

# Green Computing – An Ecofriendly Approach for Energy Efficiency and Minimizing E-Waste

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**Abstract:** The need for environmentally friendly computing gadgets and energy saving devices, under the auspices of ‘Green Computing’ has become a global phenomenon with the aim to reduce environmental decadence that emanates from abuse and the rising threat of global warming. . “Green computing” represents environmentally responsible way to reduce power and environmental e-waste. Green computing is the practice of using computing resources efficiently. The goals are to reduce the use of hazardous materials, maximize energy efficiency during the product's lifetime, and promote recyclability or biodegradability of defunct products and factory waste. It's known that as the economy expands, the demand for computing devices rises as business and individuals seek faster way of doing things – ‘The Computing way’. Information technological devices are upgraded rapidly due to the need for speed, flexibility, simplicity and cost effectiveness; thus outdating the previous technology. Hence we need to implement energy-efficient central processing units (CPUs), servers and peripherals with reduced resource consumption and proper disposal of electronic waste (e-waste).

**Keywords:** Green computing, ICT, Computing, e-waste, EPEAT

## I. INTRODUCTION

Green computing is the term used to denote efficient use of resources in computing. This term generally relates to the use of computing resources in conjunction with minimizing environmental impact, maximizing economic viability. Green computing is like reducing the use of environmentally hazardous materials like CFCs, promoting the use of recyclable materials, minimizing use of non-biodegradable components, and encouraging use of sustainable resources. EPEAT (Electronic Products Environmental Assessment Tool). EPEAT products serve to increase the efficiency and life of computing products. Moreover, these products are designed to minimize energy expenditures, minimize maintenance activities throughout the life of the product and allow the re-use or recycling of some materials. In 1992, the U.S. Environmental Protection Agency launched Energy Star, a voluntary labeling program that is designed to promote and recognize energy-efficiency in monitors, climate control equipment, and other technologies. Many IT manufacturers and vendors are continuously investing in designing energy efficient computing devices, reducing the use of dangerous materials and encouraging the recyclability of digital devices and paper.

Many governments worldwide have initiated energy-management programs. In 1998, the China National Development and Reform Commission (NDRC) founded the China Energy Conservation Program (CECP), a non-profit organization in charge of the administration, management and implementation of the certification for energy-conserving, water-saving and environmentally-friendly products. 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.

## II. NEED FOR GREEN COMPUTING



Green computing benefits the environment. Reduced energy usage from green techniques translates into lower carbon dioxide emissions, stemming from a reduction in the fossil fuel used in power plants and transportation. Conserving resources means less energy is required to produce, use, and dispose of products. In simple words, saving energy and resources saves money. The advantages of green technology are realized on both large and small scales. Green technologies are available for an entire organization or for a single employee's workstation. Unfortunately, many companies and business owners are stalled by the initially larger investment in green technology, and fail to realize the long-term benefits and cost savings. This technology is beneficial as it:-

- Reduce energy consumption of computing resources during peak operation
- Save energy during idle operation
- Use eco-friendly sources of energy
- Reduce harmful effects of computing resources
- Reduce computing wastes

## III. CHALLENGES IN ICT

Almost every element of the ICT lifecycle – from material acquisition to product disposal –affects the environment. it

includes impacts such as Energy consumption, greenhouse gas (GHG) emissions, electronic waste (e-waste) generation. Energy is used throughout the ICT product and service lifecycle, mostly as electricity but also in other forms such as gas and vehicle fuel. Many countries rely heavily on non-renewable energy sources, which are putting increasing pressure on a finite global resource. ICT's substantial energy consumption also produces GHG emissions, which are regarded as the primary cause of climate change. Industry estimates suggest ICT is responsible for 2–3% of annual global GHG emissions<sup>1</sup> – similar to the aviation industry's contribution. The figure below shows the likely increase of ICT-related GHG emissions from 2002 to 2020, and the relative split of emissions across the three major elements of ICT: data centers, voice and data networks, and end-user devices. There are some predictions that ICT-related emissions could rise further to 4–6% of global emissions by 2020, reflecting increasing demand for ICT, especially in growing economies such as China and India. As a result of this inevitable surge in ICT-related GHG emissions, the industry is focusing most of its sustainability efforts on reducing emissions by improving energy efficiency. Organizations are also increasingly conducting full ICT lifecycle emissions accounting. This allows them to make more informed decisions when they refresh their technology. For example, replacing existing desktop computers with more energy-efficient equipment may seem to be environmentally beneficial (over, say, three years), but if the company takes into account embedded emissions, the total GHG emissions might be greater than if the assets were 'sweated' for another year. Around 40–50 million tons of e-waste is generated annually, including 30 million computers thrown away in the US and 100 million mobile phones discarded in Europe. The US and China are the two biggest producers of e-waste, disposing of around 3 million tons and 2.5 million tons respectively each year.

E-waste will rise rapidly over the coming decades as the use of ICT increases, and consumers and businesses constantly invest in newer and better (and often cheaper) technology. The current slowdown in some parts of the global economy is unlikely to make more than a small dent in this trend.

The consequences of e-waste

- Air pollution from processing hazardous and toxic materials can be dangerous to human health. This is a significant problem in countries not subject to international legislation such as the European Union's Waste Electrical and Electronic Equipment Directive.
- Dumping materials that can't be recycled requires more land – an increasingly scarce resource in many areas of the world – which can't be recovered economically. 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.

- Some companies in countries with stringent e-waste regulations illegally ship e-waste to countries with few or no regulations. For example, the Environmental Investigation Agency found that much of the UK's e-waste is illegally shipped to Africa.

#### IV. GREEN COMPUTING PRACTICES

There is a lot of interest in environmental responsibility these days: debates on global warming, hybrid cars, recycling, buying environmentally friendly products, conserving energy, reducing waste, etc., etc. Additionally, there has been a growing area of discussion on the subject of "green computing." What exactly is green computing? Mostly, it's the practice of using computing resources efficiently. With today's powerful systems, not to mention the myriads of peripheral devices, the home office is an area of the house where energy is wasted and lost. There are ways to reduce your power consumption, here are ways you can go "green" at home:

1. Buy "Energy Star" labeled monitors, desktops, laptops, and printers. The "Energy Star" devices can be programmed to "power-down" to a low power state when they are not in use, helping you save energy and run cooler which helps them last even longer.
2. Put laptops in "sleep" mode when not in use. The EPA has estimated that this reduces their energy use by 60 to 70 percent – and ultimately could save enough electricity each year to power Vermont, New Hampshire, and Maine, cut electric bills by \$2 billion, and reduces carbon dioxide emissions by the equivalent of 5 million cars.
3. Even better, turn OFF computers and other equipment when not in use. Despite the debate over whether it's better for your computer to be left on or shut off, the fact is it's better for the environment to shut it off.
4. E-cycle used computer equipment. Reduce, reuse, and recycle

The simple 'reduce, reuse, and recycle' mantra has long served as best practice for organizations or individual consumers wanting to reduce their waste. It's an excellent principle, but of course there can be complexity in making it a reality. For example, a product might need to be repaired, refurbished or reconditioned before it can be reused. Once a product reaches the end of its life, you might consider various ways to reuse it, for example using it for the same purpose but in a different part of your organization; repurposing it within your organization; or remarketing it (refurbished if necessary) to another organization.



Fig 1 – E-waste Green Computing Robotics Machine & Recycling using formal techniques



Fig 2 –Symbolic Example how e-waste can be minimized

## V. SYSTEM WIDE AND INDIVIDUAL GREEN COMPUTING

When investigating green alternatives for the entire organization, consider technologies like cloud computing. Basically, cloud computing eliminates the need for hardware like servers. Also known as virtualization, cloud computing replaces hardware with "virtual" servers or servers in "the cloud." Essentially, cloud computing allows companies to reduce their need for big, bulky, energy-consuming servers by relocating them on the Internet. Cloud computing may also be used in areas like networking, data storage, software applications, and operating systems, again, potentially reducing the need for hardware. As a result, businesses stand to save a lot of time, money, and resources on maintenance and support by switching to cloud computing set-ups. There are many other techniques at the personal computer level. For instance, power management can be an easy and effective means of saving green while conserving energy. While many operating systems come with power-saving settings, there are also a variety of products that monitor and adjust energy levels to increase performance and reduce wasted energy. For instance, some surge protectors can sense when a master component (like a computer) is turned off, and respond by cutting off power to any peripheral machines, such as like printers and scanners.

## VI. ROLE OF IT VENDORS

IT vendors have invested in developing and marketing green technology. Vendors need to make a point of telling buyers they have the EPEAT products. Some vendors, such as IBM and Sun Microsystems, have developed programs to train and certify partners on green technology and services. Sun's Eco Advantage Program, for instance, trains channel partners selling the vendor's SPARC systems on datacenter power use and cooling, and the delivery of consolidation and virtualization services. Cisco, for instance, has plenty of information on its web site about going green.

Individually, some vendors are working on green training and certification programs for their partners. They also need to come together and work with a third party, such as the trade association Computing Technology Industry

Association (Comp TIA) to develop industry standards for products and processes. They should collaborate on a certification, or accreditation, for solution providers to prove to customers they conform to green



Fig 3 – Companies that go green

Standards. Vendors should implement corporate and employee policies that show they are serious about the environment. Policies should cover printing, powering down idle devices, lighting use and, where appropriate, public transportation subsidies and telecommuting. In addition, more vendors should take a cue from Google and consider investments in alternative sources of energy to show the world they are serious about going green.



Fig 4 -Mac mini: Energy-efficient desktop computer by Apple Inc

## VII. CONCLUSION

Green computing minimizes the energy consumption of the organization i.e. minimizes the power bill. Use of non-toxic material in the equipments makes the worker safe from health problem and occupational hazards. It saves the resource of the country as a whole. In the long term these green equipment will be less costly without any hidden cost of waste and enhanced resource consumption without any detrimental effect of accuracy, performance and longevity. It is therefore concluded that appropriate legislation / regulations, user education & awareness and recycling are the solutions to reduce power consumption and minimize environmental waste. Government can discourage the irresponsible disposal of computer hardware that generally lack biodegradability by putting in place proper ICT waste management body and also giving low tax incentives to industries that do not practice Green computing.

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