International Journal Of Business Management
Available at www.ijbm.co.in
ISSN NO. 2349-3402
VOL. 2(2),2015

Power Efficient IT Technology- a concept towards green computing

Anita Goyal[1],
Jaswinder Kaur[2]

Abstract: In present scenario we need an efficient mechanism in an environmentally responsible manner which can reduce power and environmental waste. Faced with the stark realities of global warming and rising energy costs, government agencies and private firms are examining different ways to protect the environment. In this paper different techniques have been suggested for implementing a power efficient IT technology.

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

1. Assistant Professor, Rayat Bahra University, Mohali, India-140301
2. Assistant Professor, Rayat Bahra University, Mohali, India-140301

. Introduction

1. What is green Computing?

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. 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. This resulted in the widespread adoption of sleep mode among consumer electronics. Green Computing is also defined as the study of designing, manufacturing/engineering, using and disposing of computing devices in a way that reduces their environmental impact. 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. Green computing practices came into being in 1992,

International Journal Of Business Management
Available at www.ijbm.co.in
ISSN NO. 2349-3402
VOL. 2(2),2015

when the Environmental Protection Agency (EPA) launched the Energy Star program.

II. **Why Green Computing**

Today almost all streams weather its IT, medicine, transportation, agriculture uses machines which indirectly requires large amount of power and money for its effective functioning. We have great machines and equipments to accomplish our tasks, great gadgets with royal looks and features make our lives more impressive and smooth. Green computing whose goals are to reduce the use of hazardous materials, maximize energy efficiency during the product's lifetime, and promote the recyclability or biodegradability of defunct products and factory waste. Therefore we use Green Computing for following benefits-

1) Using ENERGY STAR qualified products help in energy conservation.

Shined et al., International Journal of Advanced Research in Computer Science and Software Engineering 3(7), July - 2013, pp. 1033-1037

2) The Climate Savers Computing Initiative (CSCI) catalog can be used for choosing green products.

3) Organic light-emitting diodes should be used instead of the regular monitors.

4) Surge protectors offer the benefit of green computing by cutting off the power supply to peripheral devices

When the computer is turned off. 5) Donating your old computers and other peripherals can reduce the rate of e-waste creation. 6) Moreover, those who cannot afford to buy a computer can benefit from such donations. Through proper disposal of computers and its accessories, it is possible to reduce environmental pollution. 6) It was expected that computers would help reduce paper wastage. However, even today wastage of paper is a serious issue in industries. The easy availability of photocopiers and printers is also one of the culprits behind unchecked paper wastage. Think twice before using printers. 7) Use the device only if it is necessary. 8) The manufacturing of disks and boxes needed for video games takes up a lot of resources. Video game manufacturers can offer their games online for download, leading to reduction in e-waste. This move can cut down on the transportation/shipping cost. 10) Use of 'Local Cooling' software can help in monitoring and thereby, bringing down the energy consumed by your computer. This 'Windows' program makes adjustments to the power options of your computer and helps minimize energy consumption.

International Journal Of Business Management
Available at www.ijbm.co.in
ISSN NO. 2349-3402
VOL. 2(2),2015

III. **Approaches to words the Green Computing**

Data centers, which have been criticized for their extraordinarily high energy demand, are a primary focus for proponents of green computing. Data centers can potentially improve their energy and space efficiency through techniques such as storage consolidation and virtualization. Many organizations are starting to eliminate underutilized servers, which results in lower energy usage. The U.S. federal government has set a minimum 10% reduction target for data center energy usage by 2011. With the aid of a self-styled ultra efficient evaporative cooling technology, Google Inc. has been able to reduce its energy consumption to 50% of that of the industry average

Computer virtualization refers to the abstraction of computer resources, such as the process of running two or more logical computer systems on one set of physical hardware. The concept originated with the IBM mainframe operating systems of the 1960s, but was commercialized for x86-compatible computers only in the 1990s. With virtualization, a system administrator could combine several physical systems into virtual machines on one single, powerful system, thereby unplugging the original hardware and reducing power and cooling consumption. Several commercial companies and open-source projects now offer software packages to enable a transition to virtual computing. Intel Corporation and AMD have also built proprietary virtualization enhancements to the x86 instruction set into each of their CPU product lines, in order to facilitate virtualized computing. Virtual machine can be more easily controlled and inspected from outside than a physical one, its configuration is also more flexible. This is very useful in kernel development and for teaching operating system courses. Virtual machine can be easily re-located from one physical machine to another as needed. For example, a sales person going to a customer can copy a virtual machine with the demonstration software to its laptop, without the need to transport the physical computer. At the same time and error inside a virtual machine does not harm a host system, so there is no risk of breaking down the OS in said laptop.

2. Material management

1) *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

International Journal Of Business Management
Available at www.ijbm.co.in
ISSN NO. 2349-3402
VOL. 2(2),2015

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**.** In 2001, they focused on lead-free manufacturing, introducing the Enhanced Ball Grid Array (EBGA) package for power efficient VIA processors and the Heat Sink Ball Grid Array (HSBGA) package for their chipsets

2) *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.

Some programs allow the user to manually adjust the voltages supplied to the CPU, which reduces both the amount of heat produced and electricity consumed. This process is called undervaluing. Some CPUs can automatically under volt the processor, depending on the workload; this technology is called “Speed Step” on Intel processors, “Power Now”/“‘Cool‘n‘Quit” on AMD chips, Long Haul on VIA CPUs, and Long Run with Transmits processors. As IT users, we can also contribute our own effort to protect the environment by operating the IT equipment wisely. We have collected the following information from various sources for our reference:

 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.

International Journal Of Business Management
Available at www.ijbm.co.in
ISSN NO. 2349-3402
VOL. 2(2),2015

 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.

 Request recycled / recyclable packaging from your computer vendor.

 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.

3) *Recycling:* Many materials used in the construction of computer hardware can be recovered in the recycling process for use in future production. Reuse of tin, silicon, iron, aluminum, and a variety of plastics – all present in bulk in computers – can reduce the costs of constructing new systems. Electronic devices, including audio-visual components (televisions, VCRs, stereo equipment), mobile phones and other hand-held devices, and computer components, contain valuable elements and substances suitable for reclamation, including lead, copper, and gold. They also contain a plethora of toxic substances, such as dioxins, PCBs, cadmium, chromium, radioactive, and mercury.

International Journal Of Business Management
Available at www.ijbm.co.in
ISSN NO. 2349-3402
VOL. 2(2),2015

Whole computers and pieces of electronic equipment are shredded into smaller pieces to be more manageable and facilitate the separation of the constituent components. Leaded glass from cathode ray tubes is sold to foundries for use as a fluxing agent in the processing of raw lead ore. Other valuable metals, such as copper, gold, palladium, silver and tin are sold to smelters for metal recycling. The hazardous smoke and gases generated by these processes ***Shined et al.,*** International Journal of Advanced Research in Computer Science and Software Engineering 3(7), July - 2013, pp. 1033-1037 © 2013, IJARCSSE All Rights Reserved Page | 1036

Voice over Internet Protocol (VoIP) is a general term for a family of transmission technologies for delivery of voice communications over the Internet or other packet-switched networks. The reduction in telephone wiring will obviously lead to decreasing costs because of Voice-Over-Internet protocol. Voice over IP (VoIP) reduces the telephony wiring infrastructure by sharing the existing Ethernet copper, thus reduce the use of metallic waste. VoIP and phone extension mobility also made Hot-disking and more practical.

3: Green Initiatives In Information Technology It started way back in 1992, when the U.S. Environmental Protection Agency (EPA) launched Energy Star, a controlled labeling program that is planned to promote and recognize energy-efficiency in monitors, climate control equipment, and other technologies. This resulted in the widespread adoption of sleep mode among consumer electronics. 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 usage, ergonomics, and the use of hazardous materials in construction. With time IT industry has taken many initiatives towards green ICT (Information and Communication Technologies). The remarkable green initiatives in IT are: **1) Improved Data Center Cooling Methods**: This is achieved by improving the data center cooling configuration, eliminating considerable amount of energy leaks. IT can result in efficient data centers by following leading practices in data centre layout and rack and server arrangements. Effective approach include raised floors to improve airflow, moving cooling systems closer to servers to concentrate cold air in the right place, alternating hot and cool server passageway to improve airflow and using water-based air conditioning systems [9]. **2) Efficient Servers usage by Virtualization:** Generally, IT companies have been using many server

International Journal Of Business Management
Available at www.ijbm.co.in
ISSN NO. 2349-3402
VOL. 2(2),2015

farms or data centers, dedicated to a specific task. These data servers must be efficiently used. One of the mechanisms is load balancing which chooses the optimum resource among many. Also by using virtual software to perform these tasks, a single server may be used to power these virtual servers, dramatically reducing energy consumption. **3) Alternative Storage Methods:** Storage drives are another main element of data center infrastructure and, as organizations storage needs increase; more energy is used to power these hard drives. It can be reduced by using large capacity drives and performing data center audits to eliminate redundancies in the system. **4) Using Thin Clients**: With thin clients, each employee has a virtual desktop that includes a mouse, keyboard and screen while the remaining unit is shared by all at a central location. **5) Strengthen Printer's Output Management:** Centrally located printer may be used to handle all printing tasks virtually eliminating numerous machines being left on all day sucking up energy and driving up costs. **6) Explore Alternative Sources of Energy:** The efficient resource utilization leads towards efficient methods to evolve [4]**.** With time renewable and natural energy sources are being used to power data centers, such as nuclear or hydroelectric power, solar energy etc. This saves money and generates fewer CO2 emissions. **7) Energy saver initiatives:** This includes using energy saving settings and encouraging employees to turn off equipment at the end of the work day and on weekends. **8) Proper Disposal and Recycling:** This is so important because it potentially eliminates the threat of harmful toxins being released into the environment and allows for the reuse of equipment reducing the amount of waste. These initiatives exhibit the requirement of going green. Along with above mentioned IT initiatives every sector and area of IT is practicing green strategy and policies because sustainable development of ICT is the future need. Still there are many open challenges in computing which are covered in following section. **IV: Open Research Challenges** Energy is one of the most valuable and scarce resources available to the world, a significant portion of which is now being consumed to power up computers and computing infrastructure. Basically, high-performance parallel and distributed computing system, including data centers, supercomputers, clusters, real-time systems, and grids not only consume considerable amounts of power but also require air-conditioning to keep the systems cool. The exponential growth in computing is rapidly increasing the consumption of precious natural resources such as oil and coal, strengthening the alarming danger of energy shortage. These issues have been raised by the researchers from time to time and the possible measures are being taken. Still there

International Journal Of Business Management
Available at www.ijbm.co.in
ISSN NO. 2349-3402
VOL. 2(2),2015

are many areas yet to be explored. Here we present some notable areas of research in green computing: **1: New Optimization Techniques in Performance-Energy-Temperature aware Computing:** The exponential growth in computing activity and the rising concern for energy conservation have made energy efficiency in computers a technological issue of prime importance. The tradeoff between Performance-Energy-Temperature has to be made for so that the maximum benefits can be obtained. Designing techniques that are optimal with respect to performance, energy, and temperature are utmost requirement as far as green computing research challenges are concerned. **2: Information Resource Tier Optimization:**
The information resource tier represents important data base management systems in the global computation world. General paradigms include databases, directories, file-systems, and flat files. It also includes the integration of different ***Aditya et al., International Journal of Advanced Research in Computer Science and Software Engineering 3(10), October - 2013, pp. 1075-1077 © 2013, IJARCSSE All Rights Reserved Page | 1077***
database structures so that different databases can be analyzed irrespective of their storing mechanisms and data structure. Big data research topic is open in this field [10, 11]. **3: Reduce architectural complexity:** The research area is open to reduce the number of tiers and component dependency to reduce maximum system use. Intel‘s core 2 duo is a mechanism which uses power to run only those components which are necessary at any computation [12]. **4: New high-efficiency data center design** Bigger data centers can be made much more energy efficient than smaller data centers. Standards are emerging for measuring this, such as the concept of Power Usage Effectiveness (PUE). PUE is defined as the ratio of total facility power divided by IT equipment power [13]. Thus, it is a measure of how much of the power being consumed by the facility is actually being used to power the IT equipment itself rather than all the other things. Therefore it will quiet be a challenge to make the bigger data centers power efficient **5: Developing Green Maturity Model:** Full equipment life cycle is the main area for green maturity model, with energy reduction as the best measure of ―greenness.‖ The need **of maturity models** for equipments, IT organizations, computing techniques is an issue which has been addressed by some researchers but is limited to specific

International Journal Of Business Management
Available at www.ijbm.co.in
ISSN NO. 2349-3402
VOL. 2(2),2015

areas. Green maturity model for virtualization [14] depicts that each level describes the degree of green characteristics. **7: Wireless Sensor Network for Data Center Cooling:** data center cooling is a major issue as far as power consumption is concerned. Data centers are backbone of any computing organization and must be reliable and available at every point of time. Measuring the data center effectiveness and maintaining the baseline is an issue. Wireless sensors could play a big role for managing data centers power management [15]. **8: Green Software's:** Recently, green software movement has become a research subject for most of the software developers companies because of need for sustainable development [16]. Most of the research has been done on the characterization, metrics and technical answer for green software, but few have addressed green software from the business perspective. Business organizations are moving towards green software's and still some considerable steps need to be taken.

Conclusion: Green computing will be the driving force of future computing. New computing innovations and applications need to fulfill the green computing requirements for the sustainable development of Information and communication technology (ICT). Every research challenge carries a future prospect for employing efficient computing in different areas. We will further analyze these challenges for better understanding and future research.

References:

[1] OECD, Working Party on the Information Economy, Towards Green ICT Strategies:Assessing Policies and Programmes on ICTs and the Environment. <http://www.oecd.org/dataoecd/47/12/42825130.pdf> (accessed November 2011).

[2] W. Van Heddeghem, W. Vereecken, M. Pickavet, P. Demeester, Energy in ICT – trendsand research directions, in: Proceedings of the IEEE Third International Symposium on Advanced Networks and Telecommunication Systems (ANTS), New Delhi, 14–16 December 2009.

[3] A. Bianzino, C. Chaudet, D. Rossi, J. Rougier, A survey of green networking research, IEEE Communications Surveys and Tutorials (2010) 1–18.

[4] http://en.wikipedia.org/wiki/Jevons_paradox

International Journal Of Business Management
Available at www.ijbm.co.in
ISSN NO. 2349-3402
VOL. 2(2),2015

[5] http://www.mooreslaw.org/

[6] San Murugesan, ―Harnessing Green IT: Principles and Practices,‖ IEEE IT Professional, January–February 2008, pp 24-33.

[7] Kolbasuk McGee, M. (2007), ―Data Centre Energy Consumption Has Doubled Since 2000,‖, InformationWeek, p. 1-5.

[8] Arnfield, R. (2009). ―Information security goes green‖. Infosecurity, p. 33-38.

[9] http://www.google.co.in/about/datacenters/efficiency/

[10] http://www.cra.org/ccc/files/docs/init/bigdatawhitepaper.pdf

[11] K. Michael and R. Clarke, ―Location and Tracking of Mobile Devices: Überveillance Stalks the Streets,‖ Computer Law & Security Rev., vol. 29, 2013, pp. 216-228.

[12] http://www.intel.com/products/processor/core2duo/specifications.htm

[13] http://www.datacenterknowledge.com/archives/2013/09/17/google-has-spent-21-billion-on-data-centers/

[14] Ma Liangli; Chen Yanshen; Sun Yufei; Wu Qingyi, "Virtualization Maturity Reference Model for Green Software," Control Engineering and Communication Technology (ICCECT), 2012 International Conference on , vol., no., pp.573,576, 7-9 Dec. 2012

[15] Rodriguez, M.G.; Ortiz Uriarte, L.E.; Yi Jia; Yoshii, K.; Ross, R.; Beckman, P.H., "Wireless sensor network for data-center environmental monitoring," Sensing Technology (ICST), 2011 Fifth International Conference on , vol., no., pp.533,537, Nov. 28 2011-Dec. 1 2011