

# GREEN IT- WHERE THE WORLD AND INDIA STANDS IN GREEN COMPUTING

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**Abstract - Green computing, green IT or ICT Sustainability, is the study and practice of environmentally sustainable computing or IT. The goals of green computing in general 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. This also includes disposing off the various tertiary devices along with the computer like servers, monitors, printers, storage devices and under IT phones in fact all electronic items. This initiative is taken by various companies and countries to reduce and eliminate e-waste. The aim of this paper is to present the adoption of Green Principles to practical practice on both local and international Information Technology industries. The reason of the embracement of these principles in industry is a result of environmental impacts caused by the Information Technology infrastructure in various areas such as greenhouse gas emissions, polluted water, hazardous waste, etc.**

## I. INTRODUCTION

Information Technology (IT) has, without doubt, substantially improved business productivity and enhanced the overall quality of our lives. Consequently, there has been a proliferation in the number and size of IT facilities, the equipment and people working in these facilities. This growth is placing a tremendous burden on our environment, both in the consumption of natural resources such as fuel, water and other raw materials as well as in greenhouse gas emissions and the waste that is generated. This phenomenon is raising several red flags in the minds of corporate executives, governmental organizations, environmentalists and the broader public, thus leading to green IT initiatives. It is not exaggerated to say the World Wide Web is the most excited impacts to the human society in the last 10 years. It changes the ways of doing business, providing and receiving education, managing the organization etc. In recent years, the “Green Information Technology” has been implemented with incredible success among companies on both local and international scale. The environmental protection aspect has become the adequate core that many industries are trying to follow in order to be more environmentally responsible [1]. Computers and electronic machines from all companies are consuming significant amounts

of electricity, releasing a carbon dioxide gas (CO<sub>2</sub>), which contributes to greenhouse gas emissions. The electrical usage is the main cause of climate change [1]. Furthermore, the unwanted Information Technology (IT) hardware's also posed to environmental problems during both of production and disposal process. The name for these unwanted hardware equipments is electronic waste (E-Waste) [2]. Most companies are trying to minimize or eliminate the environmental impact of IT and to support the managing sustainable environment. In particular, Green IT is about improving or maintaining computing performance, while reducing the energy consumption and the carbon footprint [3]. However, implementing Green IT principles into practice involves the usage of many resources. The companies have to spent big amounts of money in order to reconstruct their IT infrastructure.



Figure 1: Ecological Footprint [3]

The paper is structured as follows. Section 2 provides an introduction of Green IT in Practices and Principles. Then, Section 3 presents a review of existing work on Green IT. In Section 4, is presented the content analysis methodology used and the Dell and Toshiba's approaches related to Green IT. Finally, Section 5 contains discussions and limitations on the paper's subject.

## II. GREEN IT IN PRINCIPLES AND PRACTICES

Green IT is implemented into the IT framework [4] as set of best practices for optimizing the usage of computing resources [4]. The environmental impact towards IT, creates many issues such as growing accumulation of greenhouse gases or modifying the climate world and weather pattern [1]. The producing of electricity is the major cause of the climate change, because coal and oil are used to generate the electricity, releasing carbon dioxide (CO<sub>2</sub>) gas during the process [1]. The principles of Green IT were created not only to protect the environment and to save energy, but also to reduce the company's expenses on the long-term scenario [2]. The Green IT principles show the concepts of reducing the environmental impact. There are four key green holistic principles, which are focused on different areas and activities.

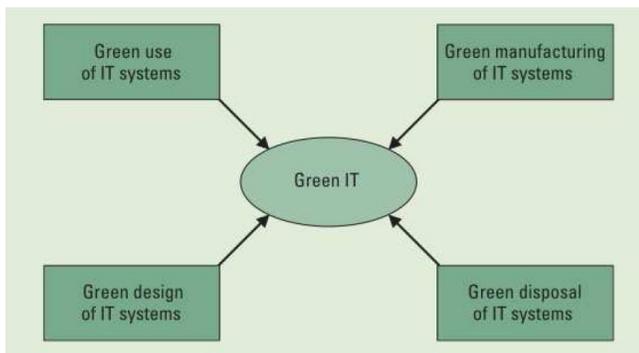


Figure 2. Four green holistic principles [1].

Figure 1 presents the four green holistic principles. These principles are focused on different areas and activities as follows [1]:

- Green use – Reduce the energy consumption of data centers, computers and other information systems and use them in the environmental ways e.g. virtualization, turning off computer when not in use, etc.
- Green design – Design energy efficient and environmentally sound components, computers, servers and equipment's and concern more on the future of electronic parts e.g. eco-friendly design, LED monitor, etc.
- Green manufacturing – Every process in manufacturing electronic components, computers and other associate subsystems should imply a low or no impact on the environment.
- Green disposal – In this practice the company should plan refurbishment and reuse of old computers. Also, recycling process for unwanted computers or other electronics components should be prepared.

Recently, computer industry realizes that going to be Green IT is the best direction to get success in both of environmental

friendly and cost reducing [6]. The companies try to engage those four green holistic with the entire IT life cycle.

### A. Issues and economics

Green IT practices attract media and management attention today, in part, because of a broader interest and emphasis on corporate social responsibility (CSR) programs. With increasing public awareness of environmental issues, CSR efforts also are tied to initiatives that build a positive environmental brand image [5]. In the infrastructure support and data center management communities, there is a growing body of evidence that IT organizations can also “green-up” their energy, procurement and recycling practices. These efforts are being closely watched across the industry because, while they contribute to the broader corporate social and environmental agenda, evidence indicates that the initiatives make sound economic sense and in many cases generate substantial savings. With this “win-win” opportunity emerging across CGI's network of clients, IT is increasingly becoming a major area of focus and opportunity for organizations looking to adopt green or sustainable business practices. In a practical sense, the new programs target a wide range of energy, cost, environmental and travel-related issues. Among the issues most commonly reported, and those that appear to be fueling the Green IT movement, are the following:

- Rising energy demand with a more limited supply and increasing utility costs
- Management of hazardous waste and electronic equipment disposal (e-waste)
- Increasing gasoline costs, which drive up employee commuting costs leading to retention issues
- Increasing real estate costs
- Rising airline ticket costs and travel complexities
- A stronger regulatory climate at the federal, state and local levels.

### III. PROBLEMS

Performance-wise, computer design has progressed staggeringly well and astonishingly fast but looking at it from a green perspective, the work is at its epoch. It takes a lot of energy to create, package, store, and move. Conventionally, manufacturing computers includes the use of lead, cadmium, mercury, and other toxics in general. Usually, computers can contain 4 to 8 pounds of lead alone, according to green experts. It's no wonder that computers and other electronics make up two-fifths of all lead in landfills. To counter this growing pollution threat all over the world due to the growing use of electronic device in general and computers in particular there is a need to look for a eco-friendly computer. “Data center servers use 50 times the energy per square foot as an office [does],” says Mark Bramfitt, principal program manager at PG&E. Data centers are the main reason behind energy consumption, Energy consumed by data centers in the United States and worldwide

doubled from 2000 to 2005, according to Jonathan Koomey, a consulting professor at Stanford University and staff scientist at Lawrence Berkeley National Lab. As a result, some companies are chasing cheaper data center power. Google is building a data center on Oregon's

Columbia River to tap hydroelectric power, while Microsoft builds nearby in Washington for the same reason. Financial services company HSBC is building a data center near Niagara Falls. To keep servers at the right temperature, companies mainly rely on air-conditioning equipments. The more powerful the machine, the more cool air needed to keep it from overheating. By 2005, the energy required to power and cool servers accounted for about 1.2% of total U.S. electricity consumption, according to a report released in February by staff scientist Jonathan Koomey of Lawrence

Berkeley National Laboratory and sponsored by chip manufacturer AMD (AMD). According to Gartner by 2010, about half of the Forbes Global 2000 companies will spend more on energy than on hardware such as servers. Energy costs, now about 10% of the average IT budget, could rise to 50% in a matter of years, Kumar says. Faster processors use ore power, because they use too much power and their waste heat increases temperature for which air conditioning necessary, especially in server farms--between the computers and the HVAC. The waste heat also causes reliability problems, as CPU's crash much more often at higher temperatures.

#### IV. RELATED WORK

In order to better understand how Green IT should function, let's work with another analogy from professional forestry. By definition, a forest is a system that not only comprises large and small trees, but also flowers, grasses, ferns, fungi, and of course animals. It is this biological diversity which constitutes a forest. Information technology works very similar, and that means it can only be transformed into a sustainable system if all subsystems (products) and their interconnections (architecture, processes, workflows) come under scrutiny. This examination also must include the manufacturing process, resource-sparing operations, and disposal/recycling possibilities. In this context, resource-sparing operations require policies that all of a company's employees have to adhere to – because after all, what's the use in deploying desktops with energy-efficient power supplies if users still activate screen savers that have been rendered meaningless since LCD monitors became standard parts of the equipment? Based on such a holistic approach, this Paper attempts to provide a representative overview of all options companies have to implement Green IT and sums up detailed technical information. The need to take action to address this growing list of business and environmentally linked issues is driving a wide range of thinking and problem-solving activities. New initiatives are reported from all segments of the industry, including businesses, government, computer

manufacturers and service providers. Global enterprises also are being driven by toughening regulations adopted by the European Union. As a result, many IT organizations are looking at Green IT programs to achieve objectives that include improving energy efficiency and power management practices, increasing hardware utilization, reducing life-cycle costs and looking for ways to cut down on computer waste. The major areas of activity associated with these programs fall generally into three categories [5,8]:

- *Energy efficiency programs:* These programs focus on maximizing energy use and computing efficiency in the IT infrastructure and data center levels to reduce energy consumption, electric utility costs and associated global greenhouse gas impacts.
- *Power consumption:* This category includes efficient approaches to power conservation. For instance, as part of CGI's technology infrastructure management offering, CGI's ongoing data center electro-mechanical improvement program combines methods, processes and energy-focused solutions for power and cooling efficiency. For example, CGI data centers use raised floor lighting and cooling retrofits to orient projects toward energy conscious and cost-saving solutions. Using current and efficient power consumption technologies has enabled the centers to reduce utility inefficiency and waste by right-sizing to new, more efficient cooling and power solutions.
- *Cooling:* By leveraging local climates and using chilled loop and free cooling strategies, IT organizations can decrease energy consumption through cooling practices. For example, CGI has decreased energy consumption with its own data center cooling strategies. Through the use of dual, air-cooled, split-type screw chillers, N+1 redundancy is achieved. This use of innovative, green, renewable energy resources enables CGI to reduce its demand for electricity, which also relieves the pressure on already over-burdened local electricity grids.
- *Green procurement and asset management:* This category includes initiatives that focus on purchasing computing equipment that is more energy efficient and environmentally friendly and includes programs to extend equipment useful life, recycle and engage with suppliers that demonstrate a commitment to reducing hazardous materials in their manufacturing, packaging and factory waste management programs.
- *Technology-based solutions:* This category includes programs that employ technology in ways that are designed to reduce travel, commuting and real estate costs along with the environmental impacts of jobs related to people movement.

There are several corporate social responsibility and cost efficient green initiatives, which are not necessarily pertaining to IT. Many such efforts are in progress at TCS. There are several

green practices employed across TCS facilities. These include opportunities for

- i. Energy savings (for example, energy efficient LED lighting, sensor based light turn on/off, building design for cooling efficiency, automatic cooling system modulation based on need and load, alternate energy for lighting and cooking)
- ii. Reducing water consumption (for example, recycling, rain water harvesting) and ground water recharging
- iii. Waste reduction (for example, paper reduction, composting and digesters for bio waste) and
- iv. Fuel and emissions reduction through cycling, car-pooling and buses.

## V. **TECHNIQUES USED**

### A. *Content analysis*

It is a methodology used in the social sciences research for summarizing or compressing large contents into fewer various aspects. This is a popular technique used in several fields of research to quantify and to analyze the relationships of the concepts and words from available resources e.g. company reports, newspaper items, interviews, etc. [9, 10].

### B. *Software Virtualization*

It is one of the common options chosen by companies to improve server utilization and reduce energy costs. Virtualization helps enterprise lower power and cooling consumption by reducing the number of physical machines and servers it needs. Virtualizations platforms can also be created to run across hundreds of interconnected physical computers and storage devices to create an entire virtual infrastructure.

### C. *Energy efficiency in datacenters*

The significant energy use in datacenter is a big issue for IT professional. From environmental, financial and operational perspectives, it is important to find a way of reducing the datacenters use of energy without compromising the performance. Otherwise, the carbon footprint and the IT bill will explode and the energy suppliers may be unable to satisfy the increasing demand in energy for datacenters. Coordinated efforts from governments and IT industrials have led to raising awareness about this issue and promoting energy efficiency best practices. Recommendations have been made by European Union in a document named “Code of Conduct on Datacenters Energy Efficiency” [10] which is a good reference for datacenters operators and owners. Also, the Green Grid consortium is a remarkable initiative. It is a global consortium of companies dedicated to developing and promoting standards, measurement methods, processes and new technologies that lead to energy efficiency in datacenters [11].

### D. *Printer Consolidation*

For more than 65% of companies, decreasing consumables such as paper, toner, ink and energy are driving forces behind printer consolidation and reduction. As one manager of a 1000-employee insurance firm said, “We eliminated 300,000 pages of output a year by moving to print-on-demand . . . with [savings of] six to nine cents per page”. The firm realized operational savings of nearly \$30,000 year-over-year. Additionally, many businesses wish to reduce maintenance and management costs associated with scattered printer fleets composed of different makes, models and hardware requirements. The majority of businesses are happy with the decreases they see in paper, toner and ink consumption. More than two-thirds report that projects meet or exceed energy consumption goals. This is not surprising, since typical mid-size companies have the potential to reduce fleet size by two-thirds, as one 350-employee international services firm did.

Apart from technology causing some environmental issues, it is also one of the best tools we have available to the human race to help us understand how we can fix environmental issues. For example, technology can help us achieve things such as climate change modeling. Climate change modeling requires massive computer processing capability. Super-fast computers are sitting in labs across the world calculating scenarios for our future – how much will the sea rise? Which countries would be wiped out? How long will it take? Another example of technology helping to solve environmental issues is carbon sequestration. But what is carbon sequestration? Well without getting into a science class discussion, it's really about storing excess carbon. At the moment you probably know that trees store carbon but we simply don't have enough trees to store all the carbon we produce. So we need to look for other places to store carbon. There are numerous proposals from scientists on how we do this, including storing it underground or in the sea. However before we go drilling places around the world and disturbing the flora and fauna, computers can help identify suitable storage areas – without the unnecessary drilling.

## VI. **CONCLUSIONS & FUTURE WORK**

The good news is that through modern technology, such as the Aqua forest suite of products, we can adopt greener IT processes which not only have an efficient and economic benefit to an organization, but will also fulfill the brief for the corporate and social responsibilities we all share. Many governments worldwide have initiated energy-management programs, such as Energy Star, an international standard for energy-efficient electronic equipment that was created by the United States Environmental Protection Agency and has now been adopted by several other countries. Now we have future of Green computing. There is lot of technique with green computing. By using these technique we can save energy,

pollution and any type of wastage in IT and environment. In the future, we plan to conduct a more comprehensive series of case studies in classrooms to improve the understanding of how these techniques perform in real world scenarios

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