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Powering down technology

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Introduction to U.S. Energy

In his State of the Union address in January 2006, President Bush announced that the United States has become addicted to oil. Crude oil prices have shown an alarming increase over the past two years. At the same time, world consumption rose by 3.8 million barrels per day.

The Energy Information Administration (EIA) publishes the official energy statistics from the United States Government. The following table details the increase in energy prices and demand between 1993 and those projected for 2007.

Since electric companies use a varied mixture of crude oil to generate electricity, the cost of electricity parallels the increases in oil. The EIA further predicts that the demand for electricity will increase by 45 percent in 2030 (EIA, 2006).

It is evident that the new millennium consumes more and pays a higher premium for energy. Economists suggest that the global demand for energy is a result of the expansion of China and India, the war in Iraq, the hurricanes in the Gulf Coast, and the proliferation of powerful computers (Patton, 2006). Since such factors are all outside of our immediate control, this paper will focus on managing the impact of computer technology on the nation's power consumption.

Business Computing

Livermore National Laboratory houses one of the world's most advanced super computers. The system is designed to simulate a nuclear reaction. The project was named ASC Purple and was completed in September 2005. Within minutes of turning the new system on, laboratory workers received a call from Pacific Gas and Electric Company asking to be notified next time ASC Purple was turned on or off. This is an example of how super computing requires super energy (Patton, 2006).

Academic institutions and scientific testing are not the real energy culprits. Experts estimate that 3–8 percent of the nation's electricity is absorbed by data centers (Iwata, 2001). Data centers house computer equipment for one or more business entities. Because most equipment requires special care, controlled climate, and large amounts of space, businesses have found it more economical to consolidate all office equipment into one location, usually off-site.

TABLE 1 **Annual U.S. Energy Supply and Demand: Base Case**
(Energy Information Administration\Short-Term Energy Outlook)

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Real Gross Domestic Product (GDP) (billion chained 2000 dollars)	7533	7835	8032	8329	8704	9067	9470	9817	9891	10049	10321	10756	11135	11514	11804
Imported Crude Oil Price ($ per barrel)	16.13	15.53	17.14	20.62	18.49	12.07	17.26	27.72	22.00	23.71	27.73	35.99	48.96	60.51	60.41
Total Energy Demand (quadrillion Btu)	87.6	89.3	91.3	94.3	94.8	95.2	96.8	99.0	96.5	97.9	98.3	99.7	99.4	99.8	102.3
Electricity Costs (cents per kilowatthour)	8.32	8.38	8.40	8.36	8.43	8.26	8.17	8.24	8.63	8.46	8.70	8.97	9.42	9.76	9.97
Total Electrical Demand	2989	3068	3157	3247	3294	3425	3494	3602	3554	3642	3668	3727	3827	3859	3951

Source www.eia.doe.gov

A "server" is a high-end computer capable of managing multiple processes simultaneously. Today's servers are mainly used for business applications, can process and store enormous amounts of data, and are much more powerful than a personal computer. Blade servers are the most recent trend in the server market. They are more efficient, compact and flexible. In addition, they offer rewards in reduced floor space, lower power consumption, and easier maintenance. Market researcher IDC predicts that 2.2 million Blade servers will ship worldwide by 2007, representing 27 percent of all new servers sold (Edwards, 2004).

Data centers can house thousands of servers. For example, Yahoo maintains 200,000 servers in 27 data centers nationwide. Data centers consume large quantities of energy. The utility costs for a 100,000 square-foot data center has been reported to be as high as $5.9 million annually. In 2005, businesses paid $3.3 billion for electricity. This amount was an average of 20 to 40 percent more than previous years. Dunn (2006) estimates that the number of servers supporting American businesses will jump 50 percent over the next four years. Forecasts also show that an additional 12 million square feet of data center space will be needed by 2009 (Patton, 2006).

Computer equipment generates heat. At the same time, computer equipment is sensitive to heat. Studies have shown the failure rate of a processor doubles with every increase in temperature of 10 degrees Celsius (Anthes, 2005). Keeping data centers cool is an expensive and challenging proposition. Equipment in data centers is usually densely populated. Space that is leased for $20 per foot can often cost $60 per foot to keep cool. When looking to find a new location for data centers, decision makers are more concerned with price-per-watt than price-per-foot (Dunn, 2006).

Researchers are working on clever solutions to cooling servers. Although newer technologies, such as Blade servers, may require less energy to operate and less physical space than traditional servers, they still have not overcome the issue of generating heat. One popular solution is Egenera and Liebert's Cool Frame system that mounts on top of a Blade server.

The ASC Purple super computer uses a spray cooling system that vaporizes and condenses heat away from the hardware. Liquid cooling systems are also being deployed in many data centers. This method uses chilled water to cool air and is more efficient than air conditioning.

In addition to these solutions, data center managers also are using detection systems to maintain and monitor the facilities. The system detects "hot-zones" and focuses cooling on those areas. Therefore, instead of cooling a 100,000 square-foot region, cooling can be targeted to specific areas. Air conditioning systems offer "economizer mode" that reduces the power consumption when cooling is not required.

Personal Computing

In 1965, Gordon Moore predicted that the number of transistors on an integrated circuit would double every 18 months. Moore made this statement with no factual data to support his claim. He went on to found the Intel Corporation in 1969. Intel's first microprocessor, the 4004 microcomputer, was released at the end of 1971. The chip was smaller than a thumbnail, contained 2,300 transistors, and could execute 60,000 operations in a second. Since 1969, the number of chips has virtually double annually, supporting Moore's now legendary law (Roberts, 2000).

Intel plans to release a new chip in 2007 that will house one billion transistors. The SRAM chip will be unique in many ways. It is a functional static random access memory (SRAM) chip using 45-nanometer process technology. The SRAM chip was designed to require less power and be more energy efficient than previous chips. Manufactures have always built chips to meet consumer and business demand for machines that deliver high performance in small packages at competitive prices. The market demand is now changing with the increase in the cost of energy. Instead of processing speeds, consumers are now looking at a new metric, performance-per-watt.

The Environmental Protection Agency has launched a voluntary EnergyStar program that encourages manufacturers to develop energy efficient computers. Computer equipment that demonstrates power efficiencies will be affixed with the EnergyStar label. Environmentally conscious consumers have learned to recognize this label on household appliances and will purchase computer equipment with the EnergyStar label. In addition to higher performance per watt, computer equipment that meets EnergyStar criteria also has power management settings that will allow them to automatically power down to a low-powered state during idle times (Roberson et al., 2002).

There are many other advancements and strategies to reduce the amount of power consumed by computer equipment that are currently being evaluated and deployed. Several are discussed below.

Chip-Level Power Management

Most office equipment remains in an idle state during the average day. It is estimated that the average microprocessor load for office environment is approximately 8 percent (Roth et al., 2004). While idle, most machines are still drawing power. Many power management (PM) systems allow administrators to manually adjust the power consumption during idle periods. One new solution is to have the internal computer chips have the ability to adjust power consumption automatically to the level required by the current application. For example, applications such as word processing and Internet browsing require less computational demand on the microprocessor than regression analysis or video games. If less demand on the microprocessor could lead to less power consumption, energy would be saved. Nationally, chip-level power management reduces annual energy consumption by 14 percent (Roth et al., 2004).

E-paper: Electronic Reusable Paper

E-paper is an emerging product that will display text and images on a flexible, thin medium. It will be capable of storing a virtually unlimited number of simultaneous documents. Displays will be static and will require no power to maintain the image. Power will only be required to retrieve or refresh documents. Although e-paper will not completely remove consumers' need for paper, it has the potential to significantly reduce printing requirements.

Inkjet Printers

Inkjet printers consume significantly less energy because they do not require as much heat to produce copies as laser printers or copy machines. Because of low image quality and slow printing speeds, inkjet printers have had limited success in business applications. Recently, inkjet printers targeted for small- to medium-sized business applications have entered the market. On a nationwide basis, inkjet technology could reduce average energy consumption for imaging by more that 40 percent (Roth et al., 2004). Continuous improvements in printing page throughput and image quality will allow business to adopt inkjet printers without sacrificing quality.

Remote Power Management

There are a wide variety of power management (PM) systems for office equipment. However, a large percentage of commercial offices do not have PM features enabled. Recently, network products have been introduced that allow the network administrator to enable and manage PM settings remotely for all PCs on a network. By remotely setting system parameters, the network administrator can set PCs within a network to enter a low-power (auto sleep) mode when inactive for a period of time, or shut down (auto off) if machines are left on over the weekend.

Conclusion

It is clear that managing energy consumption is a national and worldwide concern. The solution will require business and consumers to take part in efforts to conserve energy. Technology is a growing part of our daily lives and paramount to our continued success as a nation. It is also represents a growing drain on our finite resources. Technologists are actively researching and introducing new products that will help offset the energy consumption from computer equipment. As energy prices continue to grow, individuals and business decision makers will trade energy efficient solutions for processing speeds.

References

Anthes, G. (2005). "Power Play: The Search for Energy Efficient Chips." *Computer World*. Retrieved May 22, 2006 from http://www.computerworld.com.

Bianchini, R., Rajamony, R. (2004). *Power and Energy Management for Server Systems*. IEEE. 37(11) 68-74. Retrieved June 1, 2006 from http://www.eia.doe.gov.

Dunn, D. (2006). "Power Surge." *Information Week*. Retrieved May 22, 2006 from www.informationweek.com.

Edwards, J. (2004). "The Inevitability of Blade." *CIO Magazine*. Retrieved May 29, 2006 from www.cio.com.

EIA Short-term Energy Outlook. (2006). Energy Information Administration (EIA). Dunn, D. Power Surge. *Information Week*. Retrieved June 4, 2006 from www.informationweek.com.

Intel (2006). "Intel First to Demonstrate Working 45nm Chips." Retrieved June 5, 2006 from www.intel.com.

Iwata, E. (2001). "Experts Debate Nets Role in Power Crisis." *USA Today*. Retrieved June 2, 2006 from www.usatoday.com.

Patton, S. (2006). "Powering Down." *CIO Magazine*. Retrieved May 29, 2006 from www.cio.com.

Roberson, J. et al. (2002). *Energy Use and Power Levels in New Monitors and Personal Computers*. Office of Atmospheric Programs, U.S. Environmental Protection Agency. Prepared for the U.S. Department of Energy. Retrieved May19, 2006 from http://repositories.cdlib.org/lbnl/LBNL-48581/.

Roberts, L.G. (2000). *Beyond Moore's Law: Internet Growth Trends*. Packetcom Inc., USA. IEEE. 33(1). 117-119.

Roth, K., Larocque, G., Kleinman, J. (2004). *Energy Consumption by Office and Telecommunications Equipment in Commercial Buildings*. Building Technologies Program. NTIS. U.S. Department of Commerce.

State of the Union Address, President George Bush. (2006). United States Capitol, Washington, D.C. Retrieved on June 2, 2006 from www.whitehouse.gov.