"GREEN COMPUTING: APPLICATIONS, IMPACT AND SUSTAINABILITY"

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ABSTRACT

The greening of information technology (IT) we mean that, it offers various ways for companies to significantly improve the performance, whether through efficiency use energy of computers and its peripherals via power management, managing e-waste or asset management, or greening data centers with virtualization or cloud computing. The goals of green computing are; reduce the use of hazardous materials, maximize energy efficiency, and promote the recyclability and waste. Green computing, also termed as green IT or ICT Sustainability. The area of "green technology" comprise of a broad range of subjects — from new energy-generation techniques to the study of advanced materials to be used in our daily life. It has taken upon itself the goal to provide society's needs in ways that do not damage or deplete natural resources. Mainly this means creating fully recyclable products, reducing pollution, proposing alternative technologies in various fields, and creating a center of economic activity around technologies that benefit the environment. Green computing refers to environmentally sustainable computing or IT. green computing can be defined as "it is field of study and learning of using, manufacturing, disposing and designing of computers, peripherals, 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. Many corporate IT departments have Green Computing initiatives to reduce the environmental impacts of their IT operations. Research continues into key areas such as making the use of computers as energy-efficient as possible, and designing algorithms and systems for efficiency-related computer technologies. This research paper through a light on the application areas of green computing & what are the impacts of green computing in environment, business & society. We also discuss some tools for improving the performance of these methods.

Keywords: *Green technology, recyclability, deplete resources*

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WHAT IS GREEN COMPUTING?

Green computing is the environmentally responsible use of computers and related resources. Such practices include the implementation of energy-efficient central processing units (CPUs), servers and peripherals as well as reduced resource consumption and proper disposal of electronic waste (e-waste). 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 and ensuring social duties. Green computing is very much related to other similar movements 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.

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Green computing, the study and practice of efficient and eco-friendly computing resources, is now under the attention of not only environmental organizations, but also businesses from other industries. In recent years, companies in the computer industry have come to realize that going green is in their best interest, both in terms of public relations and reduced costs.

Perhaps the most important aspect of green technology is the promise of alternative energy sources. However, scientists are working on other aspects of the problem as well, testing building materials and studying chemical processes to reduce the use and generation of hazardous substances. Nanotechnology is also being used in an attempt to manipulate materials at the nanometer scale; scientists are hoping it can transform manufacturing on a global level, from government purchasing to a technological revolution.
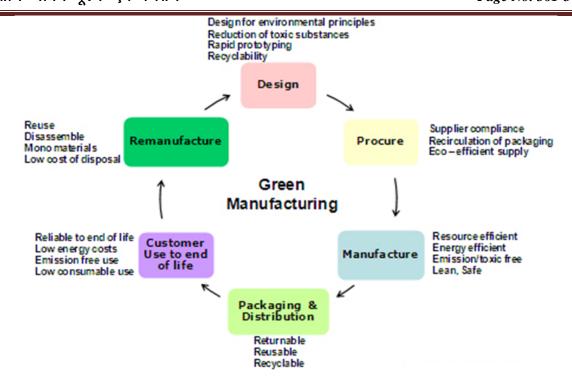
The huge amount of computing manufactured worldwide has a direct impact on environment issues, and scientists are conducting numerous studies in order to reduce the negative impact of computing technology on our natural resources. Companies are addressing e-waste by offering take-back recycling programs and other solutions, with lower energy consumption and less wasted hardware. A central point of research is testing and applying alternative nonhazardous materials in the products' manufacturing process.

One of the spin-offs of green computing is EPEAT or Electronic Products Environmental Assessment Tool. EPEAT products serve to increase the efficiency and life of computing products.

Green computing is an umbrella term, referring to an eco-conscious way of developing, using and recycling technology, as well as utilizing resources in a more planet-friendly manner. Here are some key elements of green computing:

- Using energy-efficient hardware like notebook computers, displays, servers, printers and desktop computers.
- Better use of resources, such as reduced paper consumption and lower energy utilization.
- Greater awareness so that technology components don't end up in the waste stream.
- Stronger environmental controls for technology production, leading to fewer toxic chemicals in the finished products.

In general, green computing works at all levels - development, manufacturing, usage and disposal to minimize technology's impact on the global environment. Following figure (a) shows the green manufacturing process

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A BRIEF HISTORY OF GREEN COMPUTING

One of the first manifestations of the green computing movement was the launch of the ENERGY STAR program back in 1992. Energy Star served as a kind of voluntary label awarded to computing products that succeeded in minimizing use of energy while maximizing efficiency. Energy Star applied to products like computer monitors, television sets and temperature control devices like refrigerators, air conditioners, and similar items.

One of the first results of green computing was the Sleep mode function of computer monitors which places a consumer's electronic equipment on standby mode when a pre-set period of time passes when user activity is not detected. As the concept developed, green computing began to encompass thin client solutions, energy cost accounting, virtualization practices, eWaste, etc.

Many governmental agencies have continued to implement standards and regulations that encourage green computing. 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.

There are currently 26 US states that have established state-wide recycling programs for obsolete computers and consumer electronics equipment. In 2010, the American Recovery and Reinvestment Act (ARRA) was signed into legislation by President Obama. The bill allocated over $90 billion to be invested in green initiatives (renewable energy, smart grids, energy efficiency, etc.) In January 2010, the U.S. Energy Department granted $47 million of the ARRA money towards projects that aim to improve the energy efficiency of data centers. The projects will provide research on the following three areas:

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optimize data center hardware and software, improve power supply chain, and data center cooling technologies.

CAUSE FOR GREEN COMPUTING

- **Uses lot of electricity:** Most of the natural resources are being used to get the electricity, that all have some impacts on the environment.

- **Creates lots of toxic waste :** Most of us are updating our computers, throwing our outdated computer resources, peripherals, and other hardware devices etc, these are the hazardous toxic waste we are producing that really damaging the environment now a days.

- **Impact of Electricity to the Environment :** The Electric power produces more pollution to the environment. They are Air pollution, Water Pollution and Land pollution. Fossil fuel power plants release air pollution and require lot of water. Nuclear power plants release lot of radioactive energy and hazardous waste. Even renewable energy sources affecting water and wild life and even hurting the food chain too. Air pollution impacts on Climate change, Acid rain, Ozone, Air toxics Water pollution impacts on Consumption of water resources, Polluting water bodies Land pollution impacts on Degrade and devalue the land, impacting ecosystem and aesthetics.

- **Impact of Toxic waste to the Environment :** The computer crowding our landfills contains lead, mercury, cadmium, beryllium and traces of many other hazardous materials. Incineration, this releases heavy metals like lead, mercury and cadmium into air and ashes. Even recycling the electronics can harm the workers and the environment surrounding them.

So, we can't stop using computers and we can't stop using electricity. Those are more important parts of our lives and economy. But we can do something to make the environment healthy. These are the some of the main causes for the Green Computing.

HOW TO CREATE A GREEN MACHINE
Activating the power management features on your computer saves energy and money while helping the environment. Your computer's SLEEP and HIBERNATE settings are two of the most effective ways for you to make your computer more environmentally friendly.

- **Sleep Mode:**

Sleep or standby mode conserves energy by cutting off power to your display, hard drive, and peripherals. After a pre-set period of inactivity, your computer switches to a low power state. When you move your mouse or press any computer key, you exit sleep mode and your computer takes you back to its previous operating state. Sleep mode is an especially effective way to conserve battery power in a laptop computer. However, if your computer loses power for any reason while in sleep mode, you may lose unsaved work.

- **Hibernate Mode:**

Hibernate mode saves energy and protects your work by copying system data to a reserved area on your hard drive and then completely turning off your computer. It also reduces wear and tear on your

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components. When you turn power back on, your files and your documents appear on your desktop just as you left them. Be sure to set your system to automatically go into hibernate mode any time your battery power reaches a critically low level.

POWER MANAGEMENT IN VARIOUS OPERATING SYSTEM

Windows Vista	Windows XP/2000	Windows 98	Mac OS X	Mac OS 9
• Select Start > Settings > Control Panel from the Start Menu. • The Control Panel has two views. If you are in the Theme View, select System Maintenance and then Power Options. • If you are in Classic View, simply double click on Power Options. • Once you are in Power Options, click Create a Power Plan link. • Enter a name for your new plan in the Plan Name field and click Next. • Set Turn Off the Display for 15 minutes of less. • Set Put Computer to Sleep for 30 minutes or less. • Click the Create button to create and activate your new Power Plan. • To make additional changes, click on Change Plan Settings underneath the name of the plan you just created. • Click on Change Advanced Power Settings. Here you will be able to enable or set values for a variety of Power Management options. • Set Turn Off Hard Disks After for 15 minutes or less. • Click OK. • Click Save Changes.	• Select Start > Settings > Control Panel from the Start Menu. • In Display Properties window, click the Screen Saver tab, then click the Power button in the Energy Saving Features of Monitor box. • Under Power schemes, select Home/Office Desk. • Set Turn Off Monitor for 15 minutes or less. • Set Turn Off Hard Disks for 15 minutes or less. • Set System Standby for 30 minutes or less. • Click OK.	• Select Start > Settings > Control Panel from the Start Menu. • Double-click the Display icon in the Control Panel window. • In the Display Properties window, click the Screen Saver tab, then click the Settings button in the Energy Saving Features of Monitor box. • Under Power Schemes, select Home/Office Desk. • Set Turn Off Monitors for 15 minutes or less. • Set Turn Off Hard Disks for 15 minutes or less. • Set System Standby for 30 minutes or less. • Click OK.	• Click on the apple symbol (Apple Menu) in the upper left corner of your screen. • Go to System Preferences, click Show All, & select Energy Saver from the Hardware row. • Click on the Show Details button. • Select Power Adapter under Settings For. • Using the slider, set Put the Computer to Sleep When It Is inactive for 30 minutes or less • Check the box for Use Separate Time to Put the Display to Sleep and set the time for 15 minutes or less, using the slider. • Check Put the Hard Disk to Sleep When Possible.	• Click on the apple symbol (Apple Menu) in the upper left corner of your screen. • Go to Control Panels and select Energy Saver. • Click on the Sleep Setup tab. • Using the slider, set Put the System to Sleep Whenever It's Inactive for 30 minutes or less. • Check the box for Separate Timing for Display Sleep and set the time for 15 minutes or less, using the slider. • Check the box for Separate Timing for Hard Disk Sleep and set the time for 15 minutes or less, using the slider

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STEPS TO GREEN COMPUTING

Here are five first steps you can take toward a green computing strategy.

1. **Develop a sustainable green computing plan.** Discuss with your business leaders the elements that should be factored into such a plan, including organizational policies and checklists. Such a plan should include recycling policies, recommendations for disposal of used equipment, government guidelines and recommendations for purchasing green computer equipment. Green computing best practices and policies should cover power usage, reduction of paper consumption, as well as recommendations for new equipment and recycling old machines. Organizational policies should include communication and implementation.

2. **Recycle.** Discard used or unwanted electronic equipment in a convenient and environmentally responsible manner. Computers have toxin metals and pollutants that can emit harmful emissions into the environment. Never discard computers in a landfill. Recycle them instead through manufacturer programs such as HP's Planet Partners recycling service or recycling facilities in your community. Or donate still-working computers to a non-profit agency.

3. **Make environmentally sound purchase decisions.** Purchase Electronic Product Environmental Assessment Tool registered products. EPEAT is a procurement tool promoted by the nonprofit Green Electronics Council to:
    • Help institutional purchasers evaluate, compare and select desktop computers, notebooks and monitors based on environmental attributes
    • Provide a clear, consistent set of performance criteria for the design of products
    • Recognize manufacturer efforts to reduce the environmental impact of products by reducing or eliminating environmentally sensitive materials, designing for longevity and reducing packaging materials.

   All EPEAT-registered products must meet minimum requirements in eight areas of environmental impact and be energy efficient to reduce emissions of climate-changing greenhouse gases. To demonstrate corporate social and environmental performance, manufacturers must offer safe end-of-life management and recycling options when products become unusable.

4. **Reduce Paper Consumption.** There are many easy, obvious ways to reduce paper consumption: e-mail, electronic archiving, use the "track changes" feature in electronic documents, rather than redline corrections on paper. When you do print out documents, make sure to use both sides of the paper, recycle regularly, use smaller fonts and margins, and selectively print required pages.

5. **Conserve energy.** Turn off your computer when you know you won't use it for an extended period of time. Turn on power management features during shorter periods of inactivity. Power management allows monitors and computers to enter low-power states when sitting idle. By simply hitting the keyboard or moving the mouse, the computer or monitors awakens from its low

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power sleep mode in seconds. Power management tactics can save energy and help protect the environment.

SUSTAINING THE FUTURE

"The greatest challenges for businesses trying to be eco-responsible are really understanding what that really means, then making changes that are sustainable over time, while adding business value," explains Frey. *"Another challenge is balancing the needs of various stakeholders who each have different ideas of what changes should be made."*Some environmental non-governmental organizations would like certain flame retardants removed from electronic products, while the fire safety community is concerned about removing or changing flame retardants in electronics. One problem is that the substitute replacement must be assessed to ensure that environmental and health impacts are lower than the original material; however, since most replacements are fairly new, they have not been necessarily assessed with the same rigor applied to the original materials. 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.

FACTS ABOUT GREEN COMPUTING

Some facts you may not know about business computing:
*   Simply leaving a computer running consumes electricity and adds to computing costs.
*   The use of screen savers does not save energy.
*   It is estimated that a typical desktop PC with a 17-inch flat panel LCD monitor requires about
*   100 watts—65 watts for the computer and 35 watts for the monitor.
*   If left on 24x7 for one year, this same system will consume 874 kilowatt hours of electricity
*   enough to release 750 pounds of carbon dioxide into the atmosphere and the equivalent of
*   driving 820 miles in an average car.
*   According to the Columbia University *Guide to Green Computing*, if the paper used each year
*   for personal computing were laid end to end, it would circle the Earth more than 800 times

BENEFITS OF GREEN COMPUTING

For a small-business owner, it can feel satisfying to be employing more earth-friendly tactics, and there are even more advantages. Being more environmentally responsible can lead to that other green: cash in your pocket. Green computing can help your wallet, since it creates a system of energy efficiency and lower utility costs.

For example, you can use notebook computers that are proven to be energy-efficient when compared to desktop computers. By putting an automatic power-down system in place for reducing energy consumption during periods of inactivity, you can save even more in energy costs. Then, if you also power-down peripherals like laser printers (which are notorious energy users), your energy usage drops even more.

With every green computing strategy, cost savings follow. And using fewer resources like this will extend the life of your systems, giving you better ROI and lowering your carbon footprint.

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GREEN COMPUTING PRACTICES

Some common green computing practices include turning off the monitor when it's not in use or using more energy efficient monitors like LCDs instead of the traditional CRT monitors, volunteer computing or file sharing practices, virtualization of servers, using more energy efficient and less noisy cooling systems (like using liquid cooling systems instead of the conventional heat sinks and fans), temperature maintenance and regulation to reduce thermal shock wear and tear to computer parts, and increased online security measures through the use of firewalls, anti spyware and antivirus programs to reduce the increasing amount of eWaste on the Internet and on other networks.

CONCLUSION

Many people's says that Green Computing methods does not saves money as the set up cost for eco-friendly electronics is more than what we save but we personally feel that even if the set up cost is higher than what we save we still can aim towards saving our earth using these green computing methods. As what can be better than building a safe and eco-friendly healthy environment to live on.

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