Green Computing : An Ecofriendly Approach to Manage E-waste

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ABSTRACT

The advances in technology resulted not only in faster analysis and speedier calculations but also resulted in an increase in the carbon footprints. Conservation of the non-renewable resources and protection of our environment have become issues of great concern. It has also given utmost attention to minimization of E-waste and to the use of non-toxic materials in preparation of e-equipments. Green computing, the study of efficient and eco-friendly computing resources, is the environmentally responsible use of computers and related resources. It includes the implementation of energy-efficient processors, reduced resource consumption and proper disposal of electronic waste (e-waste). In recent years, companies in the computer industry have come to realize that going green is the way to be and many steps are being taken in this regard. This paper discusses the different approaches at all levels to be green which would help to deal with E-waste effectively.

Keywords: Green Computing, E-Waste, Green Design, Green Disposal, Green Manufacturing, Green Use.

I. INTRODUCTION

The term 'green' has always been associated with the name of something that is inclined towards nature or something that benefits the environment. 'Going Green' means reducing the energy use and pollution footprints.

'Green Computing' is a term coined by technology community of the world which aims at achieving the highest possible environmental sustainability by campaigning and implementing the best possible operations of the computer and its related peripherals to minimize their adverse effects. It is also a step towards achieving a paperless office.

Green computing, green IT, or ICT sustainability, is the study and practice of environmentally sustainable computing or IT. According to San Murugesan this can include "designing, manufacturing, using, and disposing of computers, servers, and associated subsystems—such as monitors, printers, storage devices, and networking and communications systems — efficiently and effectively with minimal or no impact on the environment."[1]

In 1992, the US Environmental Protection Agency (EPA) launched Energy Star, a voluntary labeling program that is designed to promote and recognize energy-efficiency in monitors, climate control equipment, and other technologies.[2] This resulted in the widespread adoption of sleep mode among consumer electronics. The Energy Star program was revised in October 2006 to include stricter efficiency requirements for computer equipment, along with a tiered ranking system for approved products.

II. THE NEED FOR GREEN COMPUTING

Computer Design has progressed really well in all these years yielding very fast and high performance systems. But this has been achieved at the cost of a lot of energy. Also the concerns related to global warming due to increased CO_2 emissions have come up as high performance chips consume a lot of energy. For this, heavy air conditioning is required which also adds to increase in energy consumption. A lot of energy also goes in creating, packaging, storing and moving. Enhanced research and development efforts were undertaken to reduce power usage, heat transmission and in turn the cooling needs of the hardware devices.

Another area of concern is the manufacturing process which apart from using heavy amounts of power also uses 4 to 8 pounds of lead alone. Other metals like mercury and cadmium are also used. Lead is used in soldering of printed circuit boards. It affects the central nervous system, blood system and kidney. Mercury is used in batteries and switches. It spreads out in the water transforming into methylated mercury damaging the brain. Cadmium is used in resistors for chips in semiconductors. It is very toxic and damages the kidney.The computer and other electronics make up for up to two thirds of all lead in landfills.

Also the problem of growing E-waste has to be addressed.. Around 40–50 million tons of e-waste is generated annually, with the US and China being the two biggest producers of e-waste. E-waste will rise rapidly in the coming time with the increase in the use of ICT and with people constantly investing in newer, better and cheaper technology. The consequences of E-waste are:

- Air pollution from processing hazardous and toxic
materials can be dangerous to human health.
- Dumping materials that can't be recycled requires

more land . According to the US Environmental
Protection Agency (EPA), only 15–20% of e-waste is
recycled, with the remainder going to landfill or being incinerated.
- Recycling uses large amounts of energy, generating
GHG emissions.

To counter this growing pollution threat all over the world we are looking for eco friendly computers.

So the main reasons for going green are:
- Toxicity or the release of harmful gases from electronics.
- For minimizing the heavy use of power
- Increase of E-waste and improper PC disposal.
- Reducing the consumption of paper.

Goals of Green Computing

The goals of green computing are:
- reduce the use of hazardous materials
- maximize energy efficiency during the product's lifetime
- promote the recyclability or biodegradability of defunct products and factory waste.
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III. APPROACHES TO GREEN COMPUTING

To promote green computing concepts at all possible levels, the following approaches are employed:[3]

Green design: Designing energy-efficient computers, servers, printers, projectors and other digital devices.
Green manufacturing: Minimizing waste during the manufacturing of computers and other subsystems to reduce the environmental impact of these activities.
Green use: Minimizing the electricity consumption of computers and their peripheral devices and using

them in an eco-friendly manner.

Green disposal: Re-purposing an existing computer or appropriately disposing of, or recycling, unwanted electronic equipment.

A. Green Design

There are various ways to achieve this:

1) Product Longevity

Gartner maintains that the PC manufacturing process accounts for 70% of the natural resources used in the life cycle of a PC. More recently, Fujitsu released a Life Cycle Assessment (LCA) of a desktop that show that manufacturing and end of life accounts for the majority of this laptop ecological footprint.[4] Therefore, the biggest contribution to green computing usually is to prolong the equipment's lifetime. Manufacturing a new PC makes a far bigger ecological footprint than manufacturing a new RAM module to upgrade an existing one.

2) Data Center Design

Data center facilities are heavy consumers of energy, accounting for between 1.1% and 1.5% of the world's total energy use in 2010 .Energy efficient data center design should address all of the energy use aspects included in a data center: from the IT equipment to the HVAC equipment to the actual location, configuration and construction of the building.

3) Algorithmic Efficiency

The efficiency of algorithms has an impact on the amount of computer resources required for any given computing function and there are many efficiency trade-offs in writing programs. Algorithm changes, such as switching from a slow (e.g. linear) search algorithm to a fast (e.g. hashed or indexed) search algorithm can reduce resource usage for a given task from substantial too close to zero. A study by a physicist at Harvard, estimated that the average Google search released 7 grams of carbon dioxide (CO_2).[5] However, Google disputes this figure, arguing instead that a typical search produces only 0.2 grams of CO_2.

B. Green Manufacturing

Computer manufacturers are finding alternative and eco-friendly materials to make computers. These materials may be renewable, eco-friendly, or produced using less energy. Here is a list of the different materials that manufacturers are using to build computer parts.

1) Bamboo: It is becoming increasingly popular for making casings for computers and peripherals. It has the advantages of being a sustainable and quickly renewable resource and it is lightweight and stylish.

2) Recyclable Plastics: Many computers are constructed from non-recyclable plastics but there is an alternative way of using recyclable polycarbonate resin.

3) Eco-Friendly Flame Retardant: There are flame retardant silicone compounds available that are flame retardant and completely non-toxic.

4) Eliminating Lead Soldering: Lead if not used will make a big difference, it can protect individuals responsible for breaking down computer component during the recycling processes and prevent toxins leaching into the ground and water supplies at landfills and storage points.

Computers and other electronics often contain substances that are harmful to the environment and therefore can also have adverse effects on the health. A few of those substances are discussed below.

1) Bromine And Chlorine: Bromine and Chlorine are used in flame retardants and in the plastic resins of many of today's electronic products. During the burning of electronic

waste these compounds build up in the environment, over time they can pollute not only the air, but also the water and soil. The compounds of Bromine and Chlorine do not break down quickly; therefore, they can linger in the environment for a long period of time. Currently, Apple products make use of safer flame retardant substances such as ammonium polyphosphate and metal hydroxides.

2) Lead: Electronic devices are responsible for about 40% of lead found in landfills. Lead in landfills can translate to lead in water supplies. Lead can damage the human nervous system and can affect brain development. In computers, lead can be found in glass components of Cathode Ray Tube (CRT) monitors. It is also used in processors and chipsets. In 2001, VIA Technologies introduced a processor that replaced lead with a tin, silver, and copper composite. Intel took similar steps in 2007 with the introduction of their lead free processor, which utilizes the same composite used by VIA Technologies.

3) Mercury : Mercury is often contained in the cold cathode fluorescent lights (CCFL) used to backlight LCD screens. Dell is one company that seems to be making considerable efforts to remove or reduce the use of some hazardous materials in their products, including mercury. In 2008, Dell released their Latitude E4200 laptop, which replaced the LCD screens with light-emitting diode (LED) displays. Dell claims that not only are these displays mercury-free, but also consume less power, have a longer life, and are more recyclable than their LCD counterparts. Other companies, such as Apple and Hewlett Packard, have also taken similar strides to rid their products of mercury by transitioning to LED backlighting.

C. Green Use

As IT users, we can also contribute our own effort to protect the environment by operating the IT equipment wisely.

- Do not leave your computer running overnight and on weekends.
- A modest amount of turning on and off will not harm the computer or monitor. The life of a monitor is related to the amount of time it is in use, not the number of on and off cycles.
- Do not turn on the printer until you are ready to print. Printers consume energy even while they are idling.
- Do not print out copies of email unless necessary.
- If you spend a large amount of time at your computer, consider reducing the light level in your office. This may improve CRT (cathode ray tube) screen visibility as well as save energy.
- Most computer equipment now comes with power management features. If your computer has these features, make sure they are activated.
- The best screen saver is no screen saver at all - turn off your monitor when you are not using it. This option is second best only to turning off your computer all together.
- Use "paperless" methods of communication such as email and fax-modems.
- When typing documents, especially drafts, use a smaller font and decrease the spacing between lines, or reformat to keep your document to as few pages as possible, especially when typing drafts.
- Review your document on the screen instead of printing a draft. If you must print a draft, use the blank back side of used paper.
- Use a printer that can print double-sided documents. When making copies, use double-sided copying.
- Always buy and use recycled-content paper. Look for papers with 50-100% post-consumer

waste and non-chlorine bleached. Also, recycle your paper when done.

- Buy a monitor only as large as you really need. Although a large monitor might seem more attractive, you should remember that a 17-inch monitor uses 40 percent more energy than a 14-inch monitor. Also, the higher the resolution, the more energy it needs.
- Ink-jet printers, though a little slower than laser printers, use 80 to 90 percent less energy.
- Buy vegetable (or non-petroleum-based) inks. These printer inks are made from renewable resources; require fewer hazardous solvents; and in many cases produce brighter, cleaner colors.
- Instead of purchasing a new computer, try refurbishing an existing device
- Use flat-screen or LCD monitors, instead of conventional cathode ray tube (CRT) monitors
- Buy energy efficient notebook computers, instead of desktop computers

Green Disposal

Green disposal is based on three principles: Reuse, Refurbish and Recycle.

Reuse

Donate your computer and its peripherals to some charitable trust or those who may not be having them.

Refurbish

Rather than discarding your computer upgrade it by changing   some of its parts like replacing the RAM or Hard disk.

Recycle

Recycling can keep harmful materials such as lead, mercury and chromium out of landfills and can replace equipment that otherwise needs to be manufactured saving further energy and emissions. Never discard computers in a landfill. Recycle them instead through manufacturer programs such as HP's

Planet Partners recycling service or recycling facility. Or donate still-working computers to a non-profit agency.

IV. SOME GREEN INITIATIVES

1) The Green Electronics Council offers the Electronic Product Environmental Assessment Tool (EPEAT) to assist in the purchase of "greener" computing systems. The Council evaluates computing equipment on 51 criteria - 23 required and 28 optional - that measure a product's efficiency and sustainability attributes. Products are rated Gold, Silver, or Bronze, depending on how many optional criteria they meet.

2) RoHS: In February 2003, the European Union adopted the Restriction of Hazardous Substances Directive (RoHS). The legislation restricts the use of six hazardous materials in the manufacture of various types of electronic and electrical equipment. The directive is closely linked with the Waste Electrical and Electronic Equipment Directive (WEEE), which sets collection, recycling, and recovery targets for electrical goods and is part of a legislative initiative that aims to reduce the huge amounts of toxic e-waste.[6]

3) Energy efficient Computing: The Advanced Configuration and Power Interface (ACPI), an open industry standard, allows an operating system to directly control the power-saving aspects of its underlying hardware. This allows a system to automatically turn off components such as monitors and hard drives after set periods of inactivity. In addition, a system may hibernate, where most components (including the CPU and the system RAM) are turned off. ACPI is a successor to an earlier Intel-Microsoft standard called Advanced Power Management, which allows a computer's BIOS to control power management functions.

4) VIA Technologies, a Taiwanese company that manufactures motherboard chipsets, CPUs, and other computer hardware, introduced its initiative for "green computing" in 2001. With this green vision, the company has been focusing on power efficiency throughout the design and manufacturing process of its products.[7] Its environmentally friendly products are manufactured using a range of clean-computing strategies like carbon free computing, solar computing and quiet computing.

5) Blackle : Blackle is a search-engine site powered by Google Search. Blackle came into being based on the concept that when a computer screen is white, presenting an empty word or the Google home, and your computer consumes 74W. When the screen is black it consumes only 59W.Based on this theory if everyone switched from Google to Blackle, mother earth would save750MW each year. This was a really good implementation of Green Computing. The principle behind Blackle is based on the fact that the display of different colours consumes different amounts of energy on computer monitors.

6) Zonbu Computer: The Zonbu is a new, very energy efficient PC. The Zonbu consumes just one third of the power of a typical light bulb. The device runs the Linux operating system using a1.2 gigahertz processor and 512 meg of RAM. It also contains no moving parts, and does even contain a fan.

7) Sunray Thin Client: Sun Microsystems is reporting increased customer interest in its Sun Ray, a thin desktop client, as electricity prices climb said an engineer in the Eco Responsibility office at Sun. Thin clients like the Sun Ray consume far less electricity than conventional desktops, he said. A Sun Ray on a desktop consumes 4 to 8 watts of power, because most of the heavy computation is performed by a server. Sun says Sunrays are particularly well suited for cost-sensitive environments such as call centres, education, healthcare, service providers, and finance.

V. CONCLUSION

Whilst the performance and the breadth of application of computers is increasing, so too is our awareness of the cost and scarcity of the energy required to power them, as well as the materials needed to make them in the first place. However, because computing developments can enable individuals and businesses to adopt greener lifestyles and work styles, in terms of the environmental debate computing is definitely both part of the problem and part of the solution.

The computing industry is more prepared and far more competent than almost any other industry when it comes to facing and responding to rapid change. Environmentally it is not a good thing that most PCs -- especially in companies -- have typically entered a landfill after only a few years in service. However, this reality does at least mean that a widespread mindset already exists for both adapting to and paying money for new computer hardware on a regular basis. Hence, whereas it took decades to get more energy efficient cars on the roads, it will hopefully only take a matter of years to reach a state of affairs where most computers are using far less power than they needlessly waste today. Green computing represents a responsible way to address the issue of global warming. By adopting green computing practices, business leaders can contribute positively to environmental stewardship—and protect the environment while also reducing energy and paper costs.

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