

Need of Green Computing Measures for Indian IT Industry

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Abstract

In the last few years there has been a lot of hype about Green computing and about providing greener computing solutions to almost everything. Green computing is a new approach which aims at designing computer systems that achieves better processing and performance with least amount of power consumption. Numerous studies and surveys have already shown that the power costs put together form the lion's share of total costs of management of a data center. Till now green computing measures had been restricted to mainly achieve lower power consumption within the organizational framework. In this paper we have tried to illustrate the importance of green computing beyond minimizing power consumption and towards delivering better customer value and finally achieving the ultimate goal of sustainable IT growth.

Keywords: green computing; virtualization; server power; sustainable IT ; Green IT

1. Introduction

The traditional approach towards green computing had been that of reducing the overall power costs and developing energy aware, high performance computing systems. For this purpose generally many techniques have been developed. But most people have devoted their time and energy in developing components and hardware that consumes less power. However we also need to consider other aspects involved in computing for which we need to drop our legacy and start thinking and developing from scratch. The ever increasing prices of power have further provided an incentive to organizations and individuals to further hasten up the evolution of greener computing practices to the next level. Several techniques like the use of virtualization technology, organizing PC lifecycle definition, green procurement and waste recycling.

2. Need for Green Computing

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 like carbon dioxide. 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. The CPU and fan consume power; screen savers consume power even when the system is not in use. Insufficient power and cooling capacities can also results in loss of energy. It is observed that most of the datacenters 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.

3. Methods for Green Computing

There are a number of more fundamental steps that can be taken to significantly decrease the environmental impact of computing. These mainly involve measures for reducing energy consumption. Some such well known methods are discussed below.

3.1 Lower Power Hardware

PCs can be made to use less electricity by using a lower power processor, opting for onboard graphics (rather than a separate graphics card), using passive cooling (rather than energy consuming fans), and either a solid-state disk (SSD) in place of a spinning hard drive as the system disk, or else a 1.8" or 2.5" rather than 3.5" hard disk drive. Intel has launched a dual core Atom processor and accompanying 'Pinetrail' motherboard which can form the heart of a quite powerful PC that still uses only around 20W of power. Several mainstream manufacturers are now starting to launch relatively-low-power PCs or "nettops" - usually based around an Atom processor. Very low power computers are often not able to perform some of the tasks (such as video editing and games playing) demanded of their more power-hungry current counterparts. However, being largely silent, they are more pleasant to use. They are also perfectly suited to cloud computing.

3.2 Virtualization

Virtualization is the use of computer software to simulate hardware. Within data centers, server consolidation applies virtualization in its replacement of many stand-alone physical servers with virtual servers that run as software on a small number of larger computers. To their users, virtual servers can be configured to still appear as physical machines on their network. However, via a virtualized server consolidation a company can obtain a far more optimal use of computing resources by removing the idle server capacity that is usually spread across a sprawl of physical servers. Very significant energy savings can also result. IBM, for example, is currently engaged in its Project Big Green, and which involves replacing about 2,900 individual servers with about 30 mainframes to achieve an expected 80 per cent energy saving over five years. To assist further with energy conservation, virtualization can take place at the level of files as well as servers. To permit this, file virtualization software is already available that will allocate files across physical disks based on their utilization rates (rather than on their logical volume location). This enables frequently accessed files to be stored on high-performance, low-capacity drives, whilst files in less common use are placed on more power-efficient, low-speed, larger capacity drives.

3.3 Cloud Computing

Cloud computing is where software applications, processing power, data and potentially even artificial intelligence are accessed over the Internet. Cloud computing has many benefits, one of which is enabling anybody to obtain the environmental benefits of virtualization. Whilst most servers in company data centres run at c.30 per cent capacity, most cloud vendor servers run at 80 per cent capacity or more. By choosing to cloud compute and in particular by adopting online computer processing power in the form of PaaS or IaaS companies may therefore potentially reduce their carbon footprint. As well as allowing server capacity to run at a more optimal energy efficiency, cloud computing can also remove the need for most users to run high-power PCs and laptops. Indeed, by opting to use SaaS applications from the cloud, one of the benefits of cloud computing is that lower power hardware becomes a more and more viable option. It is also worth noting that the use of SaaS tools may also enable more people to collaborate without the need to physically travel, in turn reducing the environmental impact of the activity.

3.4 Energy Efficient Coding

The principle behind energy efficient coding is to save power by getting software to make less use of the hardware, rather than continuing to run the same code on hardware that uses less power. Energy efficient coding may involve improving computational efficiency so that data is processed as quickly as possible and the processor can go into a lower power "idle" state. Alternatively or in addition, energy efficient coding may also involve data efficiency measures to ensure that thought is given in software design to where data is stored and how often it is accessed. Finally, programmers also need to write software that has "context awareness" of the power state of a computer and its selected power policy, and so that it can behave appropriately.

3.5 Improved Repair, Re-Use, Recycling and Disposal

Hardware repair which may involve the recycling of old computer hardware into a second-use situation, the re-use of components from PCs beyond repair, and/or the less frequent upgrading of computer equipment in the first place. Personal computers are one of the most modular and hence the most repairable products purchased by individuals and organizations. Re-using at least some parts from broken PCs is in practical terms very easy indeed. The problem is that both companies and many individuals have got into the habit of changing their computers every 2-3 years. However, with the practical benefits of hardware and software “advances” rapidly diminishing, such a rapid upgrade cycle is no longer required, and hence increasingly hard to justify in either cost/benefit or environmental terms.

3.6 Less Pollutant Manufacture

A great many hazardous chemicals - including lead, mercury, cadmium, beryllium, bromine flame retardants (BFRs) and polyvinyl chloride (PVC) are used to make computers. By reducing the use of such substances, hardware manufacturers could prevent people being exposed to them, as well as enabling more electronics waste to be safely recycled. Whilst less pollutant computer manufacture is something that clearly needs to be undertaken by those companies who make the hardware in the first place, individuals and organizations can play an important role in their choice of new hardware. Both individuals and organizations are therefore in a position to influence the number of hazardous chemicals they purchase in the form of computing equipment.

3.7 Further Innovation

3.7.1 Increasing the total virtual-to-physical server presence

There are ample opportunities in every organization to further expand the scope of virtualization across all platforms and environments present in the organization. A study revealed that almost 90 percent of firms are already virtualizing or are planning to virtualize their servers. However only 37 percent of their x86 operating systems instances are virtualized servers which is expected to rise upto 65 percent in the next two years. Another factor is the extent to which the servers and all other platforms are virtualized. To ensure maximum power savings make sure that the unused servers are turned off and the target virtualization for servers should be over and around 65 percent.

3.7.2 Maximizing virtual machine-to-physical host and utilization ratios

Modern hardware and technology is quite developed for the purpose of virtualization. However the full capabilities of the equipment are usually not harnessed. We can go a step ahead towards making the virtualization process more cost effective by increasing the virtual-to-physical host ratio. It is quite normal to see a 4-1 virtual machine-to physical host ratio, but most modern day servers can accommodate upto 15 virtual machines (VM). Therefore, virtualizing carefully will not only save the cost of purchasing more number of servers but also the power, maintenance, cooling cost involved with each server. Generally it has been observed that most firms are not eager to push the utilization of their virtualized servers beyond 30-40 percent. Underutilized servers also consume considerable amount of power. Hence proper virtualization and utilization of the servers will result in considerable amount of savings for the firm.

3.7.3 Wireless Network and Sensors

Sensors can be employed in different parts areas in a data center to determine the temperature of each area. This way it will be easily known which area needs more cooling and where to reduce the cooling.

3.7.4 Computing Power on demand

Developing systems that use up as much computing power as a website operator requires at all times. This can be in the form of a software product that can ramp up and down the power consumption of data centers to coincide with the demand of its web company users.

3.7.5 Liquid-Cooled Servers

Liquid-cooling components are connected to a re-circulating water supply that transfers heat from the servers to the air outside the data center, which is popularly called “end to end” liquid cooling. The system can reduce data center cooling costs by 95%.

4. Green Computing Metrics

Several power related metrics can help IT organizations to understand and further improve the energy efficiency of their data centers. Figure 1 shows the model of a Data center.

4.1 Power Usage Effectiveness

Power Usage Effectiveness (PUE) was introduced by The Green Grid in 2007. PUE may be understood as a metric which has a focus on the Data Center Infrastructure.

$$PUE = \text{Total Facility Power} / \text{IT Equipment Power} \quad (1)$$

IT equipment power is defined as the load associated with computers, storage, network equipment and peripherals. Total facility power is the total power measured at the utility meter. The PUE can range from 1.0 to infinity. Ideally, a PUE value approaching 1.0 would indicate 100% efficiency.

4.2 Data Center Infrastructure Efficiency

Data Center infrastructure Efficiency (DCiE) was also developed by The Green Grid. As IT equipment uses less energy per unit of performance, then less energy is needed for cooling and DCiE will move higher.

$$DCiE = \text{IT Equipment Power} / \text{Total Facility Power} \quad (2)$$

4.3 Data Center Performance Efficiency

Data Center Performance Efficiency (DCPE) metric is a refined version of the PUE metric adopted for all major power-consuming subsystems in the data center is described below. Total Facility Power is measured at or near the facility utility meter to accurately reflect the power entering the data center. IT Equipment Power would be measured after all power conversion, switching, and conditioning is completed and before the IT equipment itself.

$$DCPE = \text{Useful Work} / \text{Total Facility Power} \quad (3)$$

4.4 Energy Reuse Effectiveness

Energy Reuse Effectiveness (ERE) is a metric that is used to gauge the energy efficiency to data centers that re-use waste energy from their data center.

$$ERE = (\text{Cooling} + \text{Power} + \text{Lighting} + \text{IT-Reuse}) / \text{IT} \quad (4)$$

$$ERE = (1 - \text{ERF}) \times PUE \quad (5)$$

4.5 Server Compute Efficiency

The Server compute Efficiency (ScE) metric developed by The Green Grid. ScE percentage over any time period is calculated by summing the number of samples where the server is found to be providing primary services (p) and dividing this by the total number of samples (n) taken over that time period and multiplying by 100. Any server with an ScE of 0% over a prolonged period is not being used and can be decommissioned or repurposed.

$$ScE = \frac{\sum_{i=1}^n p_i}{n} \times 100 \quad (6)$$

4.6 Data Center Compute Efficiency

Data Center compute Efficiency (DCcE) aggregates ScE across all servers in the data center. DCcE is not a productivity metric – it does not measure how much work is done, just the proportion of work that is useful.

$$DCcE = \frac{\sum_{j=1}^n ScE_j}{m} \quad (7)$$

4.7 Compute Power Efficiency

Compute Power Efficiency is metric that seeks to quantify the overall efficiency of a data center while taking into account the fact that not all electrical power delivered to the IT equipment is transformed by that equipment into a useful work product. Some of the equipment within a data center consumes power while it sits idle. Other equipment is being used but not at 100% of its capacity.

$$CPE = (\text{IT Equipment Utilization} \times \text{IT Equipment Power}) / \text{Total Facility Power} \quad (8)$$

4.8 Data Center Energy Productivity

Data Center energy Productivity (DCeP) is a metric that quantifies the useful work that a data center produces based on the amount of energy it consumes.

$$DCeP = \text{Useful Work Produced} / \text{Total Data Center Energy Consumed Producing this Work} \quad (9)$$

4.9 Partial Power Usage Effectiveness

The Partial PUE (pPUE) is a new conceptual metric where a PUE-like value for a subsystem can be measured and reported.

$$pPUE = \text{Total Energy within a boundary} / \text{IT Equipment Energy within that boundary} \quad (10)$$

4.10 Water Usage and Carbon Usage Effectiveness

The Green Grid very recently released Carbon Usage Effectiveness (CUE) and Water Usage Effectiveness (WUE).

$$CUE = \text{Total Carbon dioxide Emissions from Total Data Center} \text{ Energy} / \text{IT Equipment Energy} \quad (11)$$

$$WUE = \text{Annual Site Water Usage} / \text{IT Equipment Energy} \quad (12)$$

5. Power-Cost Analysis

The growth in computing capability is causing an ever increasing demand for energy. While data centers represent only a small fraction of the square footage at IT sites, they are a large and growing energy consumer. At some sites, growth in data center energy use is expected to at least double overall site energy use. It is evident from Figure 2 that servers along with cooling equipment consume the major part of total power in any data center. It is therefore essential to identify an approach to build and develop green data centers mainly through reduction in server and cooling power consumption. Companies need complete solutions that efficiently and cost-effectively address data center power and cooling. Some such measures to reduce power costs are suggested here.

5.1. Proper Insulation of data center environment

Data Center managers should ensure the data center is properly insulated with a vapour barrier that isolates the controlled environment from the building environment. Vapour seals can be created using plastic film, vapour-retardant paint, vinyl wall coverings and vinyl floor systems. This is a cost effective method, but most important and often overlooked, factors to controlling relative humidity levels in a data center. Broken or improper seals can allow humidity from the outside to get in, making it more difficult to cool a data center.

5.2 Improvements in Air-Flow movements

Most IT equipment take in air from the front and release hot air from their rear, hence the hot-aisle/cold-aisle management can be employed for better and energy efficient arrangement of racks.

5.3 Improvements in Sensible heat/Latent heat removal capacity

IT equipment generates sensible (dry) heat. Latent heat comes from people and outdoor humidity infiltration. As server density or capacity increases, it creates a corresponding increase in the sensible heat load. The latent heat load is unaffected. Thus, using cooling solutions that can operate at a 100 percent sensible capacity, except when dehumidification is required, will result in reduced energy consumption.

6. Scenario of India

Indian IT Industry has witnessed huge growth in the last decade making it a unique brand in the world. However this has lead to increased power consumption and escalation of realty costs in major cities. Due to the already vast population India already struggles to put an end to its power shortage woes. In order to remain competitive, Indian IT companies need to adopt green and sustainable computing measures on a large scale. Recent down turns in the world economy has also forced companies to lower their operational costs to ensure profitability. Power costs form a major part of the total operational cost for IT firms. Hence it has become almost essential for IT firms to adopt green computing measures.

7. Conclusion

The ever increasing power costs have forced individuals and firms to develop newer methods and technologies to more efficient and lower power consumption. This paper analyzed the role of green computing towards reducing power costs and thereby supporting a sustainable growth model. Green computing practices go far beyond just reducing power as they can help enhance a company's image in the public as being socially responsible. An important technique for green computing is to improve the efficiency of power distribution as well as the computational capabilities of the servers and computing devices. The efficiency of the various methods and applications can be measured by the use of metrics such as those developed by the Green Grid. Finally, a model for the development and implementation of sustainable IT services needs to be developed.

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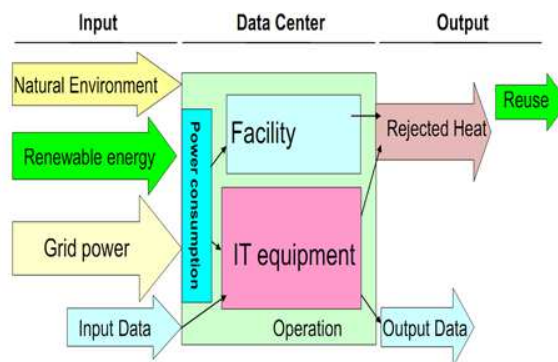


Figure 1. Data Center Model

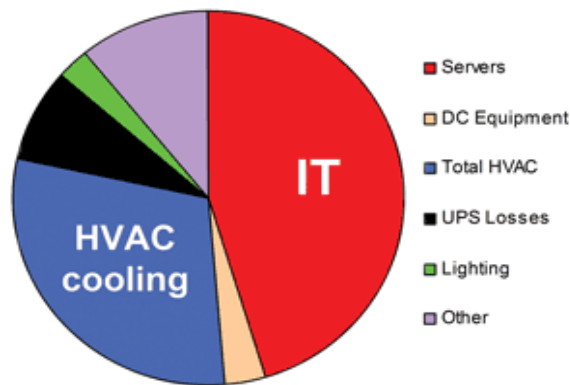


Figure 2. Typical breakdown of the data center energy consumption.

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