An Approach to Energy Efficient Eco -Friendly Computing - Green Computing

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Abstract: *First and foremost conclusive research shows that CO_2 and other emissions are causing global climate and environmental damage. Preserving the planet is a valid goal because it aims to preserve life. A planet like our Earth, that supports life, are very rare. In this technology Era, we cannot live apart PC's and other electronic devices. A single computer emits about 0.1 ton of CO_2 in a year. The emissions by computers account for 2 percent of world's total CO_2 emissions, almost equal to that contributed by aviation. Gartner has estimated that 133,000 personal computers are discarded by U.S homes and business each day. Disposal of these devices constituted 20-50 million tons per year (about 5% of the total damage of our planet).This further enhances the necessity of Green Computing and how to live with them in a way that makes them friendlier to the environment.*

Keywords: *Green Computing, Energy Saving, Eco - Friendly, Virtualization, Solar power*

I. INTRODUCTION

Green computing is an umbrella term, defined as the study of designing, manufacturing / engineering, using and disposing of computing devices in such a way that reduces environmental impact. Green computing is an environmentally responsible and eco–friendly use of computers and their resources. The goal is to reduce the use of hazardous materials, maximize energy efficiency during the product's existence, to reduce e-waste or WEEE (Waste Electrical and Electronic Equipment) also to promote reusability and recyclability. It is worth appreciating that green technology should not be just about sound bites to impress supporters, but action should meet verbal commitments. Computing power consumptions of organizations have reached a critical point. For e.g. an e-commerce business with 100,000 can easily spend up to $20 million a year on server power, $10 million for air conditioner cooling. So, total $30 million a year for power alone. Obviously there is a huge potential for saving in their infrastructure. Despite the huge surge in computing power demands, there are many existing technologies and methods by which significant savings can be done. Hence to create new profit center's while trying to help the environmental cause

II. BACKGROUND OF GREEN COMPUTING

In 1992, the U.S Environmental Protection Agency (EPA) [2] launched "Energy Star", a labeling program designed to promote and recognize energy-efficient products to reduce greenhouse gas emissions [30]. Device having Energy Star logo (Fig.1) uses 20-30% less energy than required by federal standards. Computers and monitors were the first labeled products.

Fig 1 Logo: Energy Star

The term "Green Computing" was coined shortly after energy star began.

III. PURPOSE OF GREEN COMPUTING

- The Purpose is to inculcate social responsibility among public and to create environmental awareness.
- To lower the impact of carbon footprints on environmental and human health.
- Minimize improper use of power consumption and to improve energy management.
- Increase energy efficiency during product's lifetime.
- Growing need for employing green products and the process leads to new business opportunities.
- To reduce the use of hazardous material so as to reduce pollution and toxicity.
- Promote reuse and recyclability.
- Lessen the usage of paper and WEEE.
- Curtail travel requirements for employees.
- Cultivate refurbishing for the next generation.
- A step needs for tomorrow's future.

IV. APPROACHES TO GREEN COMPUTING

Many of today's computer users are beginning to rely on both hardware and energy saving to push their computer system towards cooling. It is possible to make cool for one computer system. This is hard to balance to achieve the same for each and every computer worldwide. Every mystery has a way out with different aspects and different approaches.

Power Management

The Advance 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. The ACPI has this facility. What about the other systems which are not related to ACPI standard?

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Table I. Energy consumption in watts [4]

Component	Energy consumption (On Mode)	Energy consumption (Off Mode)
Desktop PC	180	83.3
15-17" Monitor	50 – 60	7.8
Laser Printer	481	4.5
Inkjet Printer	22	5
CPU	120	85
CRT	124	74.5

If 8 hours of usage of computer for 5 days a week needs 562 Kilowatts but if the computer is left on all the time without proper power saver modes, this can lead to 1600 Kilowatts. For large institution, say a university, the power bill for just computers alone hits to $2 million per year.

Ways to reduce energy consumption:
- Turn off the computer when not in use, even if just for an hour.
- Turn off the monitor when not in use (opposed to running a screen saver as it consumes more power).
- Use power saver mode (Sleep mode, Hibernate mode).
- Don't print unless necessary.
- Use double side printing functions.
- E-mail communication as an alternative to paper work and fax documents. Use hardware/Software with the Energy Star label.
- Plug your computer it to surge protector with a master control outlet.
- Use flat screen monitors instead of CRT's.
- Switch from Google to Blackle.

EPEAT

EPEAT (Electronic Product Environmental Assessment Tool) is a comprehensive global environmental rating system that helps purchasers to identify greener computers and other electronics. In the United States, a product registry (EPEAT) has begun to establish itself as a major force in Green IT procurement. [25] EPEAT is a federally sponsored initiative that uses 51 environmental product compliance requirements that were developed through an industry group led by the Institute of Electrical and Electronic Engineers (IEEE). Under the program, suppliers can register their desktop, laptop and monitor products in 23 mandatory and 28 optional categories. Products that meet the appropriate combinations of mandatory and optional criteria can then be registered in either the basic, bronze, silver or gold rating categories. For purchasers, EPEAT offers guidance for assessing the trade –offs of cost versus performance across a broad range of devices. There are currently over 900 products in the registry with more being added weekly. EPEAT also provides guidance on performance criteria for the design of new products and provides an opportunity for manufacturers to gain market visibility and recognition for their efforts in reducing the environmental impact of their products. Although it is a voluntary program, the organization operates a verification process to assure the credibility of product listings in the registry. While the IEEE standards currently cover only Pc s and Monitor, the program is reportedly being executed to cover other devices such as a server, router and printers.

Table II. EPEAT award in US and Canada

Components	EPEAT GOLD	EPEAT SILVER	Total
Notebooks	17	0	**17**
Eee PCs	23	2	**25**
Monitors	21	0	**21**
Desktops	5	3	**8**
All-in-Ones	3	2	**5**
	69	**7**	**76**

Electronic Product Environmental Assessment Tool is a method for consumer's to evaluate the effect of a product on the environment. It can also be used to help develop the business case for replacing older generation devices such as CRT's with newer, more power efficient equipment. The tool can be used to compare power cost between devices.

Virtualization

Virtualization is duplicating hardware with software. Realize a piece of hardware such as a web server or file server in software rather than hardware. Writing a program (software), that does the same, exactly like hardware.
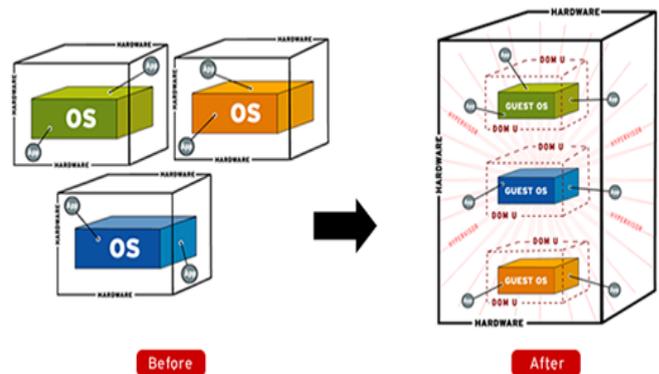

Fig.2 Duplicating hardware with software

It is the consolidation of servers and systems to reduce power consumption and energy utilization. It leads to usage of more than one system on a single piece of physical hardware. This allows for minimum power consumption and maximum cooling. VMs share the centralized servers, processors, memory and storage. With solutions from VMware, Microsoft and IBM, a single physical server can come out of virtual

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machines or VMs. Besides energy efficiency, the virtual machine which can imitate or pretend to be multiple servers on the network. The Virtual server environment is transparent on the network. The users interact with virtual servers as if they were still multiple physical servers only now, they are hosted by a solitary piece of hardware. Instead of maintaining, powering and cooling a large number of servers, a company will have to maintain, powering, cool just a few. By this technique, we can save money, energy, time and prevent system crash or overheating.
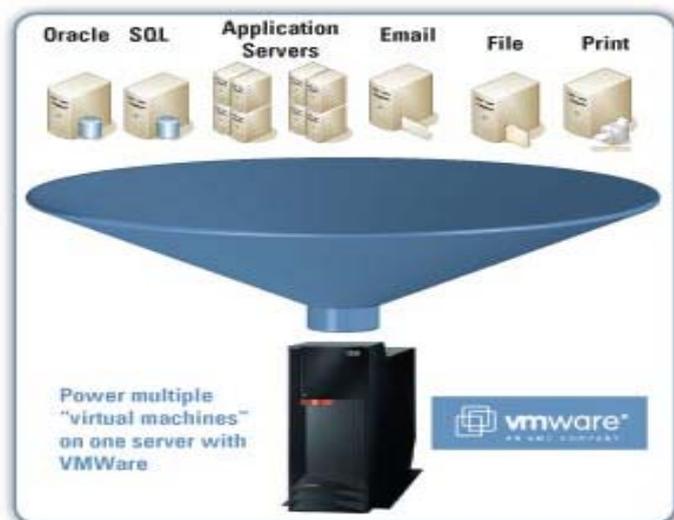

Fig 3 Server Virtualization

1) *Advantages of Virtualization:*

- No PC Maintenance
- No individual software updates
- No hard drive crashes
- Costs less
- Uses less energy

2) *Effects of Virtualization:* The USDA used virtualization to reduce/ consolidate 255 servers into 22. Four years ago Los Alamos national laboratory undertook a virtualization product that decommissioned 100 servers, resulting in the use of only 13. This has resulted in a savings of almost $1.5million dollars. 50 –70 % of energy can be saved from virtualization [26].

Disposal

Each year 130 million cell phones are retired. Between 1997 and 2004 it is estimated that 315 million computers become obsolete. Users in China and India will require the creation of new computers. Then think about the old equipment? What to do? Obviously it leads to dispose of. This waste is called E-Waste. E-Waste is due to the improper practice of disposing of computer and its components. So it is our responsibility to manage it in a proper way. E-Waste management includes manufacturing, processing techniques, recycling and consumer awareness efforts.

1) *Lead Free and RoHS Computing:* In February 2003, the European Union adopted the Restriction of Hazardous Substances Directive (RoHS). The legislation restricts the

user of six hazardous materials in the manufacture of various types of electronic and electrical equipment [27].The directive is closely linked with the Waste Electrical and Electronic 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 which impact on the environment. Driven by these directives, VIA implemented a set of internal regulations in order to develop products that are grievance 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 their chipsets.

2) *Reuse:* Instead of disposing of electronic devices like computer, donate your computer components to people who may not have or have lesser quality computers. Donate to Schools, churches, libraries, non-profit organizations and lower income families. Many organizations provide information on donating computers.

3) *Refurbish:* Rather than discarding your computer when the next generation is released, just get a new CPU, memory chips and upgrade rather than replace.

4) *Recycling:* If it is inevitable to reuse or refurbish then there is a better option of Recycling. If companies can recycle the plastics and other components, this can greatly reduce waste and toxins which affect the environment.

V. IMPLEMENTATION OF GREEN COMPUTING

Organizations all over the world are beginning to understand their corporate social responsibility towards the environment. Most companies now believe in conserving energy and power and using environmentally friendly products that help in reducing their carbon footprint. In fact, in many organizations, the need for green computing is put at the top of the agenda. Nowadays, it is imperative for all sized organizations to implement aspects of green computing in their daily workings. Some of the companies or applications that implementing go green concept are as follows.

A. *Solar Computing: Powering PCs with the Sun*

Part of the VIA Green Computing Initiative, VIA Solar Computing seeks to overcome the challenges of power infrastructure deficiencies, especially in rural and remote areas, and to define clean energy solutions for developed urban markets. As a clean energy that can be harnessed to provide reliable, sustainable power, solar naturally complements VIA's power efficient silicon, platform and system technologies in promoting environment-conscious computing. VIA Solar Computing combines advanced, cost-effective solar panel technology from leading solar product innovators, Motech, with the power efficiency of VIA processor platforms to develop complete solar-powered computing solutions that are less polluting, more affordable, more reliable and more flexible for a wide variety of new markets, applications and environments[29]. There are many products available which

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promote Green computing such as Chipsets, Processor Solar charger Laptop bags etc.,

Fig 4(a) VIA Green Product

Fig 4(b) Solar charger Laptop bag

B. Greener FireFox Surfing

There has been a similar initiative taken for folks who surf by using FireFox. These users can easily make their surfing hours greener by installing the new "InferKnow" application, which is basically an add-on. It installs as an extension and when you surf with it, the cause of fighting global warming gets a contribution. How? This FireFox add-on takes out a small proportion of the revenue generated from ads displayed on web pages of online environment-oriented projects and diverts it towards eco-causes.

C. Being Green with Google & Yahoo

Google and Yahoo search engines are also making efforts to be greener without encouraging the users to download other applications. How? Google has created a system wherein web developers who are willing to incorporate Google Search on their websites would have a small share in the advertising revenue. Hence, many of the green entrepreneurs have started to include Google Search within their sites to ensure that a steady flow of funds for green causes is generated from the shared advertising revenues.

D. The Zonbu Computer

It is a new, very energy efficient PC. The Zonbu consumes just one-third of the power of a typical light bulb. The device runs the Linux operating system using a 1.2 gigahertz processor and 512 Mega of RAM. It also contains no moving parts and does even contain a fan. You can get one for as little as US$99, but it does require you to sign up for a two-year subscription [32].

E. Fit –PC

It is the size of a paperback and absolutely silent, yet fit enough to run Windows XP or Linux. Fit - PC is designed to fit where a standard PC is too bulky, noisy and power hungry. If you ever wished for a PC to be compact, quiet and green – then fit- PC is the perfect fit for you. Fit-PC draws only 5 Watts, consuming in a day less power than a traditional PC consumes in 1 hour. You can leave Fit-PC to work 24/7 without making a dent in your electric bill [32].

F. The ultra portable and Asus Eee PC

The "ultra-portable" class of personal computers is characterized by a small size, fairly low power CPU, compact screen, low cost and innovations such as using flash memory for storage rather than hard drives with spinning platters. These factors combine to enable them to run more efficiently and use less power than a standard form factor laptop [34].
The Asus Eee PC is one example of an ultraportable. It is the size of a paperback, weighs less than a kilogram, has built-in Wi-Fi and uses flash memory instead of a hard drive. It runs Linux too. Asus is the first company to receive the Carbon Footprint Certificate (PAS 2050) for a notebook from the Carbon Trust, the UK's leading authority on carbon reduction. In 2008, Asus become world's first to receive both EU Flower and Czech Eco Label award for computers.

G. Sunray thin client

Sun Microsystems is reporting increased customer interest in its Sun Ray, a thin desktop client, as electricity prices climb, according to Subodh Bapat, vice president and chief engineer in the Eco Responsibility office at Sun Microsystems. Thin clients like the Sun Ray consume far less electricity than conventional desktops, he said. A Sun Ray on a desktop consumes 4 to 8 watts of power because most of the heavy computation is performed by a server. Sunray thin clients are particularly well suited for cost-sensitive environments such as call centers, education, healthcare, service providers, and finance. PCs have more powerful processors as well as hard drives, something thin clients don't have. Thus, traditional PCs invariably consume a substantially larger amount of power. In the United States, desktops need to consume 50 watts or less in idle mode to qualify for new stringent Energy Star certification

H. Greener Browsing – Blackle

Blackle is an energy saving search engine powered by Google search. It has a dark background which consumes less energy. If a computer screen is white it consumes 74 watts whereas Black consumes 59 watts. By switching from Google to Blackle, Earth would save 750 MW / year [34].

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VI. GOVERNMENT PROGRAM FOR GOING GREEN

A. *Countries undertook the govt. programs:*

USA: "ENERGY STAR."
Australia: "ENERGY STAR" Australia.
China: "China Energy Conservation Program"
Europe:"European Commission Directorate-General for Energy and Transport"
Japan: "Energy Conservation Center"
South Africa: "Department of Minerals and Energy".

B. Companies Going Green

Going green may seem to be the latest trend, but it is a trend with a variety of benefits for business owners. Applying green processes to the workplace creates a healthy environment for employees, reduces unnecessary waste and recognizes the role that businesses play in leading the way for social and environmental change.

Table III. Companies adopted Green Computing

Companies	Details
HP	Programs to reduce GHG and Toxic wastes in their products and supply chains
IBM	Has had formal Environmental policies since 1971, and requires all employees to have environmental awareness training.
Microsoft	The new design of Windows uses less energy. Also includes the use of virtualization technologies.
intel	Focus is on increasing speed while reducing energy usage in their products.
Dell	Carbon Neutral, Headquarters uses 100% Renewable energy, computer products use 25% less power (by 2010)

VII. CONCLUSION

Little changes make a big difference. It is not only seen as an organizational responsibility but also the responsibility that must be undertaken by all computer users. Home computer owners must also resort to green computing practices to make the environment more sustainable. At the simplest level, green computing is no rocket science and certainly does not require doling out large amount of cash in terms of up-front investment. As detailed above, proactive steps for a green computing merely takes a little effort, yet the lowered energy consumption typically translates into immediate savings. We expect everyone to make a promise personally and organizationally for Eco-Friendly computing. Money is not all you're saving, save the environment which ultimately saves the planet.

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