

# Green Computing: An essential trend for secure future.

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**Abstract—** In the yester years ICT has become the important aspect for success of any organization or in other words it has become the backbone of any organization. Along with this the focus has also moved onto green computing and has encouraged researches into different energy saving techniques ranging from home based computer systems to the client server systems. As stated above ICT has become an indispensable part of our daily lives and this ultimately becomes a source for excessive power consumption, excessive spending on resources and uses of many toxic materials. All of these are malpractices which directly or indirectly lead to hazardous impact on the environment. This study throws light on the issues like green computing, the current trends in green computing, and the challenges in field of green computing, and the guidelines which highlights our responsibilities as computer users, the future trends of green computing. These issues will help us in optimum use of ICT along with minimal negative consequences which may occur during its use.

**Index Terms—**ICT, Green Computing, toxic, e-waste, power consumption.

## INTRODUCTION

The term Green Computing refers to eco-friendly computing or it is also termed as green IT. Green computing is sustainable to environment as its major goals are to reduce the use of hazardous materials, maximizing energy efficiency during the product's lifetime, and promote the recyclability or biodegradability of factory waste. Green computing also concentrates on reducing the resource consumption and responsible disposing of electronic waste (e-waste). In today's era the number of computers is increasing day by day as they have gained same importance in organizations as well as at homes. This in turn has increased the amount of energy consumption which becomes the source for increasing carbon content in the atmosphere. Green computing is the study which emphasizes on the operation of computers and its peripherals in order to minimize the carbon footprint. Green computing had given the perspective to think in the direction that technology is not only meant for accomplishment of our tasks but also making sure that the technology is not harming the environment around

us. Implementing green computing strategies can help to build a safe place for living and will also ensure a safe and secure future.

## NECESSITY OF GREEN COMPUTING

We know that we need computers more than anything, today in our hectic schedules we are completely aware of the thing that we can't survive without computers just because they help to us accomplish our tasks in lesser time but why do we fail to analyze that the computer which we are using for hours and hours is releasing so much amount of heat and returning large amount of green house gases, some like CO<sub>2</sub> that is resulting in problems like global warming back to the environment, and what global warming is giving to us is visible to all of us in forms of floods, melting of glaciers, droughts, increase in temperature of earth surface etc and has contributed to almost 15% of the total deaths in last 5 years. It is observed that most of the computer energy is often wasteful. This is because we leave the computer ON even when it is not in use. The CPU and fan consume power; screen savers consume power even when the system is not in use.

Datacenters use a large amount of power and consequently cooling energy is needed to counteract the power usage. It can be an endless circle of energy waste hence the three main reasons that made realization of the need for implementing green computing are

1. Release of harmful gases from electronics.
2. More utilization of power and money.
3. Increase of E-waste and improper disposal.

Why is it always that what is seen is believed, in the same context what about the invisible effects of the technology used without the implementation of green computing.

To overcome all these issues it is the need of the hour that people should be made aware about the concept of green computing.

## CURRENT TRENDS IN GREEN COMPUTING

*Develop a green computing plan which is sustainable*

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.

#### ***E-Waste Recycling***

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. Recycling computing equipment such as lead and mercury enables to replace equipment that otherwise would have been manufactured. The reuse of such equipments allows saving energy and reducing impact on environment

#### ***Reduce Paper Consumption***

There are many simple yet effective ways to reduce paper consumption. While using e-mails the electronic archiving uses the track changes feature in the electronic documents rather than using the redline corrections on the paper. While printing any document be sure that both the sides of the paper are utilized. Use of smaller fonts and most importantly selectively printing of required pages.

#### ***Reduce Power Consumption***

Being energy conscious can help to save many natural resources, water, improve the quality of air, reduce the mercury emissions. Turn off the computers when there's no use for extended period of time. The power management features should be turned on while there is short duration of work to be done. With the help of power management techniques the monitors and computers enter the low power states when they are idle. Power consumption can also be controlled by following simple tactics like turning the monitor off if the system is going to be idle for a certain amount of time. Also use of LED and LCD monitors is encouraged over the CRTs as it helps to reduce a lot of power consumption. The hard disks should be turned off when the system is going to be idle, it can be reviewed back by first setting the off time depending upon the usage. Switching to the hibernate mode is another way to save power as this mode allows to shut everything down as before shutting down it writes the information in the hard drive whereas in the standby mode the memory is not shut down which consumes power even if the system is idle.

#### ***Data Center Consolidation & Optimization***

Currently much of the emphasis of Green Computing area is on Data Centers, as the Data Centers

are known for their energy hunger and wasteful energy consumptions.

With the purpose of reducing energy consumption in Data Centers it is worthwhile to concentrate on following [1]:

Information Systems – efficient and right set information systems for business needs are a key in building Green Data Centers. As per green computing best practices efficient servers, storage devices, networking equipments and power supply selection play a key role in design of information systems.

Cooling Systems – it is suggested by the researchers that at the initial stage of design process for data center cooling systems, it is significant to consider both current and future requirements and design the cooling system in such a way so it is expandable as needs for cooling dictates.

Standardized environment for equipment is must for Data Center Air Management and Cooling System. Consider initial and future loads, when designing & Selecting data center electrical system equipment.

#### ***Virtualization***

One of the major trends of green computing is virtualization of computer resources. Virtualization means abstraction of computer resources such as running two or more logical computer systems on single set of physical hardware. Virtualization helps to achieve saving of space, saving resources and the environment. Virtualization runs fewer systems at higher levels of utilization. Virtualization allows full utilization of computer resources and benefits in

1. Reduction of total amount of hardware
2. Power off Idle Virtual Server to save resources and energy
3. Reduction in total space, air and rent requirements which ultimately reduces the cost

#### ***IT Products and eco-labeling***

Another approach to promote Green Computing and save environment is to introduce policies all around the World, so that, companies design products to receive the eco-label [7]. There are several organizations in the world which support —eco-label IT products. These organizations provide certificates to IT products based on factors including design for recycling, recycling system, noise energy consumption etc. [8].

#### ***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.

#### CHALLENGES IN THE FIELD OF GREEN COMPUTING

According to the researches carried on in the past, focus was on computing efficiency and cost associated to IT equipments and infrastructure services were considered low cost and available. But today the scenario is reversed where the infrastructure is becoming the bottleneck in IT environments and the reason for this hike is due to the growing computing needs, energy costs and global warming. This issue is a challenging factor for the IT industry. Therefore the researchers are focusing on the cooling system, power consumption and data center space. There are two points at extreme ends one is processing power that is important to business and the other extreme is the challenge of environment friendly system and the infrastructure limitations [9]. Green computing challenges are not only for IT equipments users but also for the IT equipments vendors. Several major IT equipments vendors like Hewlett-Packard have recently unveiled what they call the 'greenest computer ever' i.e. HP rp5700 desktop PC. The HP rp5700 exceeds U.S. Energy Star 4.0 standards, and has an expected life of at least five years, and 90% of its materials are recyclable[10]. Dell is speeding up its programs to reduce hazardous substances in its computers, and its new Dell OptiPlex desktops are 50% more energy-efficient than similar systems manufactured in 2005, credit goes to more energy-efficient processors, new power management features, and other related factors[10].

IBM is working on technology to develop cheaper and more efficient solar cells plus many other solutions from IBM to support sustainable IT. According to researchers of Green Computing following are few prominent challenges that Green computing is facing today [9]:

1. Equipment power density / Power and cooling capacities; Increase in energy requirements for Data Centers and growing energy cost;
2. Control on increasing requirements of heat removing equipment, which increases because of increase in total power consumption by IT equipments;
3. Equipment Life cycle management – Cradle to Grave; and
4. Disposal of Electronic Wastes

#### FUTURE TRENDS IN GREEN COMPUTING

Technology is ever-changing and expanding and so any device which is new today will become obsolete tomorrow. Thanks to the advancements happening in the area of information technology, new computers enter the market and soon remain nothing more than a piece of junk. Which is becomes a challenge for IT environment and that is precisely why a new area of computing has emerged, which is popularly known as Green Computing. The technology encourages people to use computers as well as accessories that are environmentally-friendly and that cause little or no harm to the environment during their usage or when they are disposed off. . The future of Green Computing is going to be based on efficiency, rather than reduction in consumption [11].The primary focus of Green IT is in the organization's self interest in energy cost reduction, at Data Centers and at desktops, and the result of which is the corresponding reduction in carbon generation. The secondary focus of Green IT needs to focus beyond energy use in the Data Center and the focus should be on innovation and improving alignment with overall corporate social responsibility efforts. This secondary focus will demand the development of Green Computing strategies. The idea of sustainability addresses the subject of business value creation while ensuring that long- term environmental resources are not impacted.

There are few efforts, which all enterprises are supposed to take care of [12]:

#### *Certifications*

There are several organizations providing certificates to green technology. Vendors are based on their product quality, material, life of the product and recycling capabilities. In future such certifications together with recommendations and government regulations will put more pressure on vendors to use green technology and reduce the impact on the environment.

#### *Cloud Computing*

Cloud Computing has recently received significant attention [13], as a promising approach for delivering Information and Communication Technology services by improving the utilization of Data Center resources. In principle, cloud computing is energy-efficient technology for ICT [14] provided that it's potential for significant energy savings that have so far focused on only hardware aspects, can be fully explored with respect to system operation and networking aspects also. Cloud Computing results in better resource utilization, which is good for the sustainability movement for green technology.

#### *Power Management Tools*

Power management is proving to be one of the most valuable and clear-cut techniques in near future to decrease energy consumption. IT departments with focus on saving energy can decrease use with a

centralized power management tool. Compiling data from Energy Star case studies for 7 deployments of 11,000 - 499,000 machines, it was found that sleep scheduling was able to save between \$10.75 and \$95 per computer per year. These deployments used a combination Windows built-in sleep function, group policies, different software systems, such as PC Power-down, EZ GPO, Tivoli systems, BigFix etc. [11].

#### **Data Compression**

In enterprise, huge amount of data that is stored is somehow or other duplicated information. Information System backups are true example of such duplicated data. Intelligent compression techniques can be used to compress the data and eliminate duplicates help in cutting the data storage requirements.

#### **Recyclable paper laptop**

One of the most environmentally friendly computers that you can think of purchasing is the Recyclable Paper Laptop. This concept laptop is crafted from papers that have been recycled or pulp materials that are essentially packed in layers. Consumers, especially tech geeks keep looking for newer and latest models of computer and junk the old machines by dropping them into landfills. This further adds to the e-waste items. By purchasing the Recyclable paper laptop, you won't have to worry about repairing it as well as it is comparatively easier than the traditional laptops. Besides, the damaged parts of these laptops can be easily replaced with newer ones and then sent across for recycling.

#### **IMEC laptop**

This unique laptop can be easily powered using just two solar cells and encourages people to understand the importance of solar energy or alternative energy. This prototype laptop has been designed by industrial designer Jan Leyssens and runs completely on solar energy. It is popularly known as the —IMEC Meets Howest— computer and combines the mobility feature of the laptop with solar cells capable of generating renewable energy.

#### **Life book Leaf multipurpose laptop**

This innovative gadget has been designed using the new environmentally-friendly technology that will further help in revamping laptop productions in future. The idea of designing such a concept based laptop came to designers Carl Burdick and Laura Karnath who were competing for the —Fujitsu Design Award - A life with future computing—. Some of the other exciting features of the gadget include OLED touch screen that spreads out easily and can be conveniently folded as a laptop. Its exterior is carved out of polycarbonate, which is optically sensitive material and shatterproof as well.

#### **Solar Laptop Concept**

The solar laptop concept is the brainchild of designer Nikola Knezevic and is perfect for

safeguarding the environment as well as minimizing your electric bill. The top half portion of the laptop is attached to a solar panel that is capable of extracting the maximum amount of sun's rays when it is folded out. Even when the laptop is closed; the solar panel can still attract sun's rays so that the energy can be used for charging the battery of your laptop. This is an ideal solution for professionals and surveyors who work outdoors most of the time.

#### **Applications**

Green Computing is a diverse field and due to its nature and priority from all fields of life Green Computing has applications in every sector of computing as the goal is to save the environment and ultimately the life. The current main applications of Green Computing are covering following computing sectors [15]:

Equipment design; Equipment recycling;  
Data Center optimization and consolidation;  
Virtualization;  
Paper free environment;  
Application Architecture; and  
Power Management

#### **BENEFITS OF GREEN COMPUTING**

We might not realize the benefits of green computing when we look at ourselves using a PC for about an hour a day thinking that how can we contribute to the increasing pollution just by using a PC for a fraction of time in the whole day but the moment we will widen our view we will realize why we actually need to adopt green computing and how very few things if taken care of can change the present scenario completely. The following are the enlisted benefits of green computing.

1. Cost.
2. Efficiency & Improved Performance
3. Environmental Sustainability throughout the entire IT Lifecycle by addressing the key areas like green use, green disposal, green design, green manufacturing.

#### **GUIDELINES FOR BEING A RESPONSIBLE COMPUTER USER**

1. Turn off your computer at night so it runs only eight hours a day—you'll reduce your energy use by 810 kWh per year and net a 67 percent annual savings.
2. Purchase flat screen monitors—they use significantly less energy and are not as hard on your eyes as CRTs.
3. Unplug the electronics if not in use.
4. Consider a smaller monitor—a 14-inch display uses 40 percent less energy than a 17-inch one.
5. Power off your monitor when you are not using it instead of using screen savers.
6. Buy vegetable or non-petroleum-based inks—they are made from renewable resources require hazardous solvent.

7. Save Paper when Printing: When it comes to the environment, one of the first places most offices can improve is the giant pile of discarded paper by the network printer. Aside from obvious things you can do on your own—like printing duplex, printing to PDF, previewing before printing, and not printing hundreds of copies of an email forward to plaster around the office— there are a few other tools you can use to minimize wasting paper and ink when printing

8. Recycling - Electronics Waste Can be Recycled. Recycling can be defined as the process of used materials processing into new useful materials with the aim to reduce environmental pollution. The recycling process is more environmentally friendly than the process of making new stuff because it can reduce the use of new raw materials, land degradation, pollution, and energy usage and also can reduce greenhouse gases[16].

### CONCLUSION

Technology is not a passive observer, but it is an active contributor in achieving the goals of Green Computing. IT industry is putting efforts in all its sectors to achieve Green computing. Equipment recycling, reduction of paper usage, virtualization, cloud computing, power management, Green manufacturing are the key initiatives towards Green computing. Current challenges to achieve Green Computing are enormous and the impact is on computing performance. Efforts of Governments and Non-Government Organizations (NGOs) are also appreciate-able. Government regulations are pushing Vendors to act green; behave green; do green; go green; think green; use green and no doubt to reduce energy consumptions as well. All these efforts are still in limited areas and currently efforts are mainly to reduce energy consumption, e-Waste but the future of Green Computing will be depending on efficiency and Green products. Future work in Green Computing discipline will also rely on research work in academics since this is an emerging discipline and there is much more need to be done. There is need for more research in this discipline especially within academic sector.

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