

THE ENERGY SMART DATA CENTER

Going green can be the secret to significant cost savings as well as aggressive performance growth. Dell offers a comprehensive strategy that includes virtualization and consolidation onto energy-efficient systems, best practices for power and cooling optimization, and expert services that can help businesses achieve immediate benefits.



By John Pflueger, Ph.D.
Albert Esser, Ph.D.

Companies go green for a variety of reasons. Thanks to a 56 percent increase in global electricity prices since 2002,¹ green initiatives are often conceived as a response to the rising cost of energy. Some businesses go green simply to improve customer and public perception of their organization. Still others are driven by environmental concerns to minimize the impact of global carbon dioxide emissions.

Whatever the motivation, IT is a key component of green initiatives.² IT infrastructure accounts for a disproportionate share of energy relative to head count and operating costs—and these energy issues can inhibit business innovation and growth. Power and cooling capabilities are maxed out in many data centers, and power and cooling expenses frequently outstrip the cost of IT equipment. IT managers are also grappling with operational issues such as difficult-to-manage “hot spots” while trying to meet the needs of an ever-increasing server population.

Conflicts between IT and facilities management groups are often the cause of inefficient practices in the data center. These conflicts typically surface when organizations are planning for upcoming data center changes such as consolidations and expansions, new redundancy requirements, or incremental power requirements. IT managers are typically concerned with the ability of the IT facility—including its space, power, and cooling capacity—to fully support server consolidation, virtualization, or high-performance computing initiatives, and the ability of existing server room and data center cooling systems to support new equipment. For example, in one typical enterprise usage scenario, power distribution and cooling equipment consumed 59 percent of data center power, whereas compute servers accounted for less than 30 percent (see Figure 1).

Existing server room and data center power distribution systems cannot always support future growth—and organizations frequently cannot afford the costs associated with a major business disruption. Meanwhile, facilities management groups have different priorities when planning data center changes. They must consider power usage caps from the utility company as well as energy costs, which often exceed equipment costs.

Related Categories:

Dell Data Center Solutions (DCS)	Energy efficiency
Dell Infrastructure Consulting Services (ICS)	The Green Grid
Dell OptiPlex desktops	Green IT
Dell PowerEdge servers	Power and cooling
Dell PowerVault storage	Simplify IT
	Virtualization

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And in many cases, companies are literally running out of space in the data center because existing server racks are full. Moreover, the data center may be running out of circuit breakers. Facilities managers often cannot deploy any additional servers until a new data center is brought online.

SIMPLIFYING THE GREEN DATA CENTER

Because energy consumption is about much more than just the IT equipment, Dell takes a comprehensive approach to greening the data center. Dell engineers start by designing energy-efficient platforms with built-in power management features—and suppliers are encouraged to do the same. Examples include high-efficiency power supplies and optimized thermal design, and can also include silicon changes, component changes, and energy-efficient motherboard design. (For details on other aspects of Dell environmental initiatives, see the “Green, not greenbacks” sidebar in this article.)

Dell also helps organizations optimize the office IT environment through effective client power management (see the “Best practices: Client usage policies that pay off” sidebar in this article). In addition, data center optimization measures such as enhancing system utilization through virtualization and workload management technologies, highly efficient cooling architectures, and energy-efficient storage design can complement these efforts and enhance efficiency.

A positive change in the energy usage of IT equipment can have a direct effect on power and cooling requirements (see Figure 2). For example, in an internal Dell data center usage scenario, a 10 percent improvement at the server level netted about an 8 percent improvement at the facility level. However, efficiency improvements in cooling or power delivery were relatively independent; a 10 percent increase in power delivery efficiency manifested itself as about a 4 percent improvement at the facility level.

Dell Infrastructure Consulting Services experts can help data center managers pinpoint facility and IT improvements that enable efficient operation. For example, simply running the facility at a

¹“Electricity Prices for Industry,” by the Energy Information Administration, U.S. Department of Energy, June 7, 2007, www.eia.doe.gov/emeu/international/elecprti.html.

²For an executive perspective on why green data center design is gaining momentum and tactics for immediately putting unused IT capacity to work, see “Best Practices for Unlocking Your Hidden Data Center,” in *Dell Power Solutions*, February 2008, DELL.COM/Downloads/Global/Power/ps1q08-20080198-Esser.pdf; and DELL.COM/HiddenDataCenter.

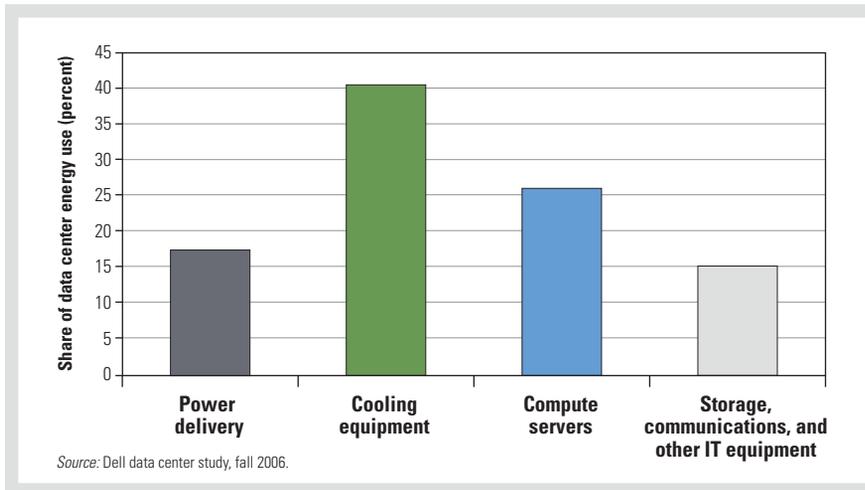


Figure 1. Power distribution and cooling equipment consumed 59 percent of data center power in a typical enterprise usage scenario

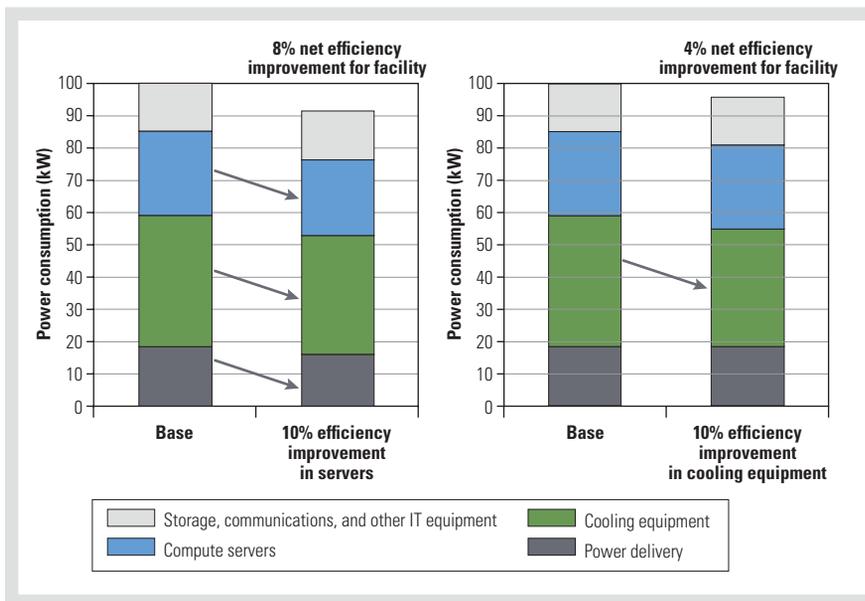


Figure 2. Increased server efficiency can lead to improvements in overall data center efficiency

slightly higher temperature than usual can often provide an opportunity to increase efficiencies. Coupled with air-handler energy-efficiency options, savings of 5 percent or more at the facility level are not uncommon. Savings may result from staged compressor operation, slowdown of airflow with variable-frequency drives, increased chiller efficiency, or minimized condensation and re-humidification in the air handler.

ADVANCING EFFICIENCY THROUGH VIRTUALIZATION AND CONSOLIDATION

Through virtualization and consolidation, enterprises can reduce the number of physical servers in the data center while dramatically increasing compute capacity. Virtualized servers can provide more efficient space utilization, more effective energy consumption in the remaining servers, and lower overall power and cooling requirements than traditional non-virtualized servers (see Figure 3).

Virtualization typically allows organizations to consolidate anywhere from 3 to 20 virtual systems onto a single physical platform. Results vary greatly based on the particular applications, user demand, and configuration of both the old and new servers; Dell customers commonly report 10:1 consolidation ratios. Because they are designed to facilitate dense computing environments—with substantial memory to help remove barriers to running

GREEN, NOT GREENBACKS

Contrary to popular belief, greening the data center does not necessarily mean revamping server and storage infrastructures. Dell offers several non-technology options to help organizations reduce environmental impact.

Carbon offset programs such as the Dell “Plant a Tree for Me” and “Plant a Forest for Me” initiatives make it easy to help offset carbon emissions associated with the electricity required to power computer equipment. Through these programs, Dell partners with the Conservation Fund and Carbonfund.org to plant trees in sustainably managed reforestation projects.

By shipping multiple products in a single box with reduced or reusable packaging, Dell can help simplify deployment and reduce environmental impact.

When organizations select the “Multipack” option for consolidated delivery, they can minimize on-site packaging waste and recycling costs, streamline on-site logistics, and help lower shipping costs. The Multipack option also helps reduce redundant documentation, cables, and other unnecessary extras—helping both speed deployment and reduce deployment costs.

In addition, Dell offers a variety of asset recovery programs to help ensure proper disposal of retired IT equipment. Besides being environmentally friendly, asset recovery allows organizations to maximize the residual value of systems they no longer use. For more information about Dell environmental initiatives, visit DELL.COM/Earth.

BEST PRACTICES: CLIENT USAGE POLICIES THAT PAY OFF

By reaching beyond the data center to implement simple usage policies for power management throughout the enterprise, organizations can achieve significant energy conservation and put dollars back into the bottom line immediately. These common-sense strategies may seem small, but they can make a big difference:

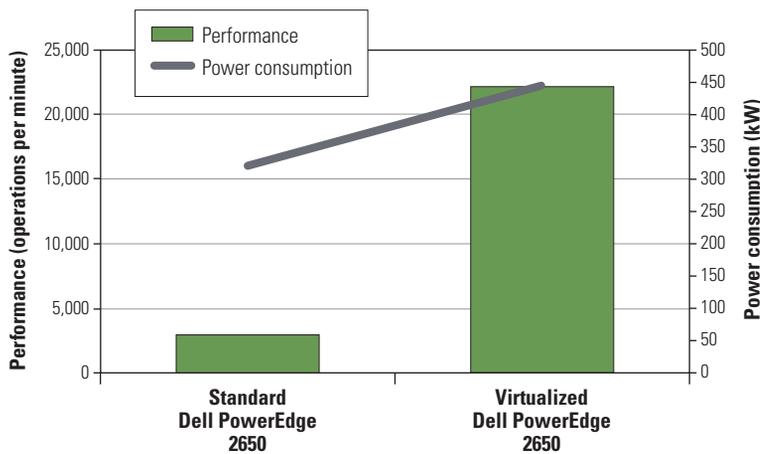
- **Activate power management settings:**

Dell Energy Smart power management settings can be turned on before client systems are shipped from the factory, enabling organizations to reduce power consumption by up to 78 percent using thermally optimized Dell OptiPlex™ Energy Smart 755 desktop systems compared with the previous generations of OptiPlex desktops. Similarly, energy-efficient Dell Latitude™ Energy Smart notebooks consume up to 70 percent less energy on average than previous-generation OptiPlex GX620 desktops.*

- **Stagger startups:** Creating a staggered schedule for powering up computers helps avoid overburdening network servers and triggering increased costs for peak energy demands.

- **Turn off desktops at night:** During the approximately 100 hours per week that computers are unused, organizations should switch them off to avoid creating heat and increasing demand for power and cooling throughout the building.

*Based on product specifications and 7 hours of typical office use, 1 hour of maximum-performance use, 1 hour of idleness, and 15 hours of sleep for 264 days a year, with 24 hours of sleep for the remaining 101 days each year. For more information, visit DELL.COM/Energy.



Source: "Competitive Power Savings with VMware Consolidation on the Dell PowerEdge 2950," by Scott Hanson, Dell Enterprise Technology Center, August 2007, DELL.COM/Downloads/Global/Solutions/compowersavings.pdf.

Figure 3. Virtualization increases server utilization and helps lower power and cooling requirements

memory-bound applications—Dell™ PowerEdge™ servers can be the driving force behind a variety of data center efficiency improvements.

MANAGING PERFORMANCE PROACTIVELY

Replacing legacy servers with higher-performance, higher-capacity systems designed with efficient thermal characteristics and power delivery can be an effective way to cut power consumption and costs in the data center. Dell PowerEdge Energy Smart 1950, PowerEdge Energy Smart 2950, and PowerEdge Energy Smart 2970 servers—industry-standard systems specifically configured to optimize energy efficiency—can help deliver dramatic savings by reducing power consumption through features such as low-voltage processors, high-efficiency memory, high-efficiency power supplies, and energy-optimized BIOS settings. Dell studies show that a PowerEdge Energy Smart system configuration can deliver up

to 21 percent greater performance per watt over a similarly configured server³ and enable savings of up to US\$200 per server per year in energy expenses.⁴

Today, the power and cooling challenge is focused squarely on servers. However, it is important to proactively manage storage to help prevent potential power and cooling issues. With data volumes growing exponentially, increasing volumes of storage will likely be required in virtually every organization. Right-sizing storage systems, drive mixes, and media to information usage can help achieve considerable power savings. Dell offers expertise and services that can help organizations match application profiles with a range of energy-efficient storage options for enhanced utilization and efficiency.

Additionally, because up to 60 percent of the power consumption in a storage array may be attributed to disk drives, reducing the number of physical drives by using centralized storage—such as the Dell PowerVault™ MD3000i Internet SCSI

³Based on AC power measurements using an Extech 380803 Power Analyzer taken during the peak load of the SPECjbb2005 benchmark test performed by Dell Labs in March 2007. The PowerEdge Energy Smart 2970 configuration consisted of two dual-core AMD Opteron™ 2212 HE processors at 2.0 GHz; eight 1 GB, 667 MHz double data rate 2 (DDR2) error-correcting code (ECC) 1R dual in-line memory modules (DIMMs); and two 73 GB, 10,000 rpm, 2.5-inch Serial Attached SCSI (SAS) drives running the Microsoft® Windows Server™ 2003 Enterprise x64 Edition OS, compared with a PowerEdge 2970 standard configuration consisting of two dual-core AMD Opteron 2212 processors at 2.0 GHz; eight 1 GB, 667 MHz DDR2 ECC 1R DIMMs; and two 73 GB, 10,000 rpm, 2.5-inch SAS drives running the Windows Server 2003 Enterprise x64 Edition OS. Actual performance and power consumption will vary based on configuration, usage, and manufacturing variability. For the latest SPECjbb2005 benchmark results, visit www.spec.org/jbb2005.

⁴Based on energy costs obtained from the International Energy Agency using a worldwide average of US\$0.13/kWh based on 2003 and 2004 global average cost of energy. Assumes server operation 24 hours a day, 365 days a year. Actual AC power measurements were obtained using an Extech 380803 Power Analyzer taken during the peak load of the SPECjbb2005 benchmark test performed by Dell Labs in November 2006. The PowerEdge Energy Smart 2950 configuration consisted of two dual-core Intel® Xeon® 5148LV processors at 2.33 GHz; four 1 GB, 667 MHz fully buffered DIMMs; and two 73 GB, 10,000 rpm, 2.5-inch SAS drives running Windows Server 2003 Enterprise x64 Edition, compared with a PowerEdge 2950 standard configuration consisting of two dual-core Intel Xeon 5140 processors at 2.33 GHz; four 1 GB, 667 MHz fully buffered DIMMs; and two 73 GB, 10,000 rpm, 3.5-inch SAS drives running Windows Server 2003 Enterprise x64 Edition. Actual performance and power consumption will vary based on configuration, usage, and manufacturing variability. For the latest SPECjbb2005 benchmark results, visit www.spec.org/jbb2005.

(iSCSI)/Fibre Channel storage area network (SAN) or the Dell PowerVault NX1950 unified network attached storage (NAS) and SAN data storage system—can also help lower energy costs. Eliminating boot drives in servers using boot from SAN can yield significant savings for a large fleet of servers. iSCSI helps lower the cost of deploying a SAN by using an Ethernet-based network compared with a Fibre Channel fabric—while single-instance storage, a feature that is part of the Dell NAS family, helps eliminate duplicate files.

SCALING COMPUTE DENSITY COST-EFFECTIVELY

Traditional raised-floor data centers typically have about a 5 kW limit per rack—so, for example, even if 75 percent of the physical space in a rack remains vacant, the 5 kW limit would mean that the rack is operating at its full capacity. Dell-Liebert Energy Smart Solutions are designed to help organizations increase computing density within the same power envelope. By helping reduce fan power, reduce mixing and short-circuiting of air, and eliminate the negative effects of condensation, alternative cooling products can be an energy-conscious alternative to traditional raised-floor cooling.

For example, Liebert XD cooling systems from Emerson Network Power provide a pumped refrigerant infrastructure with cooling modules that can be placed directly above or alongside high-density racks. The Liebert XD system can be up to 30 percent more efficient than traditional perimeter cooling, helping to overcome cooling-related density limitations so that organizations can increase computing capacity in cost-effective increments. In this way, Dell-Liebert Energy Smart Solutions help maximize data center layout and density, allowing organizations to defer the cost of expensive data center leases or build-outs.⁵



SIMPLICITY AND EFFICIENCY: GREEN IN ACTION

The Dell Cloud Computing™ Solution is expected to cut Ask.com's power bills while supporting ever-higher computational demands.

How can organizations increase their computing capacity with the same power expense? That was the key question for Ask.com, the popular online search engine that helps millions of people find information on the Web every day.

With its advanced ExpertRank ranking algorithm that helps identify the most authoritative sites on the Web—a process that demands many additional calculations that other search engines do not perform—Ask.com requires an enormous amount of processing power and uses thousands of servers to run its search engine. These servers are linked into clusters, or “clouds,” that are spread across several data centers. Because the company was committed to reducing its environmental impact, it adopted energy-efficient servers throughout—and then went one step further. The Ask.com IT group decided to locate one of its new data centers in eastern Washington, where it could use renewable hydroelectric power, and developed a novel evaporative cooling system that requires less electricity than a traditional cooling system. But it was still searching for other ways to offset its carbon output.

IDENTIFYING ENERGY SMART BENEFITS WITH EXPERT SERVICES

Dell Energy Smart Data Center Assessment services, offered by the Dell Infrastructure Consulting Services team, are designed to help identify potential problems or opportunities for improvement in data center efficiency. Identifying inefficiencies is the first step toward achieving efficient utilization of power, cooling, space, servers, storage, and communications equipment. Improved power usage practices help mitigate the risk of hardware failure due to overheating and can help reduce energy expenses. Organizations may also be able to consolidate and expand IT capacity without building new facilities or exceeding existing heating and cooling limits.

During a Dell Energy Smart Data Center Assessment, Dell experts conduct a review of the organization's existing power and cooling capacities and practices. They then perform computational fluid dynamics analysis to highlight problem areas.⁶ At the completion of the review, an organization receives an assessment report with practical advice for maximizing power and cooling in that specific environment. Virtualization Readiness Assessment services also are available to help customers plan effectively, implement rapidly, and maintain efficiently.

CULTIVATING A STRATEGY FOR SUSTAINABLE GROWTH

Whatever an organization's motive is for going green, Dell can deliver products and

⁵ For more information about Dell-Liebert Energy Smart Solutions, see “A Systems-Level Approach to Efficient Data Center Design,” by Fred Stack, in *Dell Power Solutions*, February 2008, DELL.COM/Downloads/Global/Power/ps1q08-20080216-Emerson.pdf.

⁶ For more information, see “Best Practices for Increasing Data Center Energy Efficiency,” by Paul Rad, Max Thoenne, and Tim Webb, in *Dell Power Solutions*, February 2008, DELL.COM/Downloads/Global/Power/ps1q08-20080185-Rad.pdf, and “High-Efficiency Cooling Through Computational Fluid Dynamics,” by Paul Rad; Kailash Karki, Ph.D.; and Tim Webb, in *Dell Power Solutions*, February 2008, DELL.COM/Downloads/Global/Power/ps1q08-20080187-Rad.pdf.

“By partnering with Dell on multiple green initiatives, we can help ensure that our data centers minimize energy use and waste. We are pleased to be using less and giving back more.”

—Chuck Geiger
Executive vice president of technology and engineering at Ask.com
December 2007

Dell Data Center Solutions (DCS) approached Ask.com with a proposal for a new strategy: let DCS custom-design a purpose-built rack server—optimized for the Ask.com data centers—that would have very low electricity needs yet deliver high computing power.

Initially, says Chuck Geiger, executive vice president of technology and engineering at Ask.com, the company just wanted straightforward optimizations to help minimize power draw. However, Dell DCS engineers went a step further, designing a server around Ask.com’s specific workload requirements and selecting only the components required. To streamline it, Dell DCS removed all unnecessary components, including PCI slots and the secondary power supply, which is a helpful backup when a server is working alone but typically unnecessary in a cloud computing configuration.

“In the system we co-developed with Dell DCS, we were able to right-size the power supply precisely for the parts in our design,” says Geiger. “Compared to the servers we were using before, the energy bills for these are 18 percent lower. And with the thousands of machines we use, that 18 percent savings adds up.”

Dell and Ask.com continue to optimize the cloud computing solution. For example, the two companies are testing other server components, which potentially could be another 15 percent more energy-efficient and need fewer repairs compared with the current solution.

To help reduce packaging waste, new servers arrive at Ask.com in Dell Multipack bundles. Ask.com also became the first corporate customer to participate in the Dell “Plant a Forest for Me” program. Through partnerships with Dell, the Conservation Fund and Carbonfund.org plant trees in managed reforestation projects to sequester carbon. To help offset the carbon emitted by Ask.com, those organizations plan to plant thousands of trees on behalf of Ask.com.

“While we are always evaluating our server options, this has been a good process for us so far, what with the savings in power, maintenance, and packaging; high performance and reliability; and opportunity to deepen our company’s working relationship with Dell,” Geiger says. “The Dell DCS team really listened to us. They have worked with us closely to provide the best solution, in a collaborative co-development process. And we are extremely happy with the results.”

For more information about Dell DCS Cloud Computing Solutions, visit DELL.COM/CloudComputing.

services to help make green goals a reality. Energy-efficient features are built into Dell products from the desktop to the data center. Dell can also help organizations extend the benefits of efficient equipment through intelligent data center design—enabling them to optimize power and cooling configurations to achieve high computing density without performance degradation.

Dell partnerships with industry leaders and industry consortiums such as The Green Grid; the Climate Savers Computing Initiative; the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE); the Storage Networking Industry Association (SNIA); the Distributed Management Task Force (DMTF); and the Standard Performance Evaluation Corporation (SPEC) create broad-based opportunities for enterprises to address their energy efficiency issues by

leveraging cost-effective, standards-based power and cooling equipment.⁷

John Pflueger, Ph.D., manages the Dell technical strategy for facility and system thermals, focusing on ways to improve efficiency. He has 16 years of experience in product development, product marketing, and product management. John has a Ph.D. from the Massachusetts Institute of Technology.

Albert Esser, Ph.D., serves as vice president for data center infrastructure at Dell, where he is responsible for enhancing Dell’s enterprise-class IT solutions by sharing customer insights with the company’s Server, Storage, Data Center Solutions, and Services teams. Albert has an M.S. and a Ph.D. in Electrical Engineering from the University of Aachen. He holds 12 U.S. patents.

⁷For more information, see “The Green Grid: Enabling the Energy-Efficient Data Center,” by Christian Belady and John Pflueger, Ph.D., in *Dell Power Solutions*, February 2008, DELL.COM/Downloads/Global/Power/ps1q08-20080199-GreenGrid.pdf.

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