A Survey on Power Efficiency in Cloud Computing to Optimize the Cost

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ABSTRACT
In this paper, we describe about power minimization in cloud computing. Cloud computing is the well-known technology for scaling of extensive data and complex computation. Increasing data volume is giving the bigger task of Data Centers (DCs) to provide a better quality of cloud computing. These DCs, servers, cooling and also security systems consume enormous power, resulting with an increase in CO2 emission and ramp-up in the operational cost. The Power Consumption (PC) rate will increase simultaneously, with DCs size expansion or increase in the number of DCs to fulfill the needs of data storage, processing and hosting demands. However, present and future environment for cloud computing is changing rapidly which ease necessity of Power Efficiency (PE) is balancing. The PC can be minimized by efficient resource management of DC in virtualized manner. This paper discusses a survey on Power Efficiency in Cloud Competing (PECC) to optimize the cost and describes the discussion over green IT technologies. Finally, future work flow towards CC cost optimization is presented.

General Terms
Green IT Technologies, Security.

Keywords
Cloud computing, Cost optimization Data Centers, Virtualization.

1. INTRODUCTION
An emerging computing model in the computer field is known as cloud computing [1] and provides many advantages. Computing model has function of scalability for required cloud and the virtualized resources are used as service on internet [2]. CC is conventional technology in networking field consisting of parallel computing, distributed computing, technologies of network storage, utility computing, load balance and virtualization etc. are combined with other different product [3]. CC functions on demand access of computing resource (configurable) by setting the software and hardware systems over data center. The green computing is the advanced version of cloud computing helps in high performance design, having efficiency in power consumption and with safe mode of operation [4]. CC possesses three service delivery models (SDM), such as:

i. Software as a service (SaaS): This allows users of cloud to access the provider's apps (PA) over the internet.

ii. Platform as a Service (PaaS): This allows users to deploy their apps on platform development which service provider of cloud (SPC) provides.

iii. Infrastructure as a Service (IaaS): allows users to rent, storage, processing of network capacity by SPC.

The CC is exhibit security issues for both the users and suppliers. The provider can ensure their services and resources are used only by concerned users; user likes to ensure their data need to be maintained securely over the cloud and were servers are not performing this [5]. The present generation or society is dependent over data. The growth in mobile devices, adoption of cloud data networking and also data storage needs are creating huge data traffic. The emerging issues of data centers and also digital content, media, technology, software are associated with these [6].The development over CC and technology of network communication, service providers of cloud such as Microsoft, IBM, Yahoo and Google are deploying the data centers in all the locations all over the world to have better cloud services [7].

The data centers are used to host the cloud applications are normally consuming enormous amount of electrical energy, which yields increment in operational cost and more emission of Co2 for the environment [8, 9]. There are green computing technologies for cloud service issues, which helps to reduce the operational cost and also the carbon impact on environment. Many governments are focusing on the issues of carbon emission reduction, so that the impact over climate hazardous can be reduced [10]. Minimizing the usage of electrical energy in data center is the challenging task and is the complex issues as the computing apps are growing with enormous data hence the load on the server also increasing which causes requirement of more disks to process in desired computation time. The green cloud computing is playing a vital role as business point of view, where the energy saving during resource allocation is considered for account. Hence, resource allocation should be done properly and also energy efficiency is need to be achieved [11].

This paper aims with the survey on energy efficiency in cloud computing and also related work on it. Also IT industries adoption of green cloud computing, statistics of energy efficiency in cloud computing is also discussed. The rest of the paper is organized as follows: In Section 2 presents the background of this paper. Section 3 provides statistics of energy efficiency in cloud computing. Significant related work done by other authors. In Section 4 gives research methodology conducted in this paper. Section 5 introduces security issues in mobile payments. Finally, Section 6 and 7 gives the future research direction and conclusion respectively.

2. BACKGROUND
2.1 Data Center
A data center (server farm) is a unified archive for the capacity, administration, and dispersal of information and data. Commonly, a server farm is an office used to house PC frameworks and related segments, for example, information transfers and capacity frameworks. Regularly, there are excess

or reinforcement power supplies, repetitive information correspondences associations, ecological controls, and security gadgets. In April 2005, the Telecommunications Industry Association (TIA) delivered determination TIA-942: Telecommunications Infrastructure for Data Center. This was the principal standard to explicitly address server farm framework. This standard incorporates all parts of server farm plan, including cabling, office, system outline, and server farm levels (see sidebar). One key advantage to the server farm is that physical hard drive stockpiling assets are accumulated into capacity pools, from which "sensible capacity" is made. The heterogeneous way of most stockpiling frameworks permits various merchants' stockpiling equipment to be added to the framework with practically no perceptible impact (aside from the extra storage room) [14].

These intelligent storage rooms can be come to from various PC frameworks that have the same pool of storage room. One of the greatest advantages to capacity virtualization – other than the conspicuous ones, for example, brought together reinforcements an the requirement for less hard drives generally speaking – is the way that the information can be imitated or moved to another area straightforwardly to the server utilizing the consistent stockpiling point. One of the not all that fabulous or "hello there tech" advantages of the server farm is the combination of the greater part of the office assets, for example, HVAC, electrical, system associations, wiring, equipment, programming, and individual. Numerous companies have various server rooms with copied administrations over their whole association, all of which are running on copied equipment and programming stages. While trying to diminish duplication and squandered cost, numerous companies are merging their server rooms into private server farms, decreasing the duplication of equipment, programming, and offices expected to work their business [15].

2.2 Cloud Computing

Utilizing outsider registering ability over the system is a decent approach to cut costs, build scale, and enhance spryness. The idea of distributed computing includes a server farm some place on the planet, or even various server farms scattered far and wide. This is an outlook change from the authentic customer server design where the system clients possessed, kept up, and worked their own particular system framework, server rooms, information servers, and applications [16]. Run of the mill distributed computing suppliers convey regular business applications online that are gotten to from web programs, while the product and information are put away on the servers or SAN gadgets. These applications are extensively isolated into the accompanying classifications: Software as a Service (SaaS), Utility Computing, Web Services, Platform as a Service (PaaS), Managed Service Providers (MSP), Service Commerce, and Internet Integration. These server farms are facilitating the servers and applications the customers use to work their business. This structure diminishes capital consumptions, since by leasing from an outsider supplier to give the administrations to a scrutinize charge the business pays for the assets utilized [17]. Some Cloud suppliers utilize a utility processing model, which means they charge customers like an utility, for example, an electrical organization. Others bill on a membership premise. In either case, the client picks up the security of an administration level understanding (SLA) and in addition the spared cost of contracting an IT staff to keep up a neighborhood server ranch. There are numerous assets accessible in a server farm and in the cloud that a customer can buy or lease, for example, preparing time, system transfer speed, plate stockpiling, and memory. Customers just need to know how to associate with the assets and how to utilize the applications expected to perform their employments. With cloud-based figuring, the applications keep running on servers in the server farm, not the neighborhood portable workstation or desktop PC the client is working. The client's PC gives a window into the application, yet does not really run the application; as such, it runs a client interface. This technique lessens the requirement for huge preparing force and memory on the end client's PC and brings together it in the server farm [18].

2.3 Benefits of Cloud Computing (BCC)

Cloud computing has many advantages compare to the convention computing methods [19]. Advantages of cloud computing are shown in table.1.

Table 1. Gives the Benefits of Cloud Computing.

Flexibility	CC is flexible, due to its quicker capacity to update the software's and hardware's to keep technology update with user demands.
Savings	By CC IT personnel and capital expenditure can be reduced.
Reliability	CC allows business continuation and loss recovery by providing multiple data centers over the cloud.
Scalability	The load balance among all the users can be called out by CC using multiple hardware platforms.
Security	The data sensitivity centralization allows improving the security as data can be removed from user machine. Cloud providers provide all updated security to protect the data.
Maintenance	The centralized update for user's machines will help in maintenance.

2.4 Green IT Technologies in Cloud Computing

IT industry is degrading the environment in many ways, out of them Green IT sustainability matrix is shown in figure.1. The IT industries consume enormous energy and produce

the emission of more green-house gas, during usage, production and also IT hardware disposal also leads severe many environmental issue.

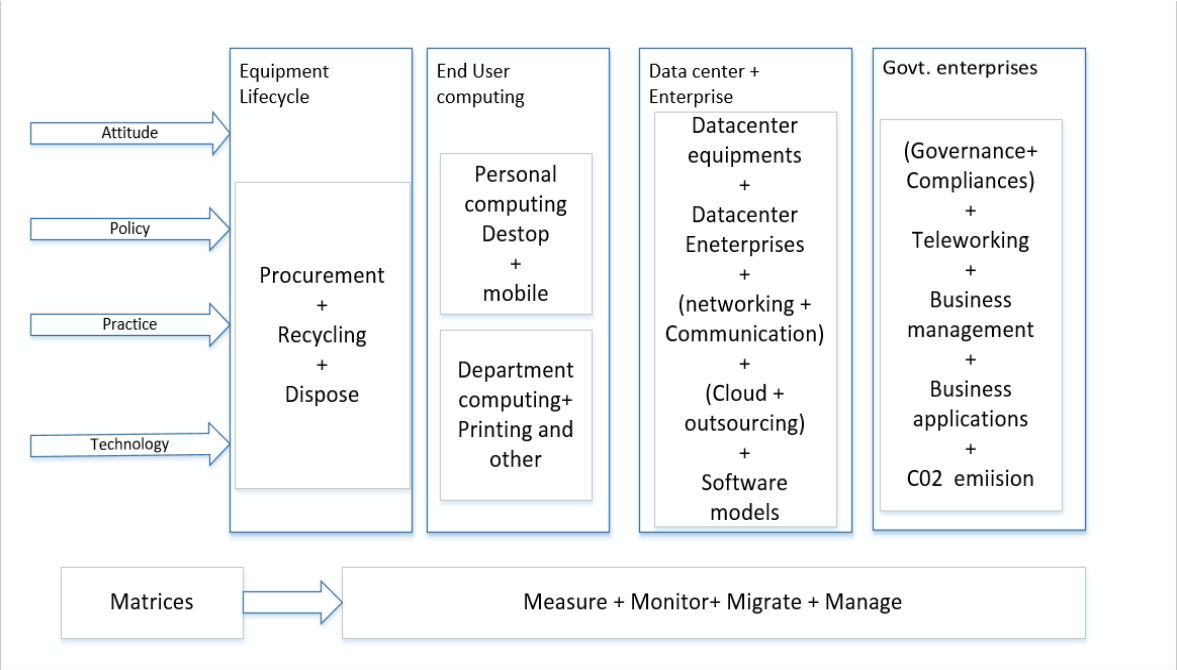

Fig 1. Matrix sustainability for Green IT technology

The Green IT technology helps in reduction in greenhouse gas, energy efficiency improvement and also allows recycling and reuse [20]. The waste disposal cost increment and environmental legislation are approved research in green IT initiation. There are many frameworks developed in Green IT to reduce the energy consumption and greenhouse gas. One of the frameworks is discussed in this paper. The framework is consisting of five different phases which divide datacenter into resource pools and also green matrices such as energy efficiency, datacenter efficiency and CO2 emission measurement. These frameworks help in matrices measurement, evaluation [21].

3. STATISTICS OF ENERGY POWER EFFICIENCY IN CLOUD COMPUTING

The statistics of Energy efficiency in cloud computing is surveyed in the IEEExplore (cited on 29/01/2016 at 7.15, pm) and following data is found:

Table 2. Gives the Research Statistics in Cloud Computing

SI. NO	Type	Count
1	Conference publication	25,764
2	Journal and magazine.	2,651
3	Early access articles	460
4	Books and eBooks	86
5	Standards	2
6.	Courses	37

Further when the search is refined with the key term 'energy efficiency', then the statistics are shown in table.2.

Table 3. Gives the Research Over Energy Efficiency in Cloud Computing.

SI. NO	Type	Count
1	Conference publication	778
2	Journal and magazine.	130
3	Early access articles	46
4	Books and eBooks	3

From the above survey, it is known that research in energy efficiency as per IEEE Xplore (table 2 and table 3), the conferencing publications have only 3.01% of cloud computing, while the journals and magazines are of 4.9% of Cloud computing. The early access articles found in energy efficient cloud computing is only 10 % and have 3.4% of books and eBooks on energy efficient cloud computing. There are no standards and courses energy efficiency cloud computing. The plot of above statistic is shown in fig.1. Where the x-axis represents the IEEEXplore data type and y-axis gives the count.

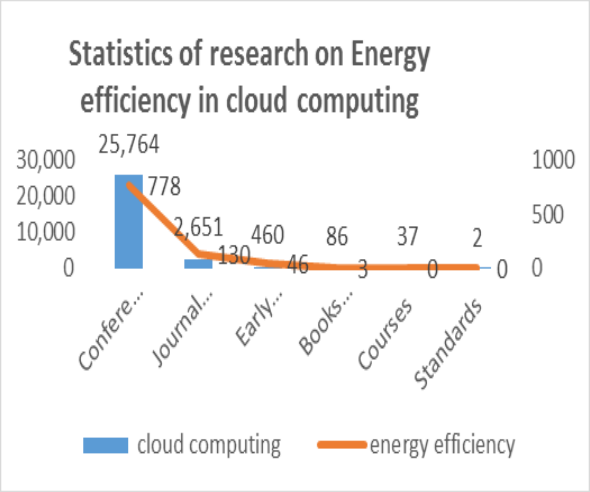

Fig.2 The plot of statistics (Energy efficiency in cloud computing)

4. LITERATURE SURVEY

Cloud computing helps in providing better computation for massive data. This section lights on the related works done over energy efficient cloud computing (EECC) and is tabled as below:

Table 4. Shows Literature Reviews of Power Efficiency in Cloud Computing.

Authors	Workdone
Miettinen and Nurminen [22]	Have discussed about the factors afffecting the energy consmption (EC) in CC for mobile users. Authors have next provided the charecterstics of mobile devices. The study outcomes with the proper solutions for mobile cloud computing (MCC).
Anton and Buyya [23]	Have presented a technique for cloud computing in a virtual network.
Qian and Medhi [24]	Have introduced an optimization model to reduce the operational cost. Also provided EC in the virtual environment.
Verma and Kaushal [25]	Have illustrated cost time (CT) optimization algorithm to schedule the workload and minimize the cost. Authour has considered budget and deadline constrains but not a quality of service.
Breitgand et al. [26]	Have given a cloud-based service model in virtualized environment to enhance the profit rate by keeping QoS. Authors have the contribution towards the formulation of integer linear program.
Bittencourt et al. [27]	Have presented an optimized cost scheduling algorithm for hybrid cloud (OCSAHC). The authors experiment concludes that the algorithm will reduce the cost in desired computation time.
Poobalan and Selvi [28]	Have presented an optimized cloud resource allocation algorithm (OCRAA) to formulate the programming model. Authors have considered price and cloud.
Dabbagh et al. [29]	Have presented the energy efficient framework for cloud computing (CC) by considering cost and virtual environment. The authors have experimented with taking Google data for 29days and outcomes with the substantial energy savings.
Farahnakian et al. [30]	Have presented distributed architecture for the virtual machine to reduce the EC in the cloud by keeping similar QoS.
Nguyen et al. [31],	Have discussed the data center activity in variable environment and its energy efficiency (EE). An author has provided a solution for virtual environment by formulation and concludes that the proposed system provides the better performance.
Zhan et al. [32]	Have presented a new method to divide the power between computing infrastructure and cooling purpose. The author focused on power reduction in cooling, to provide full power for CC. The study outcomes with the 3-4% better performance in power budgeting over the data center environment. The performance is evaluated in power budget and power saving case.

By the closer observation of above literature, it is categorized into two types of research on cloud computing (CC) and literature on power efficiency (PE) and are briefly explained below:

4.1 Cloud-Computing

Anton and Buyya [23] have presented a technique for cloud computing in the virtual network. The authors concluded the proposed method with high efficiency in many different load conditions. Verma and Kousal [25] have illustrated cost time (CT) optimization algorithm to schedule the workload and minimize the cost. Authors has considered budget and deadline constrains but not the quality of service. The cloud computing issues like resource management and user schedule are addressed to maintain the workflow.

Breitgand et al. [26] have given a cloud-based service model in virtualized environment to enhance the profit rate by keeping QoS. Authors have contribution towards formulation of integer linear program and federated placement problem is applied to load balancing and solving the issue within the cloud. Bittencourt et al. [27], have presented an optimized cost scheduling algorithm for hybrid cloud (OCSAHC). The authors experiment concludes that the algorithm will reduce the cost in desired computation time. The OCSAHC algorithm decides the proper resource release from private cloud to provide required processing power to have workflow within the computation time. Poobalan and Selvi [28], have presented an optimized cloud resource allocation algorithm (OCRAA) to formulate the programming model. Authors have considered price and cloud. The authors have examined many approaches.

4.2 Energy/Power Efficiency (PE)

Miettinen and Nurminen [22] have discussed about the factors affecting the energy consumption (EC) in CC for mobile users. Authors have next provided the characteristics of mobile devices. The study outcomes with the proper solutions for mobile cloud computing (MCC). Authors also described with concrete example, which favors energy savings. Also the workload issues in CC.

Qian and Medhi [24] have presented an optimization model to reduce the operational cost. Also provided EC in virtual environment. The authors have considered two factors 1) Dynamic Voltage/Frequency Scaling (DVFS), 2) turning servers on/off over a time horizon. The study outcomes with the EC in ON/OFF situation. Dabbagh et al. [29] have presented the energy efficient framework for cloud computing (CC) by considering cost and virtual environment. The authors have experimented with taking Google data for 29days and outcomes with some energy savings.

Farahnakian et al. [30] have presented distributed architecture for the virtual machine to reduce the EC in the cloud by keeping similar QoS. Nguyen et al. [31] have discussed the data center activity in a variable environment and its energy efficiency (EE). The author has provided a solution for the virtual environment by formulation and concludes that the proposed system provides the better performance in EC, virtual machines migrations, and QoS.

Zhan et al. [32] have presented a new method to divide the power between computing infrastructure and cooling purpose. The author focused on power reduction in cooling, to provide full power for CC. The study outcomes with the 3-4% better performance in power budgeting over the data center environment. The performance is evaluated in power budget and power saving case.

5. ISSUES IN CLOUD COMPUTING

Security is always biggest issue in cloud computing and is the primary task for IT personnel. CC favors in storage, networking, operating system and each face the security issues. For an example, attacks on browser will the cause service issue. Some of the issues are mentioned in the following table 5 [33].

Table 5. Shows Issues in Cloud Computing.

Issues	Description
Availability	CC scales the data availability (DA) only when it is needed. This is the prime issue in safety and mission organizations. DA can be extended only by another provider migration. Ex: Google Gmail, Google Gmail, Windows Azure, Flexi Scale, Amazon S3, etc.
Data Security	CC risks loss of personnel, physical and also logical data control. The risk includes vulnerabilities of virtualization, vulnerabilities of SaaS (i.e. exposure of Google Docs in private user files), scams of phishing etc. Also a risk includes data interception and data leakage, encryption key losses, distributed service and economic denial. The only risk of resource sharing and multi-tenancy are included. CC lacks with segregated data and confidential data exposure in co-tenants investigation time. Authorizarion issue in financial, health and in insurance data.
Third-Party Control:	This issue is the primary concern for the cloud, due to growth in corporate information. TPC leads to trade secret and property losses. Sometimes the user may lock to the some vendor, which causes difficulty in data migration of new vendor. Recovery of lost data will be difficult in TPC.
Privacy and Legal Issues	The data distribution over cloud may leads to the data privacy issue, where the user provides personal information (PI) without knowing the his privacy security.

6. RESEARCH GAP

Due to the vast applications of cloud computing in many areas is facing several issues and it helps to many researchers to work over it and explore. The virtual environments are given many issues in cloud computing due to random changes in the work load. There are virtual machines to solve this issues but with less energy consumption. These virtual machines are needed to be created and the task is required to be executed again, if the software or hardware failures occur during the task processing. This issue will cause requirement more power and resource utilization. Most of the researchers have worked on service improvement or energy efficiency in cloud computing (EECC) separately. There is lack of studies in service improvement with energy efficiency (EE).

7. CONCLUSION

Cloud computing is having wide usage in world but it lacks with many issues and are addressed in the research gap, mainly the service reliability with energy efficiency. Due to increased data in today's world is also increasing the complexity in the cloud computing as per energy consumption is concerned. Many researchers are working on the optimized energy efficiency technologies with better scalability and reliability of cloud computing. This paper concluded that, there is more study is required over these issues. In this paper, the Green IT Technology framework specified helps in reduction in greenhouse gas, energy efficiency improvement and also allows recycling and reuse. This framework also provides datacenter efficiency and CO2 emission measurement.

The future scope is to optimize energy consumption and provide response time guarantee by considering the performance parameter and also by increasing the data volume so as to reduce the expenditure of cloud providers.

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