Going Green in K-12

Improvements you can make to your IT operations (from network-wide systems to individual PCs) for greater efficiency and sustainability

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Executive Summary

Implementing green technology is quickly rising to the top of many schools' IT agendas, and with good reason: It takes a tremendous amount of energy (and budget dollars) to power data centers, networks and computers.

As budgets shrink and environmental concerns grow, schools' IT departments are under pressure to do more with less, while also reducing waste and energy consumption. Fortunately, taking a more environmentally friendly approach to technology deployment will also help IT departments reach those goals.

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

With appropriate policies, practices and some sensible investment, great strides can be made toward becoming responsible stewards of our natural resources while setting a positive example for students and the community. This white paper provides helpful knowledge and actionable tips to assist you in reaching your green goals and producing measurable results.

Green Purchasing

Many K-12 schools are now realizing that going green starts with finding ways to operate more efficiently (which also saves money). A big step toward that green goal is for schools to reduce their power consumption in the data center (or server closet) and elsewhere. This process can start at the point of purchase by choosing smart product designs. You can 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.

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.

K-12 Energy Use

The keys to reducing power consumption by computers and related equipment are measuring energy usage over time and providing incentives for reductions. This requires a baseline of current energy consumption to measure progress toward reducing energy use. There are software tools for measuring end-user computing and hardware monitors for data centers.

If you are looking for a decent, quick estimate of energy usage oriented to K–12 organizations and covering both end users and the data center, there is a free energy usage calculator on the Consortium for School Networking's Green Computing website: www.cosn.org/greencomputing.

Gold certification means that in addition to 23 required criteria (including reporting the amount of mercury used in light sources and 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.

Measuring Data Center Efficiency

In order 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, an IT advocacy group in Beaverton, Ore. (www.thegreengrid.org).

How does 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 provide significant savings.

If you want to start saving energy, assess the energy consumption of your data center by using the Lawrence Berkeley National Laboratory's online self-benchmarking guide: hightech.lbl.gov/documents/DATA_CENTERS/Self_benchmarking_guide-2.pdf.

Green Data Center Strategies

It's likely that 20 to 25 percent of a school's power bills can be attributed to the data center (or server closet), end-user computers and related equipment, according to the Department of Energy. Data centers alone use 10 to 100 times the power per square foot than other office or classroom space.

Going green in the data center is sometimes easier said than done. But a few small process tweaks here and there can translate into big dividends by reducing overall power consumption.

1. RAISE THE TEMPERATURE. Evidence suggests that hardware runs better when it's cooler. But making a data center too cold can result in a big energy bill. Working closely with IT equipment manufacturers, the American Society of Heating, Refrigerating and Air-Conditioning Engineers determined that data-center equipment can withstand higher temperatures and wider humidity ranges than previously thought.

Five years ago, ASHRAE recommended an environmental range of between 68 and 77 degrees Fahrenheit, with relative humidity between 40 and 55 percent. In 2008, the organization widened the recommended temperature range to between 64 and 81 degrees and the relative humidity range to between 35 and 60 percent.

Most data centers operate at between 65 and 70 degrees Fahrenheit, while some run as low as 60 degrees to guard against emergencies, such as failure of the cooling systems. The strategy is to make the data center as warm as possible without putting equipment at risk of overheating.

2. IMPROVE DESIGN. A few design changes can help improve the airflow, thereby reducing your cooling costs. One option is rearranging the perforated floor tiles to implement a hot-aisle/cold-aisle configuration.

You can also install energy-efficient lighting and retrofit cooling systems with variable speed motors so they generate less heat and consume less power. Using contained cabinets that take air from the floor and vent it directly out the top will dramatically improve airflow.

3. MANAGE POWER REMOTELY. IT teams can install equipment and sensors to measure everything, from the amount of energy that servers, storage, networking and cooling equipment use to the temperature and humidity in front of server racks and in every corner of the data center. That provides another source of baseline data that IT administrators need to determine how to make their data centers more efficient, which in turn helps save energy and money.

4. UPGRADE POWER SUPPLY SYSTEMS. Most new uninterruptible power supply (UPS) systems maintain at least 97 percent efficiency, which means only 3 percent of incoming power leaks out as heat. Older UPS systems operate at 70 to 80 percent efficiency, which means 20 to 30 percent of power is lost.

Buying new modular UPS systems also can save energy. A 500kW system, for example, can be made up of 20 25kW power modules. In the past, IT departments used two large UPS systems side by side for redundancy, with each UPS operating at 50 percent loads (or less, if the data center anticipated growth).

5. 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.

Electricity Consumption

Here's a breakdown of end-user electricity consumption in a typical building by activity:

28%: cooling
26%: office equipment
22%: lighting
8%: other
7%: ventilation
6%: space heating
1%: refrigeration
1%: water heating
1%: cooking

Source: IBM

Start with microprocessors. Shifting to multicore microprocessors can save energy right off the bat. Multicore 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.

Consolidation and Virtualization in the Data Center

One of the wisest green investments that K-12 schools and districts 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 schools:

- 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)

While these initiatives will require some upfront investment, they will not only benefit the data center (and ultimately the environment), 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 green benefits. It means moving to a smaller number of servers, increased 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 data centers. 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.

With consolidated infrastructure in place, the school 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.

Why Virtualize? Cost Savings.

While virtualizing your data center may have fantastic green benefits, most schools are motivated to go virtual for another reason — money. Saving money is the top reason for switching over 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."

Management Tools

An example of a management tool that can help you better understand the dynamics of your server infrastructure is HP's Insight Dynamics — VSE Suite. This system tracks the 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 school or district, 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: servers, software 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.

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 that enhances both application performance and disaster recovery.

Many schools and districts 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 district with thousands of PCs, and you have very noticeable power-cost savings.

Enable Power Management Features

Many staff members and students 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. Some of the additional features that power management tools have include allowing IT staffers to customize wattage settings to specific groups of users, estimating power savings before deployment and providing reports on the amount of power, kilowatt hours and dollars saved.

Keep in mind that PC manufacturers also offer power management tools on individual PCs, giving schools an alternative approach to managing their PCs better.

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. 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.

Thin Clients

School districts that have big computing needs but small budgets are turning to a more affordable solution: thin clients.

Thin-client computing is easier to troubleshoot and manage because, in most cases, the computing infrastructure and all the applications and data are housed centrally in the data center. Thin-client devices are less expensive and consume less power than regular PCs.

And because thin clients have no hard drives, fans or moving parts, they last longer — five to seven years, twice the lifespan of PCs. The technology is also more secure because students can't change computer settings or install unauthorized software.

In the traditional thin-client model, which is the most widely deployed, keystrokes and mouse clicks are sent to the data center, where servers perform the processing and send a view of the screen back to users' thin-client devices. But in recent years, three thin-client alternatives emerged:

- **STREAMING OS:** This approach delivers a computer image (with a full operating system and applications) onto thin clients over the network, and then the thin clients run the software locally.
- **BLADE PCS:** Blade PCs are actual PCs that are housed in data centers as if they were servers. Users connect to the PCs through thin clients.
- **VIRTUAL DESKTOP INFRASTRUCTURE (VDI):** This approach has received the most buzz and is expected to see rapid adoption in the next few years. With VDI, servers are partitioned into different virtual machines (VMs). Each VM shares the same server resources, such as processors and memory, but each VM provides users with their own "virtual computer" with a full operating system and applications.

While thin-client computing is typically server-based computing, school districts can also use regular PCs to power their thin clients. NComputing, for example, offers desktop virtualization software that uses PCs to run thin clients, while Wyse's WSM software allows a PC with a dual-core processor to power as many as 50 thin clients.

While thin-client devices themselves are less expensive, there are additional upfront infrastructure costs in a thin-client deployment, such as buying new servers and upgrading network equipment. At best, the upfront capital cost of thin clients is 5 percent cheaper, and at worst, it's a wash.

Thin Client Best Practices

1. Upgrade the tech infrastructure, so it has the capacity to handle thin clients. That includes having redundant servers and a network that can handle bandwidth requirements.
2. Users (particularly teachers and administrators) are attached to their PCs, so you must explain the benefits of thin clients, such as improved performance.
3. Work out the cultural issues. IT leaders must determine who among their staff will manage thin clients. Historically, help-desk support personnel managed PCs, while server administrators handled the data center. Who will now handle thin-client support?
4. To save money, IT departments can use old PCs as their thin-client devices.
5. Districts no longer have to purchase one copy of software for every PC. Instead, they can purchase a smaller number of licenses, and when users need the software, they access them over the server.

Sources: John Sloan, Info-Tech Research Group; Gregory Partch, Hudson Falls Central School District.

But over the long term, schools can expect significant savings — as much as 40 percent savings from reduced help-desk support and maintenance costs.

The thin clients also consume less power, which results in lower electricity bills. According to Forrester Research, thin clients consume between six and 50 watts of power, much less than the 150 to 350 watts required by PCs. When server, networking and cooling requirements in the data center are factored in, thin clients reduce power by 24 percent, the Forrester study found.

Because thin clients are more environmentally friendly than traditional computers, teachers can also point to thin client use as an example of green practices.

Asset Disposition

As more schools and districts recognize their responsibility to include a sustainability strategy as part of their IT programs, the disposition of IT assets deserves a special mention.

Disposing of retired PCs is an integral part of the PC lifecycle. Asset management tools allow IT departments to keep track of the age of computers and when to retire them. As part of the process, IT administrators need to budget for PC disposal, including the cost of wiping out hard drives and the cost of recycling equipment to comply with electronics recycling laws.

Schools have three main options for asset disposition: resell it, donate it or recycle it.

RESELL: This is the one option that provides any kind of monetary reimbursement (what little there is). Some schools organize an employee purchasing program that allows workers to purchase retiring equipment.

Short of that, you may have to do some legwork to find a buyer. Your best bet is to locate a reputable local third-party service that will sell or auction your equipment for you.

DONATE: Organizations can also consider donating their equipment to a worthwhile cause. There are plenty of charity and nonprofit organizations that can make good use of retired equipment.

And many charitable organizations are experienced enough with receiving IT donations that they have an established regiment down for renovating the computers, including wiping the hard drives clean and removing any asset tags or other identifying information.

But keep in mind too that charities often have specific requirements about what they can and cannot take. Be sure that any organization you donate to is partnered with a recycler, for any donated equipment that cannot be used.

RECYCLE: Organizations can hire a recycling service or negotiate a deal with PC makers to do the recycling for them. Fortunately, there are third parties that handle recycling and disposal in accordance with local regulations.

Depending on the state, they might even pay you; in other states, you will have to pay a small fee. An Internet search by county and "technology disposal" will help your organization find local agents.

Data Wiping

If you decide to use a recycling service, you will want to make sure that the data on your equipment is truly erased as part of the disposition process. Data on hard drives and other storage media can be read long after you think you've deleted it — even after it's been written over by newer files. Your school should have a strict policy covering the disposal of storage media.

You can either do the data wipe in-house using software that is NIST SP-80088 certified compliant or find a recycler. And if the third-party recycler is responsible for the data wipe, they must be NIST SP-80088 compliant and be able to provide an audit trail of their recycling process for you.

Reducing Waste

Computer technology can be used to save money and natural resources in several other ways, including reducing printing, limiting travel and managing energy use for buildings.

There are several ways to get more energy efficiency from printers, including consolidation of printers and copiers into multifunction devices. While consolidating printers is a good strategy, a more

effective tactic is to reduce what is actually printed. The question to ask is, "What are we printing today, and how much of that can be managed electronically through online forms and web-based applications?"

There is certainly an opportunity to reduce paper for school or district internal communications, and there also might be e-mail and web-based opportunities for student and parent communications.

Travel also has costs and related adverse effects to the environment. It makes sense to investigate current travel by students, teachers, IT support and other staff, and to search for alternatives to minimize the need for travel.

If student field trips are being curtailed because of budget restrictions, this might be the time to introduce virtual field trips through video conferencing or video streaming. It's not just like being there, but with this technology students can visit almost anywhere in the world.

Likewise, staff from around the district can meet via video conferencing, conference calls or a growing number of web-based online meeting services. Also, travel time for IT end-user support personnel can be reduced by implementing centralized support functions through help desks and remote management tools.

For managing energy use in your buildings, there are utility management and reporting tools that audit, track and analyze utility consumption and costs to identify opportunities for significant savings.

Now is the time for schools to save money while reducing the impact on our environment, setting a positive example for students and the community.

Printing Goes Green

Beside printing less, schools have other green printing options. 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.

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 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.

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: 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 HP Power Manager on its desktops. And Acer has ePower Manager, 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.