

Review of Recycling of E-DATA Through Green Computing

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Abstract: *This century has a progressive evolution in IT. New techniques gadgets and tools are being invented every day. This Leads to consume energy and resources. The planet need a friendly environment in which consuming resources is balanced and temperature is decreased. So; one of the most important responsibilities of human is providing green industry in order to get a purity environment This paper is a review of a few vital writings identified with the field of green processing that underscores the vitality of green registering for reasonable improvement.*

Keywords: Green Computing, E-data, E-waste, data footprint, Eco-friendly.

1. Introduction

The necessity for the friendly environment computing with energy economizes devices, namely "Green Computing" has considered as a global situation. The aim is reducing the environmental degradation that rise threats of global warming. "Green computing" present responsible ways to reduce the consummation of energy and decrease e-waste [1][2][3][4].

The process of utilizing computers' resources such as monitors, printers, storage devices, networking and communication devices can be done efficiently and effectively with slight effect or no impact on the environment. The objective is to minimize the utilization of risky materials, save energy during product's lifetime and enable recyclability of factory waste. The demand for electronic machines rises as business and individuals look for a faster way of task accomplishment and computing [27] [28]. According to the rapid broth of computer numbers which is increased gradually, the amount of electricity that they use, which increases the carbon content in the atmosphere. This issue has been addressed by people and measures have been taken which help in minimizing the power usage of computers. Saving resources means using less energy to produce or to use, and dispose of unused products. Saving energy and resources save life and money [10] [11]. Attention of environmental organizations and business industries have also been drawn into green computing. Recently, going green is the interest

of computers' industry, in term of reducing costs [16]. To realize "Green Computing", several factors have to be taken into consideration according to [12] [43]. The recent researches have concentrated on the practice of IT vendors; on the other hand it does not much focuses on the behavioral approach in accepting "Green Computing". The authors [12] went further and addressed out that social responsibility among others is a KEY approach towards sustainability of "green environment". Two main questions are used to form hypothesis in this paper. Which are: Do IT users' belief or intend to practice "Green Computing"? Do IT users actually follow consistent methods with "Green Computing". [12] Shows that attitudinal approach towards green resources

Computing"? Do IT users actually follow consistent methods with "Green Computing"?. [12] Shows that attitudinal approach towards green resources more efficiently while performance is being increased or maintained. Green computing has been applied in the integration of sustainable information technology services such as power management, virtualization, cooling improvement technologies, recycling, electronic waste elimination and IT infrastructure optimization. Recently, studies have illustrated that the utilized power by IT departments is about 50% of the overall energy utilized for an organization unless adrastric step is taken, which shows how the implementation of green computing is essential [33][34][35].



Figure (1): Green Computer; The Future of IT

There is an increased demand of computation, web application and large data storage. So; companies are investing to build large datacenters Cloud services hosting with complex infrastructure, which need huge amount of energy. Some studies have proposed new technologies like virtualization and consolidation to make these datacenters efficient. But even, these solutions and suggestions are indirectly address the critical impact on the environmental sustainability in terms of CO₂ emissions [30][31][32]. Cloud computing provides the best belt solution as part of the Green IT initiative to decrease the adverse ecofriendly impacts and saves energy through the introduction of Green Computing. This paper is interested in reviewing the important metrics and factors of cloud computing Green Technology which makes the environment green and shows advantageous over other suggestions by earlier researchers [36]. In the past few years, the computer model is conveyed to remote data centers, software and hardware services that are obtainable on the basis of payment for use. This known as "Cloud Computing", which means that user have to use the prepaid services. The new trends of information technology is managing data remotely. So; cloud computing which based on consuming large amount of energy and because of most servers don't provided with a qualified cooling system. So these servers emit carbon. Green computing can enable more energy for efficient use of computing power [8] [9].

Nowadays, the computational power grows rapidly hence the "Cloud computing" concepts appeared to fulfill the required needs. However, "Cloud computing" had high performance so cloud servers are used for advance computational requirements. Due to these computational unit executions, a large amount of power is consumed; on the other hand the effect is that some harmful gases are also released in a similar amount of energy. Green Computing is the concept which tries to confine this procedure by inventing new methods that would work efficiently by consuming less energy and making less pollution [20]. Because of the information technology become a part of the infrastructure in organizations and businesses.

Computer industry companies have changed their concepts in order to become green [13]. In an attempt to find a final solution to the problem of power consumption as a goal of "Green Computing", a group of researchers Proposed a technique for saving cache energy leakage and called it "Palette". The idea is to use reconfigurable cache emulator to estimate performance and energy consumption of multiple cache configurations and then select the configuration with the least energy consumption. This is to reduce the cache energy consumption of computing system which has recently drastically increased [22]. Since 1991 the "Environmental protection Agency (EPA)" has introduced the fast growth of internet based business computing. Nowadays the term "Green Computing" or "Green IT" is widely used. Although the concept of "Cloud computing" is well known for the last twenty years [33]. Another advantage of Green Computing techniques is energy usage reduction which eliminate emissions of carbon. This leads to safeguard resources and saving money. Even government policies begun to aware individuals to rationalize energy usage and encourage people to use recycled products [15] [20].

2. The Need for Green Computing

"The Newton Third Law of Motion" has rightly described what we face today which called industrialization, the Law states that "For every action, there is equal and opposite reactions". Looking at the amazing world of technology where virtually, we do everything at the speed of light with just a click or touch of distant, we have achieved so much in every sector with IT and other technologies whereby people make money and live luxurious life, but what then have they given back to the nature; the food that they eat, the water which drink and the air they breathe-in? People have succeeded in polluting the entire worlds with toxic and wastes from our deluxe and technological lifestyle. The worst is poor management and improper disposal of these toxic wastes which daily increase in our society. This gives birth to what we called Global warming which proves right the Third Law of Motion.[3][6][8][17][18][26]. The basic objective is reducing of energy consumption. Most the observations shown that energy efficiency has been improved and economic costs have been reduced. One of the most important contributors of a life-cycle cost of a data center is energy cost, where business is

transacted 24/7 via any provided channel, data need to be collected, stored, tracked and analyzed huge data even logs to mobile call records. But this all comes with a cost to both businesses and environment. There is a need for a huge power not only to run data centers but also to cool them, according to [15] [26][40] "A whopping 61 billion kilowatt-hours of electricity, the annual estimated cost is approximately \$4.5B". More efficacious approaches of cooling systems have been used by IT industry that handled energy consumption. For example, virtualization and storage area network.



Figure (2): CO₂, Major course of Global warming

3. Steps and Approaches towards "Greening Computing" Life

Data centers improve their efficiency by adopting green computing, for example virtualization which could reduce energy. A fantastic suggestion by Computer Science Professor, David Culler of University of California [7] shows that computer motherboard should be redesigned using Toking ring or Time Division Multiple Access principle. He said this will help to reduce the disproportionally of large power demand processor doing small or no job to save power. In the principle of TDMA [7], a Node about to transmit will first sense whether or not network is idle before sending. If we apply this on the motherboard design, it's a step towards green computing [7]. On the other hand, the process of Recycling can help to recover materials that have been used in the computer hardware construction during recycling process for use in future production. There are many materials that can be reused or recycled like plastic, tin, aluminum and iron. These materials can reduce the cost of the new constructed computers, mobile, phone, televisions. We also have Telecommuting through the process of e-work, accomplish work from home which provide flexibility in time and transpor-

ation. Video calls enable staff of a company, participants of a conference to communicate via internet which save time and money[10].

One major giant step towards future Green computing is Green Cloud Computing [14][38]. Green Cloud Computing encompasses of Virtualization, Service Oriented Service, Market Oriented Service (Pay as you GO), Autonomic, Elasticity, Dynamic and Distributed Service and Shared Economy of Sale [14]. It is an evolving paradigm that makes outsourcing IT infrastructures possible from a single well maintained Internet shrunk with easy management and administrative processes Cloud Computing is a green opportunity according to [21] that enables users to share resources and carryout tasks remotely. Today Cloud service have gone a long way to help reduce installation of IT resources and reduce cost of IT practice by providing service to both small and Large industries using cloud services such as Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS) [14]. Although, investigation reveals if Cloud Computing is actually Green since it contributes major threat to the depletion of Ozone layer due to its heavy release of CO₂, but there is indication that it helps save lots of infrastructure and the architecture is very organized [14].

We have further measures that should be taken in the implementation of Greener Computing towards reductions of power consumption wastage of computer resources, Some of these steps are stated below according to [10][41][42]

- ✓ Get a monitor with a size 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.
- ✓ The printer must not turned on till you are ready to print. Printers consume energy even while they are idling and also, do not print out copies of email unless necessary.
- ✓ machines now are supplied 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" email and fax-modems to communicate with others.
- ✓ Use a printer that can do double-sided copying.
- ✓ Use recycled-content paper. Look for papers with 50-100% post-consumer waste and non-

chlorine bleached. Also, recycle your paper when done.

- ✓ Do not leave your computer running overnight and on weekends except if it is a Server. Life of any machine is related to the time that a machine has been utilized not how many times that the machine has turned on/off.
- ✓ In addition to turning off computers while not in use, adjust your power options to a very considerable rate to save power [23]
- ✓ **KILL THE VAMPIRES:** Any equipment that needs a remote control to consume power. This is called "vampire energy use" or "phantom energy use".
- ✓ Ink-jet printer is slower than laser printers. But it consumes less energy.
- ✓ Request recycled / recyclable packaging from your computer vendor.



Figure (3): Recycling of E-Waste

4.1. Computer E-Waste Recycling Process and Disposal Method

Researchers in [46] conducted an experimental hypothesis to analyze levels and characteristics of electronic wastes and their effects on the environment and human health. The hypothesis results suggested strict government regulations, banning of electronic waste exports and increase E-waste recycling through government support and introduction of tax as ways to reduce the electronic wastes on third-world states [46]. In [43], the researchers suggested that management of E-waste should begin at the point of generation through waste minimization technique and sustainable products design. These can be achieved by the adoption of inventory management, production-process modification, volume reduction, recovery and reuse (Recycling) into the E-waste management process [43]. Also, in [45], the author suggested the use of Radio Frequency Identifiers (RFID) as a new technique for E-waste handling. They suggested a recycling collection process that makes use of special RFID-tagged recycling containers that use low frequency RFID tags. These containers are collected by trucks equipped with smart scale tags reader that as-

sociate each container with the owner and bills based on the weight of the waste

[45]. This not only serves as a relief to E-waste management but creates jobs.

There are several E-waste products in computing that could be recycled. For example but not limited to; Cables, Circuit Boards, Computer Laptops, LCD Screens, Modems, Electric Light Ballast, Monitors, Motherboards, Servers, Telecommunications Equipment, Telephones and Wiring [23].

Computer E-waste products can be categorized into Hazardous (Toxic) and Non Hazardous Components. The hazardous ones need extra handling for disposal and are mostly not reusable. Currently, different companies have established "ULTRA HIGH SHEARING (UHS)" [23].

Computer components such as CRT, circuit Boards, batteries and mercury lamps / switches belong to the category of risk, and components such as plastic, metal and wood are classified as non-hazardous [41] [44].

During the operation of reusing, the electronic waste management experts carefully break down, classify and package all electronic components received for processing to prepare them for shipment. In the final sorting center, some elements, for example, quite used computers, are restored and resold as they are used, and the rest are divided into its components and are prepared for reuse in commodity markets. [41]. Below are the steps for recycling a PC:

- Collection and Processing: Identify things to be recycled and deliver to E-Waste manager. The Manager sends the E-waste products to recovery facility to be sorted (hazardous/non-hazardous), cleaned and processed into materials that can be used in manufacturing.
- Manufacturing of New Products from the Recycled E-Waste: Several products today are manufactured with recycled contents. For example, common household products, Newspapers, Paper towels, Aluminum, Plastic, glass soft drink container, steel can, plastic and so on. Some of the E-wastes that are toxic in nature are properly disposed either by burning, refining, shredding or other forms.
- Purchasing New Products made from Recycled Materials: We promote Green Computing and help to close recycling loop by purchasing products made from recycled materials. There are thousands of products that contain recycled contents.
- Promote the Waste Recycling Program: It's very important that people get involved in special pro-

grams that promote waste recycling both with and outside of their organization. This will help to maximize the benefits received from the program. The more we promote it, the more the likelihood that additional recycling resources and vendors will become available to our societies.

Utilization of electronic waste not only benefits companies, creating additional revenue and increasing profits by reducing the cost of waste disposal, but also reduces consumer costs, as the recovered products are cheaper than new ones. Finally, recycling helps to promote green computing by reducing discharges to landfills and reducing the risk of introducing toxic chemicals from electronic waste into the soil, which causes serious damage to people.

4.2. Eco-Friendly Approach of Green Computer towards E-Waste Management

Effort is currently on-going by various electronic giants to construct more eco-friendly computers and other electronic hardware. Hazardous materials such as brominated flame-retardant, PVC and heavy metals such as Lead, Cadmium and Mercury that are used in the manufacturing of computer have currently been placed under restriction. Research is currently going on to find better replacement to some of these toxic chemicals. The issue of reliability of replaceable chemicals is a big factor towards eco-friendly approach [26][47].

Below are some of the incoming approaches by manufacturers to construct Eco-friendly computers. Power consuming can be replaced with green light made of OLEDs, or organic light-emitting diodes etc.

4.3. "Green Computing" application for Virtualization and Energy Reduction in Data Center

Special efforts have been on going to implement green computing in various Data Center in order to reduce energy consumption of IT and use IT to reduce energy consumption [1]. According to [6], data center consume so large amount of energy for its effective running and several millions of dollar are spent yearly to run a single data center. Researchers in [37] have suggested that more effective air circulation can help in going green which can be achieved by optimal configuration of server racks, integrated thermal-computational model, effective distribution of workload and effective usage of IT resources [37]. In [5], findings show that over 50% of the costs of running data center are power related. Some ideas that came up are the restructuring of data center application architecture for effective resource

management, implementation of virtualization on data center by allowing several applications run effectively using fewer resources which helps hardware effective utilization and reduce energy wastage. Some experts in [6] also suggested that using wireless sensor network will help to reduce heating in the wireless center. It is evident that a little fractions of the energy utilized in data center are used to power IT equipment such as computers and servers, the rest energy utilization goes to cooling system such as humidifiers, air conditioning and water chillers. The introduction of wireless sensor network is a welcome approach for data center monitoring. This is because, sensor network is less expensive to set up and it can be used to trigger off or trigger on redundant equipment at any time. A large scale data center monitoring sensor network with about 700 sensors deployed. Results from the implementation of DC Genome shows that it provides 99 percent data reliability and environmental monitoring. Other suggestion to implement green IT in data center is the SQL Server Consolidation. The idea targets various layers of application in data center which include File Server Utility, Computer Utility, Storage Utility and so on.

The researcher came up with the introduction of the following over data center

- Intelligent Allocation of hardware resources
- Energy Efficient Hardware
- Hardware Consolidation
- Enabling Power Management

In addition to all aforementioned, we see the proper design of data center as another means of going green [24]. Some of the toxic releases of CO₂ from data center can be reduced or contained by giving it proper design to shield this gas. In [24], the researchers suggested that using materials such as Stone and Recovered Bricks, Green Insulation and Drywall or Synthetic Gypsum Board to construct the building that house the Data center will help to save from harmful and toxic gas.

5. Conclusion

This paper has reviewed the emergence "Green Computing" has been as the future of IT industries smooth functioning. There is an urgent need to go green and complete implementations of green computing in various IT industries. The complete implementation over datacenters saves cost of running, energy wastage and pollution. Put in consideration recycling as a strategy of green computing to utilize E-waste for secondary productions of goods. And discouragement of dumping in landfill should also be propagated and everyone should be involved. Man-

agement of energy in various datacenters calls for more holistic studies, this will help to save money, and the world from eminent global warming. The release of CO₂ from datacenters will be drastically reduced. We all have to contribute our efforts towards achieving the goals of Green IT by getting involve in both practice and create awareness for better and green future.

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