

Information Technology

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Energy Drain by Computers Stifles Efforts at Cost Control

'We don't have a meter on the data center,' says one college official

By JOSH KELLER

Menlo Park, Calif.

For decades, the major computers at the Stanford Linear Accelerator Center have multiplied almost without limit.

Row by row, racks of computer servers have expanded outward in a constant quest to provide computing power for the center's data-intensive experiments. The servers have taken over new wings of an office building at the site, which is operated by Stanford University. Many of those unfortunate enough to work nearby have been displaced, and their former offices house towering black machines.

Now the pipes that supply cold water to help keep the servers cool are running at full capacity. The building has trouble taking in the huge amounts of electricity that modern-day servers require. For each dollar spent on computers, the center must spend an equal amount of money to build the power and cooling systems to keep them running.

That cost "has been killing us," says Richard P. Mount, the center's head of scientific computing. The price of storing and processing data, in fact, is hurting every college and university in the country.

In response, some institutions are embracing greener technologies, as much to keep costs down as to help the environment. Stanford is moving toward building a new center that uses outside air instead of chilled water, and it hopes to save just over \$3-million per year. "Arguably, this pays for itself," says Phil Reese, the university's faculty and research computing strategist. "There's not many arguments you can give that are that strong." And there are other steps, like consolidating servers and outsourcing services, that are less expensive than building a new facility and reduce data's budget-devouring appetite, computer experts told *The Chronicle*.

But compared with other industries, colleges and universities have been slow to understand the problem and to adopt energy-saving techniques, experts say. Colleges are decentralized, and they often lack a cohesive strategy to reduce energy use. Researchers, in fact, often resist plans for centralization because they want their own servers just down the hall. As a result, many institutions waste millions of dollars per year powering inefficient machines, outdated cooling systems, and improvised clusters of servers stored in lab closets and back rooms.

One survey, for instance, found that higher-education institutions are less likely than businesses, the K-12 sector, and the federal government to have a formal policy to encourage energy-efficient buying decisions and are less likely to hold information-technology departments responsible for their own energy costs. The survey was conducted in June by the computer vendor CDW-G.

"We typically in higher education have not had the financial incentives lined up," said Mark S. Askren, assistant vice chancellor for administrative computing services at the University of California at Irvine. "Folks in data-center organizations like mine who are consuming energy, we don't have a meter on the data center. We don't even know how much we're consuming."

At Stanford, leaders realized the depth of the problem when plans for every new major building included requests for major computing facilities inside of them, says Mr. Reese. The requests were symptomatic of a larger problem that plagues many institutions, Mr. Reese says: Data centers are spread out across the campus, making it more difficult to ensure that the computing facilities are energy efficient.

In response, the university is moving toward building a new, greener data center off-campus, on the site of the Stanford Linear Accelerator Center. The new data center would serve the university's research needs as well as take over half of the computing capacity of the linear accelerator itself, alleviating some of its infrastructure problems.

The new facility would be twice as energy efficient as the university's current model, Mr. Reese says. The building is designed to take advantage of Northern California's temperate climate, cooling the servers with circulated outside air instead of using chilled water, which is expensive to cool down. It would also expel the hot air given off by the servers, reducing the need for external cooling.

Mr. Reese says he expects the data center could cost upwards of \$50-million, but he said the center will save the university \$3.2-million per year in energy costs over 25 years.

Stanford's proposed improvements are dramatic, but many efforts to increase efficiency do not require such a large initial investment. In interviews, data-center experts recommend steps college administrators could take to begin reducing a data center's energy costs.

Conduct an Audit

Some colleges do not understand how much money they are spending powering their data centers, and that makes it difficult to solve the problem.

For many, the first step is to conduct an energy audit. Representatives from facilities departments can typically measure how much power is being consumed at each of the campus's major data-center clusters, says Dallas Thornton, a division director for cyberinfrastructure services at the San Diego Supercomputer Center at the University of California at San Diego. They can then add up the readings to determine the total data-center energy usage of the campus.

"More times than not, it will be a high number," Mr. Thornton says.

Private consultants and some equipment vendors also offer efficiency audits, though Mr. Thornton says an effective audit can often be done in-house. A couple of common measurements have been developed to evaluate the approximate energy efficiency of a data center, which often focus on the excess energy used by the facility that houses the machines.

PUE, for example, which stands for power usage effectiveness, is calculated by taking the ratio of the energy use of the total data-center facility and the energy use of just the IT systems themselves. (The Green Grid, a prominent industry group that promotes energy-efficient data centers, explains the details of measuring data center efficiency at thegreengrid.org.)

Colleges can often save significant amounts of energy by making small improvements to their cooling systems, which can account for 50 percent of a data center's energy usage, says Jesse Hanz, a regional director in Pittsburgh for APC, an equipment vendor that offers energy audits to colleges.

"There's no better place to start in the data center to become more energy efficient, because there's a lot of waste there," says Mr. Hanz.

Establish a Working Group

The roadblocks to establishing more efficient data centers are as much organizational as they are technical. Historically, IT departments have been responsible for selecting and paying for data-center equipment, but facilities departments have been responsible for footing the electricity bill. Unless the two departments coordinate their budgets and set energy efficiency as a common goal, reducing usage is difficult.

"The people buying the computer equipment don't have the incentive to spend a dollar to get a more efficient computer even if they might save \$5 or \$10 on more-efficient energy use," says Jonathan Koomey, a consulting professor at Stanford.

Long-term planning for operational costs could more easily be ignored when data centers were smaller and the most important things were speed and access to the equipment. But now that the costs are so high, establishing incentives to encourage energy-efficient behavior on the part of IT departments and faculty is imperative, Mr. Koomey says. On some campuses, IT departments that can prove their purchases saved money on operational costs recoup some of that money in their budgets.

Don Carli, a research fellow at the Institute for Sustainable Communication, an advocacy group, says reducing energy use requires setting common goals among many parts of an organization, always difficult on college campuses. Mr. Carli recommended forming a committee that has the power to create incentives that seek to encourage more energy-efficient behavior.

"By its very nature, sustainability is an interdisciplinary concept," says Mr. Carli. "It's a systems-thinking concept, and basically institutions of higher learning are a collection of silos."

Consolidate

One particularly inefficient strategy for grouping servers is common at colleges. Instead of using a centralized data center, research groups install their own servers locally, often in back rooms and closets. The set-up helps give researchers greater access to their machines, but it can take 50 percent more energy than the same amount of resources at a centralized data center. Researchers call them "server closets" or "closet clusters."

Amin M. Vahdat, a professor of computer science at the University of California at San Diego, says the strategy is particularly wasteful because researchers might only use the servers every so often, when they have a paper due or need to perform calculations.

"I have my cluster and I only need it twice a year — well, I'm not going to power it down," says Mr. Vahdat, who is researching how to build more energy-efficient networks. "I build my cluster, put it in an energy-efficient closet, and use it twice a year, and I'm not exaggerating."

Forcing employees to use centralized facilities is much more difficult at a university than in the business world, which makes it hard for colleges to control energy costs, says Gregory Ganger, director of the Parallel Data Laboratory at Carnegie Mellon University. Researchers do not trust that IT departments will be able to fit their individual needs, and they like to have direct access to their machines.

"At a company, the company can dictate the software you're going to use," Mr. Ganger says. "At a university, theoretically the central administration could dictate the software you're going to use, but in practice that's impossible. ... You're not going to dictate to them, 'Thou shalt use the following version of Linux.'"

More and more types of researchers are depending on large amounts of computing power to perform their research, however, making a centralized data center for research all the more important. Mr. Ganger says the practice of virtualization, which allows researchers to establish different operating environments while using the same data center, has matured enough to work in a wider variety of situations.

New infrastructure is expensive, of course, and the recession is forcing some institutions to forgo building their own new data centers. Instead, they are looking at ways campuses can share their facilities to achieve greater economies of scale.

At the University of California, administrators are discussing establishing two data centers that will serve some of the system's 10 campuses in each half of the state, says Mr. Thornton, at the San Diego Supercomputer Center. Taking a regional approach, he says, could allow the university to build fewer specialized facilities to power and cool the servers.

"It's something that in tough budget times that people are a lot more likely to be interested in," Mr. Thornton says. "It's hard to go to bat to get new funding for a data center right now."

Outsource

Some of the most energy-efficient data centers are those run by technology companies like Google and Microsoft and the online retailer Amazon.com, whose profits depend on finding cost-effective ways to store and process data. In the long term, experts expect many colleges to export much of their operations to companies like these to save money and focus on what they know best.

Already, more than 1,000 colleges have signed up for e-mail service through Google or Microsoft, helping those colleges reduce, if only slightly, their need for on-campus data centers. Despite some concerns about student privacy, many colleges have reported that letting professionals take care of e-mail results in significant savings.

A model for outsourcing more significant parts of the data center — the computing needed for scientific research, for instance — is still being developed, says Thomas A. DeFanti, a professor of computer science at the University of Illinois at Chicago. Even if some universities did figure out how to outsource more of their computing resources, he says, some do not have access to networks that would support efficiently moving such large amounts of data.

"There isn't a price model that everybody believes in yet, and it does of course depend on networking that's not available in some places," Mr. DeFanti says.

Still, Mr. Koomey, the Stanford consulting professor, says the idea of using external resources "makes a ton of sense."

"Why not let the people who have a lot of users do all the work?" he says. "It puts you at risk in some other ways, but for the most part there really are economies of scale."

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