GREEN COMPUTING:
FOR A SUSTAINABLE FUTURE

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ABSTRACT

Green computing also called Green IT describes the environmentally responsible and efficient use of computers and related resources. Green IT starts with manufacturers producing environmentally friendly products and encouraging IT departments to consider more friendly options like virtualization, power management and proper recycling and disposal habits. This paper also provides a review of how IT equipment power consumption across the industry is changing the IT industry priority. It focuses on how equipment power consumption impacts the overall power usage and total cost of ownership and how the power issues may impact what customers may or may not buy and deploy to meet their business needs. It briefly covers the general technological trends in the IT industry of what technologies are available in the pursuit to meet green computing requirements.

INTRODUCTION

Green computing 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 Computing lays out four paths: Green use, green disposal, Green design, and Green manufacturing. 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 the recyclability or biodegradability of defunct
products and factory waste. In the current trend,”going green” becomes an agenda for the IT industries in terms of public relations and reduced costs. Green computing focuses on the triple bottom line of economic viability, social responsibility and environmental impact.

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 as solution may comprise items such as end user satisfaction, management restructuring, regulatory compliance, disposal of waste, telecommuting, virtualization of server resources, energy use, thin client solutions, and return on investment (ROI).

ORIGIN

The term “green computing” came into existence after the “Energy Star programme” by the U.S. Environmental Protection Agency in 1992. It was a voluntary labeling program which is designed to promote and recognize energy-efficiency in hardware of all kinds.

When it comes to PC disposal, it is necessary to know everything there is to know in order to be involved in green computing. Basically, the whole green aspect came about quite a few years back when the news that the environment was not a renewable resource really hit home and people started realizing that they had to do their part to protect the environment.

Many businesses simply focus on a bottom line, rather than a green triple bottom line, of economic viability when it comes to computers. The idea is to make the whole process surrounding computers friendlier to the environment, economy, and society. This means manufacturers create computers in a way that reflects the triple bottom line positively. Once computers are sold businesses or people use them in a green way by reducing power usage and disposing of them properly or recycling them. The supreme motto of green computing is to make computers from beginning to end a green product.

REGULATIONS AND INDUSTRY INITIATIVES

GOVERNMENT

Different governmental agencies have implemented 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.

The European Union's directives 2002/95/EC (RoHS), on the reduction of hazardous substances, for personal computers monitors and other office equipments. In 2003, the California State Senate enacted the Electronic Waste Recycling Act, which Establishes a statewide recycling program for obsolete computer and consumer electronic Equipment. And required the substitution of heavy metals and flame retardants like PBBs and PBDEs in all electronic equipment.
INDUSTRY

- **CLIMATE SAVERS COMPUTING INITIATIVE**: CSCI is an effort to reduce the electric power consumption of PCs in active and inactive states. The CSCI provides a catalog of green products from its member organizations, and information for reducing PC power consumption. It was started on 2007-06-12.

- **GREEN COMPUTING IMPACT ORGANIZATION, INC.**: GCIO is a non-profit organization dedicated to assisting the end-users of computing products in being environmentally responsible. This mission is accomplished through educational events, cooperative programs and subsidized auditing services. GCIO Cooperative, a 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.

- **GREEN ELECTRONICS COUNCIL**: The Green Electronics Council offers the Electronic Products Environmental Assessment Tool (EPEAT) to assist in the purchase of "green" computing systems. The Council evaluates computing equipment on 28 criteria that measures product efficiencies and sustainability attributes.

- **THE GREEN GRID**: It is a global consortium dedicated to advancing energy efficiency in data centers and business computing ecosystems. It was founded in February 2007 by several key companies. The Green Grid has grown to hundreds of members, including end users and government organizations, all focused on improving data center efficiency.

**APPROACHES TO GREEN COMPUTING**

Several methods can be adopted in order to reduce the environmental impact of a computing system.

**POWER GENERATION**: Green computing aims at usage of power from eco-friendly and low impact sources like windmills and hydroelectric mills, solar power and power produced by nuclear power plants.

**VIRTUALIZATION**: Virtualization is the process of running two or more logical computer systems on one set of physical hardware. In order to reduce power and cooling consumption. Several commercial companies and open-source projects now offer software packages to enable a transition to virtual computing.

**POWER MANAGEMENT**: power management suggests directly controlling the power-saving aspects of hardware. To become more energy conscious The Advanced Configuration and Power Interface (ACPI), allows a system to automatically turn off components such as monitors and hard drives after set periods of inactivity. There is also certain software package that allow the user to manually adjust the voltages supplied the CPU, which reduces both the amount of heat produced and electricity consumed. Some CPUs can automatically adjust the processor.
depending on the workload; this technology is called "Speed Step" on Intel processors. In 2007, Intel Corporation released a utility called power top, which measures and reports on a PC’S power consumption.

NEWER HARDWARE: In 2007, computer vendors designed systems which reduce power consumption by decreasing the volume and size of peripherals and low-voltage components suitable for computer gaming and video production. Nowadays, LCD monitors are also being replaced by light emitting diodes or LED’s that reduce the amount of electricity for the display. Desktop computer power supplies (PSUs) are generally 70–75% efficient, dissipating the remaining energy as heat. An industry initiative called 80 PLUS certifies PSUs that are at least 80% efficient.

CHILLING OF DATA: As computers and other hardware devices, when in use produce heat and this heat must be compensated by incorporating cooling conditions for safety of the devices. The more powerful the machine, the more cool air needed to keep it from over heating. By 2005, the energy required to power and cool servers accounted for about 1.2 % of total U.S electricity conception. By 2010, half of the Forbes Global 2000 companies will spend more on energy than on hardware such as servers.

MATERIAL RECYCLING: Waste from discarded electronics will rise dramatically in the developing world within a decade, with computer waste in India alone to grow by 500 per cent from 2007 levels by 2020. Recycling computing equipment can keep harmful materials such as lead, mercury, and hexavalent chromium out of landfills, but often computers gathered through recycling drives are shipped to developing countries where environmental standards are less strict than in North America and Europe. The Silicon Valley Toxics Coalition estimates that 80% of the post-consumer e-waste collected for recycling is shipped abroad to countries such as China, India, and Pakistan. Computing supplies, such as printer cartridges, paper, and batteries may be recycled as well.

ENERGY EFFICIENT COMPUTING

Energy efficiency makes good sense not only for your bottom line, but for the planet as well. Follow these steps, and you’re right on track towards implementing energy efficient measures in your environment:

- Do not leave your computer running overnight and on weekends. Also, wait until you are ready to use it before you turn it on.
- 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.
- Try to plan your computer-related activities so you can do them all at once, keeping the computer off at other times.
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.

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.

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.

Request recycled / recyclable packaging from your computer vendor.

Do not turn on the printer until you are ready to print. Printers consume energy even while they are idling.

For “computer server “which must be on to serve network functions, explore waste to turn servers off at night.

OTHER GREEN COMPUTING PRACTICES:

Some other green computing practices include:

a) Reducing paper waste.

b) Reusing and recycling hardware devices.

c) Purchasing recommendations.

d) VIA technology
   
   o Carbon free computing
   
   o Solar Computing.
   
   o Lead-Free and RoHS Computing

REDUCING PAPER WASTE

Computer use has vastly increased paper consumption and paper waste here are some suggestions for reducing paper waste:

➢ Print as little as possible review and modify documents on the screen and use print preview.
Do not print out copies of email unless necessary.

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.

Recycle waste paper.

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.

REUSING AND RECYCLING HARDWARE DEVICES

This is one of the most important aspects of green computing that revolves around e-waste management. It involves making unused and old hardware devices reusable through the process of recycling.

Purchasing recommendations:

- Buy only “energy star” computers, monitors and printers. Flat panel monitors use about half of the electricity of a CRT display.

- 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.

- 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.

VIA TECHNOLOGY

VIA Technologies, incorporates the idea of power efficiency throughout the design and manufacturing process of its products. It includes:

- **CARBON-FREE COMPUTING**: It aims at reducing "carbon footprint" of users — the amount of greenhouse gases produced, measured in units of carbon dioxide (CO2). An increase in greenhouse gases affects both life and world economy. So VIA aims to offer
the world's first PC products certified carbon free, taking responsibility for the amounts of CO2 they emit.

- **SOLAR COMPUTING:** Amid the international race toward alternative-energy sources, VIA is setting its eyes on the sun, and the company’s Solar Computing initiative is a significant part of its green-computing projects. For that purpose, VIA partnered with Motech Industries, one of the largest producers of solar cells worldwide. Solar cells fit VIA are power-efficient silicon, platform, and system technologies and enable the company to develop fully solar-powered devices that are nonpolluting, silent, and highly reliable. Solar cells require very little maintenance throughout their lifetime, and once initial installation costs are covered, they provide energy at virtually no cost. Worldwide production of solar cells has increased rapidly over the last few years; and as more governments begin to recognize the benefits of solar power, and the development of photovoltaic technologies goes on, costs are expected to continue to decline.

- **LEAD-FREE AND ROHS COMPUTING:** 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. VIA implemented a set of internal regulations in order to develop products that are compliant with these accepted policies, including the use of nonhazardous materials in its production of chipsets, processors, and companion chips. 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. In traditional manufacturing processes, lead is used to attach the silicon core to the inside of the package and to facilitate integration onto the motherboard through tiny solder balls on the underside of the package. VIA’s lead-free manufacturing technologies do not require a lead bead, and the solder balls now consist of a tin, silver, and copper composite.

**CONCLUSION**

Green Computing is not only a new trend; it is a technology of itself. In order to utilize this new technology, an individual needs to just be aware of the products they are buying. Paying attention to things like the energy star rating along with the general components of a computer can help to greatly reduce the amount of electricity used on a day to day basis. Replacing old equipment with new and more efficient equipment is only effective if the efficiency difference is high and the old equipment can be recycled or reused instead of simply ending up in a landfill. Every individual can help to encourage Green Computing by acknowledging corporations that use the new technology. The consumer is one of the largest influences in what determines if technologies flourish. Now its time to both government and corporate world to join hands by supporting the Green Computing initiatives to build a green-globe. So help to save the environment and save yourself and go green with green IT computing.
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