

International Journal of Scientific Research and Reviews

Green Computing-Insight Into An Evolving Eco Friendly Technology

Anusha R. ¹ and Angayarkanni A. ^{*2}

^{1,2}Asst.Prof., Department of Computer Science, M.O.P. Vaishnav College For Women(Autonomous), Chennai.

ABSTRACT

Green computing studies about the usage of environment friendly resources in a computing environment thereby reducing energy consumption. In recent years organizations and industries have started adapting green computing in their businesses after realizing going green is their best interest in terms of public relations and reduced costs. This paper focuses on goals, advantages , disadvantages and methods to implement green computing.

KEYWORDS: Energy consumption, Green computing.

***Corresponding author**

A. Angayarkanni

Asst. Professor,

Department of Computer Science,

M.O.P. Vaishnav College For Women(Autonomous), #20, IV Lane,

Nungambakkam High Road, Chennai- 600034.

E-mail : angaiaruvi@gmail.com, Phone: 9500194086

INTRODUCTION

Computing Technology plays a prominent role in the fast evolving world and has become an integral part of our daily life activities. As a consequence the associated high volume of energy consumption has become a major concern for our environment as well as economy. Green computing technology addresses this issue by providing solutions in the form of reduced energy consumption. It makes use of environment friendly ways of using computers and associated components by reducing CO₂ emissions¹.

In recent years focus of enterprises and technology firms has been shifted towards green computing. It provides solutions to support critical computing needs in a sustainable manner by reducing the loads on resources and environment. The main objective of green computing is to improve computing performance thereby reducing energy consumption.

GREEN COMPUTING

Goals of Green Computing and Elements That are Harmful to the Environment

The main goals of Green computing are²

- To reduce the use of hazardous materials as computer components

- To maximize the energy efficiency during a product's life time

- To reduce paper and other consumables used

- To minimize equipment disposal requirements

- To reduce travel requirements for employees/customers

The manufacturing of PCs involve the use of following materials which are toxic in nature

- Mercury-Used in batteries and switches which can cause chronic brain damage

- Cadmium-Used in resistors for chips which will accumulate in the body causing kidney damages.

- Lead-Used in printed circuit boards causes damage to nervous system and kidney failure, fertility problem, pollutes soil and surface water

- Chromium - used in fan causes risk for respiratory cancer or lung cancer , increased risk for nasal and sinus cancers beryllium- used in computer chip and connectors damages lungs and causes pneumonia, increase the chance of cancer development and DNA damage

Toxic materials in computer components can harm the environment and, if they enter food chains, they can harm humans too.

According to Greenpeace³, traces of flame retardants have been found in human breast milk, whales and polar bears.

Reasons for adopting green solutions

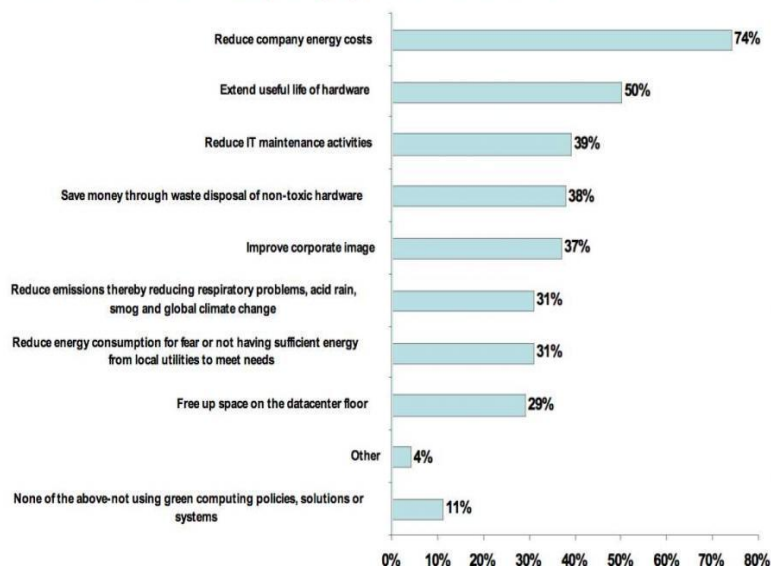


Figure 1 Reasons For Adopting Green Solutions

The figure 1 depicts the various reasons for adopting green solutions. The main reasons being reducing the energy cost, energy consumption and extending the life of hardware.

Advantages and Disadvantages of Green computing^{4,5}

1. Reduced energy usage results in low carbon di oxide emission, stemming from a reduction in the fossil fuel used in power plants and transportation
2. Less energy required to produce, use and dispose products
3. It includes changing Government policy to encourage recycling and lowering energy use by individuals and businesses
4. Reduce the risk in the usage of laptops which can be cancerous and immune reactions in humans.

The disadvantages being costly to implement, underpowered computers and rapid change in technology.

Approaches to implement Green Computing⁶:

There are various strategies by which green computing can be implemented.

Buy Energy Efficient Hardware:

Buy notebooks, workstations, and servers that meet the EPA's Energy Star guidelines for lower power consumption. Multi core processors increase processing output without substantially increasing energy usage. Purchasing High efficiency (80%) power supplies, variable speed

temperature controlled fans, small form factor hard drives, and low voltage processors may attribute to green computing

Use Power Management Technology And Best Practices⁷

OS running ACPI-enabled systems incorporate power-saving features that allows to configure monitors and hard disks to power down after a specified period of inactivity. Systems can be set to hibernate when not in use, thus powering down the CPU and RAM as well.

Computer Power Savings Modes Management of power consumption is a standard, yet often overlooked, feature of most computers and operating systems on the market today. Screen Savers, Monitor Sleep Mode, Hard Disk Sleep Mode, System Standby Mode, Hibernate Mode

Use Virtualization Technology To Consolidate Servers^{8,9}

Reducing the number of physical servers, and thus the energy consumption, by using virtualization technology to run multiple virtual machines on a single physical server.

Optimize Data Center Design

Data centers are huge consumers of energy, and cooling all the equipment is a big issue. Data center design that incorporates hot aisle and cold aisle layout, coupled cooling (placing cooling systems closer to heat sources), and liquid cooling can tremendously reduce the energy needed to run the data center.

Another way to "green" the data center is to use low-powered blade servers and more energy-efficient uninterruptible power supplies.

Use Thin Clients To Reduce GPU Power Usage

Deploy thin clients, as most of the processing is done on the server, the thin clients use very little energy. In fact, a typical thin client uses less power while up and running applications than an Energy Star compliant PC uses in sleep mode. Thin clients are also ecologically friendly because they generate less e-waste. There's no hard drive, less memory, and fewer components to be dealt with at the end of their lifecycles.

Use More Efficient Displays

Certain LCD displays can save up to 70 percent in energy costs when compared to CRT monitors.

Recycle Systems and Supplies

Old systems and supplies can be reused, repurposed, and/or recycled to reduce the load on landfills . Hand-me-down method can be adopted by workplaces, saving money and avoiding unnecessary e-waste.

Reduce Paper Consumption

By switching from a paper-based to an electronic workflow: creating, editing, viewing, and delivering documents in digital rather than printed form.

Encourage Telecommuting

The ultimate way to have a greener office is to encourage as many workers as possible to telecommute, so as to reduce the amount of office space that needs to be heated and cooled, the number of computers required on site, and the number of miles driven by employees to get to and from work.

Algorithmic Efficiency

The efficiency of algorithms has an impact on the amount of computer resources required for any given computing function and there are many efficiency trade-offs in writing programs. While algorithmic efficiency does not have as much impact as other approaches, it is still an important consideration. A study by a physicist at Harvard, estimated that the average Google search released 7 grams of carbon dioxide (CO₂). However, Google disputes this figure, arguing instead that a typical search produces only 0.2 grams of CO₂. More recently, an independent study by GreenIT.fr demonstrate that Windows 7 + Office 2010 require 70 times more memory (RAM) than Windows 98 + Office 2000 to write exactly the same text or send exactly the same e-mail than 10 years ago

Resource Allocation

Algorithms can also be used to route data to data centers where electricity is less expensive. Researchers from MIT, Carnegie Mellon University, and Akamai have tested an energy allocation algorithm that successfully routes traffic to the location with the cheapest energy costs. Nonetheless, a similar strategy could be used to direct traffic to rely on energy that is produced in a more environmentally friendly or efficient way. A similar approach has also been used to cut energy usage by routing traffic away from data centers experiencing warm weather; this allows computers to be shut down to avoid using air conditioning. Larger server centers are sometimes located where energy and land are inexpensive and readily available. Local availability of renewable energy, climate that allows outside air to be used for cooling, or locating them where the heat they produce may be used for other purposes could be factors in green sitting decisions.

CONCLUSION

Green computing is the one of the best solutions for global warming as it addresses the issue in a more responsible and methodical manner. By embracing and adopting green computing practices

businesses can contribute positively to environmental stewardship and protect the environment by reducing energy consumption and paper costs to a great extent.

FUTURE PROSPECTS^{12,13}:

List of Tech Companies going green

Intel - Far and away the largest consumer of renewable energy on the EPA's list, Intel utilizes 3.1 billion kWh annually. It gets that energy from a number of different sources, such as solar, wind, hydro, and biomass, according to the company's Corporate Responsibility Report. It even operates 18 of its own solar panels with a capacity of 7,000 kW on site. A reflection of Intel's commitment to the environment is its compensation plan, which links a portion of every employee's variable compensation to reaching energy efficiency goals.

Microsoft - In 2012, the company implemented a carbon fee charging business groups for every unit of carbon produced, creating a carbon-neutral model. Microsoft is also working toward making its cloud data centers greener, focusing on site choice and location, improving efficiency, lessening environmental impact, and increasing use of renewable energy. To that end, the company created the position of Director for Datacenter Sustainability

Cisco - With electricity accounting for 85% of Cisco's greenhouse gas emissions, green energy usage can make a big difference. Though it uses a large quantity of green energy (1.1 billion kWh annually), the company is looking to further increase its use of electricity generated from renewable sources. The networking giant also plans to reduce electricity emissions by 40% by 2017 and expand conservation throughout its partner and supply chain ecosystem. A big part of Cisco's sustainability effort includes making its products more efficient and recyclable.

Apple - In 2014, Apple converted 100% of its US operations to renewable energy, and the company is working toward a carbon-neutral footprint across its entire supply chain, Apple has recently taken steps such as purchasing solar farms to make its data centers entirely sustainable and planting and conserving forests to offset its use of paper packaging. Apple retail stores are also in the mix, with 360 of its 450 locations worldwide running on 100% renewable energy to date.

Google - Google becoming a carbon neutral company way back in 2007. According to its Google Green site, Google data centers use only half the power of a typical data center, and the company purchases 879 million kWh of renewable energy annually. The web giant has an aggressive plan to make renewable energy the only kind of power it uses in the near future. Google also puts significant money behind renewable energy innovation, and has invested \$2.5 billion in projects spanning solar, wind, electricity grids, and data center design.

Hewlett-Packard - like other computing companies, was once famous for creating polluting products. This is particularly true of printer ink. Ink cartridges from all printing companies fill up landfills at an alarming rate. To combat this, not only does HP recycle ink cartridges, but the company has also made sure all of its own products are 100% recyclable. Additionally, HP runs hundreds of e-waste centers that turn obsolete technology back into raw materials.

Dell - Electronic equipment are obviously most difficult products to safely dispose of. Luckily, one of the main leaders in this field stepped forward to make the task less unnerving. Dell launched “no computer should go to waste” recycling program which allowed customers to return dell branded products to the company for free. Dell has also established programs which accept monitors, printers and computers from other companies for safe disposal!

IBM - another early adopter of sustainability and eco-friendly business. Corporate social responsibility and environmental stewardship has been part of the company’s mission since the 1960s. Its first sustainability report was published in 1990 and its data centers have received awards from the European Commission for their long-time energy efficiency successes. Today, IBM’s efforts include smart buildings that reduce resource demand, green procurement, water resource management and more for a truly comprehensive approach.

Adobe - Adobe systems was the greenest IT company in Newsweek’s 2014 rankings, a well-earned distinction. The company has already made some impressive achievements, including obtaining LEED certification for more than 70 per cent of its workspaces, including retrofitting a historic building in San Francisco. It also has ambitious goals—including getting to net zero energy consumption and reducing its packaging, packaging being a resource drain and big contributor to plastic pollution. Adobe was also a corporate leader in reducing its water use to respond to California’s historic drought, even after it had already reduced its water use by more than 60 per cent since 2000 through means like installing environmentally friendly fixtures and landscaping with native plants.

Newsweek has ranked the world’s largest companies on corporate sustainability and environmental impact.

Rank	Company	Ranking score
17	Oracle Corp	75.80%
26	Apple Inc	73.80%
47	Microsoft Corp	70.50%
49	Accenture PLC	69.70%
53	EMC Corp	68.70%
66	ASML Holding NV	66.30%
79	Taiwan Semiconductor Manufacturing Co Ltd	64.70%
87	Cisco Systems Inc	63.80%
91	Intel Corp	62.90%
96	Adobe Systems Inc	62.30%
101	Cognizant Technology Solutions Corp	61.80%
134	SAP SE	58.20%
142	Samsung Electronics Co Ltd	57.30%
145	Telefonaktiebolaget LM Ericsson	57.10%
151	Tata Consultancy Services Ltd	56.10%
153	Murata Manufacturing Co Ltd	56.00%
166	QUALCOMM Inc	53.90%
172	eBay Inc	53.60%
173	Nokia OYJ	53.40%
185	Infosys Ltd	52.00%
197	Canon Inc	50.20%
202	TE Connectivity Ltd	49.90%
206	International Business Machines Corp	49.70%
219	Intuit Inc	47.80%
229	ALPHABET	46.40%
259	Hitachi Ltd	41.40%
301	Yahoo! Inc	35.50%
303	Texas Instruments Inc	35.30%
305	salesforce.com inc	34.70%
314	LinkedIn Corp	33.90%
328	Visa Inc	31.40%
342	Hon Hai Precision Industry Co Ltd	28.50%
344	Automatic Data Processing Inc	28.30%
358	MasterCard Inc	26.40%
370	Tencent Holdings Ltd	25.00%
377	Yahoo Japan Corp	24.30%
383	BROADCOM Ltd.	23.80%
385	Facebook Inc	23.70%
390	NXP Semiconductors NV	23.10%
391	Baidu Inc	23.10%
403	Keyence Corp	21.40%
407	VMware Inc	21.30%
414	NetEase Inc	20.60%
421	PayPal Holdings Inc	20.00%
443	Hewlett Packard Enterprise Co	17.10%
463	Alibaba Group Holding Ltd	15.20%
479	Activision Blizzard Inc	11.90%
483	Hedy Holding Co Ltd	11.10%

REFERENCES:

1. S.V.S.S. Lakshmi, Ms. I Sri Lalita Sarwani, M. Nalini Tuveera / International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com Vol. 2,

Issue4, July-August 2012, pp.1282-1285 1282 | Page A Study On Green Computing: The Future Computing And Eco friendly Technology

2. Surulinathi, M., Amsaveni, N., Maheswaran., and Srinivasaragavan, S. Scientometric Dimensions of Knowledge Management Research in India: A Study based on Scopus database, Sri Lankan Journal of Librarianship and Information Management, 2007; 2(2): 13-24.
3. Risco Taufik Achmad, Budiawan and Elza Ibrahim Auerkari. Annual Research & Review in Biology. Effects of Chromium on Human Body, 2017
4. Mujtaba Talebi and Thomas Way Applied Computing Technology Laboratory Department of Computing Sciences Villanova University Villanova, Methods, Metrics and Motivation for a Green Computer Science Program
5. Susan Fogarty. "Tech Goes Green: Top 5 Companies"[online]. 2016.[cited 2016 Mar 17] Available from:URL:<https://www.networkcomputing.com/data-centers/tech-goes-green-top-5-companies/1668947173>.
6. Emily Green. "6 Companies Going Green To Their Part For The Word"[online].2016.[cited 2016 July 31] Available from:URL:<https://usgreentechnology.com/6-companies-going-green/>.
7. Sulaiman, Ainin & Naqshbandi, M Muzamil & Dezdar, Shahin. Impact of adoption of Green IT practices on organizational performance Quality and Quantity. 2015;50 (5). Available from:URL:https://www.researchgate.net/publication/280949290_Impact_of_adoption_of_Green_IT_practices_on_organizational_performance.
8. Kelly Sampson. "10 Leading Companies That Efficiently Went "Green"[online].2015.[cited 2015 Sep 30]. Available from:URL:<http://hummingbirdinternational.net/10-companies-that-efficiently-went-green/>.
9. Deb Shinder."10 Tips for implementing green IT"[online].2008.[cited 2008 Sep 3]. Available from:URL:<https://www.techrepublic.com/blog/10-things/10-tips-for-implementing-green-it/>.
10. Care2."10 Global Companies that are Environmentally Friendly"[online].2016.[cited 2016 June 2]. Available from:URL:<https://www.virgin.com/virgin-unite/10-global-companies-are-environmentally-friendly> .
11. Newsweek."Top Green Companies in the World 2016"[online].2018.[cited 2018 Oct 26]. Availablefrom:URL:<https://www.newsweek.com/green-2016/top-green-companiesworld2016>.
12. Compactor Management Company."9 Companies with Great Environmental Initiatives"[online].2017.[cited2017].Availablefrom:URL:<https://www.norcalcompactors.net/9-companies-great-environmental-initiatives/>.

13. Murugesan S. "Harnessing Green IT: Principles and Practices".IT Professional 2008; 10(1): 24-33.
14. Ninlawan C, Seksan P, Tossapol K., Pilada W."The Implementation of Green Supply Chain Management Practices in Electronics Industry", Proceedings of the International Multiconference of Engineers and computer scientists 2010; 3 March 2015.
15. Piotr Pazowski, Green Computing : Latest Practies and Technologies for ICT Sustainability. TIIM. Proceedings of Joint International Conference 2015.
16. Prabhjot Kaur , Manoj Agnihotri . A Review on Green Computing By Resource Scheduling in Cloud Datacenter.IJETA 2016; 3(3): 35-40.
17. Junaid Shuja, Raja Wasim Ahmad, Abdullah Gani et al. Greening Emerging IT Technologies: Techniques and Practices. JISA 2017; 8(9): 1-11.
18. Basar Bener A, Morisio M, Miransky A, Akinli Kocak S. "Green IT and Green Software". Computing Now; IEEE Computer Society .[online].2014.[cited 2014 Oct]. 7:10. Available from: URL: <http://www.computer.org/web/computingnow/archive/october2014>.
19. Dr Kevin Brigden and Dr David Santillo."Toxic Chemicals in Computers Exposed- Determining the presence of hazardous substances in five brands of laptop computers". Greenpeace Research Laboratories 1 Technical Note. Published by Greenpeace International; Ottho Heldringstraat .Sep 2006.
20. Qi Deng, Shaobo Ji. "Organizational Green IT Adoption: Concept and Evidence". Sustainability 2015; 7: 16737–16755
21. Bokolo Anthony Jnr, Noraini Che Pa."A Framework for Adoption and Implementation of Green IT/IS Practice in IT Governance". Proceedings of Third International Conference on Green Computing, Technology and Innovation (ICGCTI2015), Serdang, Malaysia, 2015.
22. Meenakshi Gupta, Garima Gupta."Green computing – a step towards better milieu".JEC&AS 2013;2(9): Journal of Engineering, Computers & Applied Sciences, 2(9), 1-5.
23. Agarwal, Shalabh, Datta, Arnab, Nath, Asoke. "Impact of Green Computing in IT Industry to Make Eco-Friendly Environment". Journal of International Research in Computer Science 2014;5:510.Availablefrom:URL:https://www.researchgate.net/publication/276169342_Impact_Of_Green_Computing_In_It_Industry_To_Make_Eco_Friendly_Environment
24. Kumar Garg, S, Buyya, R."Green Cloud Computing and Environmental Sustainability".2012. Available from: URL:<http://www.cloudbus.org/~raj/papers/Cloud-EnvSustainability2011.pdf>
25. Ahmet Ozturk, Koray Umit, Ihsan Tolga Medeni et al. "Green ICT (Information And Communication Technologies): A Review Of Academic And Practitioner Perspectives" International Journal of e Business and e Government Studies.2011; 3(1):1-16. Available

from:URL:http://www.sobiad.org/ejournals/journal_ijebe/arhievs/2011_1/01ahmet_ozturk.pdf

26. Pushtikant Malviya, Shailendra Singh. “A Study about Green Computing”. IJARCSSE 2013;3(6):790-794. Available from:URL:<http://www.toknowpress.net/ISBN/978-961-6914-13-0/papers/ML15-377.pdf>
 27. Dr. Pardeep Mittal, Navdeep Kaur, “Green Computing –Need and Implementation”, IJARCET2013;2(3):12001203. Available from:URL:<http://ijarcet.org/wpcontent/uploads/IJARCET-VOL-2-ISSUE-3-1200-1203.pdf>
-