Sustainability Practices for Higher Education

Key strategies to increase efficiencies, reduce consumption, lower costs and go green in the IT department

TABLE OF CONTENTS

Executive Summary

Sustainability in IT means implementing practices (including purchasing choices) that support greater efficiencies and have a reduced impact on the environment. Having an IT sustainability strategy in place leads to a broader, more-holistic understanding of the IT environment and the important role it performs on campus.

This raised profile is important as budgets shrink and environmental concerns grow. Higher education institutions are under growing pressure to do more with less while also reducing waste and energy consumption. Fortunately, these two goals overlap each other. A more environmentally friendly approach to technology deployment will also help IT departments improve their efficiencies and reduce their costs.

Colleges and universities can simultaneously become more energy efficient, reduce their carbon footprint and save money by pursuing a strategy of sustainability that includes improving the utilization of existing IT equipment, adopting some common-sense best practices, and as budgets or regular upgrades allow, investing in new, innovative technologies.

While there's a lot of marketing hype around implementing green technologies, this white paper moves beyond that by providing actionable tips to help your institution reach its sustainability goals and produce measurable results.

Energy Efficiency

According to the EPA, in 2006, U.S. data centers used 61 billion kilowatt-hours of electricity representing 1.5 percent of all U.S. electricity consumption and double the amount consumed in 2000. So not only has the cost of energy continued to rise, but usage continues to grow. These two factors suggest that the cost of the energy needed to run an IT operation is only going to continue to climb.

Colleges and universities are slowly realizing that if they want to operate more efficiently (and save money), they need to find ways to reduce their power consumption in the data center and elsewhere. Here are four areas that IT teams can target to improve their energy efficiency.

1. CHOOSE SMART PRODUCT DESIGNS: You should demand high-efficiency products when you write requests for proposals. It's easier to do than you might think.

Your best bet is to look for guidance from the Green Electronics Council's EPEAT program — the Electronic Product Environmental Assessment Tool — at www.epeat.net. EPEAT products have reduced levels of cadmium, lead and mercury, which means they're healthier to use and less taxing on the environment. They also are more energy efficient (which reduces emissions) and easier to upgrade and recycle.

EPA Updates Energy Star Requirements

The Environmental Protection Agency has updated its Energy Star specification for computers. Energy Star 5.0, which takes effect in July 2009, toughens up energy-efficiency requirements, including increasing power supply efficiency from 80 percent to 85 percent.

While it is currently difficult to find firm guidance for green data center recommendations, the Environmental Protection Agency has begun crafting specifications for enterprise servers that would merit the Energy Star designation. In the future, the EPA hopes to develop Energy Star specs for data storage and networking equipment, as well.

In the meantime, EPEAT details the environmental impact of specific products and offers RFP templates for the eco-conscious buyer. Buyers can choose EPEAT-certified products based on 51 criteria. There are three levels of EPEAT certification: bronze, silver and gold. If you want to have the greatest impact, go for the gold. As of spring 2008, 51 of 555 notebooks, desktops, integrated systems and monitors had nabbed gold designations.

This means that in addition to 23 required criteria — including reporting the amount of mercury used in light sources and the elimination of certain flame retardants — the gold products met 21 of 28 optional specs. These include, for example, using batteries free of lead, cadmium and mercury, and housing large plastic parts free of PVC.

2. KNOW YOUR PUE: To make your data center more energy efficient, you need a baseline measurement from which to gauge improvements. To that end, green-minded IT experts suggest using the Power Usage Effectiveness (PUE) metric. The PUE can help data centers estimate their energy efficiency, compare themselves with other data centers and determine where to make adjustments.

To calculate the PUE, a center must divide its "total facility power" (all electricity that supports the data center, including the overhead lights, the servers and air-conditioning) by the "IT equipment power" (servers, desktops, networking equipment and storage devices, for example).

The ideal PUE rating is 1.0, which is earned when all the energy delivered is used for computing purposes. In reality, data centers typically have PUE ratings closer to 3.0, meaning that the center consumes three times the energy needed for the IT equipment alone, according to The Green Grid (www.thegreengrid.org), an IT advocacy group in Beaverton, Ore.

Centers can also use the PUE to determine the total energy needed to run specific equipment. For example, if the data center has a PUE of 3.0 and a server demands 500 watts to operate, then the total energy demand of the server is 1,500 watts (3 x 500).

How does all of this relate to your data center's electricity bill? In most instances — but not all — the utility company's bill reflects not only your overall consumption but the number of kilowatts demanded during peak hours. So shifting your data center's consumption to off-peak times usually will save significantly.

Want to start saving energy? Assess the energy consumption of your data center using the Lawrence Berkeley National Laboratory's online self-benchmarking guide: hightech.lbl.gov/dc-assessment-tools/DCPro_EAT_16Dec08.xls.

3. COOL THINGS DOWN: In many data centers, cooling devices (air-conditioners, chillers and pumps) consume 50 percent or more of the electricity demand for the room. Room layout, cooling-unit efficiency and the number of heat-producing devices all effect the energy draw and commensurate cooling demand.

Data centers don't have to be meat lockers. Manufacturers typically suggest ambient temperatures of between 35 and 104 degrees Fahrenheit.

"It is a fact that data centers by design are grossly over-provisioned in cooling," says Ken Baker, data center infrastructure technologist for Hewlett-Packard.

"That's because in a distributed computing architecture, many administrators will deploy a single server for a single application. When you size air-conditioners, you build the air-conditioning to match the maximum load of the server. But that's never attained. So while the servers are grossly underutilized, all this excessive air-conditioning is pumped in."

Baker suggests installing cooling equipment that senses heat produced by each system and then adjusts the temperature accordingly.

4. REDUCE ENERGY CONSUMPTION: There are many ways to dial back energy use — from the choice of microprocessors in servers to the layout of the data center — without decreasing productivity. Each improvement has exponential benefits because the less energy consumed, the less heat produced; and the less heat produced, the fewer energy-consuming cooling devices needed.

Start first with microprocessors. Shifting to multiple-core microprocessors can save energy right off the bat. Multiple-core processors contain two or more processing cores on a single die; they run at slower clock speeds and lower voltages than single-core chips, but handle more work.

Look for features such as dynamic frequency and voltage scaling. These let microprocessor frequency or voltage ramp up or down to more closely match demand, according to the EPA. When usage is low, clock speed will decline, which reduces energy consumption.

Choosing an energy-efficient server requires some work. Because there are not yet Energy Star designations for servers, institutions must rely on the manufacturer's energy-consumption ratings. "We find often the real steady-state usage is about 70 percent of this, but for planning purposes, go with the published data," says Kem Clawson, chief technology officer of EMC's federal division. "I find it best to do this for the complete solution."

There's a catch with that approach, however. One server may consume fewer watts but cannot handle the necessary workload. "So, what's better?" asks Clawson, "Server A, rated at 550 watts consumption, or B, at 950? Server A sounds better until you learn it would take three of Server A to get the job done, but that we could use a virtual server and run three guest systems on a single Server B. Now what's better: A, at 3 x 550, or B, at 1 x 950?"

Consolidation and Virtualization in the Data Center

One of the wisest investments higher education institutions can make right now is investing in consolidation and virtualization technologies in the data center. The two fast-growing technologies offer numerous economic benefits for organizations:

- Higher utilization rates of servers (and therefore reduced server costs)
- Better-managed use of data center space/capacity (saving money on additional data center infrastructure costs)
- Reduced power costs (because of fewer servers running)
- Increased speed and flexibility in facilitating changes to the network (offering savings on labor costs)

Not to mention the green benefits of consolidating and going virtual. While these initiatives will require some upfront investment, they will not only benefit the data center but will also enhance the school's performance.

Consolidation

Consolidation involves reducing large quantities of servers in favor of a smaller number of higher-powered, optimally efficient systems. While it can be applied both to hardware and software, it's generally thought of in the context of hardware.

Consolidation — in one of many forms — is likely the quickest path to start gaining some of these economic benefits. It means moving to a smaller number of servers, increasing focus on more scalable systems that can support greater computing loads and, generally speaking, less administrative workload.

There are several types of consolidation that can be considered:

- **CENTRALIZED CONSOLIDATION:** Moving all servers to a central location and out of smaller branch offices. This simplifies maintenance/administration, security, backup and more.
- **PHYSICAL CONSOLIDATION:** Combining the workload of multiple servers onto a smaller number of larger servers, typically retaining a single operating system.
- **APPLICATION CONSOLIDATION:** Running multiple platforms and a variety of applications on a single server or cluster of servers. This involves the use of partitioning and virtualization to run many "virtual" servers on a single system.

Why Virtualize? Cost Savings.

Saving money is the top reason for switching to virtual machines. Chris Wolf, a senior analyst with the Burton Group in Midvale, Utah, points out that the lower capital expenditure costs from server consolidation, coupled with reduced power and cooling savings and reduced spending for maintenance, "build a strong return on investment case for server virtualization and consequently make it easy for IT folks to secure funding for virtualization projects."

With consolidated infrastructure in place, the institution may or may not elect to take the next step to virtualize and run logical instances of operating systems and applications on partitions of a given server.

Management Tools

An example of a management tool that can help you understand the dynamics of your infrastructure is HP's Insight Dynamics - VSE Suite. This system tracks utilization of various server components (CPU, memory, power usage and more) and can show the impact if a given workload were moved from one server to another, based on how those servers are performing.

The data gathered by this kind of tool will allow a college or university, for example, to determine the minimum number of servers that a series of applications could be consolidated onto, based on the resource demands of the apps.

Moreover, for those schools that elect to virtualize, management tools are critical to dynamically move or copy applications from one virtual machine to another, based on changing performance dynamics.

Virtualization

Virtualization logically partitions the computing capacity of a server into multiple virtual machines (VMs) that can run their own software stack — operating systems, applications and so on. A server virtualization solution consists of three main components: software, servers and storage.

SERVERS: When choosing a server to use as a host for virtual machines, there are three main options: repurposing existing servers as hosts; migrating applications and storage to high-density blade servers; or investing in new, high-performance, high-memory dual- or quad-core servers with ample space and power for multiple virtual machines.

At some point, it's wise to migrate to newer, high-capacity servers designed to handle virtualization. But existing hardware with enough memory and power to serve as a host machine or backup can be repurposed as a low-cost alternative.

VIRTUALIZATION SOFTWARE: Creating, deploying and maintaining virtual machines on a host server requires virtualization software. It's the key to creating distinct environments on one physical machine and for copying and moving these virtual machines around the system.

It's also crucial for managing all of these virtual environments from one location. Without effective management tools, an organization simply trades server sprawl for virtual-machine sprawl.

STORAGE: A network storage environment with ample capacity, efficiently used, plays an important role in maximizing server virtualization. Consolidated, virtualized storage has benefits similar to those of server virtualization: a simplified system with easy creation and backup capability enhances both application performance and disaster recovery.

More and more higher education institutions are switching from direct-attached storage (DAS) to network-attached storage (NAS) to increase cost savings and efficiency. And many are migrating to higher-speed storage area networks, (SANs), which are well suited for both file serving and applications, and are steadily dropping in price.

Green PC Management

A couple of very simple, easy-to-implement practices for individual PCs can have significant power-consumption benefits. Multiplied across a college or university with thousands of PCs, and you have very noticeable power-cost savings.

Enable Power Management Features

Many staff members simply don't shut off their computers. Power management tools and remote systems management software can help IT administrators enforce a power-off policy, and either shut down, hibernate or put to sleep every idle computer. Sleep and hibernation modes can reduce energy consumption by 60 percent, according to the nonprofit Climate Savers Computing Initiative.

Those energy savings could save $15 to $20 a year per computer, says Avocent CTO Ben Grimes. Avocent's LANDesk Management Suite and tools like it allow IT administrators to remotely manage the power settings on every computer on the network and automatically shutdown, hibernate or suspend PCs at night.

The software allows IT staffers to customize wattage settings to specific groups of users and shows estimated power savings before they deploy policies. It also provides reports on the amount of power, kilowatt hours and dollars saved.

Lenovo offers LANDesk in its Lenovo desktop and notebook PCs, while Hewlett-Packard offers similar remote power management software called Verdiem Surveyer. The Verdiem product allows system administrators to centrally control power settings on desktops.

PC manufacturers also offer power management tools on individual PCs. Lenovo's Green Power Manager software allows individual users to configure hibernation and sleep settings. When power schemes meet green standards, a green leaf pops up on the screen. HP provides HP Power Manager on a range of its business desktops, allowing individual users to control when to suspend PCs, shut off monitors and spin down hard drives.

Individual users can manipulate a convenient slider bar interface to change power settings, predict annual cost, energy and carbon emissions reductions, and view historical savings. Similarly, Acer offers Acer ePower Management, allowing users to change their power settings, including adjusting processor speed and monitor brightness.

Prolong Notebook Battery Life

Like all rechargeable batteries, a notebook battery's ability to hold maximum capacity will decrease over time or with usage. Lithium-ion batteries used in notebook computers typically have a lifespan of 300 to 500 charge cycles.

After one year of usage or 300 charge cycles, a lithium-ion battery only holds up to about 80 percent of its original capacity. But there are ways to extend a notebook battery's life, which reduces the need to purchase additional batteries, which in turn saves on natural resources.

First, conserve battery power to reduce power consumption on your notebook by reducing screen brightness, removing peripherals and reducing processor speed, according to HP. Second, high temperatures accelerate the deterioration of lithium-ion cells, so keep it away from prolonged exposure to heat, such as hot cars.

Also, remove the battery if the notebook is turned off and not plugged into an AC adapter for more than two weeks. Remove the battery if the notebook will be plugged into AC power continuously for more than two weeks.

Calibrating the battery is also important. When users operate the battery in fits and starts and then recharge without fully draining it, the amount of power available in one charge cycle is reduced or the battery meter can become inaccurate.

There are four steps to calibrating a battery: First, disable power management in the Windows operating system and select "always on" in the power scheme. That prevents the notebook from going to sleep.

Second, connect the AC adapter to the notebook and charge the battery until the meter says it's at 100 percent. Third, remove the AC adapter and drain the battery until the notebook shuts off. And fourth, reconnect the AC adapter, charge the battery and then turn Windows power management back on.

And last, Lenovo Master Inventor Howard Locker recommends that you never leave your notebook constantly plugged in. "The battery will last longer if it charges/discharges. So you don't want it 100 percent charged all the time," he explains. "Once in a while, let the battery drain." But contrary to popular opinion, it does not have to drain completely the first time it's used.

Thin Clients

Thin-client computing offers some great sustainability gains for higher education institutions. The technology harkens back to the days of mainframe computers wherein the data center powers the computing functions and stores all of the applications and data. Data flows back and forth to thin clients, which are small desktop devices with no hard drives and limited functionality.

In a traditional server-based thin-client model, keystrokes and mouse clicks are sent from the desktop thin-client device to the data center, and the servers perform all of the processing and send a view of the screen back to the user's desktop.

A great deal of innovation has taken place in the thin client industry since thin clients were first developed. Thin clients are no longer simple "dumb" terminals. Most are now packed with a processor, RAM and Flash memory, allowing some applications to run locally. These upgrades boost the performance of some applications, including web browsing, videos and other multimedia applications.

Thin clients have no moving parts, such as hard drives or fans that can fail, so they can last much longer than regular PCs — a big sustainability feature. Without a hard drive, viruses and spyware have far fewer attack vectors than a Windows machine. If a thin client should break down for any reason, IT departments can get the user up and running by moving them over to another thin-client device in minutes.

Here's a closer look at the four main advantages of thin clients:

1. SUSTAINABLE COMPUTING: Colleges and universities are looking for ways to reduce energy consumption and be more environmentally friendly. And it turns out that thin clients offer far more sustainability features than PCs. Thin clients use less energy, have a longer lifespan, and are smaller and require fewer parts, such as plastics, metals and electronics.

As a result, thin clients can reduce the amount of hazardous materials that end up in landfills. According to Forrester Research, a thin-client terminal uses 6 to 50 watts, compared with a regular PC that uses 150 to 350 watts.

At an institution with 5,000 users, thin-client devices combined with the required server and cooling infrastructure will use 24 percent less energy than a PC environment, according to the research firm. Thin clients also produce 23 percent fewer carbon emissions.

2. INCREASED SECURITY: The lack of a hard drive in thin clients not only protects data from thieves but it protects the data from the users themselves. As long as the term server remains secured, the thin client itself is inherently safe. Users cannot disable antivirus software. They can't install unauthorized software or accidentally introduce viruses or spyware through web surfing or downloads.

Thin clients may have USB ports, but IT administrators can use their thin-client management software to lock down the ports, preventing users from plugging in USB Flash drives or CD-ROM drives.

3. TOTAL COST OF OWNERSHIP: Thin clients are less expensive than PCs and can last five to seven years, which is twice the lifespan of a typical PC, according to Tad Bodeman, Hewlett-Packard's director of remote client solutions. This is also a sustainability gain.

IT departments can save tremendously on support costs. A thin solution, for example, may cost close to $1,000 per user. But if an institution purchases a $700 PC, they will spend an additional $2,000 to $4,000 a year just on support, Bodeman says. "Centralized architectures are so much more efficient to maintain," he says.

It may take several years, but a thin-client solution can cut costs. A college or university can save money immediately by swapping out PCs with thin clients, but they will need to make an initial investment on the back-end of the thin client infrastructure, such as purchasing more servers or adding more server support.

Thin Clients: Fast Downloads

Network traffic between the data center and the thin client is generally minimal because all the processing occurs on the server. As a result, downloading an e-mail with a large attachment is faster on a thin client than if a remote user tried to download the same file on a regular notebook computer.

4. CENTRALIZED MANAGEMENT: IT staff can manage the computing infrastructure in one central location: the data center. IT departments can use management software to remotely manage user settings and install software and upgrades. The IT department also doesn't have to worry about backing up each user's hard drive. It's done on the server side.

Again, because thin clients have no moving parts, help-desk support doesn't have to regularly visit users' desks to troubleshoot potential hardware problems. But if a thin-client device breaks down, they simply install another one. Users log in and they're up and running again. According to IDC, IT staff productivity is increased by 78 percent, while user downtime is cut by 88 percent.

Printer Consolidation

Implementing networked laser printers (with few exceptions) is not only more sustainable (with reduced use of paper, ink, chemicals and plastics) but also reduces costs. To save more energy, consolidate stand-alone devices such as personal desktop printers, fax machines, scanners and copiers to multifunction printers or copiers.

Some additional benefits of moving to multifunctional devices throughout an institution are a lower cost per page and reduced service calls to remote sites. Also implementing duplex printing allows institutions to reduce the number of printed pages by up to 40 percent.

Management of these systems is relatively simple and can often be performed by network administrators via a web browser. Networked printing also reduces the number of devices that eventually end up in a landfill.

Many printer manufacturers offer a feature that requires staff to walk to a printer and punch in a security code before the job prints. This security feature is critical for an institution's finance and legal departments, who produce confidential documents. But it also provides a sustainability benefit because it reduces the number of pages that actually get printed, says Dick Sullivan, enterprise marketing manager at EMC.

Return and Recycle Programs

Many major printer manufacturers have launched aggressive return and recycle programs for consumables. For example, Brother offers postage-paid print labels online; Epson provides postage-paid recycled containers that can hold up to 30 inkjet cartridges; and Lexmark converts its recycled cartridges into a wood-like product called eLumber through a partnership with recycler Close the Loop. The two companies donate some of that lumber to Habitat for Humanity.

HP's inkjet cartridge recycling process uses post-consumer recycled plastics in the production of new cartridges. Thus far, more than 200 million cartridges have been manufactured with this new engineering process, which uses more than 5 million pounds of recycled plastics per year.

HP is also offering (for a short time) a trade-in program where organizations who purchase or lease select HP printer solutions can obtain a rebate of between $50 and $1,000 by trading in their obsolete desktop laser/ink printers — any brand, any condition. HP will even pay for the shipping and recycling of the used printers.

Solid Ink Printing

Xerox offers a line of Phaser MFP printers that use solid-ink technology instead of powdered toner. The printer creates color images by heating ink sticks and applying the colors to a drum inside the printer, which then transfers the image onto the page. It's safe, toxin-free and recyclable.

The Ubiquity of Paper

The average staffer uses 10,000 sheets of paper per year, according to the Federal Network for Sustainability. If green's your thing, "printing on recycled paper, reusing it and recycling it is a good place to start," recommends Doug Washburn, infrastructure and operations analyst at Forrester Research.

The Environmental Protection Agency estimates that a ton of paper made from recycled fibers instead of virgin wood conserves 17 to 31 trees, 7,000 gallons of water and 4,000 kilowatts of electricity.

Solid-ink printing produces 90 percent less waste than laser printing, with only one consumable item, compared with the multiple consumables used by color laser printers, explains Donna Covannon, vice president of market development at Xerox. After 192,000 prints, a color laser printer produces about 450 pounds of waste; the solid-ink printer produces only 23 pounds.

Manufacturer Options

ENERGY EFFICIENCY: Many manufacturers are climbing aboard the energy efficiency train. Among desktop and/or notebook manufacturers, the following meet the EPEAT criteria for energy-efficient products: Acer, Fujitsu, HP, Lenovo, Panasonic, Samsung, Sony and Toshiba. ViewSonic meets the EPEAT criteria for monitors.

CONSOLIDATION: IBM offers a number of consolidation products, including servers, hard drives, racks and service agreements. HP is another leader in the consolidation field, also offering servers, hard drives and service agreements.

VIRTUALIZATION: VMware is at the forefront of virtualization software today. Its VMware Infrastructure suite of products enables consolidation, high availability and a more efficient use of resources. However, newer products such as Citrix XenServer and Microsoft Hyper-V have begun to compete in this space. These alternatives merit an evaluation and comparison.

Although most servers are compatible with server virtualization software, HP, Sun and IBM solutions are valued because of their virtualization heritage. Also, their established product lines have key enterprise features and functionality.

The last component, storage, has a number of solid contenders to choose from including IBM, NetApp, EMC, HP and LeftHand Networks.

GREEN PC MANAGEMENT: As mentioned, Avocent offers LANDesk Management Suite for remotely managing the power settings on the network's computers, and HP offers its own remote power management software: Verdiem Surveyer.

For individual PCs, Lenovo's Green Power Manager software allows users to set their hibernation and sleep settings. HP provides Power Manager on its desktops. And Acer has ePower Management, which allows users to adjust their power settings.

THIN CLIENTS: Wyse, HP, IGEL and VXL all offer broad portfolios of thin-client devices. Wyse has a proprietary operating system, Wyse Thin OS, while HP has several software options including HP ThinConnect and HP Image Manager.

PRINTING CONSOLIDATION: Multifunction printers prove to be an essential part of most printer consolidation solutions. HP, Lexmark and Canon all offer several lines of multifunction printers to choose from.

Recycling: A Small Price to Pay

One aspect of IT sustainability that often gets overlooked is recycling, the final journey for electronic equipment that's completed its lifecycle. E-waste, as it is called, inevitably has a price tag associated with its proper disposal. Eighteen states have imposed laws to regulate or help pay for the recycling or cleanup of e-waste.

In addition to state regulations, counties and municipalities across the country, including New York City, have passed local ordinances aimed at keeping the lead, mercury, cadmium and other harmful substances in electronic equipment (especially display screens) out of the environment. While laws addressing e-waste management by smaller government entities are welcome steps, the result is a sometimes confusing hodgepodge of regulation.

For example, while California charges a fee to the purchaser of the electronic equipment (raised to $8 to $25 per screen, depending on size, on Jan. 1, 2009), Maryland requires manufacturers of the equipment to register and pay a fee. Other jurisdictions mandate the establishment of recycling programs or stipulate recycling volumes as a percentage of sales for manufacturers.

While progress is being made, there's a long way to go before the e-waste problem is solved. Just 18 percent of the 2.5 million tons of e-waste generated in 2007 (most recent statistics available) was recycled.