



# Green Computing is the next revaluating field in IT: An Overview

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**Abstract:** Sustainability has been gaining importance among software and hardware developers and users in the last two decades, due to the rapid growth in energy consumption. The computing industry is more prepared and far more competent than almost any other industry when it comes to facing and responding to rapid change. Environmentally it is not a good thing that most PCs -- especially in companies -- have typically entered a landfill after only a few years in service. Green computing is sustainable computing, aims to maximize energy efficiency and minimize environmental impact in the ways computer chips, systems and software are designed and used. In this article we will analyse the very true fact of present scenario in the field of information technology (IT) and will see how green computing is the next revaluating field in IT which concerns the consumption of computing resources in a way that means it has a net zero impact on the environment, a broad concept that includes energy, ecosystems, pollution and natural resources, able to provide sustainable environment friendly growth to IT with going green with computer ultra modern concept.

**Keywords:** green computing, high performance computing (HPC), artificial intelligence, green information and communication technologies.

## 1. Introduction

Green computing practices came into being in 1992, when the Environmental Protection Agency (EPA) launched the Energy Star program [4]. Green computing [1,2,5,7,8,13] is also known as green information technology (Green IT). The green movement has spread to many aspects of our lives. Going green any field entails taking responsibility for the environment from the data center down to the individual computer room. Green computing aims to make information technology more cost-effective and user-friendly. Developing environmentally friendly manufacturing processes, energy-efficient computers, and enhanced waste disposal and recycling procedures are all examples of green IT methods. Creating energy-efficient and effective systems that have a low environmental effect. Green computing, like other technologies, has both benefits and disadvantages. Green computing has yet to be well-explored, and there is a significant gap in knowledge across end-users, professionals, and businesses. Green computing emphasizes energy-efficient technology, which helps to reduce fossil fuel use and greenhouse gas emissions. The initial investment for it is high but in long run it is cost-effective since it requires less energy and cooling, which means one can save money. Educating consumers about the risks and benefits of adopting eco-friendly practices can raise awareness and enable individuals to adjust to it. They may be unsure of what to do because of frequent technology adjustments. Finding out what is happening in their industries and committing to making changes can be impossible because of the sheer amount of data. They must put extra effort into gathering and analyzing information [1,2,5,7,9,11, 15,16] recognizing that their technique is environmentally beneficial yet profitable for their company. Core objectives of green computing is: to reduce the power consumption of the products, to reduce the harmful effects to the environments through the use of hazardous materials, to increase the life time of the product, to maximize energy efficiency during the product's

lifetime, to promote recyclability of defunctional products and factory waste. Further we analyse the approach to automate the manager of the green computation who makes all the decisions regarding the services. Green computing is attractive to business owners, due to the possibility of dynamically increasing the resources accessed to match increases in the company's activities. For the environment, the advantages of green computing are: better strategies for energy efficiency, and reduced equipment requirements and lower carbon dioxide emissions, with, consequently, less pollutants [3,6,7]. In order to switch to green computing, enterprises might also face the challenges of a change of software/hardware architecture, obstacles to data transfer, and concerns about interoperability. These technologies carry some risks, mainly related to security issues. In spite of this, green computing technologies are constantly growing as a result of the major benefits they offer to environment, i.e., access to high-performance computing resources and high-capacity storage together with environment friendly approach. Many IT researchers are continuously investing in designing energy efficient computing devices [4], reducing the use of dangerous materials [3,6,7] and encouraging the recyclability of digital devices. In this paper, we review the main achievements of green computing. Recent studies and developments [1,2,5,7,8,9,11,15,16] are summarized and further study devoted to review green computing related techniques and its chase with modern techniques. Finally, future research directions and open problems regarding green computing are presented in conclusion section.

## 2.Green Computing is the next reevaluating field in IT

The use of Green Computing has increased substantially in the recent past. A lot of Research [1,2,5,7,9,11,15,16] has been done to incorporate and enhance the applicability of Green in real life scenarios with these help of various parameters. Usage of energy is dramatically increases in data centers. Green computing, or sustainable computing, is the practice of maximizing energy efficiency and minimizing environmental impact in the ways computer chips, systems and software are designed and used. Also called green information technology, green IT or sustainable IT, green computing spans concerns across the supply chain, from the raw materials used to make computers to how systems get recycled. In their working lives, green computers must deliver the most work for the least energy, typically measured by performance per watt. A significant economic, environmental and sustainability topic in information and communication technology (ICT) and e-business sectors is green computing. An aspect of green informatics, green computing is gaining attention because of its wide-ranging benefits over traditional computing; factors that inhibit the adoption of green computing. Over the last few years, interest in "green computing" has motivated research into energy-saving techniques for enterprise systems. Creating energy-efficient and effective systems IT that have a low environmental effect. Green computing, like other technologies, has both benefits and disadvantages. Green computing has yet to be well-explored, and there is a significant gap in knowledge across end-users, professionals, and businesses. Green computing emphasizes energy-efficient technology, which helps to reduce fossil fuel use and greenhouse gas emissions. The initial investment for it is high but in long run it is cost-effective since it requires less energy and cooling, which means one can save money. Green computing encourages the reclamation and reuse of materials, resulting in less electronic waste and environmental pollution. This technique prioritizes the use of non-toxic materials. environmental economics encourages the wise management of natural resources and their preservation. It seeks to reduce heat production in computers and other electronics to protect the environment. Green computing makes us accountable for the environment and lays the groundwork for a more sustainable future. Companies resist the shift because they have no concern for the environment and intense competition in the market. As a result, everyone must endure the consequences. Educating consumers about the risks and benefits of adopting eco-friendly practices can raise awareness and enable individuals to adjust to it. They may be unsure of what to do because of frequent technology adjustments. Finding out what is happening in their industries and committing to making changes can be impossible because of the sheer amount of data. They must put extra effort into gathering and analyzing information, recognizing that their technique is environmentally beneficial yet profitable for their company.

Green computing has become an important paradigm because it offers dynamic, high-capacity computing capabilities, including access to complex applications and data archiving, without requiring additional computing resources. Green computing with green algorithm can enable more energy optimized use of computing power. Green computing technologies have a variety of application domains, since they offer scalability, are reliable and trustworthy, and offer high performance with environment concern. The green computing revolution is redesigning modern networking, and offering promising environmental protection prospects as well as economic and technological advantages. These technologies have the potential to improve energy efficiency and to reduce carbon footprints. These features can transform computer computing into go green computer computing. The benefits of green cloud computing are focused mainly on energy saving and carbon-footprint reduction.

In Information technology, it is analysed that the personnel are not cautious of the consequences of foul operations. It is depicted that most of the computer energy is often wasteful by operational inadequacies. The reason to it is that we leave the computers on even in idle mode. The processor and heat fan consumes power. Even the screen savers consume power when the system is in idle mode. It is observed that most of the DCs do not have sufficient cooling utility capacities. This results in pollution of environment. This is because of defects in packaging, manufacturing techniques, disposal of computers and components. Toxicity is an added disadvantage. Cloud computing is a highly scalable and technoeconomic architecture for running HPC (High Performance Computing), enterprise and Web applications. As the use of huge data centres (DC) and huge cluster leaps up day by day, energy consumption by these DC is escalating quicker. This High energy consumption not only affects the high operational cost but also result into high carbon emissions. Optimal energy solutions are required to curb the impact of Cloud computing on the environment. Increased processor chips utilisation liberates more heat. This unnecessary heating requires more cooling and cooling again generates heats and thus we come to a stage where we want to balance the system by getting the same computing speed at decreased energy consumption. This study is intended to serve as up-to-date guidance for research with respect to green cloud computing.



### **3. Manufacturing eco-friendly IT equipments and disposing of computing devices in a way that reduces their environmental impact.**

Green computing is the time period that is used to indicate the profitable use of assets in computing. The key mission of green computing is to reduce energy consumption. In basic terms, green computing involves reducing the environmental impact of technology. That means using less energy, reducing waste and promoting sustainability. Green computing aims to reduce the carbon footprint generated by the IT and systems business and related industries. Energy efficiency involves implementation of energy-efficient central processing units (CPUs), servers and peripherals as well as reduced resource consumption. Greening of technology has a potential role to play in enhancing environmental sustainability by making the entire product life cycle of technologies and products greener, including research, manufacturing, use and disposal. If we think computers are non-polluting and consume very little energy, in fact the use of computer plays a big role in environment pollution so the modern concept in IT sectors working with greener concept like: \*Green design: Designing energy-efficient computers, servers, printers, projectors and other digital devices.\* Green manufacturing: Minimising waste during the manufacturing of computers and other subsystems to reduce the environmental impact of these activities.\* Green use: Minimising the electricity consumption of computers and their peripheral devices and using them in an eco-friendly manner.\* Green disposal: Repurposing existing equipment or appropriately disposing of, or recycling, unwanted electronic equipment. Green Computing has an optimistic future for saving the environment with ample avenues for making it possible. Hope we move forward with the goal of efficient computing while making the earth greener. Computer hardware is essential for modern life, but it also has a significant environmental impact. From the extraction of raw materials to the manufacturing, use, and disposal of devices, computer hardware contributes to greenhouse gas emissions, resource depletion, waste generation, and pollution. We need to reduce the environmental impact of computer hardware production and consumption. The extensive use of computers and IT has made our life easier and as such the use of IT is ever on the increase resulting in greater power consumption. Greater power consumption means greater emission of greenhouse gases. One of the main ways to reduce the environmental impact of computer hardware is to choose devices that consume less energy and have longer lifespans. Energy-efficient devices not only save our money on electricity bills, but also reduce the carbon footprint of our hardware. We require devices that have energy-saving features, such as low-power modes, automatic shutdown, and smart sensors. We can also check the energy ratings and labels of devices, such as Energy Star, EPEAT, or TCO, to compare their performance and environmental standards. It is observed that most of the computer energy is often wasteful. This is because we leave the computer ON even when it is not in use. It is observed that most of the data centers do not have sufficient cooling capacities. This results in environment pollution. This could be because of defects in Manufacturing techniques, packaging, disposal of computers and components. Another effect is because of toxicity. There are toxic chemicals used in the manufacturing of new computers as well as disposal of old computers and components which can enter the food chain and water. In today's world, it is nearly impossible to find a home or a business center without a computer. With such popularity, the inefficient disposal of computer equipments has known to cause many harms to our planet earth. This gave evolvment to the concept of green computing. Green IT (green information technology) is the practice of creating



and using environmentally sustainable computing resources. Green IT aims to minimize the negative effects of IT operations on the environment by designing, manufacturing, operating and disposing of servers, PCs and other computer-related products in an environmentally friendly manner. The motives behind green IT practices include reducing the use of hazardous materials, maximizing energy efficiency during a product's lifetime, and promoting the biodegradability of unused and outdated products. Green computing is the design and use of resources that are environmentally friendly and sustain computing power without degrading it. Resources used in computers are recycled after use. Companies making these devices should use less energy and be more biodegradable. The majority of IoT devices are energy efficient sensors, which has led to their massive use by industrial players. These sensors also help advance IT to use wireless networks efficiently. Data centers provide data storage and processing capabilities for big data. Cloud computing platforms face the challenge of increasing numbers of IoT devices. These IoT devices require low latency and mobility, which is why they employ edge computing for real-time services. Fog computing is a distributed computing paradigm aimed at connecting network devices at different computing layers. It provides IoT devices with low-latency responses that centralized cloud computing architectures cannot provide. Green computing focuses on preserving computing power while reducing energy consumption and being environmentally friendly. Computer CPU manufacturing technology has advanced, making it more energy efficient with each generation. However, as the number of computing devices in use has increased, it has become imperative to meet the demands of green computing. Green computing has been introduced to cloud computing to reduce energy consumption and reduce the use of harmful substances within devices. Cloud computing services are used to meet the ever-growing demand of IoT. Data centers are becoming one of the largest energy consumers to provide the infrastructure for the IoT paradigm. The demand for energy will increase in the future as more innovation emerges and technology follows new practices that lead to the adoption of green computing. Green computing strategies reduce the energy consumption of IoT devices without compromising performance. This research paper evaluates many aspects of green computing and analyzes key concepts, challenges, and mitigations in all area of computer operations and global net system. The foremost purpose for doing research on green computing is to reduce the dangerous material, utilize energy efficiency during the product's lifetime and promote the proper disposal and recycling of computer products.

#### **4. Green Computing proposition: " Reduce, Reuse and Recycle "**

There are several ways of saving energy and cutting down greenhouse gas from our end-free up the memory space in the computer; Clean up the e-mail box (in and out mails) periodically, not doing these means greater demand for storage and energy used by that storage; limit the number of recipients for each e-mail (cut down the number of cc's to) ; cut down the size of the attachments; enter the URL address directly rather than use a search engine. : don't leave our computer and accessories on overnight (as many offices do), not even on ' sleep mode' ; Cut down the power by doing more 'offline' work than online i.e. Talk more and twitter less as we know Facebooking and Twittering burn carbon and make carbon dioxide. Another way to reduce the environmental impact of computer hardware is to recycle or dispose of our devices responsibly when they are broken or obsolete. By recycling or disposing of our devices properly, we can prevent the release of toxic substances, such as lead, mercury, or cadmium, into the environment. We can also recover valuable materials, such as metals, plastics, or glass, that can be reused or remanufactured into new products. We can recycle or dispose of our devices through authorized collection points, recycling centers, or take-back schemes that comply with environmental regulations and standards. Whether it can be small or large scale business, it is a must to know the pros and cons in order to understand why it is important to the environment. Green computing is the environmentally responsible and eco-friendly use of computers and their resources. In broader terms, it is also defined as the study of designing, manufacturing/engineering, using and disposing of computing devices in a way that reduces their environmental impact. By learning more about the environmental implications of computer hardware and software, we can make more informed and conscious decisions about our computer choices and behaviours. We can also share our knowledge and experience with others, such as our family, friends, colleagues, or online communities, and encourage them to adopt more sustainable practices. we can also support or join initiatives, campaigns, or movements that advocate for greener computer hardware policies and practices. When it comes to research for Green Computing, the practice is not just to promote the efficiency, but involves number of activities by which we can develop a software or application that can reduce electronic waste for computer resources. Research covered specific area of green computing are: Increasing Energy efficiency at Data Centers; Recycling and Disposal; Telecommuting; Virtualization of server resources ;Thin Client Solutions; Use of open source software; The development of new software that address green computing for internal use and potential sale to other organizations; Cloud Computing Usage; Energy Efficient Coding etc. There are different approaches in green computing. It is not only about manufacturing eco-friendly IT equipments, it is also about how the applications

are going to be used in various fields overall promoting environment sustainability. The main concept behind green computing is "Reduce, Reuse and Recycle". Although green computing includes many benefits to the environment, it also comes with some downfalls. The main advertised benefits are those which refer to energy efficiency. In order to comply with regulations on environmental protection, the companies which offer cloud services should reduce to a minimum the consumption of energy from non-renewable sources and replace it with renewable energy consumption. The studies undertaken so far have highlighted that the index of clean energy usage is still quite high, outrunning the energy obtained from non-renewable sources. The use of green cloud computing may influence the reduction in the amount of equipment required by organizations and the speed of replacement. However, the cloud market is constantly growing and, if the current tendency continues, the effects on the system will be seen sometime in the future. Clearly, favorable effects on the ecosystem will be seen if green cloud computing suppliers and consumers become fully involved in the issues, as is the case for any policy or strategy which highlights the importance of the environment. As a result of the research undertaken, we mention the following aspects, which should be considered by cloud suppliers as well as users if cloud computing is to have a favorable relationship with the environment. (1) Providers of cloud computing services should justify the benefits to organizations in terms of a proper cost-benefit ratio. (2) Cloud technologies should be implemented according to green ICT principles, with the minimum possible negative influences on the environment. (3) Reducing energy consumption, CO<sub>2</sub> emissions (4) Environmental organizations should make sure that information is clearly available on the influence of cloud technologies on the environment. Specific objective analyses should be performed, aimed at providing data to organizations interested in adopting these technologies. (5) Cloud service suppliers should be aware of all the environmental recommendations in every country and adapt their activities accordingly

## 5. Conclusion and future scope

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. In this paper we addressed the problem of traditional ways and practices in IT and computer related field and the use of green IT, at the same time we enlighten the recent work which has been done in the field of go green computer field for healthy and greener environment. Consequently we gave a comparative study in the field of green computing. There are many possible directions of future work. While in this research article we address the problem of efficient way to fetch the results so that all the features covered work can be achieved. Green computing encourages the reclamation and reuse of materials, resulting in less electronic waste and environmental pollution. This technique prioritizes the use of non-toxic materials. Environmental economics encourages the wise management of natural resources and their preservation. It seeks to reduce heat production in computers and other electronics to protect the environment. Green computing makes us accountable for the environment and lays the groundwork for a more sustainable future. Companies resist the shift because they have no concern for the environment and intense competition in the market. As a result, everyone must endure the consequences. Further we can implement the approach to automate the manager of the green computing who makes all the decisions regarding the services.

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