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# Green Computing is SMART COMPUTING – A Survey

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**Abstract- The field of "Green Technology" encompasses a broad range of subjects from new energy generation techniques to the study of advanced materials to be used in our daily life. Green technology focuses on reducing the environmental impact of industrial processes and innovative technologies caused by the Earth's growing population. It has taken upon itself the goal to provide society's needs in ways that do not damage or deplete natural resources. Mainly this means creating fully recyclable products, reducing pollution, proposing alternative technologies in various fields, and creating a centre of economic activity around technologies that benefit the environment. Green computing is the environmentally responsible use of computers and related resources. Such 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). Green computing is the study and practice of efficient and eco-friendly computing (+ communication). Green computing is a very emerging topic these days, not only because of rising energy costs and potential savings, but also due to the impact on the environment. Energy to manufacture, store, operate, and cool computing systems has grown significantly in the recent years, primarily due to the volume of systems and computing that companies now heavily rely upon. Green technology plays a very important role in terms of computing. However, scope of this paper is limited to *"Smart Computing"* using green computing. Here we mainly focus on the "Smart Computing". The principle behind energy efficient coding is to save power by getting software to make less use of the hardware, rather than continuing to run the same code on hardware that uses less power.**

**Hence 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. Despite the huge surge in computing power demands, there are many existing technologies and methods by which significant savings can be made.**

**This series is dedicated to the ways a typical organization can reduce their energy footprint while maintaining required levels of computing performance.**

**Keywords: Eco Friendly Computing, Energy Efficient Coding, Green Computing ,Green IT ,Smart Computing.**

## I. INTRODUCTION

Green computing is the study and practice of using computing resources efficiently. The goals are similar to green chemistry; that is 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. Taking into consideration the popular use of information technology industry, it has to lead a revolution of sorts by turning green in a manner no industry has ever done before. It is worth emphasizing that this green technology should not be just about sound bytes to impress activists but concrete action and organizational policy. Opportunities lie in green technology like never before in history and organizations are seeing it as a way to create new profit centres while trying to help the environmental cause. The plan towards green IT should include new electronic products and services with optimum efficiency and all possible options towards energy savings. 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 electronic waste, telecommuting, virtualization of server resources, energy use, thin client solutions, and return on investment (ROI). As 21st century belongs to computers, gizmos and electronic items, energy issues will get a serious ring in the coming days, as the public debate on carbon emissions, global warming and climate change gets hotter.

Taking into consideration the popular use of information technology industry, it has to lead a revolution of sorts by turning green in a manner no industry has ever done before.[1,2]

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## II. WHY GREEN COMPUTING?

In a world where business is transacted 24/7 across every possible channel available, companies need to collect, store, track and analyse enormous volumes of data—everything from click stream data and event logs to mobile call records and more. But this all comes with a cost to both businesses and the environment. Data warehouses and the sprawling data centres that house them use up a huge amount of power, both to run legions of servers and to cool them. Just how much? A whopping 61 billion kilowatt-hours of electricity, at an estimated cost of $4.5B annually.[12] The IT industry has begun to address energy consumption in the data center through a variety of approaches including the use of more efficient cooling systems, virtualization, blade servers and storage area networks (SANs). But a fundamental challenge remains. As data volumes explode, traditional, appliance-centric data warehousing approaches can only continue to throw more hardware at the problem. This can quickly negate any green gains seen through better cooling or more tightly packed servers.[12] To minimize their hardware footprint, organizations also need to shrink their "data footprint" by addressing how much server space and resources their information analysis requires in the first place. A combination of new database technologies expressly designed for analysis of massive quantities of data and affordable, resource-efficient, open-source software can help organizations save money and become greener.[12] Organizations can do so in the following three key areas: reduced data footprint, reduced deployment resources, and reduced ongoing management and maintenance. [12]. This technology is beneficial as it:-

- Reduce energy consumption of computing resources during peak operation
- Save energy during idle operation
- Use eco-friendly sources of energy
- Reduce harmful effects of computing resources
- Reduce computing wastes

Global warming and the problem of minimising environmental impact from fossil-fuel emissions have raised to the top of global public policy agenda.

As a result, businesses and consumers alike have started to embrace environmentally sustainable products that offer low-carbon solutions that can not only reduce their global greenhouse gas (GHG) emissions, but can do so by more efficient energy consumption and lower costs.

Smart deployment of more efficient computing resources, starting with green PCs, has become a key focus for many businesses and consumers looking to reduce their own energy consumption and carbon footprint. This is fuelled by an increase in public awareness of the effects of climate change, recognition by businesses and consumers that reducing energy usage can save costs and by government regulation covering everything from energy efficiency to power management and reduction of hazardous materials to e-waste disposal.

## III. ISSUES AND ECONOMIC

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. 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:[14]

- 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

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## IV. Programs, Practices And Processes

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:[14]

• **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 electromechanical 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.

## V. Energy Efficiency Program Development

When PC visionaries Bill Gates and Steve Jobs set out to put a computer on every desktop back in the 1980s, no one could have imagined the millions of computers that drive billions of business, consumer and personal internet transactions across a global network each day. With an average desktop computer and monitor consuming between 60 and 300 watts of electricity, it is not surprising that energy consumption and cost reduction programs represent a major area of focus and opportunity within Green IT.

Thought leadership on how to approach the energy efficiency problem is now coming from both private companies and government entities, as well as from core IT product and services companies such as Google, Intel, Dell, Microsoft, HP, Sun and many others. Power usage and associated cost reduction programs are also a major area of focus for CGI's Green IT service development efforts due to the strong ROI potential this area represents for our clients.[14]

## VI. Green IT

Many of today's IT systems are beginning to rely on both people and hardware to help push their computer systems toward a more green computing system to help both the company and more. This is a hard balance to achieve, as it requires that the satisfaction of users, management, regulatory compliance, and even the disposal of computer waste is all managed so that everyone is the circle is happy with the outcome. But, many companies are learning the best ways that they can go greener when it comes to their computing and also help their business in the process.

While many home computer users may not be quite as familiar with green computing as larger firms or computer personnel, this term is starting to become more main stream and the requirements better for new computers to help both the companies and the end user of the equipment – as well as our environment

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**Figure 1**


## VII. Implementation Of Green Computing

**EPEAT: -** In the United States, a product registry called the Electronic Product Environmental Assessment Tool (EPEAT) has begun to establish itself as a major force in Green IT procurement. 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 PCs and monitors, the program is reportedly being extended to cover other devices such as servers, routers and printers. In addition to the product registry, EPEAT also provides an assessment tool to help purchasers compare and select equipment best matching their procurement needs. The tool can be used to compare power costs between devices. It can also be used to help develop the business case for replacing older generation devices such as CRTs with newer, more power efficient equipment.[14]

**ICLEI - LOCAL GOVERNMENTS FOR SUSTAINABILITY:** "(ICLEI) is an international association of local governments as well as national and regional local government organizations that have made a commitment to sustainable development. Over 955 cities, towns, counties, and their associations worldwide comprise ICLEI's growing membership. ICLEI works with these and hundreds of other local governments through international performance-based, results-oriented campaigns and programs."

## VIII. Future Of Green Computing

As 21st century belongs to computers, gizmos and electronic items, energy issues will get a serious ring in the coming days, as the public debate on carbon emissions, global warming and climate change gets hotter. If we think computers are non polluting and consume very little energy we need to think again. It is estimated that out of $250 billion per year spent on powering computers worldwide only about 15% of that power is spent computing- the rest is wasted idling. Thus, energy saved on computer hardware and computing will equate tonnes of carbon emissions saved per year. Taking into consideration the popular use of information technology industry, it has to lead a revolution of sorts by turning green in a manner no industry has ever done before. Opportunities lie in green technology like never before in history and organizations are seeing it as a way to create new profit centres while trying to help the environmental cause.[7] The plan towards green IT should include new electronic products and services with optimum efficiency and all possible options towards energy savings. Faster processors historically use more power. Inefficient CPU's are a double hit because they both use too much power themselves and their waste heat increases air conditioning needs, 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 high temperatures. Many people have been working for years to lice this inefficiency out of computers. Similarly, power supplies are notoriously bad, generally as little as 7% efficient. And since everything in a computer runs off the power supply, nothing can be efficient without a good power supply. Recent inventions of power supply are helping fix this by running at 80% efficiency or better.[8]

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**GREEN COMPUTING TIPS FOR GREENER ENVIRONMENT : -**

**1. Green Computing in Mobile Phones: -** Mobile phones are better than computers – green computing. What do you use your computer for? Surfing Internet, chat, gaming, social networking, downloading, desktop computing including documents, spreadsheets or presentation making or just watching your photos and videos ? Today's mobile phones are capable of doing it all, rather sometimes more than the traditional phones. They have faster processors, more ram, faster wireless Internet connectivity and larger memories. Mobile Phones consume very low power[15]

Today We will start another series of posts that will tell you how to use your phones to do things that you usually do with your computers including desktops, laptops and net books. This series of posts will include tips, tricks and software that you can use to avoid the use of computers and just use your phone.

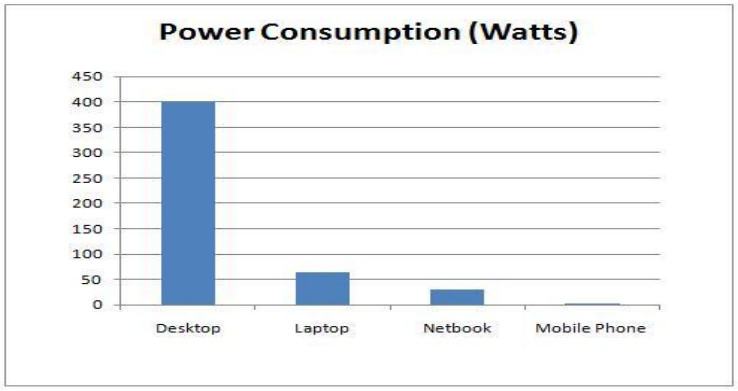


**Figure - 2**

**Why are mobile phones better?**

If you have not done so, you can read my earlier articles that prove that laptops are better than desktops, because they take around 60 watts of power as compared to a few hundred watts. Then we also discussed that net books are even better than laptops taking half the power as compared to a full sized notebook. Today we will move one step ahead.

**Figure - 3**

To prove my point I used this app called Nokia Energy Profiler. The app is a free download available on Nokia OVI store for almost all Nokia devices. The application gives you exact numbers in terms of power consumption, network bandwidth utilization and a few more important things that you never come to know when using a mobile phone. Just like any other computing device, Nokia phones consume low power when idle and take more power when performing more computation.[15]

Here are a few screen-shots. As you can see, when the phone is idle, it takes 0.18 watts on average. When navigating the menu and viewing simple content like photos on the phone screen, its consuming 0.23 watts on average. In the third screenshot, the phone is being used for a voice +video call over a wi fi network and the battery usage is at it's top, that is around 2 watts.

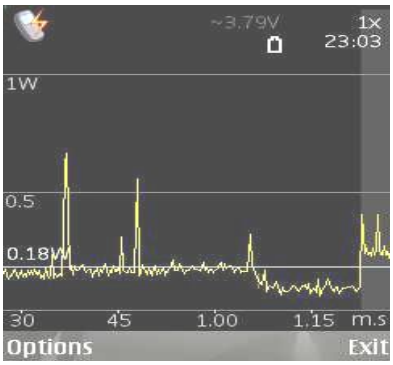


**Figure - 4: Idle State**


**Figure - 5: Phone Menu Use**

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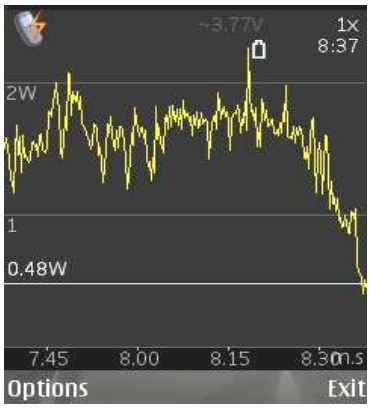


**Figure - 6: Skype Video Call - High Power Consumption**

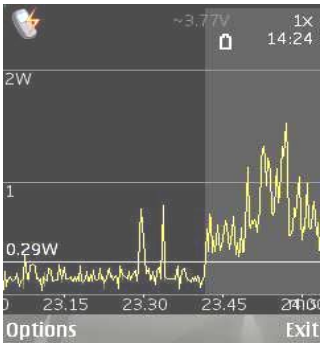


**Figure - 7: Sudden Spike when receiving call**

In the last screen shot you can see the sudden rise in battery consumption when there's an incoming call ringing and picked up. In any case, this particular cell phone is using less than 2 watts of power which is way less than the other computing devices we listed above.

**2. Green Computing in Computers: -**Our ecological balance depends a lot on **energy consumption**. So all consumers, including computer users (both professionals and casual) are now looking to adopt **Eco-friendly ways** for making this planet a better place to live .

**Figure - 8**

Computer users can **reduce negative impact of computing on global energy** resources by using the following tips:

**"ALWAYS SWITCH-OFF YOUR PC, WHEN NOT IN USE!"**

Never forget to ***turn-off your computer overnight*** or whenever your work is over. This is perhaps the most useful and logical way to ***save energy***. Remember, you can easily contribute in creating a green planet by doing this.[16]

**Vampire Power** – Many computers or monitors, even when you switch them off, can consume power from the spike strip they are connected to. Therefore always remember to turn off the power of the strips, or other connectors which you are using.

**Avoid Screensavers –** Never believe that screen-savers can save power or can keep your monitors in good health. They originally **consume more power** than monitors that are allowed to get dimmed out when not working.

## IX. CONCLUSION

Green IT practices—including exciting new efforts in the major area of data center power utilization—are earning a place on the corporate agenda, and implementation of these programs is clearly within the reach of most enterprises today. Because Green IT programs are demonstrating fundamental economic as well as environmental sense, it is understandable why organizations are exploring green computing options with such intense interest across the IT industry. As more and more companies include some form of reporting on their goals and achievements in the area of CSR, there is a growing awareness among business leaders that greening their IT practices offers the "double-win" of reducing costs while demonstrating a positive environmental commitment. Use mobile phones for your computing needs whenever and wherever possible. You'll save power and will contribute your efforts in keeping this planet green. Happy Green Computing

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