Chapter 19
Green Energy in Data Centers

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ABSTRACT

Green energy paradigm has been gaining popularity in the computing system from the software, hardware, infrastructure and application perspectives. Within that concept, data center greening is of utmost importance at the moment since data centers are one of the most energy conserving elements. Data centers are seen as the technology era's black energy-swallowing secret. Reducing energy consumption at data centers can reduce carbon footprint effect tremendously. Not addressing the issue immediately will lead to significant energy usage by data centers and will hinder the growth of data centers. The call for sustainable energy efficient data center leads to venturing into data center green computing. The green computing concept can be achieved by using several methods adopted by researchers including renewable energy, virtualization through cloud computing, proper cooling system, identifying suitable location to harvest energy whilst reducing the need for air-conditioning and employing suitable networking and information technology infrastructure. This paper focuses into several approaches used by researches to reduce energy consumption at data centers while deploying efficient database management system. This paper differs from others in the literature by giving some suitable solutions by looking into a hybrid model for green computing in data centers.

INTRODUCTION

The increase in need of data processing has led to a demand in obtainability for cheaper, faster, efficient and larger data management system. This has further introduced a significant problem in terms of energy consumption and energy usage as mentioned in (Barroso. L.A, 2005). Since the trend of Internet Infrastructure is moving towards services-based computing, data center plays a key role in this new

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computing architecture. It is used widely in variety of services independent encapsulating any vendor, product and technology including web hosting, application services, electronic markets, outsourced storage, online-monitoring system, mashups, digital nervous system and other network services. Fostering renewable energy production, developing better renewable technologies and improving the environmental performance of conventional electricity benefits heightened through improving the long-term strategy of data center performance. Environmental Protection Agency (EPA) shows that the data center and database management system in the US consume power doubled between 2000 and 2006 and may multiply again within the next decade. According to EPA, it is projected that energy consumption by data centers for the year 2008 is more than 80 billion kWh. (US Department, 2013). Report to the Congress, EPA's Energy Star Program estimates that increase efficiency in data centers could yield energy savings as the burgeoning efforts to make data centers greener is the energy and the word 'green' adds multiple meaning when applied to the data centers. (Koomey J, 2011).

Many works have been done to produce efficient result in reducing the energy usage for the purpose of data center and data management for example by Cisco System Inc., Google Inc., and many more (Barroso.L.A,2005). Some of the approaches were to design highly efficient systems at the peak performance point with maximum utilization of resources. But very few studies have addressed the energy problem comprehensively (US Department, 2013).

PROBLEM STATEMENT

In today's technological world, it is proven that there is a significant relationship between data center and investment in capital overlay and outgoing costs. Table 1 shows the detailed breakdown on the distribution of the cost from data center (Greenberg et al., 2008).

The design of computing system is being optimized based on the execution time and operates at low consumption due to entrapment of resources and fragmentation of data. No concern was made for the issue of energy consumption by the system. Uncontrolled usage of energy in data centers has negative effects on the reliability, density, scalability of information processing and the environment. Need and awareness are raised across nation through multiple solution and disciplines to optimize and save energy use in data management system (Barroso. L.A, 2005). System or even its components like CPUs, memory and disk are hardly distributing energy efficiently. It trades power for performance (US Department, 2013). Power management has become a critical issue due to large energy usage and all over the world government has started imposing the taxes on the carbon emission, ultimately aiming to reduce the emission and help make computing into green computing (Bansal et al., 2011).

Table 1. Guide on the distribution of data center costs

Amortized Cost	Component	Sub-Component
~ 45%	Servers	CPU, memory, storage systems.
~ 25%	Infrastructure	Power distribution and cooling.
~15%	Power draw	Electrical utility costs.
~15%	Network	Links, transit, equipment.

a. Source of data: A. Greenberg et al, "The cost of a cloud: research problems in data center networks", ACM SIGCOMM Computer Communication Review, 39(1), pp. 68, 2008