1. **Literature Review on Green IT**

Green computing, the study and practice of efficient and eco-friendly computing resources, is now under the attention of not only environmental organizations, but also businesses from other industries.

Followings are few of the significant books and journals published on Green IT

**Christian ReimsbachKounatze (June 2009)**

This paper describes the ways to improve the environmental performance, tackling global warming and enhancing resource management are high on the list of global challenges that must be addressed urgently. The information and communications technology (ICT) industry needs to further improve its environmental performance (it is responsible for around 2-3% of the global carbon footprint), and ICT applications have very large potential to enhance performance across the economy and society (the remaining 97-98%). Governments and business associations have introduced a range of programmes and initiatives on ICT and the environment to address environmental challenges, particularly global warming and energy use. Some government programmes also contribute to national targets set in the Kyoto Protocol (e.g. Denmark’s Action Plan for Green IT and Japan’s Green IT Initiative). Business associations have mainly developed initiatives to reduce energy costs and to demonstrate corporate social responsibility.

**Fatima Zahra Hanne(July 2011)**

This paper highlights the importance of the role played in reducing carbon emissions by the developing countries of the world. A crucial part of any global strategy is the role of developing countries, particularly the rapidly growing ones: the BRICS,3 others in the G20, and some other large and systemically important countries. The high- growth developing countries now include more than half the world’s population. If they succeed in continuing (post- crisis) their pattern of sustained growth as seems likely, then by mid- century or shortly thereafter, they will be
approaching advanced country levels of income with associated patterns of consumption, energy use, and carbon emissions. What those patterns will be and how we get to them is the central issue before us. If the patterns are like the present ones, the climate change battle will have been lost.


In light of an increase in energy cost and energy consciousness industry standard organizations such as Transaction Processing Performance Council (TPC), Standard Performance Evaluation Corporation (SPEC) and Storage Performance Council (SPC) as well as the U.S. Environmental Protection Agency have developed tests to measure energy consumption of computer systems. Although all of these consortia aim at standardizing power consumption measurement using benchmarks, ultimately aiming to reduce overall power consumption, and to aid in making purchase decisions, their methodologies differ slightly. For instance, some organizations developed specialized benchmarks while others added energy metrics to existing benchmarks. In this paper we give a comprehensive overview of the currently available energy benchmarks followed by an in-depth analysis of their commonalities and differences.

Marguerite Reardon (2009)

Author discusses that the data centers consume a lot of energy, which costs operators like Google and Amazon millions of dollars to run each year. And now as more digital information is "virtualized" and accessed in the cloud, centralized data centers are getting even bigger and are consuming even more energy. There is mounting pressure for big Internet companies to reduce their energy usage. Not only is it expensive, but these companies face pressure from governments and others concerned with the environment to reduce their carbon footprints.

Govindasamy, Joseph (Sep-Dec 2011)
This paper points out the green aspect of computing at its very heart, the operating system, how its capabilities can be nurtured for green benefit, and how it can be extended to fit our green architecture model in a optimum way. As per a recent review, Linux was highlighted as an operating system that has been in line of operating under the green approach. Linux is considered an environmentally friendly operating system, relative to proprietary systems. Author has also pointed out some reasons like reduced e-waste, reduced toxins, efficient power consumption and reduced carbon emissions.

**European Parliament (2003)**

The purpose of this Directive is, as a first priority, the prevention of waste electrical and electronic equipment (WEEE), and in addition, the reuse, recycling and other forms of recovery of such wastes so as to reduce the disposal of waste. It also seeks to improve the environmental performance of all operators involved in the life cycle of electrical and electronic equipment, e.g. producers, distributors and consumers and in particular those operators directly involved in the treatment of waste electrical and electronic equipment.

**Tom Worthington (2011)**

This article describes the points for studying of green technology strategies using computers and telecommunications in a way which maximizes positive environmental benefit and minimize the negative impact. The energy efficiency of operating equipment is a major concern of Green Technology Strategies. The embodied energy and lifecycle of the materials used in the design, manufacture and reuse and recycling of equipment and components are also concerns. Green Technology Strategies seeks to inform accepted management practices to achieve efficient and effective business interaction.
Dr. Lanjewar, Prof. Sheikh (2010)

This paper describes Green Computing and the impact of ICTs on the environment. One of the earliest initiatives toward green computing in the United States was the voluntary labeling program known as Energy Star. It was conceived by the Environmental Protection Agency (EPA) in 1992 to promote energy efficiency in hardware of all kinds. The Energy Star label became a common sight, especially in notebook computers and displays. Similar programs have been adopted in Europe and Asia. Government regulation, however well-intentioned, is only part of an overall green computing philosophy. The work habits of computer users and businesses can be modified to minimize adverse impact on the global environment.

Stoney Brooks, Wang, Sarker (2011)

Green IT is the latest manifestation of sustainable business practices. The decision surrounding whether or not to implement Green IT strategies, policies, and tools provides compelling challenges for organizations. While practitioners have been highly interested in this topic for a while there is also a growing interest on this topic among academicians. In this paper, author conduct a comprehensive review of both the practitioner and academic literature surrounding Green IT. By presenting the overlaps and differences between both perspectives, they aim to identify noticeable gaps in the current literature.

Mydhili Nair, DrGopalakrishna (2009)

This paper emphasis on a very important application of Cloud Computing i.e. Software as a Service, better knows as SAAS. The text of the paper has been supported by appropriate examples. The paper emphasizes on Web Services which is the implementation of SAAS idea.
Web services are open standard (XML, SOAP, HTTP etc.) based Web applications that interact with other web applications for the purpose of exchanging data. Web Services can convert existing applications into Web-applications.

**Krishnan, Dwivedi, Bhagwat (April 2012)**

This paper outlines the role of Graphical Processing Units in reducing power consumption in a data center. A data center is a centralized repository, either physical or virtual, for the storage, management, and dissemination of data and information organized around a particular body of knowledge or pertaining to a particular business. GPU computing is the use of a GPU (graphics processing unit) as a co-processor to accelerate CPUs for general-purpose scientific and engineering computing. This paper rightly emphasizes on the utility of GPU’s in reducing power consumption at a data center.

**ParthaPratim Ray (2010)**

This paper outlines the metrics used to measure data center efficiencies, energy consumption in data centers, and the impact of Virtualization. Virtualization is the creation of a virtual (rather than actual) version of something, such as an operating system, a server, a storage device or network resources. Operating system virtualization is the use of software to allow a piece of hardware to run multiple operating system images at the same time. The technology got its start on mainframes decades ago, allowing administrators to avoid wasting expensive processing power.

**LatikaMehrotra (2011)**

Green computing is the action of using computing resources skillfully. Contemporary IT systems have confidence in a difficult mix of people, hardware and networks, virtually a green computing
action must be systemic in nature, and address more and more cultured problems. Green computing is the absolute requirement to take care of environment and save energy along with operational expenses in today's increasingly competitive world. The focus of computation has shifted to efficient power consumption, less computations by improving Algorithmic efficiency and alternative energy sources. In this paper an effort is made to show how a product can remain green in all of its four stages that is designing, manufacturing & implementation, utilizing and disposal.

**Frederic Bordage (2011)**

Author enlightened the growing production of waste electrical and electronic equipment and their toxicity, the European Parliament is to update the directive WEEE from 2003. The committee recommends a simplification of administrative procedures for businesses and harmonization within Europe. They also reaffirm that producers must finance the recycling of WEEE and auction sites online are required to recover the old equipment when buying.

**Awan, Sarwar, Raza (Sep. 2011)**

This paper describes Green consumer behavior which is a very crucial subject as far as environment sustainability is concerned. Marketers have historically faced an uphill battle when it comes to marketing eco-friendly goods. Simply put, it is difficult to influence consumer purchase behavior without first impacting attitudes and values. These values, however, take a concerted effort over a long period of time to change. Finally, behavior change, the authors concluded, is hindered not only by values but by “behavioural inertia, created by forces [such as established habits] that are independent of – or at least not related in a simple way to – values”.

**Rajguru, Nayak, More (June 2010)**
This paper outlines the best practices Green practices, namely-green way of using system, the right way of designing systems that have minimal negative impact on the environment, always keeping the power and energy consumption by computer subsystems under check, reducing paper waste, recycling waste paper, reducing electronic waste, encourage usage of thin clients, telecommuting, remote administration and green computing practices.

Anandharajan, Bhagyaveni (2011)

Cloud Computing in the recent years has been taking its evolution from the scientific to the non-scientific and commercial applications. The paper describes the problem of Power consumption and Load balancing in computational Cloud. A computational Cloud differs from traditional high-performance computing systems in the heterogeneity of the computing nodes, as well as the communication links that connect the different nodes together. Authors propose to develop algorithms that can capture this complexity yet can be easily implemented and used to solve a wide range of load-balancing scenarios in a Data and Computing intensive applications. The algorithm developed combines the inherent efficiency of the centralized approach, energy efficient and the fault-tolerant nature of the distributed environment like Cloud.

Aziz, Sangyoon (2011)

In this paper, author has described about Virtualization. Virtualization technologies changed the way data centers of enterprises utilize their server resources. Instead of using dedicated servers for each type of application, virtualization allows viewing resources as a pool of unified resources, thereby reducing complexity and easing manageability. Server consolidation technique, which deals with reducing the number of servers used by consolidating applications, is one of the main applications of virtualization in data centers. The latter technique helps to use computing resources more effectively and has many benefits, such as reducing costs of power, cooling and, hence, contributes to the Green IT initiative. Authors propose server consolidation algorithm - Sercon, which not only minimizes the overall number of used servers, but also
minimizes the number of migrations. We verify the feasibility of our algorithm along with showing its scalability by conducting experiments with eight different test cases.

**San Murugesan (May 2011)**

As the world's climate heats up and more people become concerned about the environment, a new spotlight appears on information technology. IT affects our environment in many ways, but most people — including many IT professionals — don't realize this. Each stage of a computer's life, from production and use to disposal, presents environmental challenges. As businesses and governments try to balance growth with environmental risks, we're called upon to make IT systems and their use greener and, more importantly, to apply IT in innovative ways to address environmental problems.

**ZainalAkasah (2011)**

In this paper, author emphasizes on Malaysia Green Technology. This research focuses on the application of energy-efficient design in the office building; identify the problems causing BEI of the studied office building which did not achieve zero BEI; and to propose approaches that can improve energy efficiency for the office building. Interviews session with the office building management team, architect and energy consultant have been carried out. Outcome of the research shows that energy efficient design and renewable-energy technology applied in the office building are passive design, active system, and Building Integrated Photovoltaic system (BIPV). The inefficiency at the cool part of the cooling system, air movement, and chillers are the problems that have been identified. It is recommended that, continuous research is needed to ensure ZEB concept applied effectively in each type of buildings.

**JyotiTayade (2012)**
In this paper, Author focuses that adopting green computing strategies make sense not only from an ethical, or moral stand-point but from a commercial stand-point. Author describes there are many benefits achievable through the implementation of a green computing strategy such as cost savings, disaster recovery, business continuity planning.

Denis Du Bois (2007)

Data center energy savings are a huge opportunity. This paper outlines the consumption of energy in data centers. Author highlights the fact that data center consumes more energy per square foot than any other part of an office building. But they're part of an information and services supply chain that begins with raw materials and ends with the disposal of waste. The chain includes people, the space they occupy, and the cars they drive. Along the way, the chain increasingly gobbles energy and spews greenhouse gases. The IT department is in a unique position to change that. This is the first in a two-part series on IT’s role in solving energy and environmental problems.

RichaSinha, Nidhi, Diwanji (2012)

The paper describes that cloud computing is one of the fast spreading technologies for providing utility-based IT services to its user. Large-scale virtualized data-centers are established to meet this requirement. Data centers consumes large amount of computation power for providing efficient and reliable services to its user. Such large consumption of electrical energy has increased operating cost for the service providers as well as for the service users. Moreover, a large amount of carbon dioxide is emitted, results into increased global warming in near future. So, authors proposed a dynamic threshold based approach for CPU utilization for host at data center. This consolidation will work on dynamic and unpredictable workload avoiding
unnecessary power consumption. They also validate the proposed technique results with higher efficiency.

K. Mukherjee, G. Sahoo (Nov. 2010)

This paper emphasizes on the basic concept of Cloud Computing, its framework, and basic architecture of its model. Cloud computing is a general term for anything that involves delivering hosted services over the Internet. These services are broadly divided into three categories: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS). The name cloud computing was inspired by the cloud symbol that’s often used to represent the Internet in flowcharts and diagrams. This paper supports the below stated facets of client computing approach by relating it to the Beehive example, wherein the Bee’s capability to work is compared to the load of a CPU.

Tom Worthington (2011)

The subject matter is about how to assess, and reduce, the carbon footprint and materials used with computers and telecommunications. These are the notes for an award winning course on strategies for reducing the environmental impact of computers and how to use the Internet to make business more energy efficient.