Green IT: What, Why and Where
Overview and Analysis

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Abstract- **In present era, Green IT is the most sought after and emerging area in IT Service management. Global climate change, high energy rising cost, adverse impact on environment are some of the alarming issues which are drawing attention across globe in Technology market. Improper use/ operation/ maintenance /disposal of IT equipment are directly and indirectly causing some effect on these burning issues. However, by systematic adoption and implementation of Green IT practices, can enable offering strategies to reduce the overall required power for equipment without affecting their efficiencies, to offset rising energy cost and to use/operate/maintain IT equipment in ways that can reduce their environmental impact. This has rose interest of IT Suppliers, manufacturers, IT Organizations and IT Service providers to learn more on Green IT and adopting and implementing Green IT practices considering the potential return on investment resulting out of it. This paper has presented Green IT overview, implementation approaches and a summary of emerging Green IT concepts. It has also discussed information of key areas where IT organizations can achieve savings and excel in their field by adopting Green IT Practices.**

Keywords— Virtualization, VDI, e-Waste, Telepresence, Recycling

I. INTRODUCTION

Information Technology (IT) has become an integral part of our life and has changed the way we used to live our life before introduction of IT. IT has positively affected our life style and has contributed significantly to social, professional and economic prosperity. However, like every technology has, IT too has positive and certain negative side effects on the society, as well as on planet earth.

Rapid expansions and innovations in IT started causing certain side effects and negative impact which are listed as follows.

- Electronic Waste (e-waste) : Many IT devices such as laptop, tablets, mobiles, desktop, monitors etc., are becoming obsolete fast since newer version of these devices are introduced in the market rapidly. The old devices, which are not in, use anymore starts piling up and taking lot of space if not disposed effectively.

- Increasing Energy Demand: Introduction of new gadgets and their affordability causing larger chunk of society to go for it. This causes larger consumption of IT products and thus requires overall large power to run these devices. Large operating power ultimately leads to larger heat dissipation.

- Need of recycling of IT equipment: Large e-waste is generating due to fast obsolete of many IT products. These products normally contain toxic materials which can impose serious threat to health and environment if not disposed in systematic manner. This e-Waste is becoming burden on society and demands proper recycling.

In addition to the above, some of the burning issues which are also causing to attract attention towards Green IT movement are as follows.

- Stringent policies by government for climate and green environment

- Increasing real estate costs

- Rising air travel cost

- Management of hazardous waste

- Increasing Fuel Cost which drive up employee commuting costs leading to retention issues

It is clear that there is an urgent need to address the issues listed above to enjoy the benefits offered by IT without creating any adverse impact on society and planet earth.

Green IT practices offers effective ways to address such issues in most effective and efficient manner. Industry stakeholders and IT professionals are now started focusing on Green IT or Green Computing concepts. Green-IT includes all practices that aim to reduce the environmental impact of IT use. It is mainly focusing to reduce the carbon footprint generated by the Information Systems business while allowing them to save money. This is mainly achieved through introducing environmental friendly IT products, energy efficiency, and proper disposal of IT products in their end of life.

II. GREEN IT DEFINITION AND FRAMEWORK

There is no standard and precise definition for the standard practices collectively reported under Green IT or Green computing, however a working definition for Green IT as per CGI Corporation is as follows.
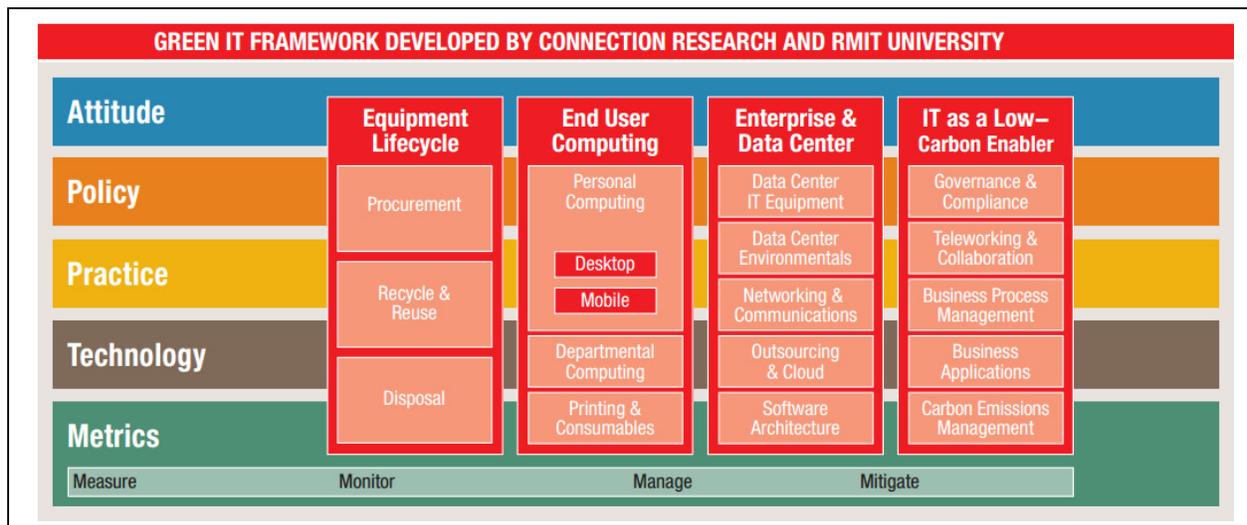
Fig. 1.   Green IT Framework [2]

"Green IT is the study and practice of using computing resources in ways that help reduce energy and operating costs, enable sustainable business practices and reduce the environmental impact of IT practices in the larger community." [3]

Some experts have described Green IT as the study and the using of computer resources in an efficient way. Green IT cycle starts with manufacturers producing environmentally friendly IT products. Organizations using IT products are encouraged to deploy IT products considering energy efficiency of the devices and operating efficiency options such as virtualization and power management. When the life of the products gets finished such devices are disposed with the most environmental friendly process. New rules, regulations and compliances recently imposed by government works towards certifying data centers as green. Green compliance includes criteria's such as recycling, using alternative energy technologies, employing low emission resources etc. and other green technologies.

Refer Figure 1, which shows the Green IT Framework. Green IT framework helps in defining Green IT and understanding its basic components. The Framework defines four general areas, or "pillars" of Green IT, which are mainly Lifecycle, End User, Enterprise and Enablement. It then breaks each of these pillars down further. Lifecycle, for example, comprise the three components of Procurement, Recycle and Reuse, and Disposal. Whereas, the End User Computing contains personal computing, departmental computing and printing and consumables. Across these four pillars are five "actions": Attitude, Policy, Practice, Technology and Metrics. Note that these actions are associated with each of the pillar and influence the way pillar can operate, maintained and disposed. Once Green IT is broken into its components, it becomes possible to measure each in turn. This is done using the Capability Maturity Model (CMM), a standardized way of quantifying the maturity of a business process. The concept of the CMM is often used in the IT industry to describe the level of implementation of various systems.

III. MAJOR ACTIVITY AREAS ASSOCIATED WITH GREEN IT

Most of the organizations including IT suppliers, manufacturers, IT organizations and service providers are looking at Green IT programs to achieve certain objectives that includes better e-waste management, IT products recycling, better hardware and software utilization, reducing life cycle costs, improving energy efficiency and power management practices, and looking for ways to reduce the overall cost on IT infrastructure operation and management. Some of the major activity areas associated with Green IT are as follows.

A. Technology based solutions

This category includes programs that employ technology in ways that are designed to reduce real estate cost and travelling & commuting cost related to resources including human resource movement from one place to another. Necessary environmental impacts are considered while designing any such solutions.

B. Energy efficiency programs

These programs focus on improving operation and power efficiency in the IT infrastructure and reducing associated energy consumption, electric utility costs and associated global greenhouse gas impacts.

C. Green procurement and asset management

This category includes initiatives that focus on purchasing of energy efficient and environmentally friendly computing equipment and includes programs to enhance equipment useful life, equipment recycling and engagement with suppliers that demonstrate a commitment to reducing hazardous materials in their manufacturing, packaging and factory waste management programs.

D. Cooling

IT organizations can decrease energy consumption through efficient cooling practices which can include leveraging local climates and using chilled loop and free cooling strategies. Using innovative, green, renewable energy resources can enable organizations to reduce its demand for electricity,

which also can relieve the pressure on already over-burdened local electricity grids.

E. Power consumption

This category includes efficient approaches to power conservation. It includes stringent policies, processes and energy-focused solutions for power and cooling efficiency. For example, instead of conventional lighting system organizations can use energy efficient lighting system such as LED lights which can reduce overall power consumption significantly. Use of motion detector devices can also ensure lighting is provided when needed and thus wastage of electricity on unnecessary burning bulbs and lights can be cut short. LED lights needs less maintenance and thus it can also reduce operation and maintenance cost.

To implement various activities as listed above, Green IT needs a champion who is responsible for Green IT technologies and policies to achieve truly sustainable outcomes, however most of the organizations doesn't have specific leader for the Green IT role, in many cases this responsibility is found offloaded to CIO or IT head.

Table 1 shows list of some of the organizations which has effectively carried out certain activities associated with Green IT and has realized significant benefits out of it.

TABLE I.   GREEN IT POLICIES REAL BENEFITS [6]

Organisation	Green IT Initiative	Benefits realized
CSC	NightWatchman Software to automati--cally power off desktop PCs during non-working hours	:-25 Million KWHs of electricity saved per year :-23 Kilo-tons of CO2 emissions eliminated
VistaPrint	Used Virtual Servers to reduce servers' energy consumption	:- Using Virtual Servers in place of blade servers in data centers servers' resulted in 75% reduction in energy usage :- Saving of 450k USD annually
Huntsville Hospital	VMware Virtual Desktop Infrastructure for desktop PC manageability	:-Virtual desktop based infrastructure helped to secure HIPAA-regulated patient infor-mation in a hosted data center. :- 72% reduction in power costs to run desktop environment due to thin client architecture. :- Desktop provisioning time reduced to 15 minutes.
Symantec	Enterprise Vault for archiving emails and unstructured data Veritas Command central storage	:- Helped reducing duplicate data and optimize archiving /tier availability by application. :-Helped to identify and reclaim unused storage capacity. Helped overall reduction in hardware resources & energy consumption.

IV.   GREEN IT PRACTICES

Green IT Practices, if properly executed, not only offers advantage of cost savings but also numerous benefits such as reduced future operational expenses or investments, reduced electricity use, reduced consumables use,   and realizing credits or rebates from local authorities and governments. Some of the most preferred and commonly used, Green IT practices are explained below.

A. Employing Open Source Methodologies

Using Open source methodologies for software development can result into energy savings. This is possible since, open source methodologies enables collaborative development process that tends to be much more efficient than the conventional software development process.

B. Telemedicine

Telemedicine facilitates doctor consultation and treatment advice from remote. Due to this, patients do not need to travel to Hospitals or to any specialized clinics located at different places. Local doctors can consult with specialists based at different places and can treat the local patients effectively. This facility is very useful and effective in rural area where timely consultation from specialist doctor is not feasible. telemedicine has not only cut down the travelling costs for the doctors and patients but also facilitates cutting down gas emissions, improve care for elderly, homebound, and physically challenges patients, better management of chronic diseases and improve community and population health.

C. Electronic Medical Record (EMR)

Electronic Medical Record facilitates creating storing and retrieving of patient's medical records and case papers in soft fashion unlike hard copies. EMR are more effective than hard medical record, since they offers many advantages such as maintaining confidentiality, easy retrieval and search, can be safely accessed from anywhere and long lasting. An analysis conducted by Kaiser Permanente, published in the May 2011 issue of Health Affairs USA, estimated that EMRs have the potential to reduce carbon dioxide emissions by as much as 1.7 million tons across the United States. The same study, which looked to 8.7 million users of Kaiser Permanente HealthConnect, showed that using an EMR avoided the use of 1,044 tons of paper for medical charts annually. It all resulted in a positive net effect on the environment.

D. WebMeeting/Teleconference/Telepresence

Rising fuel cost and travelling costs are now major concerns for most of the employees as well as organizations. To cut down on long commutes, organizations are looking for better options such as conducting WebMeeting, Teleconference or meeting through Telepresence. WebMeeting and Telepresence are newer IP-based audio video solutions, which facilitates conducting live meeting, irrespective of the geographical locations of meeting participants. Using flat screen monitors and effective audio systems, users gets life-like, real time meeting experience. It is also possible to record the meeting and share the documents online during the meeting. By using WebMeeting and solutions like Telepresence, organizations and employees can save travelling time and travelling cost and thus ensure low gas emissions. Also due to no physical movement which can be tiresome, employee productivity can get increased as well.

E. PC Power Management

By employing PC Power Management techniques end-users can manage their device power consumption easily and effectively. This can lead reduction in energy costs. The power management techniques includes following

- Using Power Management software (example NightWatchman Software) that centrally manages power settings of PCs and monitors.

- Enforcing energy efficient power settings on all machines before providing to end users.

- Procurement of Energy Star certified devices, which are more energy-efficient process.

F. Printer Consolidation

Printer Consolidation aims at reducing printer consumables such as printing paper, ink, toner and required operating power. This can be achieved through consolidating the scattered printers across organization and using centrally located Printer or Network printer. Organization policies can enforce hard printing only when essential.

G. IT Equipment Recycling

Recycling and refurbishing of IT equipment is an important part of organization's sustainable waste strategy. Businesses are encouraged to dispose of their IT equipment in an environmental friendly manner. There are also stringent polices and government regulations in place to deal with hazardous waste. Electronics and IT equipment recycling reduces the volume of waste which ends up in landfill sites, or gets dumped illegally. An efficient recycling can drastically cut down the amount of raw materials required for the manufacture of new products and instruments, besides cutting down the equipment cost.   In addition, if computing equipment is refurbished, this can benefit people and organizations that cannot afford to buy new IT equipment.

Fig. 2.   IT Equipment recycling benefits [4]
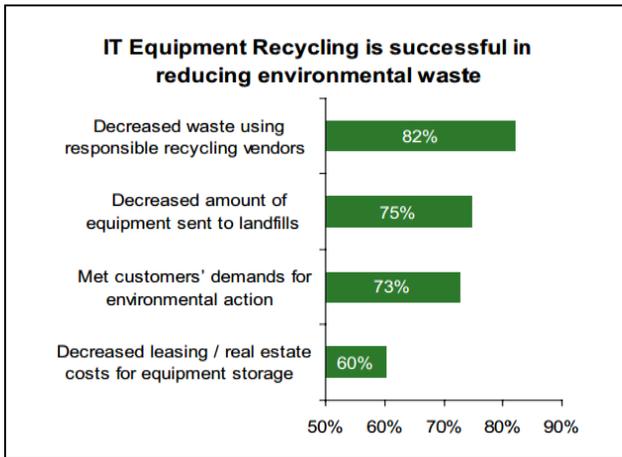
Virtualization is a technology by which the hardware resources are isolated from the operating system and applications through a software abstraction layer called as hypervisor or virtual machine monitor. This can facilitates multiple under-utilized computers accommodating into a single physical machine. By abstracting the different components of the traditional computer system virtualization can help achieve a more rationalized distribution and utilization of the various resources.

Fig. 3.   Machine Virtualization [7]
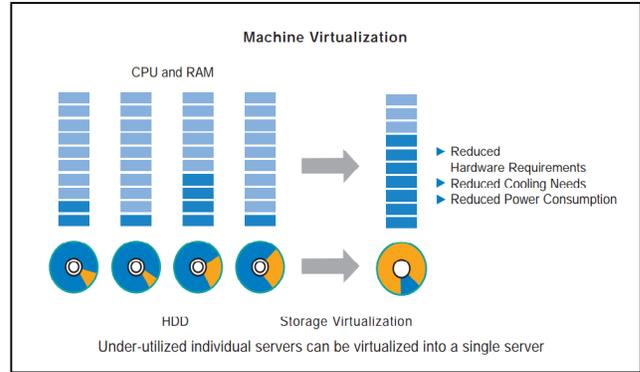
cause under-utilization of CPU power, typically at 5-15% on an average. Even desktop computers are heavily under-utilized in terms of average CPU utilization for the duration it is powered on. However on an average a computer that is idle still consumes about 60-90% of the power that it does when running at full utilization. This increases unnecessary power consumption. Virtualization on the other hand maintains efficient operation while keeping power utilization optimum. Virtualization also offers savings in space required for machine housing. Server virtualization can reduce electricity consumption as well as cooling requirements in data centers, thus reducing both costs as well as carbon emissions.

I. Virtual Desktop Infrastructure (VDI)

Virtual Desktop Infrastructure, or VDI, refers to running a user desktop via a virtual machine residing on a server in the datacenter. It is a powerful technique of desktop virtualization since it offers fully personalized desktops for each user with all the security and simplicity of centralized management.

VDI makes administrative and management tasks much easier, because every attached workstation can use the same image. Install OS and application software updates and patches required on one image, and every desktop system using that image is automatically updated and patched.

Some of the unique features offered by VDI are as follows.

- Every desktop user can utilize the same image.

- Processing moves from individual machine to a VDI server.

- Maintenance cost and Hardware costs get minimized, since almost everything will reside in the data center.

- Single OS image need to be maintained causing reduce management and support costs.

V.   SUMMARY

Organizations across the globe have realized that going Green is not only good for planet earth but also for their own benefits for savings the cost and in sustaining the business. This paper has highlighted various Green IT Practices and the benefits they are offering for the implementing organizations. The Green IT definition and framework allows user to understand, meaning, scope and impact of Green IT. The findings in this paper have highlighted how organizations are making significant cost savings by adopting Green IT practices.

Stringent policies and norms imposed by various governments are ensuring implementation of Green IT practices across organizations. Many of the initiatives studied in this paper allow businesses to save energy, money and, in many cases, realize new business capabilities. It is sure that over coming years we can see positive impact on environment due to advantages and benefits offered by Green IT initiatives. Slowly and steadily stakeholders including customers, partners and top management executives have realized their responsibility towards Green environment and are taking more and more initiatives in following, demanding and implementing Green IT practices wherever possible and applicable. New technology trends will bring advanced and more effective ways to control and implement Green IT practices whereas it is also expected that some of the most popular Green IT practices such as server virtualization, VDI,

PC power Management, recycling etc. will become mandatory policies and practices to follow across organizations.

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