more careful global concerns of protecting the planet, triggered by the awareness of a large amount of dangers brought about by the uncensored development of human civilization [Mingay, 2007], such as:

- the danger of exhaustion of energy resources
- The danger of exhaustion of raw material resources
- The danger of exhaustion of food resources
- The danger of rising above the critical threshold of the percentage of carbon dioxide in the atmosphere
- The danger of destroying the ozone layer of the atmosphere
- The danger of global warming

During the pioneering period of industrialization, its benefits seemed to be too great compared to the inherent shortcomings that one might be concerned about the latter. Of course, it was unpleasant to smell ugly in the cities, as was the case with Arad, and in the case of Timisoara, and especially in Bucharest, when in their perimeters, for instance, the technology was shaking with the skin, as it happens through the 19th century and the first

part of the 20th century. But it was considered worthwhile to wear gloves, hats and beautiful and comfortable leather clothes, on the one hand, and jobs that secured the income of a large number of families, on the other.
It had to come to true ecological disasters, such as the one in Germany in the Rhine-Ruhr area in the 1960s, when major rivers such as the Rhine became biologically dead so that the world wakes up or to have at least a throb.
Major measures to reduce the dangers listed above have been taken, as known, in the last decades of the twentieth century and in these first decades of the 21st century. But these measures are totally uneven on a planetary scale. They work very well in developed countries such as Germany and France - where the results are "seeing the naked eye" - but they are still quasi-existent in emerging countries such as China, Russia, India and Brazil and far from what should be in countries such as Romania.
Another problem, however, appeared on the agenda of this early third millennium, a much subtler than that of the classic industries: the issue of ICT industry and products. If the pollution in the classical industry has always been easy to detect "with the nose and the eye", and its energy consumption - intuitive to the appearance and size of the halls, information technology, its elegance and its distributed character, does not even let it suspect what harmful effects it has. Awareness of their existence and especially of their size was realized only at the end of the 2nd millennium and the beginning of the 3rd millennium, when a real explosion of the spread of this technology occurred. This was also the time for the emergence of the term *Green ICT*, first representing a desideratum, then a current and, inevitably, a new standard in the field. Although the term is quite new, the interest it brings is huge. It is not irrelevant, for example, that on March 15, 2012, at 22:00, the Google search engine found in just 0.14 seconds more than 1,400,000 links to documents with the term *Green ICT*.

## 22.2 Technology influence on environment

Information technology affects the environment by:

- the consumption of raw materials in its production
- the consumption of raw materials in its exploitation
- energy consumption in its production
- energy consumption in its operation
- substances released into the soil, water and the atmosphere in the production process, but indirectly also in the exploitation
- wastes generated in the production process but also indirectly in the exploitation process

Well, Green ICT means information & communication technology made with minimum inputs of raw materials and energy, with minimal releases of harmful substances to the soil, water and the atmosphere and with minimal amounts of waste and which, in exploitation, involves such minimal inputs of raw materials and energy, minimal releases of harmful substances into the soil, water and the atmosphere, and minimal amounts of waste [6].

### 22.2.1 Consumption of raw materials in the production of information technology

The raw materials used in the production of information technology are: silicon, gallium, arsenic, gold, silver, beryllium, mercury, cadmium, lithium, aluminium, copper, indium, antimony, tellurium, zinc, lead, etc. Obviously, with the exception of silicon, they all have little and problematic availability.

### 22.2.2 Consumption of raw materials in the use of information technology

In its exploitation, computer technology requires consumables like toner for carbon-based printers, waxes and various dyes, and ... plain paper, behind which there are so many killers of the trees.

### 22.2.3 Energy consumption in the production of information technology

The production of plastics and metals used in the manufacture of information technology requires large amounts of electricity.

### 22.2.4 Energy use in the use of information technology

In its exploitation, computer technology totalizes huge energy consumption. Paradoxically, right? It seems hard to believe, considering the size and appearance of today's ICT equipment, which makes us tempted to think of them as real jewelry. The explanation of the apparent paradox lies in the size of the problem. Even if a piece of ICT equipment is relatively small in energy consumption, the number of such equipment has become very high in recent years, the consumption of all of them is no longer negligible. Let's make a small calculation. It is estimated that over 1 billion computers existed in the world in 2010 [5]. Let's assume that a computer consumes an average of 100 Watts and that, according to EuP Preparatory Study's, the time a computer is powered in a year is 2,200 hours. It will result that all the computers in the world consume per year:
1,000,000,000 computers x 100 W/comp x 2,200 hours/year = 220 TWh/year
The world's electricity now accounts for about 70% of fossil fuels: coal, crude oil, gas. Or, as we know, they are in limited quantities and their rate of exhaustion is galloping. In addition, the process of producing electricity from fossil fuels is polluting, with significant heat, carbon dioxide and other residues. Of course, the so high proportion of conventional electricity in total world electricity seems disconcerting, but this is the reality of the present, despite all the efforts and progress made in recent years. Let's make a calculation. Knowing that 1 TWh of electricity involves a release of 0.415 million tons of CO2, it turns out that the 1 billion computers in use at the planetary level are responsible for loading the earth's atmosphere with:
220 TWh/year x 0.415 million tonnes CO2/TWh = 91.3 million tonnes CO2/year
In fact, both energy consumption and carbon dioxide production are much larger if other equipment than computers (printers, scanners, etc.) are taken into account and if it we also

take into account the manufacturing and transportation processes. Some authors' estimations [5] are that the ICT industry affects the environment more than aviation! To see if this is credible, let's make a transport calculation. It is shown that a computer, considering its keyboard display and at least 50% of the printer that accompanies it, weighs on average about 15 kg. That means that 1 billion computers weigh about 15 tons of finished material, which had to be produced - how much, at the entrance to the process? - and transported and which, at some point, will become ... domestic or industrial waste! How many trucks are needed to carry 15 tonnes of ICT equipment? No more, no less than 375 thousand trucks! This is the real dimension of the problem!
Considering all of the above, McCinsey & Company [7] shows that global carbon dioxide emissions from the ICT sector in the period 2002-2020 follows the graph in Figure 1:

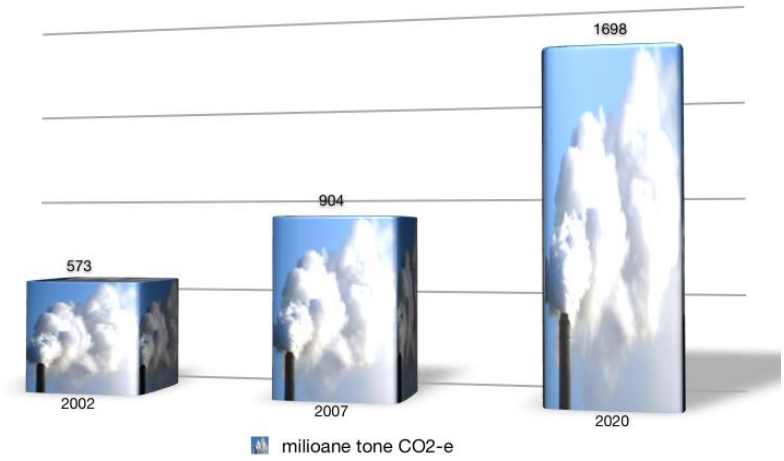



***Figure 1:*** *Global carbon dioxide emissions from the ICT sector*

### 22.2.5 Hazardous substances released into soil, water and the atmosphere in the process of production and operation of information technology

In the process of producing information technology, a lot of dangerous chemicals are used, which ultimately end up as residues in soil, water or atmosphere. In addition, in the end, each computer encompasses substances such as lead and mercury, extremely harmful to the human body and to life in general. Mercury affects nervous system, circulatory system, immune system, reproductive system, kidneys, etc. Lead negatively affects the brain, memory capacity, reactions.

### 22.2.6 Waste generated in the production and operation of information technology

Greenpeace estimates that 20-50 million tonnes of electrical and electronic waste are produced worldwide each year, of which about 2 million tonnes in the US, with only 12.5% of recyclable. In Europe, e-waste is the fastest rising. In developing countries, the rate of increase in the amount of e-waste is estimated at 300% over the next 5 years. Obviously, most of the waste resulting from the exploitation is not the cause of the products leaving their products or their inability to deal with applications, but the desire of users to always have new, fashionable products. In digital terms, the 1 billion existing computers in the world will

become warrants in the next few years about 15 million tonnes of waste, of which about 200,000 tons will be harmful substances, at least 3 million tons even dangerous.

## 22.3 Solutions

The negative aspects mentioned above should not be considered as a brake for the development of the ICT domain. On the contrary. We must be aware that, whenever there are problems, there are solutions and that, in order for solutions to be found, problems must be identified as clearly as possible. Once a problem has been identified, go through the chain of steps:
Exposing the Problem - Identifying / Creating Public Opinion - Solving Action

### 22.3.1 Standards

Resolving actions come from those who have both the necessary knowledge, the power and the will to change things. These may be manufacturers, traders, buyers, legislators or any combination of these. For example, legislators - with or without quotes - have set standards that can guide traders and buyers. The most common such standards are:

Energy Star – International standard

EPEAT – American standard

TCO – International standard

EU Ecolabel – European standard


The Nordic Ecolabel – Scandinavian standard


Der blaue engel – German standard

Buyers should only buy certified equipment in line with at least one of these standards. They are helped in this respect on the one hand by the fact that the labels of those standards appear on the equipment and on the other hand that governmental and non-governmental agencies provide them with all the information they need on their free access websites:

- Environmental Protection Agency
- Green Procurement Tool Kit
- GSA Carbon Footprint Tool
- Responsible Purchasing Network
- Sustainable Procurement Campaign

And if legislators and buyers understand and play the role well, then other actors, traders and producers can not do otherwise as they dictate. As proof, all major companies not only became sensitive to the subject, but actually turned much of their IT production into green IT.

### 22.3.2 Initiatives of major IT companies

Let's see, for example, what *Hewlett Packard* has planned for 2005-2011:

- reducing energy consumption and greenhouse gas emissions for all its products by 40% at the end of 2011 compared to 2005;
- the use of 100 million pounds cumulatively over the period 2007-2011 for the recycling of plastic from its printing products;
- saving 1 TWh through new orientations in designing the volume of its desktops and notebooks;
- 35% reduction in average weight of printer packs, 35% use of recycled paper in the carton used for printer packaging, and 50% reduce the volume of plastic used in printer packaging by the end of 2011 compared to 2005.

Obviously, without affecting the computational performance...
Unfortunately, not all those plans have been realised completely!
*Sony* has launched the "Road to Zero" plan, which aims to reach a zero-ecological footprint by 2050, that is to say, when the whole trace left on the environment in one year through consumption and spills disappears all In one year, by regeneration, respectively resorption / neutralization. The plan has set precise "mid-term" targets for 2015, namely:

- reducing the energy consumption of its products by 30% compared to 2008;
- reducing the weight of its products by 10% compared to 2008;
- 50% reduction of generated waste compared to 2000;

- 30% reduction of water consumption compared to 2000;
- 14% reduction in CO2 emissions in manufacturing and transport compared to 2008;
- 16% reduction in packaging waste compared to 2008;
- 99% or more increase of the waste recycling rate compared to 2000;
- a reduction of 5% in the rate of use of virgin oil based on the year 2008.

A final example of a project fitting in the "Green ICT" formula we present is LG's project called *LG Network Monitor*. It is based on the computational power level reached by the current desktops. This allows for a number of situations of using computer technology, especially in the functional or educational area, to use a single computer and, for each user, only one monitor, keyboard, mouse and possibly printer. The high computer computing power, its adequate memory resources and the right software can make users feel that they are not working on the same computer, but create the impression that each computer has its own. Obviously, through such a solution, all 6 parameters that define the concept of "Green ICT" are reached. In addition, user costs are considerably diminishing.


***Figure 2.*** *LG Network Monitor project [2]*

## 22.3.3 Simple rules of use

Computing equipment suppliers provide customers and potential customers with information about themselves (ISO 14001 certified or not, with other certifications, etc.) and their products (devices meet or fail to meet the energy, environmental, recycling if they contain harmful substances, etc.). An argument for their acquisition is the consequence of both the exploitation and the end of the product's life, the environment.

Once the product has been purchased, users have to enforce and obey certain simple usage rules to reduce harmful effects.

## 22.3.4 Rules of use in the office

*Idle and Sleep mode*

Unless the devices have a recognized environmental certificate or have a sleep mode, when they are unused, they consume at least half of the co-current power of the normal work;

When the equipment is not in use, it must be put into sleep mode, so it is ready to return to the nominal mode.

*Monitors*

Flat panel monitors (LCD, Plasma, LED) consume less power or space when in standby mode. Some of them switch to standby mode after a certain period of inactivity.

*Printers*
Draft and Duplex modes (on both sides of the paper) optimize the use of supplies and paper;
Documents should be reviewed and evaluated on the monitor screen, printing only in required cases, reducing the number of unnecessary prints;
Reducing a large number of smaller printers at a central location, easily accessible by all users can improve print cost management, and reduce power and paper consumption;
A print management service can help reduce waste by printing only in exactly the right cases.

*The thin client approach*
Because PCs are generally used under their nominal capacity, thin client is an alternative to devices with low data traffic and computing power. This is a terminal (monitor, keyboard, mouse) connected to a server that runs the application directly on the server. Unlike network computers, thin client transfers on the network only refer to screen, keyboard, and mouse information, and not to a certain amount of data.

*Use as Out of Office mode*
When the user is out of the office for a while, appliances may be, and are recommended, turned off. External power sources consume current, even when the device itself is off. A warm charger is an indicator of current consumption.
When configuring devices, monitor screen savers must be removed, as they consume unnecessary energy. Monitors consume 60 to 80 watts in nominal work, and in idle mode only 10 watts. Laptops use 10 to 30 watts in nominal use, and 6 watts in idle mode. In hibernation mode, computers use zero watt, while sleep mode uses about 0.2 watts.
There is a debate about how to set up a computer that is not being used, which is more effective:

- Fully shutting down the computer is inefficient, as the boot time takes a few minutes;
- In the case of non-use for two or three days, the computer should be set to hibernation mode;
- For the night, the computer should be set to *sleep* mode.

### 22.3.5 Rules for use in the computing office

Computers, storage devices and air conditioners are usually inefficiently operated;
Many servers run at less than 30% of their capacity and yet on average they are more effective than desktop computers. If the workload for each computer could double, the number of devices in use could be halved, and this would reduce the impact on the environment;
A common way of doing this is through the use of virtualization software that allows users' applications to run whenever there is space available to them on the server. Previously, a server could have run a single application. Now everyone can run a set of apps and that makes it more efficient;
Reducing the number of equipment delivers space and redundant redundant equipment that can be reused or recycled;
Air conditioning equipment can work more efficiently if temperature is optimized temporally and spatially. Computing equipment can also work at higher temperatures (as per technical specifications), thus reducing energy consumption for cooling and filtering;
Residual heat can be reused to heat adjacent areas, reducing the energy required for this task;

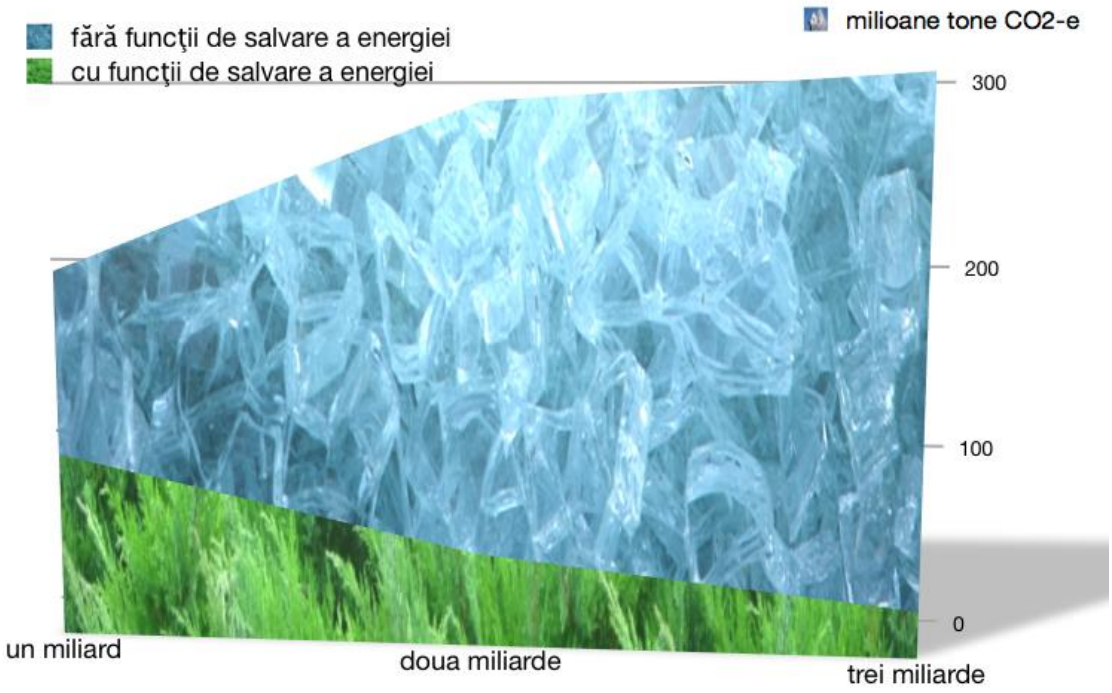
By means of outside temperature, in cold seasons, outside air is a source for the chiller. This is called "free cooling".

### 22.3.6 Rules after the expiry date of the product

Computing equipment can be recovered after the expiration of the exploitation period, and parts of it can be reused by entering the production circuit, thus saving raw material. It is important that, economically speaking, the recovery effort does not outweigh the benefits.
The priorities for all phases of production are, in order of importance, the reduction, reuse and recycling of materials, namely the use of technologies for lower consumption of raw materials, the introduction into production of recovered materials from end-of-life products and the existence of well- Effective for the recovery-reuse cycle.
If the life of IT products can be extended, the purchase of a new product is eliminated, thereby reducing the environmental impact, saving raw material and energy, manufacturing, packaging, transport and distribution effort.

## 22.4 Conclusions

Ensuring measures such as those presented and others to reduce the consumption of raw materials and energy, releases of harmful substances to the soil, water and the atmosphere and the quantities of waste in the process of manufacturing and transportation of information technology, respectively its exploitation, can make the number of computers grow further, at the level of necessity, but at the same time the ecological footprint of computer technology is diminishing.
A relevant example [5] in this regard is provided by the graph showing the evolution of the amount of CO2 released into the atmosphere by various computer numbers, respectively with no energy saving functions:



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