WHITE PAPER: SYMANTEC GREEN IT

symantec™

Confidence in a connected world.

The Green Data Center—a Symantec Green IT Guide

White Paper: Symantec Green IT

The Green Data Center—a Symantec Green IT Guide

Contents

Executive summary

High-performance IT consumes power and generates heat in enormous quantities—moving IT energy costs up corporate and even national agendas. Environmental, energy-cost, and space-planning considerations all call for conservation through a combination of operational changes, hardware replacement, and—especially—management software to cut waste and build efficiency.

Continuous inventory of server resources and optimization of their use—particularly in high-availability cluster configurations—helps data centers do more with less, even as they improve performance and service levels. Virtualization offers compelling economies, but demands sophisticated solutions for the availability, visibility, and complexity issues that the technology may introduce.

Storage consumes less power—but is growing much faster. An automated inventory helps disclose underutilized storage and sets the stage for storage tiering, which balances information priority against the speed and cost—including energy cost—of the assets used to store it. Most effective of all are data-protection policies that reduce the storage burden by deduplicating data before concentrating it into a single instance.

Outside the data center, desktop management software offers a wide range of energy-conservation, security, and productivity management capabilities. With appropriate balance among operational, hardware, and software approaches, IT can chart an energy-efficient future that doesn't depend on painful compromises to productivity or service quality.

The business case for IT energy conservation

IT professionals are familiar with Moore's Law—Intel co-founder Gordon E. Moore's 1965 observation that integrated-circuit transistor density doubles about every two years—and know that because of it, there is exponential growth in the areas of computing speed and power, as well. Sadly, without compensating improvements in leakage current and efficiency, those density changes bring exponential increases in power consumption and heat.

The power and heat implications of Moore's Law surfaced first in high-performance laptops, where they were evidenced by short battery life and uncomfortably warm cases. But in just a few short years, these implications have grown into forces that will reshape the world's data centers.

Power consumption in the data center

Information technology (IT) has an insatiable appetite for electric power, and the sector's growth is reflected in its growing consumption of energy.

U.S. and global trends

The United States Environmental Protection Agency (EPA) estimates U.S. IT-sector electricity consumption at 61 terawatt-hours (tWh) annually—1.5 percent of the national total.[1] Differences in assumptions and record-keeping complicate worldwide estimates, but advanced economies such as Germany's show IT energy consumption rates roughly comparable to those of the U.S.[2]—and a Symantec survey of Global 2000 data-center managers confirms that energy-efficient computing is a worldwide concern.[3]

Trends are up: in the U.S., IT consumes twice as much electricity as it did in 2000. Even factoring in current energy-saving trends in IT equipment and data center infrastructure, the EPA projects that energy consumption will double again by 2011, to more than 100 tWh—an annual electricity bill of US$7.4 billion.

Data-center impacts

Half of this electricity is consumed directly by IT equipment, the rest by power conversion, distribution, and cooling apparatus. Volume servers account for 68 percent of the equipment total; network equipment and storage account for 10 percent each. Geographically, the greatest energy consumption is at enterprise-class data centers—38 percent of the total—with smaller installations ranging from 12 to 18 percent.

Nor are energy costs the whole story. High-performance, space-efficient gear such as blade servers has increased power density—so organizations now build new data centers because they are running out of power and cooling capacity, not room.

These costs and risks are not lost on the leaders of the IT community. IDC estimates that power and cooling already cost $.50 of every hardware dollar, and will become the number two operational expense by 2009.[4] Gartner found that 70 percent of CIOs are already concerned about power and cooling costs, and 50 percent expect them to become an issue for their organizations by 2008.[5]

Energy conservation: the business logic

Energy conservation stands at the intersection of social and business goals. Even beyond its operational savings, conservation frees up floor space, power, and cooling capacity; eliminates expansion costs, and removes obstacles from an organization's growth path.

With careful planning and a clear sense of priorities, conservation programs can be self-funding—with payback periods of one or two years, even for expensive infrastructure upgrades. Government and power-company incentives sweeten the pot, especially for early adopters. And early conservation efforts build employee experience and commitment, creating a virtuous spiral in which each new success builds a foundation for the next.

Elements of strategy

Energy conservation planning should consider:

- Balancing short-term "quick wins" for momentum with long-term structural solutions
- Both environmental and business benefits of conservation initiatives, among them:
  - Lifecycle costs, from initial capital outlay through installation and operating expenses to retirement and recycling costs
  - Incentives such as tax breaks and power-company rebates
  - Deferred capital expenses, such as new hardware purchase or data-center expansion
- Indirect capital and operating savings from reduced power conversion, UPS capacity, cooling, and related infrastructure

Savings from operations, hardware, and software

The boundaries between operational, hardware-oriented, and software-oriented approaches to energy conservation are not clear-cut: operational improvements often require hardware or software, and few technology solutions are worthwhile without operational changes. But each approach has its strengths and weaknesses:

- **Operational improvements**—These are great for "quick wins" early in conservation initiatives. Simply switching off an idle server brings a fast operational improvement—and benefits that are equally direct. Examples include:
  - Restoring disabled power-management features such as frequency and voltage scaling, hibernation, or variable-speed fans
  - Switching off broken, obsolete, surplus, or idle equipment and its support infrastructure
  - Taking energy efficiency into account when assigning loads to systems and storage

  - Implementing and publicizing work-from-home policies and energy awareness initiatives

However, operational improvements should be approached systematically; ad hoc approaches are implemented sporadically and forgotten quickly. Many operational improvements will require both hardware and software investment, especially for management—and many will bring low returns on that investment, especially in organizations where conservation measures are already in place.

- **Hardware**—Hardware improvements represent the best combination of performance and energy efficiency available from a given technology. But there are limits to what they can accomplish. Hardware expansion is likely to more than offset any gain in energy efficiency—so net power consumption rises. Moreover, even the most aggressive IT hardware replacement program takes years to achieve its full effect. Nevertheless, hardware improvements can be achieved with purchasing strategies that favor:
  - Multi-core processors with low-leakage-current designs, offering server power utilization effectiveness (PUE) ratings of 1.5 or lower
  - Liquid-cooled equipment racks, roof-mounted cooling towers, and similar cooling infrastructure improvements
  - High-efficiency power distribution, power supplies, and backups
  - SAN and NAS storage for economies of scale, with MAID (massive array of idle disks) storage for dense near-line storage of persistent data

  Hardware replacement is the most expensive approach to energy conservation, and gains tend to be incremental. But new technologies, coupled with fresh thinking about design, hold the promise of long-term structural improvements in the effectiveness of data-center energy.

- **Software**—Often the best balance between speed and effectiveness of energy conservation is achieved by using software to make fundamental changes in the way energy-consuming IT assets are used. Software saves energy by improving server and storage efficiency in the following ways:
  - Discovering server and storage assets—and their requirements and dependencies—and then using that information to guide problem assessment and solution planning
  - Pooling resources to enable better utilization, more granular allocation, and greater flexibility in assigning assets to tasks

– Making sure that the capabilities and costs (including energy costs) of IT resources are matched to the importance of the information they store and process
– Managing IT assets for automatic enforcement of energy-efficiency policies

Infrastructure software helps organizations use servers and storage more efficiently, for rapid returns on modest investments. A software-first approach avoids "forklift upgrades" of IT equipment and the supporting infrastructure, and makes it possible to implement a gradual hardware conversion that takes advantage of purchasing, technology, and expansion opportunities. Recent software solutions even extend policy management from the data center to the desktop—for a systematic, measurable, company-wide approach to energy conservation.

The Green Data Center: servers

Servers consume more than half the energy of all IT equipment, and a disproportionate share of power and cooling infrastructure as well. Once "quick win" process changes are in place, it makes good business sense to take a close look at servers—and to start at the top.

Server resource discovery and optimization

Despite the enormous capital and energy costs of today's servers, many data center administrators would be hard-pressed to say which of their servers are running which applications, how they are configured, and on what resources they depend. Without even basic information to guide allocation, performance suffers when one server is taxed to its limit while another on an adjacent rack sits underutilized or idle. The culprit is complexity: The sheer number of servers and applications makes management difficult; the variety of hardware platforms, operating systems, and management tools makes it nearly impossible.

New configuration management software reaches across these incompatibilities to discover all the servers and applications running in the data center, along with their configurations and dependencies. Tracking changes in real time, the software helps administrators adapt configurations to established standards—including standards for energy efficiency—for policy-based optimization of server efficiency across the data center.

Direct energy savings from discovery and optimization will depend on how badly servers are congested and underused today. But resource discovery and optimization are more than solutions in themselves; they are also crucial first steps toward clustering and virtualization technologies.

High-performance servers run enterprise databases, transaction-processing systems, Web portals, and other critical applications. Business grinds to a halt if any of these applications becomes unavailable, so they are typically run on server clusters rather than individual machines.

Symantec solutions for server efficiency

Complexity is expensive. The capital, operating, personnel, and energy cost of complex, heterogeneous server infrastructure is a daily challenge for IT management. No single solution will satisfy the requirements of every data center. But server management solutions from Symantec—used individually or in combination—can reduce the complexity of any data center, for greater efficiency and more effective use of energy.

- **Veritas™ Cluster Server**, the leading cross-platform solution for high availability and disaster recovery, reduces the cost and staff needed to keep critical applications available.
- **Veritas Configuration Manager** discovers, maps, and tracks servers and applications—even across different operating-system environments.
- **Veritas Provisioning Manager** automates server provisioning and patch management and streamlines IT service management.
- **Veritas Application Director** centralizes and automates management of demanding multi-tier applications.

The high energy consumption of each machine, multiplied by the number of machines in each cluster and then by the total number of clusters, makes server clustering an attractive target for any energy conservation initiative.

The software that runs high-availability (HA) or "failover" clusters monitors applications that are running on individual nodes of the cluster, moving them to standby nodes when their primary node becomes unavailable—whether the event is planned (e.g., system maintenance) or unplanned (e.g., component failure).

Many clusters use the "dedicated spare" approach shown in figure 1 for HA. In these configurations, every application has at least one primary server and one backup. Although conceptually simple, this approach wastes money, space, and energy, matching every server with an expensive, idle duplicate that must be powered and cooled.

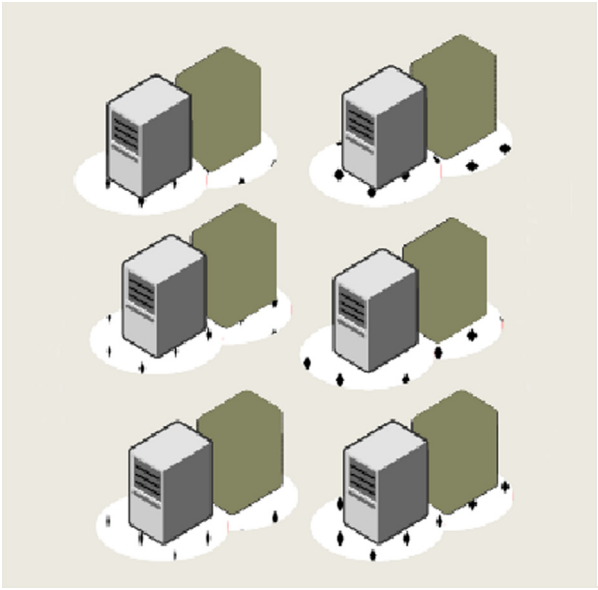

Figure 1: The "dedicated spare" approach to clustering backs every primary server with a different spare, wasting money, space, and energy.

A cost- and energy-efficient alternative is in the "roaming spare" or N+1 approach shown in figure 2. This approach provides maximum availability for critical applications without the capital and operational expense of having a dedicated spare for each one. When a fault occurs, the cluster server software automatically chooses the least-utilized node in the cluster as the backup. As repaired servers are brought back online, the software automatically returns them to the selection pool.

The math is compelling: N+1 clustering eliminates all but one spare server, no matter the cluster size. For the seven-server N+1 cluster shown in figure 2, this results in 42 percent capital expense savings stemming from the removal of five of the 12 servers required for the dedicated spare cluster shown in figure 1, plus elimination of the operational expense of maintaining—and the incremental energy cost of powering and cooling—those five idle high-performance servers.

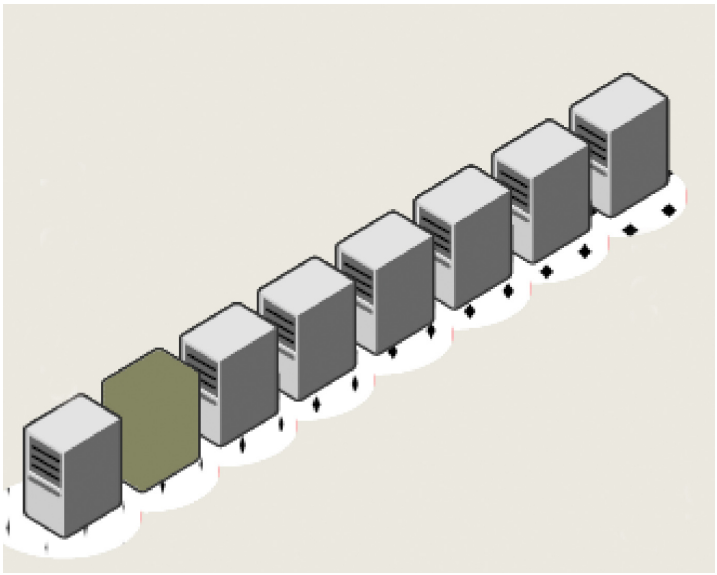

Figure 2: The "roaming spare" approach uses a single spare for capital, operational, and energy savings.

Server virtualization

Server virtualization needs little introduction—the initial public offering of virtualization leader VMware was one of the biggest IT industry events of 2007[6], and virtualization solutions from Microsoft®, Citrix, Sun™, Oracle®, and others are attracting their share of attention as well. In a way, virtualization is the reverse of clustering: instead of many servers running one application, a single server runs many of them—in "virtual machines" that share a single hardware platform.

Virtualization offers compelling economies, replacing the capital, operational, floor-space, and energy costs of multiple servers with cost- and energy-efficient fractions of the capability of a single server. But this powerful technology introduces risks as well:

- **Availability risk**—Planned and unplanned downtime affect more applications on virtual servers, and root causes are much more difficult to identify.

- **Complexity risk**—Virtualization cuts physical server sprawl, but may replace it with invisible yet hard-to-manage virtual server sprawl.
- **Visibility and management**—Even when sprawl is contained, virtualization adds complexity, forcing management software to work across virtual and physical platforms, together with their storage and network resources.

The energy math for virtualization is compelling—fewer physical servers, less supporting infrastructure, and more headroom for expansion. But managers must make sure that virtualization does not introduce unacceptable risk—especially in availability of critical applications. Management software that can work across heterogeneous virtual and physical environments should be considered a prerequisite for any major virtualization initiative.

The Green Data Center: storage

In most data centers, storage consumes far less energy than servers. But storage volume is growing, even as virtualization and other technologies promise to curb server growth. Storage management can involve a variety of tools, skills, and teams, but the underlying principles are the same. The process begins with a situation analysis, and then applies resource pooling, matching, and management processes to align the use of data-center assets with organizational goals, including energy conservation and cost-saving.

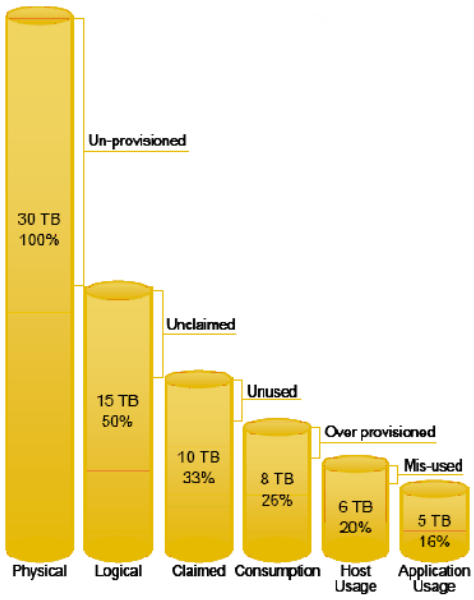

Figure 3: Fragmentation can hide most storage assets, leading to wasteful capital, operational, and energy expenditures.

Recovering storage capacity

As it does with server capacity, data-center complexity can hide storage assets that could be made available to applications. Figure 3 illustrates a representative case: of 30 TB of total physical storage, of which 50 percent is unprovisioned and an additional 16 percent is provisioned but unclaimed. Of the 10 TB provisioned and claimed, 2 TB go unused, and another 2 TB are wasted through overprovisioning. One additional terabyte is consumed by host overhead, leaving only 5 TB—16 percent of the original physical volume—available for use by applications.

In this example, 83 percent of the total storage is unused due to artificial barriers introduced by applications, hosts, operating systems, storage hardware platforms, and other distinctions that fragment data centers. Software that can cross these barriers to discover and reclaim lost storage offers immediate business benefits: capital expense deferment, increased administrative effectiveness, and greater operational flexibility. The energy math follows suit: better utilization of fewer storage assets produces sustained energy savings. But as useful as storage discovery and reclamation are on their own, they are even more valuable because they set the stage for storage tiering.

Storage tiering

Like server hardware, storage hardware sells at different price/performance points. Advanced Fibre Channel storage area network (SAN) architectures can keep enormous volumes of critical data instantly available, while network attached storage (NAS) and cost-effective SATA drives offer priority storage for valuable data. A variety of online, offline, and near-line disk and tape technologies are available to store routine, persistent, and archive information—each with latencies, capacities, data transfer rates, and costs appropriate to its value.

Storage tiering, also called hierarchical management, matches the cost, speed, capacity, and type of storage to the lifecycle-adjusted value of the information stored. Like medical triage, it deploys scarce and expensive assets where they will do the most good. Two approaches to storage tiering are:

- **Volume-based tiering**, in which data is assigned and moved to storage system volumes on physical devices with the appropriate characteristics
- **Dynamic tiering**, in which data is assigned and moved transparently to classes of storage that share latency, availability, data protection, and other characteristics

Dynamic tiering is a powerful technique with great flexibility. It first pools storage assets into tiers and then routes data to an appropriate tier following pre-defined policies, which may include energy conservation policies. To a first approximation, storage assets follow "the rule of eights"—Tier 1 storage consumes eight times as much power as Tier 2, and Tier 2 eight times as

Symantec solutions for storage efficiency

Years of double-digit storage growth, with no end in sight, have raised challenges to storage cost, operations, and power management. Storage efficiency solutions from Symantec provide visibility, analysis, and management—even for sophisticated multi-tier application data models—across operating-system, application, database, and storage hardware platforms.

- **Veritas ™ Cluster Server**, the leading cross-platform solution for high availability and disaster recovery, reduces the cost and staff needed to keep critical applications available.
- **Veritas Storage Foundation™ Enterprise Storage Management** establishes software-based storage virtualization for visibility and manageability.
- **Veritas NetBackup™** delivers high-performance data protection that scales to protect the largest enterprise environments, including remote offices.
- **Veritas Enterprise Vault** supports archiving and discovery from email, IM, collaboration, and file server environments—to protect information, reduce storage costs, and simplify management.
- **Veritas Storage Foundation Management Server** centralizes management of resources across server platforms for better staff utilization and fewer administrative errors.
- **Veritas Cluster File System** improves data availability and scalability in advanced clustered server environments, to avoid bottlenecks that compromise efficiency and service quality.
- **Veritas CommandCentral™ Storage** supports monitoring, reporting, and management of heterogeneous storage for trustworthy measurement and analysis, from application to spindle.

much as Tier 3. By implementing policies that match information value to the price/performance characteristics of storage assets or classes, organizations can address or even reverse the energy effects of the storage explosion on data-center power budgets.

Reducing storage for data protection and archiving

All of the solutions discussed so far attempt to find an appropriate way to store information. Another approach to storage management begins at the other end—by reducing the amount of data that needs to be kept.

One powerful policy-based approach is data (or Information) lifecycle management. Assigning low-priority, archival, or obsolete information to MAID (massive array of idle disks) storage or to tape—or simply getting rid of it—can cut off storage energy consumption at its source.

When policies or regulations require that information be archived, deduplication technologies offer dramatic reductions in storage volume and corresponding energy savings. There is an enormous amount of duplication in the files, instant messages, email, and attachments stored across an organization's data centers, remote offices, and disaster-recovery sites. A presentation attached to an "all employees" email may easily occupy many gigabytes of storage.

This duplication causes waste—of storage assets when the information is stationary, and of network bandwidth when it is in motion. Deduplication technologies—which exist in both hardware and software forms—examine archive data at the block level and keep only unique blocks in each archive.

Single-instance global storage takes deduplication one step further by consolidating archives worldwide—eliminating duplication across archives as well as within each one. Together, these technologies can reduce archive volumes by as much as 99.998 percent, creating an archive that is 1/500th the size of the original. The capital and energy savings achievable with this approach are apparent. It also reduces burden on remote office staff, and improves compliance with data-protection policies and regulations through central management.

Managing storage for email and other unstructured content presents special problems. End users have a strong sense of ownership over this material, and management should respect the human factor. Not only will "top-down" mailbox quotas or sunset rules fail, but they will also spawn hundreds of informal, eternal, unstable, and utterly unmanageable PST-type archives (named after the Microsoft Outlook® file type). Prudent managers will provide email archiving with an accessible, searchable single-instance store that users see as an improvement during everyday use as well as for disaster recovery.

The IT manager's view—the Symantec Green Data Center Survey

Published in November 2007, the Symantec 2007 Green Data Center Report[3] outlines progress toward the Green Data Center through the eyes of 250 global enterprise data-center managers who were surveyed online or in telephone, teleconference, or in-person interviews. Highlights of the report include the following facts:

- Increasing energy costs are driving conservation initiatives, but business managers are reluctant to compromise on performance.
- Companies are using consolidation and virtualization to balance these interests, and adopting more energy-efficient components and heat-removal techniques.
- Participating enterprises spend an average of US$1.4 million on data-center power each year. An improvement of 20 percent would save US$250,000.
- Corporate green policies are beginning to influence IT purchasing decisions, and data-center managers are adopting green technologies and strategies—but the transition to full-fledged green data centers will probably be slow.

Beyond the data center: conserving energy on the desktop

The data center environment concentrates assets, tools, and expert staff to make management at least possible, if never easy. As every IT administrator knows, the desktop environment is far less hospitable—yet the sheer number of desktop PCs demands that any comprehensive effort by IT to conserve energy address desktop power consumption.

There is plenty of room for improvement. The average desktop PC is used only four hours per day—65 percent of its power is wasted while it is idle at night. Almost half of desktop monitors are not enabled for power management, wasting energy and risking inadvertent disclosure of any information left on an active screen. Estimates of potential savings from energy management range from a low of US$10 per year to a maximum of around US$50 for CRT-equipped PCs.

Desktop differences

A software-driven strategy for energy conservation on the desktop follows the same general outline as for the data center—discover, pool, match, and manage—but the tactics are different. For example, because desktops are deliberately distributed throughout the organization, strategies based on pooling and matching may be counterproductive. Virtualization of desktop environments, for example, may require hardware-intensive, culture-changing initiatives that go well beyond the scope of energy conservation.

Attempts to manage the desktop environment through training, motivation, or one-on-one enforcement are marginal solutions at best. They work, or at least are perceived to work, against the convenience of employees, and they create unnecessary friction between IT and its internal customers. As with top-down email controls, compliance is a serious problem. Automated management solutions are both more acceptable to employees and more effective.

Automated system management

Tools available for policy-based management of desktop energy consumption are best deployed within packages of tools for other critical management tasks—for example:

- Security management
- OS deployment and migration
- Hardware and software inventory
- Software and patch management
- Software license compliance
- Remote management using Microsoft WMI and Intel® AMT

Symantec solutions for desktop management

Whether an organization's desktop and mobile assets are distributed across a campus, a country, or continents, managing those assets raises special challenges. Add employees' sense of ownership to the physical hurdles, and it can seem impossible to keep security, software patches, and power management up to date and policy-compliant.

Smart, automated management solutions from Altiris—now part of Symantec—can help track and manage IT assets around the globe, throughout their lifecycle, for policy enforcement that is realistic as well as effective.

Automated management solutions automate energy conservation by shutting down unused PCs at night and managing Windows power-saving settings for monitors. Reports on power-saving activity can be integrated into organization-wide energy-management reports for regulatory compliance, rebate calculation, or internal benchmarking.

In addition to saving between US$10 and $50 per managed PC, automated management solutions improve PC security by shutting down unused desktops, and they build awareness of security and power consumption issues as well—awareness that should help build success for company-wide energy conservation initiatives.

Getting underway

As with any major business initiative, the key is to start. As outlined above, most of the early steps are process-focused changes that can be implemented immediately—and that bring an immediate return. Longer-term, structural improvements based on hardware and infrastructure deficiencies will take longer—but their effectiveness depends on early changes in purchasing and facilities policies.

In the mid term, deployment of infrastructure software to discover, pool, match, and manage server and storage assets for energy efficiency offers excellent returns on modest investments. The EPA estimates that a combination of software-based and other best practices can not only halt the steady growth in IT energy consumption, but actually reverse it—even as business dependencies on IT continue to grow.

In addition to dramatic reductions in energy cost, businesses that implement data-center management software experience better span of control, more efficient operation, and improved compliance with regulations, standards, and policies.

References

1. *Report to Congress on Server and Data Center Energy Efficiency Public Law 109-431* (Washington, DC: US Environmental Protection Agency Energy Star Program. August 2, 2007)
2. Chamara Gunaratne, Ken Christensen, and Bruce Nordman. "Managing energy consumption costs in desktop PCs and LAN switches with proxying, split TCP connections, and scaling of link speed", *International Journal of Network Management* 2005; 15:297-310
3. *Symantec 2007 Green Data Center Report* (Cupertino, CA: Symantec Corporation. November, 2007)
4. Jed Scaramella. *Worldwide Server Power and Cooling Expense 2006–2010 Forecast*, Document #203598 (Framingham, MA: IDC. September, 2006)
5. Press release. "Gartner Says 50 Percent of Data Centers Will Have Insufficient Power and Cooling Capacity by 2008" (Stamford, CT: Gartner, Inc. November 29, 2006)
6. Lynn Cowan. "VMware Gets Ready for IPO Close-Up," *The Wall Street Journal*, abstract (New York: Dow Jones & Company. August 13, 2007) http://online.wsj.com/article/SB118696594482595604.html

About Symantec

Symantec is a global leader in providing security, storage, and systems management solutions to help businesses and consumers secure and manage their information. Headquartered in Cupertino, Calif., Symantec has operations in more than 40 countries. More information is available at www.symantec.com.

For specific country offices and contact numbers, please visit our Web site. For product information in the U.S., call toll-free 1 (800) 745 6054.

Symantec Corporation
World Headquarters
20330 Stevens Creek Boulevard
Cupertino, CA 95014 USA
+1 (408) 517 8000
1 (800) 721 3934
www.symantec.com

04/08 xxxxxxxxxx