Server & Data Center Energy Efficiency

Prepared by NEEIC
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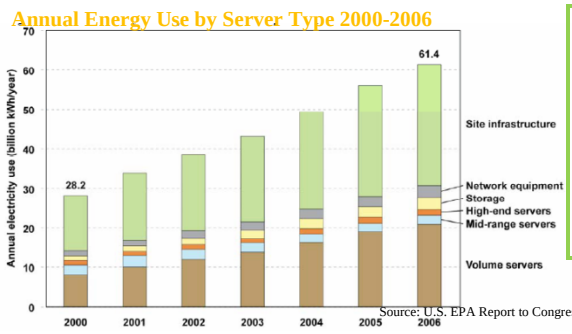
Data Centers

As our economy shifts from paper-based to digital information management, data centers- facilities that primarily contain electronic equipment used for data processing, data storage, and communications networking- have become common and essential to the function of business, communications, academic, and governmental systems. Data centers are found in almost every sector of the economy: financial services, media, high-tech, universities, government institutions, and many others use and operate data centers to aid business process, information management, and communication functions.

Data Center Energy Use

Driven by the increasing demand for data processing and storage, the energy use of the nation's servers and data centers in 2006 more than doubled the electricity consumed for this purpose in 2000. This rapid increase in energy consumption caused the U.S. Congress to issue Public Law 109-431, requesting the U.S. EPA to assess data center energy use. In August 2007, the EPA *Report to Congress on Server and Data Center Energy Efficiency* was released.

Annual Energy Use by Server Type 2000-2006



Source: U.S. EPA Report to Congress on Server and Data Center Energy Efficiency

U.S. data centers and servers consumed about **61 billion kWh** in 2006 (1.5 percent of total U.S. energy consumption) for a total electricity cost of **$4.5 billion**. This is similar to the amount of electricity consumed by approximately 5.8 million average U.S. households.

Energy Efficiency Opportunities in Data Centers and Servers

One type of server, the volume server, was responsible for 68 percent of the electricity consumed by IT equipment in 2006. The energy used by volume servers more than doubled between 2000 and 2006, which was the largest increase among different types of servers. The power and cooling infrastructure that supports IT equipment in data centers also uses a significant amount of energy, accounting for 50 percent of the total consumption of data centers.

Under current use trends, national energy consumption by servers and data centers could double again by 2011 to more than 100 billion kWh, representing a $7.4 billion annual electricity cost.

There is significant potential for energy efficiency improvements in data centers and servers. Although some improvements in efficient technologies are expected if current trends continue, many technologies are either commercially available or will soon be available that could further improve the energy efficiency of **microprocessors, servers, storage devices, network equipment, and infrastructure systems**.

Key Energy Efficiency Trends

A number of energy efficiency trends are currently underway that will likely reduce the energy used by U.S. servers and data centers in the next five years.

❖ ***Multiple-core microprocessors:*** Containing two or more processing cores on a single physical processor, multi-core processors run at a slower speed and lower voltage but handle more work in parallel than a single-core chip, delivering more compatibilities while balancing energy efficient performance.

❖ ***Dynamic Frequency and Voltage Scaling:*** These features allow microprocessor frequency or voltage to ramp up or down to better match computational needs.

❖ ***Virtualization:*** Allows organizations to replace several dedicated servers that operate at a low average processor utilization level with a single "host" server that operates at a higher average utilization level.

❖ ***Efficient Servers:*** Servers currently marketed as energy efficient have several key features including: use of multi-core processors, virtualization, high-efficiency power supplies, and internal variable speed fans for on-demand cooling. For volume servers, these factors combined can account for 50-80 percent of total server energy use; gains in these components can save significant energy.

❖ ***Storage Devices:*** Enterprise hard disk drive storage devices are expected to become more efficient in part because of a shift to smaller form factor disk drives and increasing use of serial advanced technology attachment drives.

❖ ***Site Infrastructure Systems:*** Energy efficiency improvements include low-cost measures such as improved airflow management and optimization of temperature and humidity, as well as capital-intensive measures, such as upgrading to more efficient un-interruptible power supply systems.

Annual Savings in 2011 by Scenario

Scenario	Electricity consumption savings (billion kWh)	Electricity cost savings ($billion 2005)	Carbon dioxide emissions avoided ($MMTCO_2$)
Improved operation	23	1.6	15
Best practice	60	4.1	38
State-of-the-art	74	5.1	47

Source: U.S. EPA Report to Congress on Server and Data Center Energy Efficiency

Market Barriers

The adoption of energy-efficiency technologies and practices is often impeded by higher first cost, lack of knowledge, institutional failures, and perverse incentives. Several barriers of particular importance in data centers are:

❖ The billed electrical costs are often not within the responsibility or budget of the data center operating group. This leads to split incentives, in which those most able to control the energy use of the IT equipment have little incentive to do so.

❖ The electrical bill for the data center may be included within a larger electrical bill and may not be available separately.

❖ Tools for modeling the electrical costs of data centers are not widely available and are not commonly used during data center design.

❖ Lack of efficiency definitions; data center operators need standard definitions of productivity in order to purchase energy efficiency equipment, operate it in an optimal way, and design and operate buildings to house it.

❖ Risk aversion; with the growing importance of digital information, data centers are increasingly crucial to doing business. Data center operators are particularly risk averse to changes that might increase the probability of down time.

Current Initiatives

PG&E and Sun Microsystems: High-Tech Energy Saving Innovations

Data centers can use up to 100 times the energy per square foot of typical office space. With that in mind, PG&E teamed with Sun Microsystems to look at their mutual customers and see how they were using Sun computers. Sun found that their T1000 and T2000 servers are 3 to 5 times more energy efficient than competing servers. PG&E came back with the idea to offer customers rebates to upgrade to those systems in order to help them save energy. Today, the T-1000 and T-2000 are the only servers from which a customer can receive an energy rebate from a utility any here in the world. These companies offer customers a variety of energy efficient products and services:

> **"**It's more obvious each day that extreme efficiency is good for the environment and great for business. Customers want this same eco responsibility in their datacenters.**"**
> — Jonathan Schwartz, President and Chief Executive Officer, Sun Microsystems

Sun's T2000 Server

- **Sun offers an upfront rebate for customers who trade in qualified Sun, IBM, HP, or Dell servers for a new SunFire T2000, improving their data center's efficiency and reducing its impact on the environment.**
- **PG&E offers financial incentives to non-residential customers who undertake virtualization projects that result in the removal of computing equipment. The program pays incentives based on the annual kilowatt-hour savings that will accrue from the project, at the rate of 8 cents per kWh.**
- **PG&E offers several electric demand response programs for business customers. These programs provide financial incentives and other benefits to participating customers to reduce their energy usage during times of peak demand.**

"The data center energy crisis is inhibiting our clients' business growth as they seek to access computing power," said Mike Daniels, senior vice president, IBM Global Technology Services. "Many data centers have now reached full capacity, limiting a firm's ability to grow and make necessary capital investments. Today we are providing clients the IBM action plan to make their data centers fully utilized and energy efficient."

IBM Launches Project Big Green

In May 2007, IBM announced that it is redirecting $1 billion per year across its business, mobilizing the company's resources to dramatically increase the level of energy efficiency in IR. Called "Project Big Green," the plan includes new products and services for IBM and its clients to sharply reduce data center energy consumption, transforming the world's business and public technology infrastructures into "green" data centers. IBM estimates substantial savings---for an average 25,000 square foot data center, clients should be able to realize 42 percent energy savings. Based on the energy mix in the U.S., this savings equates to 7,439 tons of carbon emissions saved annually.

IBM & APC Partner to Create Energy Efficient Data Center

In July 2007, IBM partnered with APC to implement the IBM Scalable Modular Data Center at Bryant University in order to meet the school's growing technology requirements while simultaneously being energy conscious. The IBM Scalable Modular Data Center is a cost-saving, energy efficient solution that was rapidly deployed as a pre-engineered data center, using IBM Global Services' capabilities, coupled with APC's InfraStruXure® data center architecture. IBM installed IMP Power processor-based BladeCenter servers running Linux and IBM virtualization software technology, driving higher utilization rates and helping save energy costs. The new energy efficient system was 15 percent less expensive to build than traditional systems.

HP Thermal Zone Mapping

In July 2007, HP introduced a first-of-its-kind thermal zone map for data centers and new customers and partners of the HP Dynamic Smart Cooling Solution. HP Thermal Zone Mapping enables customers to see a 3-dimensional model of exactly how much and where data center air conditioners are cooling. As a result, they can arrange and manage air conditioning for optimal cooling, increased energy efficiency and lower costs. HP reports that customers can reduce data center cooling energy costs by up to 45 percent using Thermal Zone Mapping and Dynamic Smart Cooling, an advanced hardware and software solution that continuously adjusts data center air conditioning settings to direct where and when cooling is required.

"Organizations of all sizes are currently experiencing significant challenges as a result of energy-related expenses within their data centers. The strategic relationship between IBM and APC will…provide power, cooling, racks, security, and management capabilities that directly address those energy challenges."
---Rob Johnson, APC President & CEO