

# A SURVEY ON GREEN CLOUD COMPUTING

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## Abstract

Green cloud computing has been concerned with building cloud computing resources in the way that minimises their environmental effect. Green clouds have the potential to save the significant amount of energy while also lowering operating expenses. Due to the rapid increase in global temperatures, this is now a requirement. A green cloud computing strategy is essential as more enterprises migrate to the Internet of Things (IoT). HPC that is High Performance Computing, corporate, as well as web applications may all be run on the cloud because to its scalability and economics. There has been a rapid increase in the utilisation of big data centres (DC) as even the demand for such data centres grows. This High energy use leads to large operating costs as well as high emissions of greenhouse gases. Cloud computing may have a negative influence on an environment if the right energy solutions are not implemented. Additional heat is released when the use of processing chips increases. As a result of this wasteful heating, the system must be cooled further, which in turn creates additional heat. We must thus find a way to achieve system equilibrium while using less energy. An energy-optimized cloud computing system is possible using a green algorithm. An overview of the green cloud computing is provided, along with information on how it may be implemented. Green cloud applications as well as problems are also discussed in this article.

**Keywords:** Cloud computing, Green cloud computing, Environment Sustainability, Energy Consumption.

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## 1. INTRODUCTION

Because of the widespread use of computers as well as data centres, a significant quantity of electricity is already being used. All of today's industries, from healthcare to autos to banking sector are heavily

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reliant on IT, which results in a high amount of the energy consumption and a rise in expenses, that's why Green computing was born. It is the primary goal of the Green computing to ensure that all computer equipment are utilised efficiently and environmentally friendly, such as the design as well as manufacture of devices. Also, the gadgets are to be recycled and reused as part of the plan. Designed to promote digital equipment recyclability while also promoting energy efficiency, the Energy star programme was created by the Environmental Protection Agency to promote a more environmentally friendly approach to the IT sector. A few of the approaches to encourage green computing are just as follows. Design, production, and disposal all fall under the category of environmental friendliness.

## **2. NEED FOR GREEN CLOUD COMPUTING**

In today's environment, it's impossible to envision a day with no usage of some kind of technological innovation. We're dealing with a lot of the data since we're using a lot of the technology-based items. Different data centres throughout the globe maintain this massive quantity of information. Since you don't want your server to fall down, one need to have a lot of the energy and electricity to keep such data centres running smoothly as well as effectively at all times. In today's world, information technology permeates almost every industry. Banking, Healthcare, the media, as well as automobiles are just a few of the industries that depend on IT on a daily basis. Without it, operations would grind to a halt. There are numerous additional industries where it is widely used, resulting in rising energy consumption. As a result, expenses will rise over time. Technology has also seen a lot of progress in the last few years. One of these is Cloud Computing that is in great demand at the moment, among others. When it comes to using computing services, this implies that we don't need any more hardware on our end to do so. Because everything takes place online, we may take use of a distant server's processing capacity on our local workstation. This same way we presently utilise technology has been fundamentally altered by the advent of cloud computing. It's been a huge help in a lot of other areas, too. However, with the rise of Cloud Computing, we're now dealing with a massive amount of data that we weren't previously dealing with. In addition, the quantity emissions of carbon has risen as a result of the widespread usage of Cloud Computing, that might have a negative impact upon the environment. Although we can't even limit Cloud Computing since it has become an essential part of our life, we can find strategies to lessen the negative emissions that arise from it. Finally, Internet of Things (IoT) concerns with actual goods that connect and interact via the Internet using sensors as well as software built into them. Connectivity, data, as well as the internet are all words that may be used in the same phrase because of Cloud Computing and indeed the massive data centres located at the faraway servers. Thus, the Internet of Things relies heavily on the data centres for its infrastructure. Data centres, on the other hand, need a lot of power. New technology and goods have led to an increase in energy consumption, which is a direct result of this trend. There is a need to lower the quantity of energy used whereas still using such resources, thus we must discover a means to do this. Thus, Green Cloud Computing has emerged, referring to the environmentally benign method wherein Cloud Computing is used. It is the goal of Green Cloud

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Computer to utilise computing resources in an environmentally and economically responsible manner, while yet delivering the very same value to an end user as before. More and more businesses throughout the globe are embracing Green Cloud Computing. In today's society, there are several reasons why Green Cloud Computing is essential.

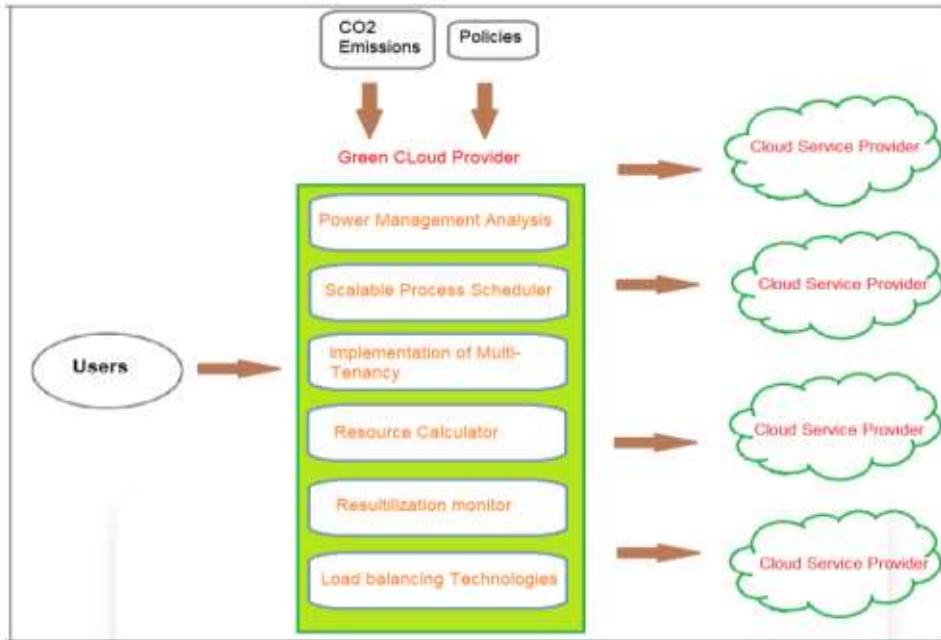


Figure 1: Green Cloud Computing Architecture

Understanding computer's life cycle is essential before implementing the GREEN IT idea. Fig. 1 was used to demonstrate this point. There are a few of these green groups that aren't quite that eco-friendly:

- 1) Data centres and corporate computing ecosystems throughout the globe may benefit from the Green Grid, a worldwide alliance of IT firms and professionals dedicated to increasing energy productivity in the data centres. Microsoft, HP, APC, as well as Dell are just some of the companies represented just on Green Grid's board of directors, along with other major technology companies like IBM as well as Intel.
- 2) A federal agency, the U.S. Environmental Protection Agency (EPA), was established to protect human health as well as the natural environment. This group also collaborated with the US Department of Energy as well as the US Environmental Protection Agency to establish the Energy Star programme.

End users in a business have a variety of priorities when it comes to implementing GREEN IT. Such are the ones I'm talking about:

- Energy/Power expenditure – When we use electricity, we must conserve it.

- Reuse - After recycling, it's important to think about whether or not the parts we've collected may be put to good use.
- Hardware/Software- Relevance in terms of computer acquisition.
- Energy utilization- The efficient use of resources and the systematic approach to computing that it requires.
- Minimize misuse- Utilizing computers to reduce the amount of Organic resources that are wasted.

### 3. PARAMETERS USED FOR MEASURING POWER CONSUMPTION

Processor and data centre power consumption can be assessed using a number of different parameters, including TDP, DCiE, PUE and Performance per Watt, as well as metrics such as Carbon Usage Effectiveness also represented as (CUE), Water Usage Effectiveness also represented as (WUE), and Data Center Productivity (DCP), all of which are used to determine how efficiently a processor or even the data centre is using energy. [1].

Table 1: Parameter used for Power Performance

Parameter	Description
Carbon usage Effectiveness (CUE)	The data center's contribution to global warming pollution is quantified using this metric. $CUE = ECO2/EI$ , and there $Eco2 = \text{Entire co2 emitted from the total energy consumed by data centre facility}$ . $EIT = \text{IT equipment's total power consumption}$ .
Water Usage Effectiveness (EUE)	Each year, it's a way to calculate how much water a data centre needs. Here's how it's calculated: $WUE = \text{Water used yearly} / EIT$ In other words, it's an indicator of how much productive labour a datacenter has produced. $DCP = \text{Useful Work-done/Tresource}$ , wherein Tresource is the total amount of resources needed to do such useful work.
Data Centre Productivity (DCP)	The greatest amount of electricity that can be dissipated by a computer system's during cooling is measured by it. In the context of an actual application, this is the max amount of power that a computer chip may consume.
Thermal Design Power (TDP)	The greatest amount of electricity that can be dissipated by a computer system's during cooling is measured by it. In the context of an actual application, this is the max amount of power that a computer chip may consume.
Power Usage Effectiveness (PUE)	Comparison of computer application as well as infrastructure equipment energy consumption as well as overhead energy waste is one of its primary uses. $PUE = \text{Total Facility Power} / \text{IT Equipment Power}$ .
Data Center Infrastructure Efficiency (DCiE)	In other words, it is PUE's opposite. For comparing efficiency of the data centres, PUE as well as DCiE are two measures that are widely used in the industry. $1/PUE$ is the formula for DCiE. $DCiE = \text{IT Equipment Power} / \text{Facility Power}$ .
Performance per Watt	The amount of data a processor could process for every watt of electricity it consumes is known as its throughput. This has to be a record. In other words, it assesses how much work a computer can do for each watt of electricity it uses.

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Green Energy Coefficient (GEC)	Measurement of green energy (electricity from renewable sources) being utilised by a datacenter's facility. There are 1,000 kilowatt-hours in one kWh. As Green Energy Consumed/Total Energy Consumed, GEC is described as:
Compute Power Efficiency (CPE)	A datacenter's computational efficiency may be measured using this metric. Each watt of electricity spent by a server or cluster was not productive all the time, thus some facilities used power even when they were idle, while others used power to do computation. To calculate CPE, divide IT Equipment Utilization by PUE, which is equal to the product of IT Equipment Utilization and IT Equipment Power.
Energy reuse factor (ERF)	Energy that can be reused except in a datacenter and is consumed by the facility is referred to as reusable energy. Total Energy Consumed/Re-used Energy Used = ERF.

## 4. GREEN COMPUTING APPROACHES

Businesses are using the given green computing techniques.

**Virtualization & Use of Terminal Servers:** It is possible to run numerous operating systems on a single machine using virtualization, a technique known as "terminal server virtualization." Applications seem to execute on separate machines. Up to 80percent of total of energy may be saved by using shared servers as well as terminals. [2]

**Power Supply & Power Management:** Only 60percent of total of power available was utilised for transmission and 40percent of total was squandered. Green computing technology is expected to reduce the amount of energy required. Utilizing a green method for the cloud computing power management lowers overall power usag. [2]

### I. APPLICATIONS IN GREEN CLOUD COMPUTING

There is a lot of interest in green computing there in areas as follows:

- Management of data centres' energy use
- a green wireless network
- Using a Big Data Network and Green Parallel Computing together is a powerful combination
- Green computing via the use of algorithms.

## 5. RENEWABLE ENERGY AND GREEN COMPUTING

The public cloud offers better scalability as well as flexibility to enterprises than on-premises technology. Using the cloud may reduce an organization's carbon footprint, something big cloud providers have been known to highlight on occasion. A good illustration being "Data Center Alley" in the Northern Virginia, which is home to over 100 data centres as well as 10 million sq ft of the data centre space, as well as is not too far from the ParkMyCloud's headquarters. [3] Data centre business

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was welcomed in the Northern Virginia since the good economic effects. More data centres will be required as the demand for the cloud services develops. It is estimated that the installed energy capacity of nine big (500-MW) coal power plants in the Northern Virginia was 4.5 gigatonnes of the commissioned energy previous year. Major cloud providers like (AWS) that is Amazon Web Services have been criticised by Greenpeace as well as the other environmental groups for not doing more to safeguard the environment while running data centres. As per them, the problem would be that the cloud providers depend on the commissioned energy from the energy firms who only concentrate on the dirty energy (coal but also natural gas) as well as very little over renewable energy efforts. Although the claims have drawn attention to energy companies, we demanded to discover what (incase anything) the main cloud providers do to lessen their dependency on such sources of energy as well as supply data centres with the cleaner fuel to make the green computing a reality.

## **6. FUTURE OF GREEN COMPUTING**

Instead than focusing on reducing energy usage, Green Computing's future will be built on improving performance. According to Green IT's primary goal of reducing the organization's own carbon footprint, energy costs are reduced both in Data Centers and on individual computers. Secondary to Data Center's energy consumption, Green IT has to concentrate on an innovation and better integration with broader corporate social responsibility activities. As a result of this supplementary emphasis, Green Computing techniques must be developed [5]. In the context of sustainability, corporate value is created although long-term environmental resources really aren't adversely affected by the activities of the company.

## **7. GREEN INITIATIVE IN GREEN APPROACHES**

### **Virtualization**

Because of the requirement to save separate systems from being overly used, virtualisation was born. However one technology that allows users to connect to servers from a distance is virtualization. As a consequence of this, original hardware as well as system may be disconnected from integrated system, which reduces power usage and need for additional cooling. Instead of putting up a server as well as cooling system, a large system server may be accessed through virtualization rather than a physical installation (Green Computing, in the year 2013). By severing the ties that bind applications, system services, components, as well as storage systems, virtualization is ideally suited for usage in environmentally friendly computing. The existence of virtualization is supporting green computing in many forms. Green initiative nowadays moved into the concept of the virtualization where cloud computing have a major role in that. The statistics of cloud users based upon the benefits provided by them has been increased sufficiently for the last two years.

### **Power Management**

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The longer battery life, lower cooling needs, and less noise all emphasise the importance of the power management in almost any computer system. The costs needed for operation of the system is also considered to be one of the main reason for the individuals to concentrate more on the power management support in the system resulting in the stability of the system leading to probable maintenance of the impact that it can create on the environment. As an example of the power management approach that has been widely and efficiently supported, a system's hibernation option turns off the RAM as well as CPU automatically, minimising the amount of the background system activity. There are certain programs available nowadays that can actually alter even the voltages of the system probably resulting in the reduction of the heat produced and electricity consumed in the system which is generally called as under voltting.

### **Power Supply**

The use of green technologies for power supply will also aid in the realisation of green computing idea. The more power the system uses, more effective it may be designed. Individuals may save the most electricity in system by acquiring and utilising power providers that have earned "80 plus" accreditation "State Legislation on E-Waste, 2008". Energy consumption as well as heat generation may be reduced by using this kind of energy-efficient and usable power supply.

### **Displays**

The heat generated by the screens directly affects the system's power consumption. As a result, it's generally agreed that switching to LED displays instead of LCD monitors is the best option. It's since the fluorescent bulb being used consumes more power and generates more heat than is healthy for the bulb. LCDs have been shown to be 66percentage points more energy effective and 80percent more qualified in reducing the size as well as weight of such system. In comparison it is found that the CRT is actually consuming around 120W power which is double the power that is been used by 22" LCD. As a result, it is critical for anybody acquiring a computer system to thoroughly inspect all of its components, such as displays, before making a final decision.

### **Video Cards**

As video cards can't utilise shared terminals, think clients, or even the desktop sharing capabilities that are very beneficial in conserving energy in system, reducing their utilisation is regarded a sensible option. Older video cards may be reused since they utilise less power, lowering the need for heat sinks or even fans. Choosing a GPU that has an average wattage or even the performance per watt is often regarded to become a much better option when it comes to implementing a green system.

## **CONCLUSION**

The quantity of energy used by the cloud data centres is expanding rapidly until enough companies migrate to the cloud, which has a huge impact on the planet's carbon footprint. This issue can be solved

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with green cloud computing, which reduces energy usage and optimises the distribution of resources. The development of the green cloud computing is being aided by cutting-edge AI approaches. It is possible to use green computing in a variety of sectors, including IoT as well as big data analytics. The general public must be made aware of the significance of eco-friendly computing. When it comes to the ecology, adopting green computing would be incredibly advantageous in the future.

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