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Green Data Center Efficiency Developments

Times were that efficiency in the data center meant more processing power and faster data transmission speeds. Now efficiency means using less energy to get more done. This E-Guide takes a snapshot of data center and storage efficiency initiatives being launched by energy companies, data center management teams and storage operatives.

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Green data center operations on docket for '07

By Richard Ptak, Contributor

A topic soon to be, if not already, hitting the 'to do' list of enterprise IT managers is the escalating pressures exacted to integrate more environmentally sensitive behaviors in the data center. 'Environmentally-friendly' or, more colloquially, 'Green IT' appears to be rapidly shooting up the list of vendor differentiation strategies. This, not incidentally, will exert major impact on data center policies from acquisition to administration to operations. The last two months have seen a slew of vendor meetings and presentations of product plans, programs, and in-house initiatives as major vendors tout just how 'green' they are in operation, products and policy. (Should Kermit be jealous?)

Several forces come into play in this area, all with a more or less direct impact on IT operations. Let's identify them:

First, there is the highly charged message of the immediate threat to mankind posed by widespread use of technology, energy and personal transit. The battle between Luddites and workers over the use of technology dates back to the 19th century Industrial Revolution (and probably earlier). The battle shows no sign of ending. The combination of forces (media, interest groups, politicians, etc.) raising the issue of being 'Green' means that ignoring the clamor, whether scientifically valid or not, is far too risky. So, the data center (and enterprise) will feel the impact in record keeping, restrictions or requirements around purchases, changes in behavior and product availability.

Second are the governmental mandates, which range from regulations aimed at recycling and anti-pollution measures to more draconian mandates, i.e., the European Union assessing taxes based on total life-cycle environmental impact. This effort requires an assessment of the environmental impact that a product has at every stage of its life-cycle; meaning a detailed examination and assessment of impact from conception through manufacture, packaging, marketing, distribution, implementation, application, retirement, re-use, and, finally, disposal. This is likely to directly impact product pricing, packaging, usability, maintenance procedures and even availability (as in products that will never see the light of day) of new technology. And, you thought Sarbanes-Oxley caused a productivity hit!

Finally, there is the real, direct impact of escalating cost of operations due to increasingly rising integrated global markets and escalating competition for access to scarce resources. This impacts data center operations, touching everything from energy to the availability (and cost) of skilled expertise. Pressures will continue to grow due to the exploding technological sophistication and demand from emerging, rapidly developing nations. The competitors for resources of all kinds are the emerging IT centers of Brazil, Russia, India and China - countries recognized to have enormous potential for revenue and consumption of all sorts.

This is where the data center will likely see the biggest benefit, albeit at a cost. It is this struggle over resources that will motivate significantly better efficiencies and lower the power demands of data center products. The fuel 'shortage' (despite the discovery of an estimated trillion plus barrels of oil lying under the Gulf of Mexico) is driving up energy prices and has vendors scrambling to lower energy demands across IT products from chips to server racks.

So, expect 'Environmentally Friendly' and 'Green' tags to appear on all kinds of products. We'll discuss the issues, vendor moves, and implications in the months to come. Our closing thought: Prince Charles (heir-in-waiting to the British throne for the past 30 years) will reduce his personal carbon footprint by having his servants, staff, and messengers walk, bicycle, and ride the Underground as they conduct business on his behalf. What a prince!!

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Data center energy efficiency hinges on utilization, not applications

By Robert Rosen, Columnist

One thing that you sometimes hear about when it comes to energy efficiency in the data center is power consumption at the application level. Windows Vista OS, for example, is rumored to be more "expensive" energy-wise than previous releases and other systems. However, I suspect that the energy difference between Vista and other Microsoft OS versions is barely measurable.

Any machine using more cycles is going to use more power, assuming that the machine has some throttling mechanism to slow down when it's not being used, which most of the PCs and even the mainframe have. There is probably more you can do with graphics in Vista that draws a little more power, but that's a nit compared to some of the other issues concerning data center power consumption.

Data center power consumption hinges on utilization

The difference in applications is really a red herring. One of the real culprits is the people who just leave their machines sitting there all day long not doing anything. In other words, what you're really talking about is the percentage of utilization.

The problem you have in the PC server world is that the average utilization is so low that multiple machines need to be running in order to keep up with computing demand. The average utilization on a PC server is around 7%. If that kind of utilization can be justified to your power bill-paying CEO then more power to you.

However, you might consider that the difference in power usage between running at 7 and 100% is very low because most of the power goes just to keeping the processor running, the fans running, the disc spinning, etc. These mechanisms are using power whether utilization is up or not.

That is not to say that only PCs have such utility issues. All servers need air-conditioning and other energy-absorbing peripherals. The mainframe is not going to be different energy-wise in that regard. The bottom line is that especially in the low-end PC server market, a lot of power is being consumed even though they're sitting there idling most of the time.

Scaling up: Mainframes, high-end servers deliver higher efficiency

Average utilization for the mainframes is somewhere around 90%. If you look at power per work being done, you're more efficient on the mainframe. Any of the larger servers that are designed to run multiple jobs, whether it's a mainframe or Unix box or other high-end server, are going to be more effective power-wise than what you're going to find on an Intel or AMD –based server. That's because low-end machines aren't designed for the same kind of workloads; most of the time they're just sitting there using power and not being very useful.

I was talking to some people in the Intel server market who said that when you're down in the smaller servers, all

the fans are lower quality fans. They don't use ball-bearing fans. The power supplies aren't as efficient. The lower end server market, the mass part of the market, are so price sensitive that you can't afford to make them more efficient. It's understandable. There are potential power savings with scale-up.

Scale up only goes so far

When you're talking about the big high-end servers, mainframes, whatever, they're all trying to be efficient. You're not going to find a whole lot of difference between those machines. The real problem that we're all facing is that we need to find a way to use less power.

We're going to get killed by our top management because we're the big power hogs. The cost of energy is going up so dramatically and when the bill shows up on the CFO and CEO's desk they're going to tell us to use 20% less power—but still do the same amount of computing. The other thing that is going to kill us is storage. We keep adding more and more storage. Running all of those discs and motors are sucking up power.

So, how do we use less energy? Some things are obvious: use the most efficient power supplies you can because the conversion to DC power costs you energy; use the most efficient chips available; etc.

SPEC has created a committee to develop a power rating benchmark. You'll be able to compare machines' power. Based on the workloads you'll be running, you can determine how much power each system will use. Now you can compare price point costs versus operating costs. I think that people will start paying attention to things like that and possibly reverse the habit of buying cheaper servers.

The future of data center power efficiency

You have to look at the total picture. For example, using alcohol in cars is compelling because it's renewable. But it takes energy, water and fertilizer to grow the corn and convert it to a usable fuel. Some of these things are energy negative. It takes more energy to generate a power source than the power source can deliver. If I do a direct hydrogen conversion using current technology, I use more energy than just using the electricity in the first place.

I think that data centers in the future are going to use combinations of things. There might be breakthroughs in solar cells that enable data centers in sunny areas to operate efficiently. Flat, windy areas might find it feasible to invest in wind energy.

The future will be multiple sources, more energy efficient computing and energy recovery. What do you do with the heat that data centers generate? Most places today use the AC to cool it, so you're just wasting this heat energy. Years ago I toured a data center where they blew all that hot air out and used it to heat the rest of the building. It's a really sensible idea, but it begs other questions that businesses need to address. For example, how do you retrofit an existing data center to efficiently recover energy? How can we make this economical?

There are companies out there whose business is helping companies become more efficient. One I spoke with offers an interesting business model. They monitor your company's energy usage, make changes to make it more efficient (e.g., replace incandescent lamps with fluorescents), all at no up front cost. Then you pay them a percentage of your energy savings.

Beyond energy efficiency in the data center

Another part of what data centers are facing is physical space. People are not only running out of space for their equipment, they're also running out of places to build new data centers. Some companies are buying the land now, even though there aren't immediate plans to build new data centers, because they're afraid that they won't be able to get it when they need it. They're also buying the land where power is less expensive.

What is driving the land rush? I think that it's a genuine concern for the ability to find the land to build the big data centers that they need. It's a resource that you can't get more of. You can buy new servers because manufacturers are going to keep making them. But nobody is making new land. I think that this is something we'll be hearing more about in the future.

ABOUT THE AUTHOR: *Robert Rosen is the immediate past president of SHARE Inc. Currently, he serves as the CIO at the National Institute of Arthritis and Musculoskeletal and Skin Diseases of the National Institutes of Health, US Department of Health and Human Services.*

Utilities team up to cut data center energy usage

By Bridget Botelho, News Writer

High-efficiency, power-saving servers and technologies, such as virtualization, are catching on as a way to cut down on electricity costs, but energy-efficiency programs have a long way to go.

That's why Pacific Gas and Electric Company (PG&E) of California announced it is leading the formation of a national utilities coalition to coordinate energy-efficiency programs for the high-tech sector, focusing on data centers.

"It's pretty obvious that data centers consume a ton of electricity and finding ways to lower their power consumption is extremely important to the entire region (surrounding the data center), and it helps the environment because we are slowing the need for new power plants," said Mike Durand of Massachusetts's Nstar, a member of the coalition.

Other organizations that have signed on to the effort so far include TXU Electric Delivery of Texas, Austin Energy and the New York State Energy Research and Development Authority (NYSERDA).

The new coalition will look for ways to improve energy efficiency in new and existing data centers, which according to PG&E, can use up to 100 times the energy per square foot of typical office space.

Pierre Bull, a representative of NYSERDA, said that organization has focused on research and development. The creation of one unified group with a shared goal will move energy-efficiency innovation forward.

"We are asking how we will meet power needs in the future, particularly with concern to data centers," Bull said. "This (coalition) is a way for us to share information with organizations all over the country."

But being new, the coalition does not have any concrete measures in place as of yet.

Areas with relatively low-cost power and access to high-bandwidth Internet infrastructure, are experiencing significant growth in the number of data centers being built. In the Northwest for example, Microsoft, Yahoo, Google and other companies are building new facilities, reported Stacey Hobart, corporate communications manager for the Northwest Energy Efficiency Alliance (NEEA).

"The electric load represented by these facilities is significant and it is in everyone's best interest to build in as much efficiency as possible," Hobart said. "Providing efficiency keeps costs low for everyone."

Green incentives

Nstar is pushing its customers toward green computing by offering customers who upgrade their equipment to more energy-efficient models, Durand said.

"The cost of buying the most energy-efficient products is what keeps people from buying them, so we give them incentives to offset the cost in addition to the monthly savings in energy costs they'll see," Durand said.

PG&E is also paying customers in the high-tech sector for pursuing energy-efficiency projects. The company approved a plan in November to reimburse up to 50% of the costs of a server consolidation project, including software, hardware and consulting, up to a maximum of $4 million per customer.

To date, about a dozen companies have signed up for the program, said Mark Bramfitt, supervisor of the customer energy-efficiency program for PG&E.

One PG&E customer made use of virtualization technology to consolidate 230 servers onto just 11 new machines and is now considering a second project to consolidate an additional 1,000 servers, the company reported.

Most companies are increasing efficiency piece by piece, like employing virtualization to cut back on servers, but no one has invested in a full upgrade of servers, power and cooling, yet, he said.

"I would love to see a customer come to me for a complete upgrade and consolidation. They would easily save one-third to one-half their data center energy costs, but people just aren't ordering full end-to-end upgrades, yet," Bramfitt said.

The reason full-scale efficiency upgrades haven't happened is that the "IT guys" who order equipment for data centers rarely see the electricity bills, Bramfitt said.

"Reliability is the utmost importance to them, and energy isn't a concern for them, unless they are running into issues with things, like power and cooling," Bramfitt said.

Bramfitt's motivation in trying to reduce power consumption is personal, since PG&E is spending $950 million a year [to buy and generate] power, and he is responsible for reducing usage.

Data centers are the places where significant savings can be made, since these facilities use around 2% of the total power consumed in PG&E's region, he said.

And energy prices continue to rise. By 2009, IDC in Framingham, Mass., predicts that technology operations in the U.S. will spend twice as much for power and cooling as they did to buy the server hardware in their data centers. National scrutiny In addition to private sector groups, the U.S. Environmental Protection Agency's (EPA) Energy Star Program is tackling the problem of data center energy consumption.

Even the federal government is getting in on the act. The U.S. House of Representatives approved a bill to study and promote the use of energy-efficient computer servers in the U.S. The final results of the study, set for release to Congress this June, will project growth in energy use of U.S. computer servers and data centers, assess potential cost and energy savings related to computer server and data center energy-efficiency improvements, and assess potential incentives and voluntary programs for promoting energy-efficient computer servers and data centers, the EPA reported.

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Rising electric rates inspire energy-efficient storage

By Alex Barrett, Trends Editor

With the cost of electricity soaring by 30% to 60% this year, IT managers are looking for ways to put some proverbial air into their storage systems' tires to eke out a few extra miles per gallon from their storage sport utility vehicles (SUV).

EMC Corp., for example, has seen a surge in interest for 500 GB disk drives in its Symmetrix DMX platforms, according to Bob Wambach, director of EMC Symmetrix product marketing. The reason? A 500 GB drive offers 66% more capacity than a 300 GB version but consumes the same power in the same space footprint, he said.

The problem is especially pronounced in urban areas like New York City, Wambach said. In some cases, customers tell him, "I can't physically get more power into my data center, but I still need to do more."

Indirectly, data growth and users' desires for disk-based data protection are inspiring more power-efficient storage designs. "Our design goal was to put 1,000 disk drives in a single box," said Chris Santilli, chief architect and co-founder at Copan Systems. Copan's product uses a massive array of idle disks (MAID) architecture, which only powers on up to 25% of the drives at a time to improve power utilization and extend the life of the disk drives. The result, the Revolution array, fell short of the 1,000 drive goal—but at 896 drives, it's still approximately four times denser than an average array and uses only one quarter the power, Santilli said. Given that, "we feature 16 times better power per disk than other systems," he added. The Revolution is used as a virtual tape library (VTL) and archiving platform.

But mechanical improvements to storage arrays can only improve power consumption so much, said David Scott, president and CEO at 3Par Data Inc. At some point, storage managers need to address the most egregious source of waste—poor utilization.

"Data storage systems are probably the most energy-inefficient systems out there," Scott said. "Average disk utilization rates continue to hang around the 20% to 25% level...more than half of the disk drives sitting there are effectively wasted," he added, and consuming unnecessary power.

3Par's answer to storage power inefficiency is thin provisioning, its oversubscription feature that assigns disk capacity to an application only when it's actually needed, reducing the number of disk drives required in the system.

Warren Habib, chief technology officer at Fotolog Inc., an online content sharing company in New York City and a 3Par customer, corroborated Scott's claim. With thin provisioning, Fotolog uses 200 fewer disk drives in its system than it would without. Assuming 0.65 kWh to power and cool a drive, "with 8,760 hours in a year, we would be using 200 x .065 x 8760 = 113,800 additional kilowatt hours," Habib wrote in an email. At a hypothetical cost of $.08 kWh, "we save $9,110 year and, more importantly, save that much wear and tear on the environment," he noted.

Hot storage—Power and cooling concerns

Storage magazine

It costs more to run a storage device over three years than to buy it. Here are several steps you can take to cut, or at least control, spiraling storage energy costs.

Many total cost of ownership (TCO) models are seriously outdated and wildly inaccurate because they haven't been updated to include the increased cost to power and cool storage arrays, storage area network (SAN) switches and hosts.

"Through 2009, energy costs will emerge as the second-highest operating cost in 70% of worldwide data center facilities," declares Michael Bell, research vice president at Stamford, Conn.-based Gartner Inc., in a recent report. In addition, analysts expect U.S. companies will spend twice as much on power and cooling by 2009 as they did to acquire their IT devices. Today, servers account for 40% of the data center's overall power consumption. Storage isn't far behind, taking 37% of the overall power, says Bell.

Power costs aren't the only factor forcing organizations to rethink their TCO analyses. The cost of end-of-life disposal and emerging green regulations that require cradle-to-grave energy tracking—costs that IT managers previously paid scant attention to—also threaten to become significant factors. Even real estate prices are a factor as IT managers wrestle with packing equipment more densely into costly floor space or spreading it out to facilitate more efficient air flow and cooling.

"Power and floor space are probably our two biggest IT concerns right now," says Michael Thomas, special project director at a major Midwest financial organization with multiple data centers. Thomas has had to delay some project implementations while waiting for the electric utility to come up with more power.

While storage prices on a cost-per-gigabyte basis continue to drop, storage managers will find their best budgeting efforts undermined by power, disposal, energy tracking and real estate costs. However, the problem isn't insurmountable. Vendors are ramping up energy-efficient green systems and tools to manage energy usage. By 2011, Gartner's Bell expects power demands to level off or even decline as innovations and best practices combine to contain the problem. In the meantime, IT managers still have to deal with the problem.

End-of-life disposal challenges

End-of-life disposal challenges

Systems and storage gear contains hazardous materials. Organizations are legally responsible for how they get rid of old storage devices. End-of-life disposal of systems and storage will eventually fall under regulations like ISO 14000, which is a set of international standards addressing environmental management. It guides organizations in developing both their environmental management system and the corresponding audit program.

DOs

- Understand and include cost of disposal in your TCO analysis
- Identify all of the costs associated with safe disposal, including eliminating data from hard drives
- Insist on an audit trail
- Expect more green regulations in the years ahead

DON'Ts

- Don't try to dodge responsibility; almost every component contains a traceable serial number
- Don't try to dispose on the cheap; use a reputable operator
- Don't try to dump overseas; rules are even more stringent in Europe and are quickly being adopted in Asia
- Don't delay in the hope that green requirements will ease

Unsustainable cost increases

"The ugly secret of smaller, faster, cheaper is that just because we can make it smaller and buy more of it, doesn't mean it is any more energy efficient," says Bob Gill, chief research officer at TheInfoPro Inc. To the contrary, smaller and cheaper means companies are buying more devices and packing them more densely into the data center. Even if the individual devices use less power, the aggregate number drives up energy consumption.

Gartner projects that more than 50% of data centers will exceed 6 kW per rack within two years; Bell expects that number to rise to 70% to 80% within four years due to the increased density of IT equipment, and that the ratio of power to cooling will hit 1:1. In addition, electrical costs per rack will increase by a factor of four, he calculates. Previously, the ratio was 0.5:1. "The cost is basically unsustainable," concludes Bell.

IT must also begin to factor in costs for getting rid of end-of-life equipment. "Disposal now has to be part of the TCO analysis," says Adam Braunstein, senior research analyst at Robert Frances Group, Westport, Conn.

The price tag includes not only the cost of safe disposal but the cost of ensuring that data is effectively removed from disk drives. "A three-times overwrite is Department of Defense compliant, but you need at least a seven-times overwrite to be completely safe and 10 times is even better," says Braunstein.

The cheapest option is to increase storage utilization. "You want to increase the utilization of the spinning motors and platters that you already have," says Jonathan Eunice, founder and principal IT advisor at Illuminata Inc., Nashua, N.H. Once the drive is spinning, additional utilization essentially costs nothing from an energy standpoint.

Erie 1 Board of Cooperative Education Services (BOCES) is a longtime mainframe shop in West Seneca, N.Y., that provides applications and IT services to more than 100 public school districts in western New York. Chief information officer Carol Troskosky has moved the organization to new mainframes with the latest channel-attached storage. (Channel-attached describes the high-speed, direct interconnect between the mainframe and shared peripherals; in this case, shared IBM storage arrays.) She then boosted utilization by consolidating open systems using Linux on the mainframe, while capitalizing on the increased energy efficiency of big iron. Erie 1 BOCES has also joined with other agencies in New York to buy energy cooperatively. But Troskosky still expects energy consumption to increase. "We try to keep our energy costs as low as possible," she says, but the organization must still meet increased demand for its services.

Energy tradeoffs

Tradeoff	Implication
Energy efficiency vs. performance	More spindles boost performance but use more energy
Density vs. cooling efficiency	Cooling efficiency requires less density but wastes rack and floor space
High vs. low disk speed	Faster disks increase performance but burn more energy
Online vs. offline (tape-based) data	Online data is much more readily available but burns more energy
Energy vs. capacity	Small form-factor disks use less energy but require more spindles to achieve high capacity

Beyond consolidation, storage managers can deploy storage in more energy-efficient ways. If you don't need high performance, deploy 7,200 rpm or 10,000 rpm disks rather than 15,000 rpm models, as the slower speeds use less energy. Similarly, smaller form-factor (2.5-inch) disk drives require only 5 volts vs. 12 volts for standard 3.5-inch form-factor drives. Small form factors, however, usually have smaller capacity (see "Energy tradeoffs").

Direct current (DC) can also be an energy-saving alternative. According to IDC, DC-powered equipment allows a portion of the heat load to move from the servers to the rectifiers, reducing heat at the system level by 20% to 40% versus a traditional alternating current (AC)-powered rack. "DC offers some efficiency, but you're mainly moving the problem someplace else," says TheInfoPro's Gill.

Rearranging the data center

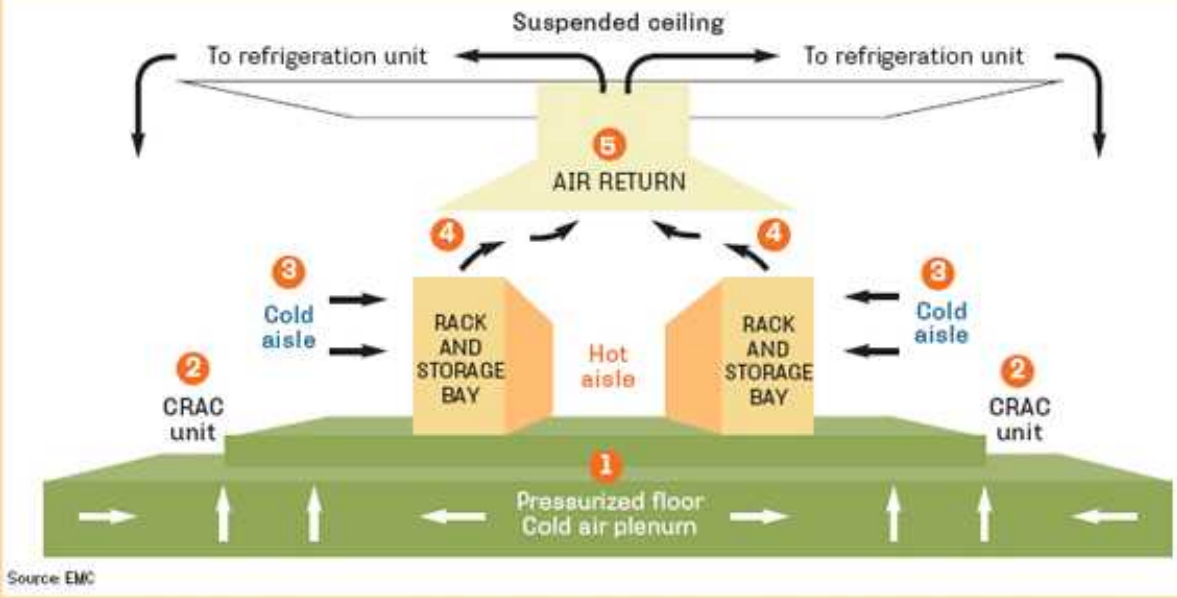
Another option is to rearrange the data center for better cooling efficiency. Bloomsburg Hospital is an open-systems shop that just built a new data center that will eventually house 70 servers, each with as many as six direct-attached disk drives. Robert Theiss, chief information officer at the Bloomsburg, Pa., organization, planned the new data center with energy and cooling in mind. "We were worried about putting in a greater [energy] load," he says.

The hospital turned to American Power Conversion (APC) Corp., West Kingston, R.I., to engineer a new power and cooling system. "Right now, we're running at about 40% of our maximum power," says Theiss, which leaves room for expansion. For maximum cooling, Theiss spread the servers and storage over racks set up in two rows separated by three aisles. AC units push cool air over the front of each row to cool the entire system.

The cooling rule of thumb for raised-floor data centers has jumped from 4 kW to 6 kW per rack. "Beyond 6 kW, you can't cool with just a raised floor. Today, a lot of gear is running over 4 kW per rack, which is getting close to the threshold," says Gartner's Bell.

In response, large organizations are creating hot and cool aisles, and using blanking panels within racks to assist with air flow. Cool air is pushed into the bottom of the rack from the cool aisle and exits as hot air from the top of the rack into the hot aisle (see "Data center design and air flow," below).

Data center design and air flow



Source: EMC

Today, the recommended configuration for optimum data center cooling is the hot-cold aisle in which air flow is directed to produce a hot aisle between two racks with cold aisles on the outside. The hot-cold aisle strategy is supported by "both pragmatic experience as well as validated simulations," says Robert C. Gray, research vice president, worldwide storage systems research at IDC, Framingham, MA. The principles are the same for storage and servers. Here's how the hot-cold aisle works:

1. The pressurized, raised data center floor with perforated tiles below the racks becomes a cold air plenum.
2. Computer room air-conditioning (CRAC) units sitting on the raised floor generate cold air for the cold aisles.
3. Fans in the rack pull cool air into the sides and bottom of the rack.
4. The combination of hot air rising and the fan action creates a chimney effect to push hot air out the top of the rack.
5. The air-return vent sits above the hot aisle and draws heated air into the suspended ceiling where it's redirected to the CRAC units; the CRAC units use fans to draw in the warm air and begin the cooling cycle again.

Humidifiers maintain humidity at 40% to 50%.

Offline savings

Another option is to move data offline. Tape not only costs less than disk but uses less energy and requires less cooling. In her analysis of SATA disk and LTO tape, "the cost to acquire, power and cool a disk system is almost eight times that of a tape library," says Dianne McAdam, director of enterprise information assurance at The Clipper Group Inc., Wellesley, Mass. Of course, this means giving up the performance of disk.

Online archiving storage system vendors, like Copan Systems Inc., offer disk systems that shut down the spindles when the data on them isn't accessed frequently. Copan has recently begun touting its energy efficiency, claiming to be five times more energy efficient per terabyte than conventional storage.

"Copan could deliver interesting energy savings," says McAdam. However, "whenever you power down disks, there are potential problems bringing back individual drives," she warns. Some data may not come back. Copan automatically powers up each idle drive at least once a month to check for data errors and rebuilds the drive if necessary.

At his Midwest financial organization, Thomas uses some Copan arrays—but not because of any promised energy savings. "We use Copan in our biggest data centers to replace tape because of floor space issues," he says. The smaller Copan footprint was quite attractive. "When we look at all of our data center costs, real estate is still a bigger headache than power," notes Thomas.

After boosting utilization, rearranging the data center and moving data offline, storage managers are left with replacing storage devices with more efficient devices. Healthy Directions LLC, a large newsletter publisher in Potomac, Md., reduced its power consumption by 50% over the last few years by replacing old servers and consolidating DAS storage onto a 10 terabytes (TB) StoneFly Inc. iSCSI SAN, says Edward Brookhouse, principal engineer, network operations. However, he fears energy consumption will go up as the organization migrates to densely packed blade servers.

New tools and metrics

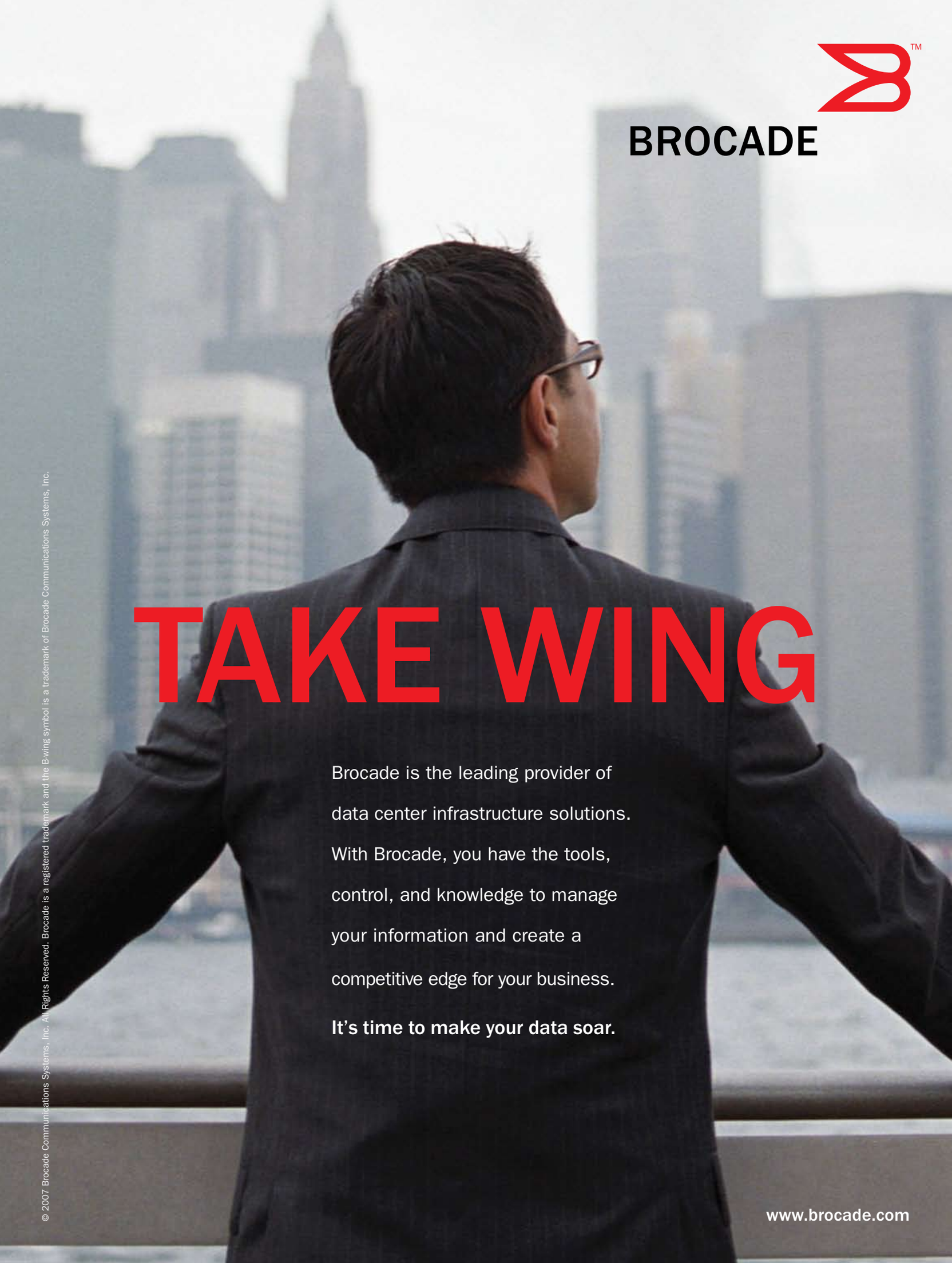
Some vendors, including EMC Corp., Hewlett-Packard Co. (HP), IBM Corp. and Sun Microsystems Inc., are starting to provide tools that measure power consumption at the device level to manage energy the way they manage other aspects of storage. New energy metrics are also entering the storage lexicon. Kilowatt and kilowatt per hour are standard energy metrics. When applied to storage, you get kilowatt/terabyte. A more common metric at this point is kilowatt per rack. Due to increased density, data centers today are pushing beyond 4 kilowatt per rack; by 6 kilowatt per rack, they're getting into a heat danger zone.

An individual drive uses 5W to 15W of power depending on its capacity, rotation speed, form factor and operating state, but "you can't just multiply the number of drives in an array by some average power rating to get a total," says Mark Greenlaw, senior director with storage marketing at EMC. The power consumption of the array is more than the sum of the power used by the individual drives. Controllers and other components consume power. Copan Systems proposes two metrics for archival data storage: storage density measured in terabytes per square foot and terabytes per kilowatt.

Storage managers also need to consider SAN switch power and cooling. Switches consume less power in the data center than servers or storage mainly because there are relatively fewer switches. Still, the power consumption of a switch is significant. "A large switch will use 1,000W [1 kW] or more," says Ardeshir Mohammadian, senior power systems engineer at Brocade Communications Systems Inc. Higher port density and performance increases switch power and cooling consumption. Don't be surprised to see kilowatt per port and kilowatt per gigabyte per second metrics soon.

Energy bills—now running at $60 per square foot for the data center, according to Gartner's Bell—currently go to the facility manager or chief financial officer, not to the storage manager. Data center space is handled by the real estate department. To lower energy costs, there needs to be more coordination among the disparate departments.

As energy costs and consumption rise, new tools—from low-power chips to digitally addressable power supplies that can regulate power to the device's changing requirements—are being developed to more effectively manage energy. Power, cooling, space and disposal are becoming integral, closely watched parts of the TCO analysis for every storage device the organization buys.



SNW: Users thrash out green storage

By Beth Pariseau, News Writer

SAN DIEGO—The buzz so far at this year's Storage Networking World (SNW) is electric—literally.

Users heard a presentation Monday morning by Microsoft senior program manager S.W. Worth on "green storage." And, the word in the halls of the conference afterward was that while storage has yet to reach the power and cooling crisis servers have brought to data centers in recent years, it is well on its way.

Worth mentioned the electricity rebate program offered by California's Pacific Gas and Energy (PG&E) to high-tech users for cutting down on power consumption, but pointed out, "not once in all the publicity around that program was the word storage mentioned until about one week ago. We've been behind on this issue as a storage industry."

However, he added, operational expenses, or total cost of ownership (TCO), are beginning to come even with capital expenses (initial purchase price) when it comes to storage products, and power consumption has a lot to do with it. "Operational expenses will overwhelm capital expenses as soon as this year in some places," Worth said.

Recent reports by analysts have also backed up this trend. Gartner Inc. predicts that within the next several years, half of the world's data centers will become obsolete because of power and space restrictions, and that energy costs will eat up to one-third of IT budgets. IDC said that already, IT organizations are spending a quarter of every hardware dollar on power.

Worth also said that users can expect to see an environmental push from storage vendors as "green" compliance standards make their way from Europe to the U.S.—Restriction of Hazardous Substances (RoHS) compliance is already de facto here, he said, since most vendors also do business in Europe.

Meanwhile, show attendees, particularly those from big companies, said they have already experienced power and cooling issues in their data centers, though most said it had not yet been systematically addressed in the way that most organizations have dealt with server power consumption.

"Heat is my biggest problem right now," said Stephen Warner, executive director of IT infrastructure for Quest Diagnostics, who gave a presentation about file virtualization that morphed during a Q&A session into a discussion of power and cooling issues. Part of the reason his company implemented a three-site virtualization and replication scheme for file systems using Acopia Networks Inc.'s ARX switch, Warner said, is so that it can switch which data center is "active" at regular intervals throughout the year in order to spread power demands and heat among the geographically separate facilities.

"We're just moving heat around," Warner said. The company has also implemented a system that cuts off 63% of the power to inactive file servers under the virtualization scheme, he said.

But when it comes to storage area network (SAN) systems, which comprise the vast majority of the 900 terabytes (TB) of data under management at Quest, Warner said, administrators are struggling to adequately cool big arrays, like EMC Corp.'s DMX. "They're almost like stoves on top," he said.

No clear solution

While there's growing recognition of the problem, however, there is little consensus on what to do about it. Some users said they thought the introduction of chargeback for electricity with storage systems could help address the problem. "I think as time goes on, that kind of accounting is emerging further [within companies]," said Neil Kassal, senior analyst, distributed systems for U.S. Airways.

But one user who's tried it said chargeback can backfire. According to Karl Lewis, storage administrator for the University of Michigan College of Engineering, the university has centralized server resources in a main data center and instituted chargeback for power usage—only to see some end users "hide" systems in order to avoid having to pay the power fee.

Kassal and several other users at the show also pointed out that right now, the emerging problem of energy is difficult to prioritize over ongoing projects, from disaster recovery (DR) to implementing virtualization products, and it remains impractical to make power efficiency the chief differentiator when choosing a storage product.

For example, according to a server engineer from a major media company, who asked not to be identified, a four-year-old Hewlett-Packard Co. (HP) XP1024 is drawing a disproportionate amount of power in his data center. "But the thing just works," he said. "How are you going to tell [the admins] that everything about that system has been reliable, but it's going to have to be replaced with something cheaper because of the power issue? It's just not going to happen."

Outlook was also mixed on the ability of data management strategies to effectively solve the problem. Users at this conference remained skeptical about MAID—"a great way to double your failure rate," one said—and added tiered storage wouldn't solve the problem, as it only adds more systems to the data center, not less. However, some users predicted tightening legal and compliance requirements around data retention might make an impact, since companies could be legally liable for how they manage data.

Looking to vendors to take the reins

Ultimately, several users said they thought the onus is on storage and systems vendors to address power efficiency at the component level. "Blade servers have allowed for much greater space efficiency in the data center, but what that means is you end up packing the same power draw into a fifth of the space," said a systems engineer for a biotech company in California, who also asked not to be named. "The systems industry focused on the smaller form factor with blade servers and 2.5-inch disks, but seemed to forget about lowering the power draws in proportion." As the storage industry also eyes a move toward the 2.5-inch form factor, and as arrays, too, grow more densely packed, the user said it is imperative for storage vendors to do a better job at dealing with the increase in "power density."

The good news on that front is that some storage vendors do appear to be jumping on the green bandwagon and have increasingly been working environmental issues into their marketing messages. So far this year, both Pillar Data Systems Inc. and Copan Systems have been pushing the green message, and as of last week, both companies announced they had joined the Green Grid, an IT industry association devoted to environmental causes. But whether these turn into real energy saving efforts is still up for debate.

"I believe there will be solutions," said Jeff Blomendahl, systems engineer for the University of Kansas Medical Center. "When I first started out in IT, a 150 MB drive was something that had its own power supply. Now, I carry around USB keys that can hold several gigabytes without drawing any power at all."

Uptime Institute schools EPA on data center efficiency

By Mark Fontecchio, News Writer

ORLANDO, Fla.—When the federal Environmental Protection Agency (EPA) files a report to Congress in June regarding data center energy consumption, it will adopt some recommendations from The Uptime Institute on data center best practices.

A law passed late last year gives the EPA 180 days to file a report on how much energy data centers are using and ways to keep that number in check. Andrew Fanara, leader of the EPA Energy Star product development team, said at The Uptime Institute Inc.'s symposium last week that as he gathers information to go into the data center energy report, he will harness knowledge from Uptime and its end-user members.

Uptime executive director Ken Brill, meanwhile, said he expects Uptime to play an active role in the EPA report by helping to draft a simple statement that will prompt executives to ask questions that IT and facilities managers can answer.

Data center efficiency metrics

Another of Uptime's goals is to agree on a common way to measure the energy efficiency of an entire data center. Brill has devised variables for measuring data center efficiency, as has The Green Grid, a consortium of major IT vendors that formed last year with the goal of reducing waste in data centers. Industry leaders have already drafted a energy efficiency metric for servers.

"We're working with Uptime on what is the proper metric to measure an entire data center," Fanara said. "Then any data center can be measured in terms of its efficiency. Then people can have a starting point. We want people to compete on efficiency."

During two afternoon sessions, a select group that included Uptime leaders, user advisors and vendor representatives discussed what the metric should look like and what it should be called. Likely, it will be named the "data center efficiency metric" or something similar and will focus heavily on two variables: the amount of power going into a data center facility and how much of that power gets to the IT equipment. The gap between the two numbers can be explained by a number of things, including cooling and lighting equipment, and inefficient power supplies.

Ultimately, that measurement will help data center managers put a hard number on how much they can save by adopting energy-efficient designs in their facilities.

For example, data center managers could calculate how much more efficient their facility could be if they powered down servers that weren't being used anymore and then come up with the resulting savings.

Energy Star for servers

The EPA is also considering starting an Energy Star program for servers. Energy Star is a federal program that provides energy efficiency ratings for appliances, such as washing machines, ceiling fans and desktop computers. Including servers in the program should lead to server manufacturers competing with one another on energy efficiency, Fanara said.

Fanara is also working with Jonathan Koomey of the Lawrence Berkley National Laboratory, which has reported on data center topics such as direct current (DC) power and airside economizing. Koomey recently released a report showing that 1.2 percent of U.S. energy is taken up by data centers. Some industry leaders put that figure closer to 2 percent when taking into account storage and networking equipment.

Uptime's Brill estimated that in five years, data centers could represent as much as 3 to 4 percent of U.S. power consumption. Much of Koomey's study will be part of the report that the EPA sends to Congress in three months.

According to participants at the Uptime conference last week, the key to making the EPA report work is keeping it simple and direct. If it starts to describe variables and metrics in terms that are too technical, the information could be harder to grasp.

"With the EPA study, you need to be very short, very smart, very attention-getting," said Robert Barden, a consultant at consultancy firm Milemark LLC, at the Uptime symposium. "You have to differentiate between what's going to be in the EPA study and what we're going to use as a tool to measure this efficiency."

Even beyond the report, there is talk about what the data center efficiency metric should look like. Should the metric be represented as a percentage from 0 to 100 percent (i.e., my data center is 63 percent efficient), or should it be a variable that improves as it approaches 1? The original variable was developed using the latter approach and will likely stay that way, but the group remained split on the issue.

The EPA's Fanara added that it was important for him to interact with IT professionals so that whatever program or metric the EPA decides to back will also be supported by leaders in the industry.

"We really have to develop this with people who know the market," he said. "We're looking for endorsement from organizations that are the experts."

RMI: Reduce data center power consumption through better engineering

By Matt Stansberry, Site Editor

*Amory Lovins, Chief Executive Officer of the Snowmass, Colo.-based Rocky Mountain Institute (RMI) says companies need to reduce data center power consumption through better engineering. Luckily, Lovins has several recommendations. RMI published an exhaustive report on data center efficiency back in 2003, back before data center power consumption was the huge problem it is today. SearchDataCenter.com interviewed Lovins after his keynote presentation at The Uptime Institute Symposium earlier this mont*h.

Was data center efficiency as big an issue four years ago when RMI wrote the report?
AMORY LOVINS: The far-sighted ones knew that the industry would have to evolve toward efficiency and reliability because they saw earlier than most where those curves were heading and you don't want to go there. I think Ken [Brill] is right to say, when we did the exercise in '03, the economic consequences of inefficiency of devices, software, servers, power supplies—therefore data centers, hadn't become as unbearably obvious as it is now. Now that there are big dollar signs attached, everyone realizes we need a solution fast. Fortunately it exists.

Can't you just stop the demand for CPUs? Nobody seems to think that's an option.
LOVINS: Some of [the demand] is coming from what you can do with more bandwidth. As we go to advanced mobile services, fiber and fast networks being ubiquitous, a lot more people are streaming video for example. It isn't just about computations anymore. There is more eCommerce. There are more demanding calculations of all kinds. If we go to a model where software is not shrink-wrapped, but leased over the Web, there is still further demand for service.

Some of the extra demand for processor cycles comes from new applications. Some substantial amount, we don't know how much, from bloatware. If software were written to a higher standard, if more people really did hate bad code and stopped buying it, we'd need a lot less computation to do what we want to do.

You mentioned Microsoft Windows Vista actually consumes more energy than Windows XP. Wouldn't you assume Microsoft would work to reduce the amount of cycles it takes to do work?
LOVINS: I'm not in a position to comment on Microsoft's practices or business model. I know their code is very complicated. I use a Mac. They are probably their own biggest customer. It would be interesting to know what their experience is.

I heard someone who knows the field better than I do comment that basic reforms in the terseness of code would be the biggest way on earth to save processor cycles. I don't know if that's correct, but it's a hypothesis that's worth exploring for them and for every other producer of code. We've tended to value good code for performance, in terms of getting a job done faster, or with less hardware. But we now also need to realize that it translates in to watts, which have costs in both dollars and climate.

You mentioned using an air-side economizer in your presentation. Should everyone be looking at that method for data center cooling?

LOVINS: Sure. If you're in Singapore where it's 84% relative humidity and ranges from hot to broiling, it's not so exciting. But in most U.S. climates, you can get half, and in many cases three quarters, of your annual ton-hours from an air-side or water-side economizer or a combination of them. An air-side economizer is very cheap in capital cost and uses essentially no energy, just a tiny bit for controls. Water-side economizer, evaporative cooling with a cooling tower and heat exchanges in your chilled water loop, [costs] $100 per ton. If you design it very well, it gives you 100 or even 125 units of coefficient performance.

You also mentioned using a slush pile to provide chilled water, can you explain that?
LOVINS: You don't need an engineering background to understand that if it's at least a few degrees below freezing you can make snow or actually slush. Not fluffy snow, you want something dense like sherbet. You can make a big mountain of the stuff and stick it on the ground or a hole in the ground. You get about 100 units or more of 32 degree melt-water harvested off the bottom in a liner and pumped through your data center for each unit of electricity that it takes to pump it and blow the snow. The capital cost is a few hundred dollars a ton
.

Another method of efficient cooling you mentioned called the Pennington Cycle uses a desiccant. Can you explain that process?
LOVINS: If you don't have the land or the winter cold to make ice, then you can cool with a desiccant that works best in very hot climates. You can use solar heat or the heat of your exhaust air to regenerate your desiccant. A desiccant is a substance that takes water out of the air, making the air hotter and drier. You can then add a little bit of water back into the hot, very dry air and make it much cooler and moderately moist, which is a good condition for a data center. You can mix that cool, somewhat moistened air with outside air directly or outside air that is cool but not moistened through an air-to-air heat exchanger. You get the mixture of coolness and moisture that you want with air going into your data center. Again, if you do this very well you can get about 100 units of cooling per unit of electricity. It's traditionally done with gas heat, but it's better to do it with free heat from your equipment. Trane has a desiccant that regenerates at 87 F.

There are also some innovations coming in the servers themselves, for example Fibonacci spiral designed fans that move air much more efficiently. When do you expect those to have an impact on power consumption?
LOVINS: They're just coming out on the market. It's been in R&D for several years and I believe this is the year that the first fans and pumps come to market. I believe the computer muffin fans will be first. There are about a billion of those made a year and the new type of blade can actually be retrofitted into existing muffin fans and give you up to 30% more flow per watt or 10 dva less noise. The parent company that develops and licenses that company is PaxScientific.com.

What do you think about the idea of hardening server equipment to withstand a greater range of temperatures, allowing data centers to use less cooling?
LOVINS: We looked at this for mainframe computers twenty years ago when people were setting extremely stringent temperature and humidity requirements. I called IBM and asked what's on your spec sheet for environmental conditions? They gave me very wide ranges. So I took them back to the first guy and said, I'm not sure where you got your assumptions, but this is what the manufacturer says this machine needs and this is how much money you would save if you just follow that spec.

But given what I've said about more efficient HVAC, I don't see why you should have to go to hardened equipment. You may want to do that in places with deficient infrastructure with major vulnerabilities of the electric grid.

What is it going to take for server manufacturers to start standardizing equipment with the 80-plus power supplies?
LOVINS: Customer demand, the desire to leapfrog competitors. You can drive that switch from the vendor side or the customer side. When customers realize that heat equals downtime, ten Celsius degrees cooler doubles your meantime between hardware failures—customers realize that saving a watt in the data center is around 20-30 bucks at six cents a kilowatt hour, they will tend to favor manufacturers with efficient equipment. And the power supply is in many ways the most important efficiency opportunity in the server because of the compounding heat and energy losses from it.

Recent studies have shown that DC power in the data center can reduce energy consumption by 20%. You mentioned that Japanese data centers have been running DC power successfully for years. Why are they so far ahead in that regard?
LOVINS: The biggest builder of data centers [in Japan] is NTT facilities, and NTT is National Telecoms Company. The telecom tribe, which is culturally distinct from the data processing tribe, has always run on DC, typically 48 volts. When they started building data centers it was natural for them to transfer their DC bus expertise. We've been told, of course, by vendors of AC UPS systems that you can't really do DC. The bus bars have to be too big and heavy, it's unsafe, and you have to keep tightening the connections. But this doesn't seem to bother our Japanese friends or other industries that have run extremely large DC currents through their electric metallurgy equipment for about a century. That engineering is well worked out. It just isn't well known to the AC tribe. This is going to be an empirical question settled in the marketplace. I was just calling attention to the existing parallel universe that does not run on AC and has about an order of magnitude better uptime and much higher efficiency.

What stops people from taking these recommendations to reduce data center power consumption?
LOVINS: Different people have different comfortable rates of change. If you're in a stove-piped organization where you see making a change as career risk and no reward, you're less likely to innovate than if you are in a learning organization where people talk to each other across departmental boundaries and all get around the same table solving their common problem. Otherwise it's easy to let your problem go on being somebody else's problem. If you're paid for maximizing uptime, but you don't pay the electric bill, you don't pay the capital cost, you have a skewed incentive. As long as we keep stove-piping this business we'll go on rewarding the wrong things and getting bad results. Conversely, the companies that learn how to create that vision across boundaries will win in the market. They will have much better computing with less energy, less capital cost and higher uptime.

I think the degree of complexity, cost, size weight, unreliability that now afflicts [data center] power and cooling systems has become unsupportable, especially combined with inefficient servers in the first place and inefficient software running them. It's time to take a fresh look at the whole thing and prune away the layers of complexity and get back to something simple that works.

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