WHITE PAPER

Green IT Practices for Education

Guidance on how educational institutions can become more efficient, support green initiatives and reduce budget costs

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Executive Summary

Taking a green approach to IT encompasses a range of activities that all have the same goal: efficiency. This includes more efficient consumption of resources such as electricity, paper and plastic; a stronger return on investment of an educational institution's IT budget; as well as improved staff productivity.

Going green has taken on greater significance in recent years for a variety of reasons, including the resurgence in attention to environmental concerns and the proven cost savings that accompany green initiatives. An environmentally sensitive organization also reaps the public relations benefits that accrue from cultivating a green profile.

IT managers can play an important role in helping their schools and universities adopt a green approach to computing and have a positive effect on both environmental and fiscal concerns. Capitalizing on this unique opportunity means carefully measuring and updating each element in the IT chain, from the data center to the equipment sitting on each user's desk or carried into the classroom or lecture hall.

Boosting efficiency is a matter of focusing on each resource. There is no magic solution, nor is there ever an end to the ongoing quest to squeeze the most out of each budget dollar or kilowatt-hour.

Power Best Practices

The opportunity to go green starts in the data center. Estimates vary on how much of the total U.S. electrical consumption is attributable to data centers. It is thought that computers of all types and their ancillary storage and networking gear use up to 15 percent of what is running on the electrical grid.

Estimates by the tech research and analysis firm Gartner put the number of servers in true data centers, defined as primary computer locations or organizations that are always under the control of the IT department, at close to 7.6 million. Server rooms and server closets may account for another 5 million servers.

Most data center managers tend to focus on redundancy and the ability to meet peak demand in their approach to running the data center. This strategy can lead to modest opportunities for power savings, for example, by replacing floor-standing servers with blades. But regardless of the form factor chosen, there are more powerful avenues to greater efficiency.

Virtualization and Consolidation

At the height of the server sprawl of the 1990s, perceptive IT managers began to take note that most servers were underutilized, only running at about 20 percent of their capacity. Here was an opportunity to begin reducing power consumption by tapping unused server capacity through virtualization.

With server virtualization, a hypervisor divides a physical server's resources, allowing it to host multiple operating systems and applications. The market offers several manufacturers with well-established and mature virtualization tools.

While it is true that the power consumed by a server rises in tandem with the CPU level of utilization, running fewer, more highly utilized servers will result in a net reduction in the electric bill.

That's because for every dollar of power required by the CPU, the server also consumes another dollar to spin the disk drives and keep its memory alive. Some estimates report that a single server hosting four virtual machines draws half the power of four servers, each dedicated to a single application or operating system.

Getting to higher levels of server utilization takes some careful work. The IT staff must understand the requirements and behavior characteristics of the applications themselves and keep them in mind when purchasing servers, avoiding the temptation to buy too much (or too little) capacity.

Application of sound IT capacity planning and change management will help you fine-tune this process. You can always buy another server, but you can't recover wasted electricity charges.

Virtualizing servers also produces ancillary benefits, including the reduction of floor space and real estate requirements. It reduces cooling requirements and the electricity used for that purpose. And it reduces the need for separate physical environments for operations, software development, and quality assurance and testing.

Heating and Cooling Strategies

Controlling heat is a major challenge for IT managers. The hotter a microprocessor runs, the less efficient it is — so efficient cooling is important. Yet, too many otherwise modern data centers use cooling strategies developed back in the mainframe era.

These approaches cool the entire facility to a target temperature, typically based on out-of-date recommendations from the American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE). Luckily, ASHRAE has updated its standards to accommodate 21st century computing architectures and the drive for sustainability.

The basic idea for improving efficiency is to focus cooling where the heat is. Server racks standing in neat rows and operating at high capacity create hot zones. When servers are virtualized and the loads move dynamically to different physical locations, the cooling issue becomes a bit more complicated because the hot spots move.

Row-based cooling is one approach that boosts efficiency. Row-based cooling points, known as computer room air-conditioners (CRACs), operate when needed at a level of cooling determined by each unit's local heat conditions.

The second component is isolation of the hot side of the servers from the cool side, a technique known as cold-aisle containment. Manufacturers offer various containment system materials and form factors, from solid plexiglass panels to tent solutions. But the end result is less mixing of hot and cold air, resulting in more efficient functioning of the refrigeration units.

Careful planning of the layout of servers and racks can consolidate the hot spots so that cooling equipment operates at top efficiency. Focusing the cooling equipment on where the heat is, and keeping the heat sources together in proximity to the cooling source, offers the most out of each cooling capacity increment the organization invests in.

A green cooling strategy related to row-based cooling is zone-based cooling, which places high-utilization servers and racks adjacent to one another. The same principle applies — concentrating cooling where it is needed, thereby reducing both the cooling and humidity-maintenance requirement in the rest of the data center.

Power Rationalizing

Consolidating capacity and applying cooling more efficiently are two of the three most valuable practices for greening a data center. The third practice is rationalizing the power infrastructure itself, as it is a major potential source of wasted electricity.

The goal is to take the power coming into the facility from the electrical utility and match it to the demands of the facility's computer equipment, while keeping losses (power absorbed by the rest of the building and the power infrastructure itself) to a minimum. Power usage effectiveness (PUE) is a basic measure that shows how close to ideal the data center is to achieving optimal energy use.

To figure PUE, gauge the power coming in and divide that number by the power that the IT equipment consumes. The theoretical goal is a ratio of 1-to-1. In practice, 1.5-to-1 is considered efficient. But many organizations find that as little as a third of the power coming in is used, either for computing or cooling.

Lowering the load from server consolidation and more efficient cooling will reduce the electric bill. However, this won't increase efficiency, and thereby release even greater savings, unless the fixed losses of the power infrastructure as a whole are reduced.

Here is the basic formula:

PUE = Total Facility Power/IT Equipment Power

Sometimes a measurement known as Data Center Infrastructure Efficiency (DCIE) is used to express the energy efficiency of the data center:

DCIE = (1/PUE) x 100 percent

One way to achieve a more optimal PUE is to right-size the power supply bank to the servers actually performing processing, and vice versa. Idle servers still produce heat. The cooling of these servers is an additional power expense that can be recouped by simply turning them off.

A cooling apparatus running at a fraction of its capacity is equally inefficient for the same reason — idle capacity represents an expense that's not producing value.

Over time, investing in more efficient uninterruptible power supply (UPS) units can also lower fixed losses. Manufacturers and third parties offer online calculators to help educational institutions figure out the return on investment.

Other Power-saving Considerations

If you are building a new data center, going green requires that all of the IT equipment be purchased and evaluated with sustainability in mind. Here are some questions to ask:

- Are the new servers being purchased the most efficient? Like endpoint PCs, servers have power-saving features, such as automatic idle mode coupled with instant wake-up. They also have fans that slow down or stop when not needed.
- Has the IT staff combed the data center for servers that are not used at all, but sit idling in perpetuity? Many operators are surprised at how many completely unneeded machines they have that are eating electricity.
- Do the peripherals in the data center fit with the organization's sustainability goals? Data centers have peripherals such as printers. The same green usage rules should apply to them as to similar machines throughout the organization.
- Is the data center lit using high-efficiency lamps? Are lights turned off in areas that can be left dark?

Putting Blades on Ice

Liquid cooling of processors is usually associated with mainframe computers. But this approach could be making a comeback for blade servers.

Blades have become popular because of their size: Typically only 1U thick (1.75 inches of vertical rack space), they can be used to build powerful computing complexes in small spaces. But those small spaces can get hot enough to damage electronics. So racked blades require auxiliary cooling beyond what their individual fans can provide.

New blade racks are coming onto the market that are capable of immersing the blades in a liquid coolant similar to the inert fluids used in transformers. The blades are lowered into the rack-tanks vertically, with their front panels facing up.

Optical drives must be removed first, and the heat-sinking grease needs to be removed from the microprocessor mounting assemblies.

Such systems have the promise of reducing air-conditioning needs radically. However, it will take long-term testing (mainly to see how watertight the hard drives are) before the technology can go mainstream.

In short, the data center is a power-intensive, mission-critical component of the organization. But it can also become a laboratory for continuous improvement in consumption and efficiency while maintaining or enhancing availability and reliability. It can even become a showcase for a university's or school's commitment to a sustainable future.

Desktop Green Practices

Desktop and notebook PCs, printers, cell phones and all the other electronic essentials that aid in an organization's productivity are likely consuming far more power than necessary.

Outside of the data center and spread throughout the educational institution, this bundle of devices — referred to collectively as "the desktop" — is not totally under the control of the IT department. That means end users must be educated and share in the organization's green goals. A culture favoring conservation, sustainability and reduction in personal and organizational carbon footprints should aid IT managers in enlisting users' help in greening the IT function.

Control Power Management

PC operating systems today embed numerous energy-saving settings, the careful and universal deployment of which is a must for reducing power consumption. The Environmental Protection Agency (EPA) estimates that potential annual savings from the use of energy-saving settings can reach $75 per PC.

CPUs and displays can be controlled separately. That is, even if for some reason the organization's PCs aren't set to automatically power down or go into sleep mode after a certain interval, monitors certainly can be.

There are two situations where PCs might not be set for auto-sleep:

1. Some applications aren't compatible with sleep mode. Every user has experienced the frustration of having to reboot after attempting to pick up where he or she left off before the machine hibernated. Such applications should be considered candidates for immediate retirement and replacement.

2. Sleep mode at night prevents the organizationwide downloading of software updates and security patches. Both proprietary and open-source products are available that solve this problem so that security and patch management are not hampered by green efforts.

The sustainability and economic benefits from desktop power management are not trivial. One major U.S. manufacturer stated recently that it had achieved an estimated $1.2 million in annual savings and reductions of as much as 25,000 annual tons of carbon dioxide (CO_2) from a program to centrally control power management settings on its desktop and notebook PCs worldwide.

Some research pegs the total annual electrical tab for unused computers in the United States as high as $2.8 billion.

Another aspect of power management that educational institutions will want to consider is the choice between desktop and notebook computers. Advances in notebook processor and battery technologies are helping reduce the overall power draw of these mobile devices. Efficient power use is a critical factor in overall notebook design.

According to the Energy Star program, notebooks typically consume about one quarter of the power that desktop PCs do. Over the lifetime of a notebook, the savings on power, multiplied over an entire fleet of computers, can be significant.

School districts and colleges will want to factor this into their decision-making process when deciding which computer form factors to standardize on. This is not to say that desktop PCs don't have their place — hardware expandability, multimedia processing power and slightly lower costs are some of the pluses in their favor — but organizations will want to give increasing attention to power efficiency.

Combine Thin Clients with Virtualization

Since the advent of Windows, the thin client industry has been marketing the benefits of offloading most computing tasks from the desktop to servers and using updated terminals for I/O tasks such as keystrokes, mouse clicks and displays.

Now, there is a slow-building trend to complement server virtualization with desktop virtualization. It is driven by security and continuity of operations considerations, but there is also a green element to thin client architectures.

Typical thin clients consist of a color display, a mouse, a keyboard and a small control unit with an Ethernet connection. They use far less power than PCs because they lack disk drives, and they use simpler, lower-power processors than PCs.

One study examined the replacement of 5,000 PCs with thin clients and found a 24 percent reduction in electricity consumed, which translates into 23 percent less CO_2 emitted. Thin clients draw between six watts and 50 watts of power each, compared with 150 watts to 350 watts for desktop PCs.

Because all computers are eventually replaced, the thin client's longer lifecycle makes it even more appealing. Less frequent replacement means less waste destined for recycling centers and landfills.

Realizing the power-saving benefits of thin client computing requires far more than simply swapping out PCs. It requires an investment in virtualization technology and in staff time to deploy it. These changes will have a strong impact on the data center, where the machines hosting the virtual users, their operating systems and applications will be hosted.

Whether as a green initiative or for security, deploying thin clients and virtualization is a step-by-step process, evaluating which groups of users are good candidates and which are not. Call centers and help desk operations are good places to start because these users tend to have identical operating environments and use only one or two applications at a time.

Software development teams, engineers and graphic designers may be less compelling candidates for desktop virtualization.

Maximize Battery Life

In the past few years, notebook PC sales surpassed those of desktops thanks to demand driven by increased staff mobility and the closing gap between desktop and notebook performance.

When in charge mode, notebooks typically draw 75 watts to 100 watts, much less than most desktop PCs. But batteries are the primary green challenge posed by notebooks. Like all batteries, the units in notebooks are chemical-intensive and difficult to dispose of in an environmentally friendly way. So the longer the battery life, the greener and more efficient the IT operation will be.

Batteries can be a real headache for IT, given their tendency to weaken long before their expected 4,000-charge lifecycle. They also can potentially burst into flames when they run too hot.

Excessive heat is a chief factor in reduced battery life. Notice we aren't calling notebook computers "laptops." That's because using them directly on a lap, pillow, car seat or even in bed can cause severe battery overheating by blocking ventilation. Batteries are heat-sinked in large measure by the air space between them and the surface on which the notebook sits.

Use of any charger other than the one supplied by the PC original equipment manufacturer (OEM) can also cause shortened battery life. Just a few charging volts above the specification can greatly reduce battery life.

Batteries do need to be fully discharged occasionally and soak-charged. Turn off Windows power management, drain and charge the battery, then restart power management. This will ensure the notebook is in sync with the battery's actual output.

Seeing the Light

The single LED on an idle power-supply brick or phone charger doesn't consume a lot of electricity. But when you take the circuit inside that powers the LED and combine that with all of the idling-but-plugged-in devices in a large organization, you can quickly contribute a great deal of waste to the electric bill.

Here is where an IT department will need to enlist the help and cooperation of users. There are countless devices drawing small quantities of power that can easily be unplugged or turned off when not in use, resulting in measurable savings.
These include:

- Chargers of all types;
- USB drives with pilot lamps left in ports (both map and memory draw electricity);
- Powered PC speaker systems that are left turned on;
- Peripheral backup disk drives;
- Local scanners and printers.

Also, consider installing intelligent power strips that shut off power to unused devices.

Rethinking Printing

Outputting digital material to paper represents a great irony of the Information Age. Office paper consumption has risen in tandem with the ubiquity of computers. The Resource Conservation Alliance in Washington, D.C., estimates that the United States consumes 4 million tons of copy paper each year.

IT departments can drive down paper consumption using three basic strategies:

CONSOLIDATE PRINTING OPERATIONS: Back when photocopiers were new and expensive, copying was a more precious commodity. Personal printers have proliferated, in part, because they are inexpensive and reliable — allowing staff to conveniently print up anything and everything.

Mandating the use of networked laser printers (with few exceptions) will not only help the educational institution's green cause (reducing the amount of paper, ink, chemicals and plastics used), but will also help reduce costs. To save more energy, consolidate stand-alone devices such as personal desktop printers, fax machines, scanners and copiers to multifunction printers or copiers.

Management of these systems is relatively simple and can often be performed by network administrators via a web browser. Taking this measure will also reduce the number of devices that will eventually end up in a landfill.

A solution to the problem that plagues nearly every office — reams of printouts that no one ever seems to retrieve — is the use of technology requiring users to enter a PIN on the printer panel before it will actually print the document they sent. If they don't take that step, the item is not printed, saving both paper and toner.

MAKE PRINTING GREENER: Many printers have drivers with green capabilities often left unused. These include:

- Two-sided, or duplex, printing;
- Lower-resolution, gray-scale printing, which uses less ink compared with high-quality settings;
- Two-page-per-side printing, which is generally readable but uses half the paper;
- Wide-margin printing, which fits more text on a page and can reduce the number of pages required by long documents.

Most manufacturers will recycle spent toner cartridges, and services exist that will refill empty cartridges. Staff should be reminded to avoid color printing unless it is specifically needed for a project.

Check the recycled content of the paper your school or university purchases. Be careful, because some machines' feeder mechanisms are sensitive to paper quality. Very inexpensive recycled paper may cause jams if the stock is too thin, wasting both time — your most precious commodity — and paper.

Printers themselves are now being manufactured to consume less ink, paper and power. For example, one manufacturer is embedding a Java Virtual Machine in its printers that can store documents through successive revisions, delaying the print job until the document is finished.

To earn the EPA Energy Star label, printers must offer duplex printing. Energy Star also sets standards for power draw during operation and sleep modes, startup and fusing power.

OFFER ONSITE RECYCLING PROGRAMS: Don't overlook the basics of recycling office paper, such as making sure there is a clearly marked container near each printer. Include a shredder for sensitive document drafts that must be destroyed.

Some educational institutions may want to consider a program of reusing printouts that otherwise might go to waste. In some cases, this paper can be used for draft printing on the blank side, depending on the machine, or as copy paper.

Another option is to have staff members preview their documents before printing. This offers an opportunity to adjust the carriage return if needed, which can reduce a document by a whole page.

Do Solid-ink Printers Make Sense?

Are solid-ink printers from Xerox more green than the more common laser and inkjet technologies?

Solid inks first became available 20 years ago. They come as colored blocks made of nontoxic resin and pigment. The ink is melted when it is introduced to the print head. Solid ink comes simply packaged and can be dropped directly into the printer.

Proponents of solid ink point to the downside of typical printers — the elaborate plastic housings and packaging required for conventional toner cartridges. Solid ink printing does not require any of that.

But critics cite the long warm-up times required of solid ink printers, which means users might be reluctant to turn them off at the end of the day. Letting the melted ink solidify wastes ink that must then be removed upon reheating. Solid ink printing also smudges more easily on the printed page.

Solid ink printing may be a good fit for some schools and universities. The reality is that all printing technologies can be used in environmentally sustainable ways. The best printing system depends on a number of factors, including the paper to be used and color quality needed, among others.

Video Conferencing Green Benefits

Educational institutions have staff that travel for many reasons: management meetings, staff training, recruitment, mobile staff that operate in the field and plain-old commuters to and from the institution. Determining what travel is necessary has become an ongoing question as educational institutions seek higher productivity, a lower carbon footprint and better work-life balance for their staff.

For many educational institutions, the location where certain staff work is becoming increasingly irrelevant. Yet face-to-face communication remains an important component in the workplace, because greater collaboration fosters creativity and productivity.

Video communication over an IP network is becoming an increasingly attractive option for achieving the aligned goals of lowering travel and commuting costs while maintaining the personal interaction that is the essence of successful communication and collaboration.

Once a college or school district opts for video conferencing, its strategy should tailor the technology to its various uses. Person-to-person solutions can use existing PCs with cameras mounted on monitors or embedded in the lids of notebooks. Enterprise software products that support these point-to-point sessions are more robust for an office setting compared to popular home version offerings.

At the other end of the spectrum is full telepresence. Telepresence refers to high- bandwidth, high-resolution video on large screens that present a realistic sense of people being in the same room. Large institutions can balance the cost of building internal telepresence centers against the savings from reduced travel.

For smaller schools and universities, or when the need is less frequent, third-party telepresence centers are available to use on an as-needed basis. Standard teleconference centers with large-screen TVs and conventional cameras are more common.

Other video conferencing systems include multicast products used to stream live, one-way messages — for example, from the educational institutions' leadership. Web products that operate within a browser can deliver video or audio in conjunction with presentation materials and may include online chat functions for interaction between moderators and participants.

Telepresence Options

Not including the network bandwidth required, high-definition teleconference setups can run as high as $250,000 per room. But competition among manufacturers has been steadily driving prices down. New systems aimed at small and midsize organizations are available for $30,000 to $40,000.

For IT staffs willing to do more of their own systems integration, lower-resolution, room-size video conferencing packages (including cameras and monitors) can be had for about $6,000. Such systems don't qualify as true telepresence in terms of image fidelity and number of locations that can be networked simultaneously, but they do yield a large-screen, smooth-motion image of participants.

Purchase prices must be balanced against the objective of reducing the expense, time and carbon emissions of travel. One international company spent approximately $15 million on telepresence rooms but saved four times that much from reduced travel and higher productivity.

Sustainable Products and Purchasing

Several green initiatives, some dating back to the early 1990s, consist of public-private partnerships for efficiency standards. They recognize that green is not only profitable but is also a public good.

ENERGY STAR: Now in its 18th year, the federal Energy Star program helps IT managers identify energy-efficient products. Operated jointly by the Environmental Protection Agency and the Department of Energy, the program claims 17,000 partnerships with manufacturers and many other organizations that voluntarily meet efficiency standards or follow best practices in the use of energy. Partnerships include 3,000 manufacturers and 40,000 products.

Energy Star standards extend to buildings and facilities — last year even houses of worship were added to the eligibility list for receiving the EPA's green stamp of approval.

Keep in mind that while the EPA maintains and revises standards for products and certifies the test procedures, it doesn't actually test products. The program relies on self-reporting by manufacturers. Mainstream IT manufacturers that carry Energy Star labels can usually be trusted to have put their products through the required tests.

In general, to earn an Energy Star label, a product must meet a specified criteria for energy efficiency in a form that is beneficial to users. Energy consumption ratings must be independently verifiable using standard tests. The latest specifications, Energy Star 5.0, have been in effect since July 1, 2009.

A variety of IT products — including desktop and notebook computers, workstations, thin clients, small servers and enterprise servers — carry Energy Star labels. Enterprise servers must include efficient power supplies and require minimal air-conditioning.

The EPA periodically updates a list of Energy Star products sorted by manufacturer. Extensive guidelines on building and facilities management are also provided online by the agency.

EPEAT: Billing itself as "green electronics made easy," the Electronic Product Environmental Assessment Tool (EPEAT) system encompasses 33 computer and peripherals manufacturers that agree to produce equipment that meets 23 environmental performance standards. Another 28 optional standards determine whether the products receive bronze, silver or gold ratings.

The EPEAT program criteria are expressed in the Institute of Electrical and Electronics Engineers (IEEE) Standard 1680. Like Energy Star, EPEAT-compliant manufacturers self-declare their products, but make them available for independent verification.

Some educational institutions already have requirements to buy EPEAT-rated products in place. The EPEAT program itself is operated by the Green Electronics Council in Portland, Ore.

LEED: The Leadership in Energy and Environmental Design (LEED) designation is a program for rating the energy efficiency of buildings. Developed by the U.S. Green Building Council, LEED is now widely accepted by architects, engineering and construction firms, building owners, operators and tenants.

Depending on the materials used and the efficiency of various subsystems within a building, a structure may achieve a bronze, silver or gold rating. The LEED program has been a success in gaining cooperation and recognition from ancillary groups including the U.S. General Services Administration and various engineering and architectural standards organizations. LEED certification is now a marketing advantage for new and retrofitted buildings.

Unlike Energy Star and EPEAT, LEED requires that buildings seeking certification must have third-party verification of adherence to LEED's 100-point scale. The criteria cover many components of construction, starting with site planning and including the efficiency of water, energy and materials use.

Do Energy Star and EPEAT interoperate?

Are Energy Star 5.0 and the Electronic Product Environmental Assessment Tool (EPEAT) compatible? Recently the EPA and the Green Electronics Council moved to align their efforts to promote the manufacture and purchase of sustainable computer products.

The IEEE 1680 Standard that underlies the EPEAT standards includes the requirement that EPEAT products also meet Energy Star criteria. In December 2009, IEEE 1680 was revised to require any EPEAT-registered product to meet the latest Energy Star requirements on the date it is adopted. Previously there had been a six-month grace period for compliance.

Manufacturer Options

Here is a sampling of technology manufacturers offering computers, monitors and thin clients with EPEAT certification.

ACER has a total of 28 desktops, displays and notebooks meeting EPEAT criteria. The manufacturer's Eco Product Requirement covers the lifecycle, from energy conservation in design to eventual disposal.

HP, a broad-based manufacturer of computers, servers, networking equipment and printers, has 209 products certified under EPEAT, including 136 different notebook PCs.

LENOVO offers 77 EPEAT products. The manufacturer produces servers, desktop and notebook computers, and displays.

NEC DISPLAY SOLUTIONS has 13 monitors under EPEAT. The manufacturer produces a wide range of displays, from desktop monitors to large-screen units used in high-traffic public areas.

WYSE TECHNOLOGY is a source for thin clients, offering both mobile and office devices. Its R90L model is EPEAT-certified.