# A Study of Green Computing Techniques

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*Abstract:* **Green is the burning topic these days. In this paper, we present a brief overview of Green Computing. Green computing refers to supporting business critical computing needs with least possible amount of power or sustainable computing. This is a new paradigm of designing the computer system which considers not only the processing performance but also the energy efficiency. In the past, the sole focus was on IT equipments, processing power and associated equipment which includes infrastructure, power, cooling and data center space which was always assumed as readily available and affordable. The driving force behind this change comes from the ever growing business computing needs, fast growing burden of energy cost, growing awareness of global warming issues, and increasing sense of national energy security. Here we also provide a review of how IT equipment power consumption across the industry is affecting the industry. It will focus on how equipment power consumption impacts the overall power usage and total cost of ownership and deploy to meet their business needs. It will also briefly cover the general technological trends in the IT industry which are available in the race to meet green computing requirements. So in this paper we depict the need of Green Computing to the society, roads to Green Computing, and the Strategies to implement Green Computing for creating a sustainable environment.**

*Keywords:* **Green Computing, E-waste, Energy Star, EPEAT, Save Mother Earth, Recycling.**

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## 1. INTRODUCTION

**B**ill Gates predicted many years ago of a PC in every home. He was widely considered to be simply promoting an unlikely scenario with the aim of boosting Microsoft's profits. However, how right he truly was. Not just at home but also virtually every commercial organization of any size is heavily reliant upon IT. At home there is little we can do regarding our use of IT, other than not leaving our PC's switched on unnecessarily, but for organizations there is massive scope for affecting energy use, recycling, the public image, and profits through adopting a green approach to IT. With increasing recognition that man-made greenhouse gas emissions are a major contributing factor to global warming, enterprises, governments, and society at large now have an important new agenda i.e. Tackling environmental issues and adopting environmentally sound practices. Greening our IT products, applications, services, and practices is an economic and environmental imperative, as well as our social responsibility. Therefore, a growing number of IT vendors and users are moving toward green IT and thereby assisting in building a green society and economy.  Environmental and energy conservation issues have taken center stage in the global business arena in recent years. The reality of rising energy costs and their impact on international affairs coupled with the increased concern over the global warming climate crisis and other environmental issues have shifted the social and economic consciousness of the business community. Fortunately, solutions to this problem exist today and Enterprise Management Associates (EMA) recommends businesses to implement a green computing solution not only to contribute to the global environmental movement, but also to decrease operating expenses and boost profitability.

## 2. WHAT IS GREEN COMPUTING?

"Greening" your computing equipment is a low-risk way for your business to not only help the environment but also reduce costs. It's also one of the largest growing trends in business today. Making a conscious decision to go green in the workplace, not only improves your bottom line, but also reduces your carbon footprint. It's a win-win no matter how you look at it. Green

Computing or Green IT refers to environmentally sustainable computing or IT. It is "the study and practice of 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. Green IT also strives to achieve economic viability and improved system performance and use, while abiding by our social and ethical responsibilities. Thus, green IT includes the dimensions of environmental sustainability, the economics of energy efficiency, and the total cost of ownership, which includes the cost of disposal and recycling. It is the study and practice of using computing resources efficiently. As we know that the IT industry has long been a significant contributor to global warming, but green computing is a strong and growing trend that seeks to reverse that impact. First steps include some relatively simple technical and behavioral changes that can help make a difference and pave the way for larger-scale efforts. The goals of green computing are similar to green chemistry; 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. Green computing researchers look at key issues and topics related to energy efficiency in computing and promoting environmentally friendly computer technologies and systems include energy efficient use of computers, design of algorithms and systems for environmentally-friendly computer technologies, and wide range of related topics. Green computing 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). Modern IT systems rely upon a complicated mix of people, networks and hardware; as such, a green computing initiative must be systemic in nature, and address increasingly sophisticated problems. Elements of such a solution may comprise items such as end user satisfaction, management restructuring, regulatory compliance, disposal of electronic waste, telecommuting, and virtualization of server resources, energy use, thin client solutions, and return on investment (ROI).

## 3.    WHY IS GREEN COMPUTING?

The first transistor was built in 1947. The first integrated circuit was invented in 1959. Now a days number of integrated circuits is increasing everywhere. Market is driven by military, computer, communications, and consumer needs. Equipment once used by the military are now available on a number of consumer products. Six billion microcontroller units were shipped in 2004, predicted to be increasing by 10% each year from 2004-2009 (Instate Inc. market research).Semiconductor annual revenue of 2004 is estimated at US is $211.4 billion. Do you know how much energy your computer uses? Probably not but if you do a little research to find out then you will realize how important green computing is.

## 4.    HISTORY OF GREEN COMPUTING

The U.S Environment Protection Agency launched energy star', a voluntary labeling program in year 1992, which is designed to promote and recognize energy-efficiency in monitors, climate control equipment, and other technologies. This resulted in the widespread adoption of sleep mode in computers and electronics popular among consumer electronics. The term "green computing" was probably introduced after the Energy Star program began; there are several USENET posts dating back to 1992 which use the term in this manner. Concurrently, the Swedish organization TCO Development launched the TCO certification program to promote low magnetic and electrical emissions from CRT-based COMPUTER DISPLAYS; this program was later expanded to include criteria on energy consumption, ergonomics, and the use of hazardous materials in construction. The Organisation for Economic Co-operation and Development (OECD) has published a survey of over 90 government and industry initiatives on "Green ICTs", i.e. information and communication technologies, the environment and climate change. The report concludes that initiatives concentrate on greening ICTs rather than tackling global warming and environmental degradation through the use of ICT applications. In general, only 20% of initiatives have measurable targets, with government programmes including them more frequently than business associations. 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. More than 26 US States that have established state-wide recycling programs for obsolete computers and consumer electronics equipment. Green Computing Impact Organisation (GCIO) is a non-profit organization dedicated to assisting the end-users of computing products in being environmentally responsible motivating community of environmentally concerned IT leaders who pool their time, resources, and buying power to educate, broaden the use, and

improve the efficiency of, green computing products and services. Members work to increase the ROI of green computing products through a more thorough understanding of real measurable and sustainable savings incurred by peers; enforcing a greater drive toward efficiency of vendor products by keeping a community accounting of savings generated; and through group negotiation power.  It is becoming widely understood that the way in which we are behaving as a society is environmentally unsustainable, causing irreparable damage to our planet. Rising energy prices, together with government-imposed levies on carbon production, are increasingly impacting on the cost of doing business, making many current business practices economically unsustainable. It is becoming progressively more important for all businesses to act (and to be seen to act) in an environmentally responsible manner, both to fulfill their legal and moral obligations, but also to enhance the brand and to improve corporate image. Companies are competing in an increasingly 'green' market, and must avoid the real and growing financial penalties that are increasingly being levied against carbon production.

IT has a large part to play in all this. With the increasing drive towards centralized mega data centers alongside the huge growth in power hungry blade technologies in some companies, and with a shift to an equally power-hungry distributed architecture in others, the IT function of business is driving an exponential increase in demand for energy, and, along with it, is having to bear the associated cost increases.

## 5. GREEN COMPUTING STRATEGIES

Computing uses large amounts of energy. The amount of energy used worldwide by servers (alone), amounts to 1% of the world's total electricity usage. From 2000 to 2005 – a five year period - the energy used by servers doubled. It is predicted that by 2010 the amount of energy used by these servers would have increased by up to 70%. This is only for servers, the figure for personal computers is likely to be higher as we had over 870,000,000 PCs in 2005 and the predicted number last year was over 1.1 billion. Such use of energy is unsustainable and contributes enormously to green house gas emissions. Think also of the amount of computing hardware we have all around the globe. This equipment is made of some of the most toxic and dangerous chemicals. The worst part is that most of the equipment has very short life spans – sometimes less than three years. The hardware is not being properly disposed of, ending in landfills, third world countries, etc. So ultimately the toxic chemicals which are in this hardware end up polluting the environment. Now, a lot of new arriving industries as well as the old and trusted ones have entered into the mission of green computing. Though a lot of ideas and issues have been put forward during this decade, efforts are being taken by Governmental as well as Non Governmental Organizations to make the dream of green computing come true. Electronic components and associated systems are manufactured in such a way that they create low or minimal impact on the environment. You might be familiar with the eco-labeling in several products. These efforts aim a realistic approach towards an economically sustainable and energy efficient computing in the near future. Non-governmental organizations, Governments, Multinational corporations are now joining the move towards GREEN IT or Green Computing. Which is a completely new environmentally friendly and cost-effective way of power usage. Businesses and individuals are being called upon to:

➢ Reduce the amount of energy used in their computing needs

➢ Start Using green(er) or more sustainable energy sources

➢ When replacing their IT infrastructure, to buy more Earth-friendly IT infrastructure - in terms of the energy they consume and the material from which they are made.

To comprehensively and effectively address the environmental impacts of computing/IT, we must adopt a holistic approach and make the entire IT lifecycle greener by addressing environmental sustainability along the following four complementary paths.

Green use — reducing the energy consumption of computers and other information systems as well as using them in an environmentally sound manner

Green disposal — refurbishing and reusing old computers and properly recycling unwanted computers and other electronic equipment

Green design — designing energy-efficient and environmentally sound components, computers, servers, cooling equipment, and data centers

Green manufacturing — manufacturing electronic components, computers, and other associated subsystems with minimal impact on the environment.

### 5.1 Using Virtualization to Reduce Numbers of Servers

The traditional model of dedicated servers to specific computing functions has been broadly adopted due to resilience based on isolation. Many software vendors such as Microsoft have recommended dedicated servers for the various utility tasks such as domain controllers, file servers, email and database servers. This has led to a proliferation of servers in the data-centers, spiraling requirements for power and air-conditioning. With this large expansion of server estate has become increased problems of standardization and patch management further driving up the total cost of ownership. Many of the servers in typical traditional production environments can operate way below optimal capacity in terms of memory, CPU and disk. Adopting a Green Computing Strategy does not mean a move away from the logical model, only the physical model. Where servers are typically underutilized, virtualization can be used to carve up a single physical machine into a number of virtual servers. From a green perspective the net result is normally a substantial reduced in power and air conditioning requirements saving energy, money and thus reducing the carbon footprint of the server estate.

### 5.2 Using Virtualization to Reduce Power and Disposal Requirements of Desktops

Virtualization of desktops can be an emotive subject. The mention of removing users PCs and replacing those dumb terminals easily start a mutiny! However this is simply fear of change and the reality can be very different. Virtualization of the desktop basically does mean replacing PCs with dumb terminals the reality is that users PCs are migrated to virtual PCs running on the server estate. Nothing need be lost from the PC, and better still for the user, the user's PC will follow them around wherever they go, whether they are in the office, working from home or even the other side of the globe. If they have remote access it is relatively simple to enable them to run their virtual PC from anywhere. Boot times can also be dramatically reduced and the users instantly gain the resilience levels of the company's server platforms lower maintenance and cost of ownership. The green benefits of changing the desktop lie primarily in reduced power consumption, but also that dumb terminals will not need to be upgraded as often as PCs so purchasing and equipment disposal requirements are reduced. By reducing maintenance requirements and also centralizing maintenance we are also able to reduce traveling engineers and support workers, cutting their carbon footprints in the process.

### 5.3 Replacing Paper Systems with On-line Communication Systems

Reducing paper purchasing and consumption helps to reduce consumption of forests, as well as reducing toner requirements and maintenance requirements on printing equipment. It is important to remember that by reducing any purchasing that the operating company's carbon footprint can be reduced as manufacture and supply of virtually any commercial goods typically carries high levels of carbon emissions.

### 5.4 Reducing Travel Requirements of Staff, Customers and Suppliers

For many organizations the level of travel required can be challenged for staff, customers and suppliers. In recent years we have seen a large upturn in commuting and traveling requirements for employees due to enhanced infrastructure and the general ease of mobility. This has clearly generated substantial increases in carbon emissions and can often provide an area for substantial savings. The implications for the CTO (Chief Technological Officer) may mean improving remote working technologies, setting up conference calling facilities, or video conferencing, or investment in web cams through to adoption of instant messaging software to allow better remote communications. These technologies are all relatively inexpensive and can easily be justified against the costs of traveling.

# 6. ALGORITHM 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. As computers have become more numerous and the cost of hardware has declined relative to the cost of energy, the energy efficiency and environmental impact of computing systems and programs has received increased attention. Algorithms can also be used to route data to data centers where electricity is less expensive.

## 6.1 Terminal Servers

Terminal servers have also been used in green computing methods. When using terminal servers, users connect to a central server; all of the computing is done at the server level but the end user experiences the operating system. These can be combined with thin clients, which use up to 1/8 the amount of energy of a normal workstation, resulting in a decrease of energy costs and consumption. There has been an increase in using terminal services with thin clients to create virtual labs.

## 6.2 Storage

Smaller form factor hard disk drives often consume less power per gigabyte than physically larger drives. Unlike hard disk drives, solid-state drives store data in flash memory or DRAM. With no moving parts, power consumption may be reduced somewhat for low capacity flash based devices. Even at modest sizes, DRAM-based SSDs may use more power than hard disks. Though most flash based drives are generally slower for writing than hard disks.

# 7. IMPACT OF GREEN COMPUTING

Most industry people feel that the new concept of green computing amongst diverse service sectors including large, medium and small sized industries will prove to be a successful tool in terms of driving better cost and energy efficiency in the long run. Companies these days are continuously seeking for new means of data management. As a result, most of them are found to take resort to the data centers that form to be standardized and modular form of meeting up the varied requirements of their diverse client base and allowing them to optimize much of their consumption of power. Exhibited as POD or Performance Optimized Data centers, it is through green computing that a business process outsourcing partner can offer more flexibility to the customers by means of offering a balance between their operating expenses and capital expenditures. While at the same time, they also try to meet the varied needs for further capacity seamlessly and quickly.

# 8. CONCLUSION

Adopting Green Computing Strategies make sense not only from an ethical, or moral stand-point, but from a commercial stand-point. There are many business benefits achievable through the implementation of a green computing strategy such as cost savings, resilience, disaster recovery, business continuity planning and of course public relations. Given the prolific nature of IT within today's information economy IT leaders have an excellent opportunity to significantly impact the fight against global warming, whilst enhancing the business operation and efficiency. So Green computing is the utmost requirement to protect environment and save energy along with operational expenses in today's increasingly competitive world. Adopting a holistic approach to greening IT is our responsibility towards creating a more sustainable environment.

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