Virtualization and the Green Data Center
Server virtualization can help reduce energy costs by up to 50 percent.

Running a more energy-efficient IT operation is a high priority for many organizations. And the movement behind green computing zeros in on processes that make the data center more efficient.

One of the most successful ways to increase efficiencies in the data center is through virtualization. Designed to make a single piece of hardware function as multiple pieces, this technology can help slash power and energy costs.

The complexity of the data center and the often large number of servers are factors that drive up energy consumption for power and cooling. Server virtualization coupled with consolidation can help data center managers with efficiency and cost issues.

Energy and Power
It's important to provide some context for the value of server virtualization today. According to a recent study by management consultancy McKinsey in conjunction with research and advisory firm Uptime Institute, data centers are a fast-growing contributor to global warming.

The report entitled "Revolutionizing Data Center Energy Efficiency" (released in 2008) recommends that organizations double their data center energy efficiency by the year 2012.

On average, data centers today consume the energy equivalent to that used by 25,000 homes in the United States. According to experts, data center energy consumption is almost 0.5 percent of world energy production.

In many industries, data centers are one of the largest sources of greenhouse gas emissions, the report continues. And if current trends continue unchecked, data center greenhouse gas emissions will quadruple by 2020.

According to statistics from the U.S. Environmental Protection Agency (EPA), the nation's servers and data centers consumed about 61 billion kilowatt-hours in 2006, or 1.5 percent of total U.S. electricity consumption, for a total electricity cost of about $4.5 billion.

The EPA says under current efficiency trends, the national energy consumption by servers and data centers could nearly double again by 2011 to more than 100 billion kilowatt-hours. This would represent a $7.4 billion annual electricity cost.

The agency says U.S. data centers are in the midst of a major growth period stimulated by increasing demand for data processing and storage. The demand is driven by several factors, including the increased demands for digital processing in all types of industries from banking to music downloads.

The research firm Gartner says during the next five years most U.S. data centers will spend as much on energy (power and cooling) as they will on hardware infrastructure. All of these stats and numbers point to a growing need for organizations to find ways to make their data centers more efficient.

Server Sprawl
The need for turning an efficient eye on the data center has been coming for a while. Over the years, many data centers have seen a huge increase in the number of servers in place and an underutilization of those servers. This has contributed to increasing facilities, power and cooling costs.

"Data centers are still overcrowded due to server sprawl," says Rob Smoot, group product marketing manager at VMware in Palo Alto, Calif. "This is driving up related facilities and energy costs."

It's not always a matter of oversupply of servers. Sometimes inefficiencies develop because of how the systems are being used in data centers.

"Many organizations could use all of the capacity they have purchased, or will soon be able to do so," says Anil Desai, an independent consultant based in Austin, Texas. "It's not as much about replacing or removing perfectly viable hardware; it's more about making the best of existing investments and maximizing future ones."

Mark Linesch, vice president of Enterprise Storage and Servers Software, at Hewlett-Packard in Palo Alto, Calif., agrees that many servers are not being used optimally. "Many [organizations] are underutilizing what they have," Linesch says. "Most servers are around 20 percent utilization. That's leaving a lot of unused horsepower."

Furthermore, most servers use 50 percent of their rated power when idle, according to Barb Goldworm, president and chief analyst at Focus Consulting in Boulder, Colo. For every productive dollar gained from servers, almost two dollars are spent on energy-related technologies or functions, such as AC/DC conversions, Goldworm reports.

It's important that organizations "right size" their IT infrastructure. This includes servers in the data center in order to reduce power consumption.

"There are two important goals: One is to maximize resource utilization," Desai says. "And the other is to ensure that IT organizations remain aligned with the [organizations] they support."

Consolidating and right sizing "can reduce power consumption significantly," according to Goldworm. This can contribute real dollars directly to the bottom line.

Server Virtualization
One of the most effective ways to enhance server utilization, consolidate physical servers and decrease energy consumption is through virtualization.

With virtualization, physical servers are provided as pools of logical computing capacity. Servers are divided into multiple "virtual machines" that can run multiple operating systems and applications as if they were running on physically separate machines.

As a result, organizations can reduce the number of physical servers needed. Fewer servers mean less power being used and less electricity and air-conditioning needed.

"Consolidation and server virtualization can dramatically reduce the number of servers required to deliver the same workload," Goldworm says. "Consolidation ratios can range as high as 5- or 10-to-1."

Because idle servers still use 50 percent of their rated power, servers running at 20 percent utilization (the average utilization of nonvirtualized servers) are using substantial power at a significant cost. Consolidating and reducing the number of servers can reduce power and, cooling and as a result, can cut the energy bill by a huge amount.

"By deploying virtualization technology on their server assets, organizations can improve their utilization rates and ultimately increase their ROI [return on investment]," HP's Linesch adds. "Virtualization can also lower costs associated with administrative time and power and cooling."

Incremental Benefits
Organizations can reap other benefits from virtualization as well. The technology "provides an unprecedented degree of portability and isolation for applications and services," Desai says.

"This allows IT groups to quickly deploy new systems," he adds. "And they can make infrastructure resource changes based on new user requirements."

In addition, systems administrators have fewer physical systems to purchase, install and configure. "The process and lead times for installing new physical servers can be weeks, even in well-organized IT groups," Desai adds.

"Production delays from vendors can increase that time. By treating the data center as a single, large pool of computing resources, organizations can greatly reduce the amount of work involved with physical system management."

Making efficient decisions, such as increasing hardware resource utilization through server consolidation, helps a great deal in the overall effectiveness of IT departments, Desai notes.

"By requiring justifications for new physical server deployments, departments can verify whether new systems are needed or whether existing ones should be reconfigured," he says. "The goal is not just to reduce spending, but also to make better decisions about aligning IT with [operations]."

Consolidation and virtualization allows organizations to do more with less hardware. In addition, organizations can gain the ability to do things that are not possible on nonvirtualized systems, such as pooling resources and automating disaster recovery strategies.

Virtualization Manufacturers
The server virtualization solution consists of three main components: software, servers and storage. VMware is a market leader in virtualization software today. However, Citrix, Microsoft and HP are also offering products that have begun to compete in this market.

According to VMware's Smoot, VMware customers have been able to reduce energy costs and consumption by 80 percent by consolidating 10 or more application workloads onto one physical machine. This will increase utilization from the typical 5 to 10 percent to 70 percent or more.

"For every server virtualized, the annual savings are 7,000 kilowatt-hours," he says. "That translates to $700 in power and cooling costs."

VMware provides a suite of virtualization software for desktop PCs and x86 servers. They are designed to allow organizations to run multiple applications and operating systems on one physical machine.

One component, VMware Server, enables organizations to accelerate server provisioning by building a virtual machine once and deploying it multiple times. It allows organizations to easily evaluate software in ready-to-run virtual machines without installation and configuration.

In September 2008, the firm announced a comprehensive roadmap of new products and technologies that expand its flagship suite of virtual infrastructure into a virtual data center operating system (VDC-OS). The VDC-OS allows organizations to efficiently pool different types of hardware resources — servers, storage and networks — into an aggregated, on-premise "cloud."

Among its other capabilities, VDC-OS provides a set of infrastructure services called Infrastructure vServices. These are designed to seamlessly aggregate servers, storage and networks as a pool of resources and allocate them to applications that need them most.

VMware also has an experimental feature in its VMware Infrastructure suite called Distributed Power Management (DPM). It continuously monitors resource requirements and power consumption across a virtualized environment.

The feature consolidates workloads and puts servers in standby mode to reduce power consumption. When resource requirements of workloads increase, DPM brings powered-down hosts back online to ensure that service levels are met.

Citrix Systems in Fort Lauderdale, Fla., offers XenServer, a server virtualization solution designed to quickly deliver workloads across virtual or physical servers. XenServer is based on the open source Xen hypervisor, which provides lower overhead and near-native performance.

The product leverages both Intel VT and AMD Virtualization (AMD-V) platforms for hardware-assisted virtualization. The open Application Programming Interface (API) allows organizations to access and control advanced functions from existing server and storage hardware.

The software features performance monitoring, reporting and alerting dashboards that make it easy to see both real-time and historical views of virtual machines and physical host performance.

Citrix also provides desktop virtualization through its XenDesktop offering. XenDesktop dynamically assembles virtual desktops on-demand, providing end users with a personalized desktop each time they log on.

The assembly of desktops is enabled through the separation of operating system, applications and user settings, which simplifies desktop management. This includes the creation, provisioning, personalizing, monitoring and updating of desktop images centrally from a data center.

The benefits of consolidation through virtualization can reach well beyond reduced energy consumption and lower costs. Organizations can run greener operations, which can improve their image among the public, end users and partners.

In September 2008, HP announced a broad portfolio of products and services for virtualization environments. These cover applications and operations management, infrastructure and client architecture.

The solutions include HP's Business Technology Optimization (BTO) software for virtualization, designed to help organizations minimize operations service risk and lower costs. Unlike specialty tools that monitor either physical or virtual environments, the HP software is able to manage across both environments.

Another component is the HP ProLiant BL495c virtualization blade, the first server blade designed specifically to host virtual machines. HP says the product eliminates performance bottlenecks and is designed for virtualized environments requiring significant memory, data storage and network connections.

The firm also unveiled HP Virtualization Accelerator Services, consulting services for planning, designing and implementing virtualization initiatives. The services are aimed at simplifying the buying process, reducing costs and decreasing deployment time.

Energy Conservation
A recent survey conducted by Focus Consulting shows that while most organizations (74 percent) are motivated toward energy conservation for cost reasons, 64 percent also list environmental impacts and sustainability as part of their motivation.

"Particularly for consumer-facing organizations, where public image is important, going green can be a key part of improving the public image," Focus's Goldworm says.

There's growing pressure on organizations to be better environmental stewards, HP's Linesch says. In addition, the benefits to be gained from creating more energy-efficient data centers will fuel ongoing efforts to virtualize and consolidate IT environments.

Adopting virtualization broadly in the data center "significantly reduces carbon footprint by consolidating hardware and increasing energy efficiency," Linesch says. "Therefore, it is possible to leverage technology, such as virtualization, to take a proactive position on environmental issues while still delivering robust [services]."

Organizations are increasingly focused on the environmental impact of their operations, VMware's Smoot adds. "Data centers are huge carbon dioxide factories and have a great opportunity to reduce that impact.

"Virtualization can help reduce that impact significantly," he says. "Similar benefits can be achieved by consolidating desktop PCs in the data center and replacing them with thin clients. In aggregate, these efforts can have a huge impact on the environment."

Data Center Energy Savings

Data rooms can now pack more processing power into less real estate. These high-density computing environments can be a huge drain on operating budgets.

According to an Eaton Powerware white paper, "Top 10 Ways to Save Energy in Your Data Center," even small data centers can save money through the smart choices listed below:

1. Turn off idle IT equipment.

2. Virtualize servers.

3. Consolidate servers, storage and data centers.

4. Turn on the CPU power management feature.

5. Use IT equipment with high-efficiency power supplies.

6. Use high-efficiency uninterruptible power supplies (UPS systems).

7. Adopt power distribution at 208/230V.

8. Adopt best practices for data center cooling.

9. Conduct an energy audit of your data center.

10. Prioritize actions to reduce energy consumption.

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