



Improve Energy Efficiency and Manage Power Consumption with Windows Server 2008 R2

White Paper

Published: June 2009

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Overview

Reducing power consumption is a priority for businesses and organizations seeking to control costs and to minimize their impact on the environment. One way to reduce power usage is to implement an energy-efficient server infrastructure that facilitates power management and that helps allocate power to computing resources as needed.

The Windows Server® 2008 R2 operating system, like its predecessor Windows Server 2008, has been designed with energy efficiency firmly in mind. It provides customers with ready and convenient access to a number of new, exciting power-saving features.

For example, Windows Server 2008 R2 includes updated support for Advanced Configuration and Power Interface (ACPI) processor power management (PPM) features, including a new PPM engine. Windows Server 2008 R2 includes a variety of features that help improve the power efficiency of individual servers, as well as features that enable centralized control of active power policies across servers and clients, using Group Policy and remote management interfaces to “throttle down” the system during off hours. Windows Server 2008 R2 also supports new power measurement and management capabilities that work with new server hardware features to provide insight—and control—of power consumption across the datacenter.

Power savings are also made possible by Hyper-V™, the hypervisor-based virtualization technology that is included as a server role. Hyper-V makes it possible to consolidate an organization’s IT infrastructure onto a much smaller number of physical servers, significantly reducing power consumption without unduly sacrificing performance. Many of the power saving capabilities of Windows Server are also present in Hyper-V.

New for Windows Server 2008 R2 is the Enhanced Power Management Additional Qualifier (AQ) for the Windows Server 2008 R2 logo program. With this qualifier, OEMs, together with Microsoft, help customers identify energy-efficient hardware capabilities that are available for use by the operating system and that help ensure optimal power efficiency.

The High Cost of Power

The evolution of modern business has brought unbridled growth, mergers, acquisitions—and an ever-growing numbers of servers. As businesses use more servers, and as these servers become more powerful, they use more power-hungry hardware, and the amount of electricity it takes to operate them rises proportionately. A recent study found that the amount of electricity that servers and auxiliary equipment worldwide used more than doubled between 2000 and 2005 to more than 1.2 billion kilowatt-hours (kWh) per year—a figure that represents 0.8 percent of the estimated world electricity sales.¹ The cost of electricity for running servers is therefore an increasingly significant expenditure for many businesses and other organizations, and will most likely continue to grow in the future.

The environmental impact of excessive power usage is also a growing concern for governments and businesses seeking to reduce the production of greenhouse gases that contribute to global warming. Under international agreements and local regulations in jurisdictions around the world, businesses are subject to limits on greenhouse gas emissions, which are typically managed through carbon credit programs. Operators that cut their emissions production can frequently trade unused carbon credits on exchanges, providing additional revenue. Implementing “green” policies can also provide businesses with valuable public-relations benefits among an increasingly environmentally conscious populace.

¹ *Estimating Total Power Consumption by Servers in the U.S. and the World*, Jonathan G. Koomey, Ph.D., Staff Scientist, Lawrence Berkeley National Laboratory and Consulting Professor, Stanford University, February 15, 2007.

For these reasons, businesses frequently look to energy-efficient server infrastructures to help manage their energy usage.

Saving Power with Microsoft

Microsoft actively strives to be a good steward for the environment by adhering to sound environmental principles and business practices, and has therefore made a serious commitment to power savings with a three-pronged approach: reduce energy demands, manage energy and environmental impact, and rethink business practices (see Figure 1).

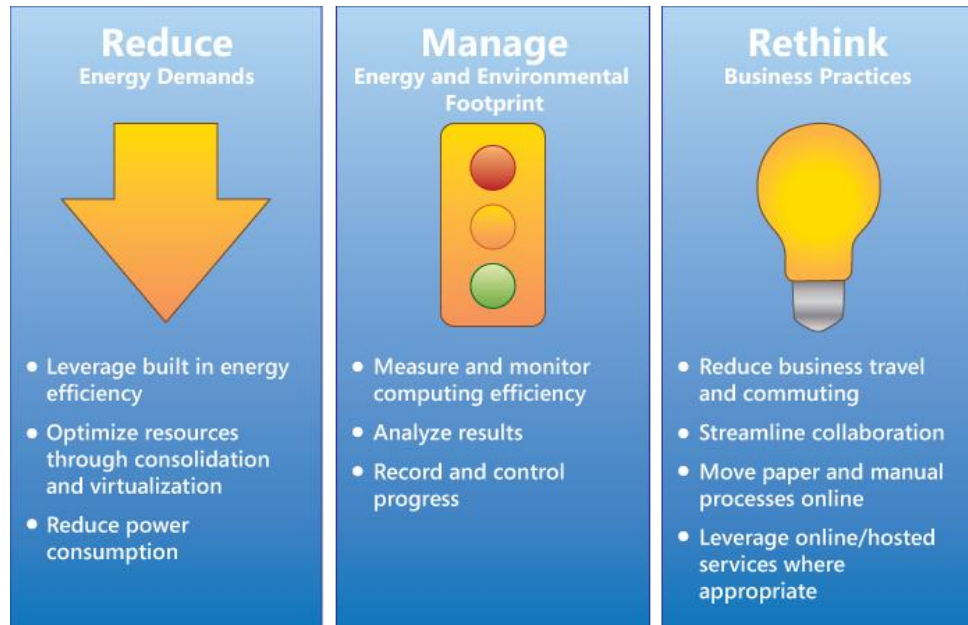


Figure 1. Reduce, manage, and rethink for customer impact

- **Reduce energy demands**—Microsoft helps organizations reduce the amount of energy used by their IT energy departments—helping them use only the amount of power they need, and only when they need it. Organizations can rely on Microsoft to help increase hardware utilization, minimize energy consumption, and maximize efficiency through power-saving technologies and products that are more energy efficient, that include new power management features, and that turn these power management features “on” by default.
- **Manage energy and environmental impact**—Organizations can better monitor, measure, manage, and analyze their energy consumption with Microsoft business intelligence (BI), enterprise resource planning (ERP), and energy management system (EMS) solutions. Systems management products from Microsoft also help customers realize the full potential of Microsoft power management and server consolidation solutions.
- **Rethink business practices**—Microsoft technologies can help transform the way companies do business—helping them find innovative ways to reduce their carbon footprints without sacrificing productivity. For example, organizations can use Microsoft Unified Communications (UC) solutions to moderate travel, reduce commuting time, and move paper and manual processes online. Customers also can use Microsoft products and technologies to analyze environmental trends and

patterns through online maps and data, arming them with information that can be used to help reduce their power consumption.

Windows Server 2008 and Windows Server 2008 R2 embody the Microsoft commitment to efficient use of energy; they enable organizations to both reduce power usage for their individual servers and to manage power usage across the entire server environment. Windows Server 2008 and Windows Server 2008 R2 provide numerous opportunities to save power without compromising on performance.

Saving Power with Windows Server 2008

Windows Server 2008, launched in February of 2008, introduced compelling energy-saving technologies—such as server virtualization with Hyper-V technology and the native power management capabilities of the platform—that are turned “on” by default. This lets organizations realize true power savings benefits without adding overhead to the IT infrastructure.

Power Savings Out of the Box

Windows Server 2008 is more energy efficient overall than its predecessor, Windows Server 2003. By default, Windows Server 2008 runs the “Balanced” power savings plan, which aims to keep performance high while saving power whenever possible. This means that Windows Server 2008 uses less power than does a baseline installation of Windows Server 2003. Because the “Balanced” mode maximizes out-of-the-box (OOB) power efficiency, Microsoft highly recommends leaving the default “Balanced” settings selected in most cases.

Windows Server 2008 includes two additional default modes, “Power Saver” and “High Performance,” which have different power and performance goals and may be appropriate in some situations. The “High Performance” mode may be appropriate for servers that run at very high utilization and need to provide maximum performance, regardless of power cost. The “Power Saver” mode can be used for little-utilized servers that have more performance capability than they really need; using “Power Saver” in this situation may provide incremental power savings.

To quantify the power savings possible with Windows Server 2008, Microsoft conducted a series of tests to compare its power consumption with that of Windows Server 2003. Because power usage varies dramatically with specific workload and server utilization, a separate test focused on measuring power efficiency (work per watt) under varied workloads. Both operating systems used were 64-bit editions and were installed with OOB configurations on a single server with two dual-core processors and 4 GB of RAM.

The tests revealed that Windows Server 2008 OOB achieved a power savings of up to 10 percent over Windows Server 2003 OOB at comparable levels of throughput. Furthermore, Windows Server 2003 was only able to attain approximately 80 percent of the Windows Server 2008 maximum throughput. (See Figure 2, which shows the power consumption under each operating system,² with wattage and workload expressed as a percentage of the maximum that was observed under Windows Server 2008.)

² Power usage varies with different system units from different vendors, because power consumption is dependent on the hardware configuration in addition to the software.

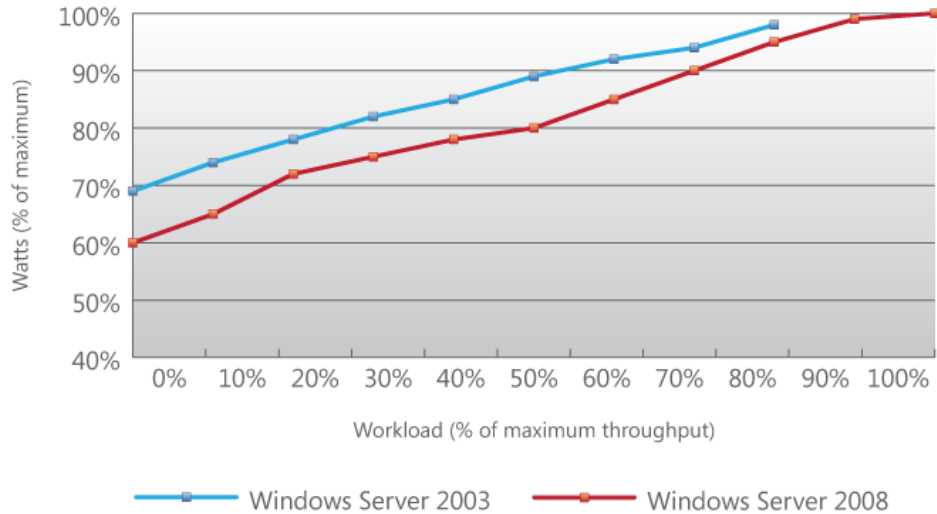


Figure 2. Out-of-the-box power usage comparisons

These energy savings add up. Table 1 projects the number of kilowatt-hours that would be consumed by each server for an entire year, as well as the estimated cost in U.S. dollars and the estimated amount of carbon dioxide (CO₂) produced (which can be useful for calculating carbon credits) for the same time period.³

Table 1. Projected cost and carbon dioxide output

Server configuration		Measured	Projected equivalents		
Stand-alone server setup	Processing load	Average watts	kWh per year	Cost	Kilograms of CO ₂
Windows Server 2003 IIS 6.0	Idle	467.62	4,099.16	\$374.66	3,187
Windows Server 2008 IIS 7.0	Idle	456.73	4,003.70	\$356.94	3,113
Windows Server 2003 IIS 6.0	20 active clients	536.66	4,704.36	\$429.98	3,657
Windows Server 2008 IIS 7.0	20 active clients	500.10	4,383.88	\$400.69	3,408

The data confirms that even if you change nothing else, Windows Server 2008 in its OOB configuration can reduce your power usage by up to 10 percent compared to the Windows Server 2003 OOB configuration. Additional energy-saving features in Windows Server 2008, however, can extend the power savings even further.

³ See Average Retail Price of Electricity to Ultimate Customers by End-Use Sector, by State from the Energy Information Administration (http://www.eia.doe.gov/cneaf/electricity/epm/table5_6_b.html) and Greenhouse Gas Equivalencies Calculator from the U.S. Environmental Protection Agency (<http://www.epa.gov/cleanenergy/energy-resources/calculator.html>).

Processor Power Management in Windows Server 2008

In Windows Server 2008, PPM is enabled by default. Windows Server 2008 has the native ability to throttle the CPU performance based on the workload; it evaluates the workload on the processor on an ongoing basis and adjusts the P-states (processor performance states within the ACPI specification, with P0 set as the highest-performance state) accordingly. (This ability depends on the processor architecture). Adjusting the P-state involves changing frequency and voltage—a higher P-state, or lower performing processor, results in lower power consumption. The ability to adjust ACPI P-states of processors can therefore provide very fine control over power consumption of individual servers; power consumption and performance can be adjusted automatically throughout the day as demands on the server vary.

Managing Power Usage with Group Policy

Windows Server 2008 and Group Policy can enable an enterprise-wide, centrally managed power policy across compatible client workstations that are running Windows® XP, Windows Vista®, or Windows® 7, all of which include similar power-management features to those introduced in Windows Server 2008. Group Policy provides the infrastructure for centralized configuration management of the operating system and of the applications, and all power options have been Group Policy-enabled.

For example, enterprise users often leave their computers on overnight, either by choice or to comply with the organization's IT policy. This can enable administrative tasks, such as disk defragmenting, virus scanning, and software update downloading and installation, to occur without disrupting daily business activities. However, leaving desktop computers on overnight and on weekends can waste thousands of kilowatt-hours of electricity every year, even in small and medium-sized organizations.

To solve this problem, an administrator can configure the computers so that they automatically enter a sleep state after a specified period of inactivity. The power options on the individual computers can be modified through Group Policy settings, or the administrator can build a custom power plan that is deployed by using Group Policy. An administrator can also use Group Policy settings to enforce a company's power policy by specifying the range of P-states at which the clients can operate.

A centrally managed power policy can be enhanced by the new power management options available in Windows 7. In contrast to the limited selection of options that are available in the Windows XP **Power Options Properties** dialog box, the **Power Options** dialog box in Windows 7 offers direct control over a much greater number of options (see Figure 3), including:

- Wireless adapter power settings
- Hybrid sleep (a state in which the computer writes the contents of RAM to disk before going to sleep)
- USB selective suspend
- PCI Express bus power management
- Minimum and maximum processor state
- Power savings mode for search and indexing
- Adaptive display control

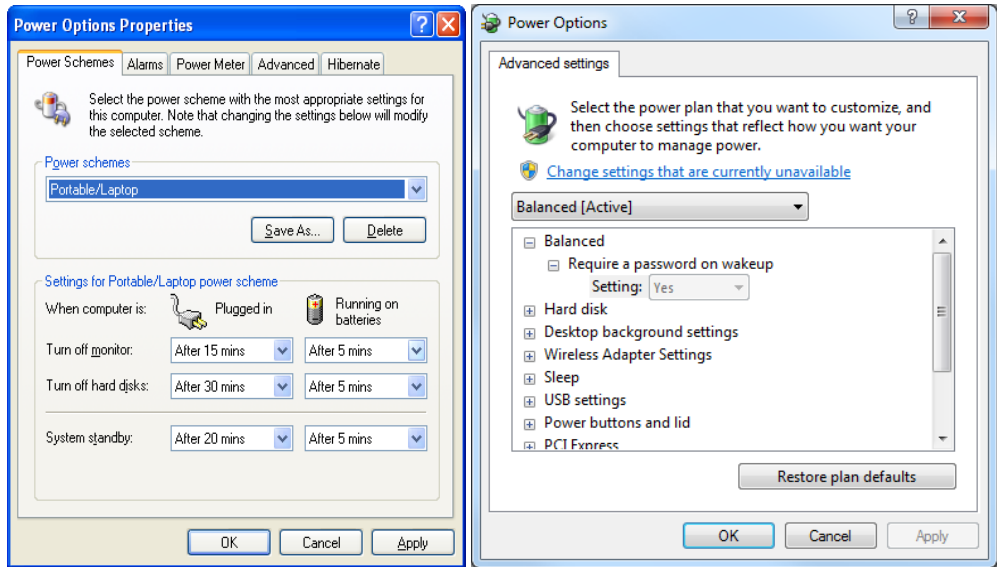


Figure 3. Power management options in Windows XP (left) and in Windows 7 (right)

(Note that to take advantage of the advanced CPU power saving features of Windows Server 2008, the CPU and BIOS must comply with the ACPI specification for processor performance states.)

Saving Power through Virtualization

Windows Server 2008 R2 also includes the new Microsoft virtualization technology, Hyper-V, designed to both augment existing virtual machine (VM) management and address specific IT challenges, especially around server migration.

Each physical server in an organization's infrastructure generates a power usage overhead, dictated by factors such as the power supply, any physical devices that are connected to the server, and cooling requirements. This overhead usually consumes 60 percent or more of the server's maximum power draw, even when the server is completely idle.

Additionally, servers typically run at far below their capacity and on average only utilize 5 percent to 15 percent of their actual CPU capabilities. This low asset utilization is due to a number of factors, including a lack of flexibility in utilizing computing resources and the difficulty of estimating how much capacity will actually be needed. Most organizations allocate processing power, storage, and memory resources in order to handle anticipated peak loads and unanticipated usage spikes rather than for normal operating requirements—resulting in an excess of capacity during periods of normal operation and wasting power.

Such scenarios are ideal candidates for consolidation using Hyper-V, the hypervisor-based virtualization technology that is included as a feature of Windows Server 2008 and Windows Server 2008 R2.

To quantify the power savings that virtualization makes possible, Microsoft conducted a series of power usage tests on stand-alone servers and on Hyper-V servers that hosted multiple virtual machines. The results showed that the physical server consumed just 3.5 percent more power when it ran four VMs than it used when it was configured as a stand-alone server, keeping comparable throughput.

The implications of these results are significant. Since multiple virtual machines can run on a single physical server without consuming significantly more power than a stand-alone server and without sacrificing throughput, it is possible to add virtual machines at essentially no power cost, as dictated by hardware and performance needs.

The savings continue to scale with the number of servers virtualized. Running four virtual machines means saving the equivalent power output of three physical servers; running 10 virtual machines means saving the equivalent power output of nine physical servers. Adding four physical servers that have the same hardware profile that was used in the tests would consume more than 17,000 kWh of electricity per year; adding 10 physical servers would consume almost 44,000 kWh of electricity per year. The difference adds up to thousands of dollars a year at current electricity rates. (See Figure 4.)

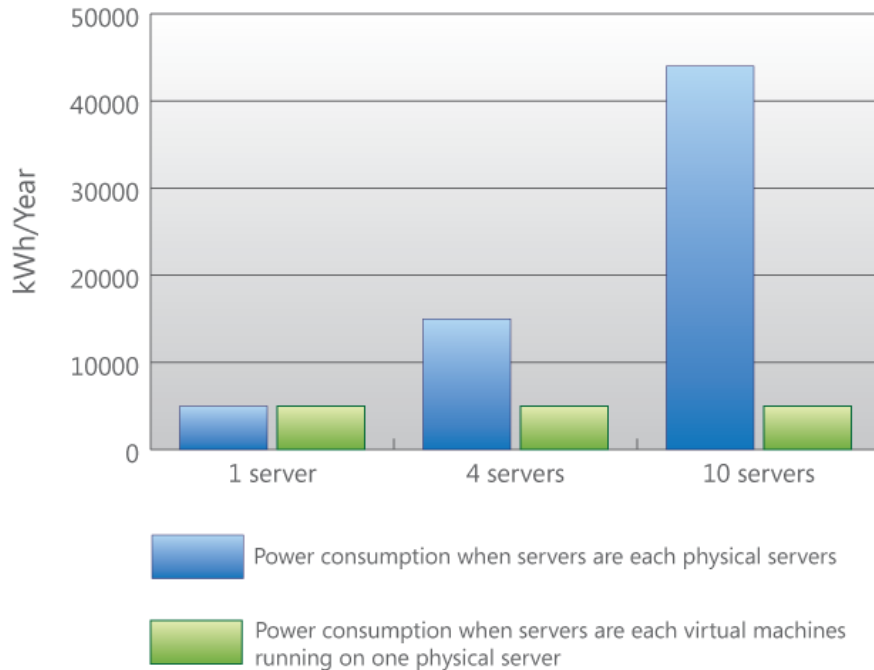


Figure 4. More servers, less power usage with virtualization

Consolidation ratios of up to 10 virtual machines are very reasonable on modern server hardware. An organization with 10 older dual-processor servers, each with a single-core processor and 2 GB of RAM, might consolidate onto 1 new four-processor server with 16 cores and 32 GB of RAM and still have room for additional virtual machines.

Saving power also means reducing the amount of CO₂ a data center contributes to the atmosphere. A single Hyper-V server with 10 virtual servers can reduce the CO₂ output by more than 30 metric tons compared to the output of 10 physical servers with the same hardware profile. In carbon terms, this is the equivalent of burning 1,500 liters of gasoline rather than burning 14,000 liters of gasoline (or 396 gallons rather than 3,698 gallons).

In addition to its beneficial effects on the environment, this reduction can translate directly into revenue in jurisdictions that engage in carbon trading. At the current market rate of about €25 per metric ton for European carbon allowances, even this modest Hyper-V deployment could free up carbon credits worth €750, or more than \$1,100 USD, every year. The potential power savings that Hyper-V virtualization provides are clear and significant.

Rethinking Business Practices

Saving power also involves rethinking business processes in ways that impact energy usage. This is not just “saving power and money within the IT department,” it is saving power and money *by* using the IT department effectively—and this involves changing corporate behavior:

- Reducing business travel
- Reducing employee commutes
- Moving paper and manual processes online
- Leveraging anytime, anywhere access to e-mail, voice over IP (VoIP), instant messaging (IM), presence, and conferencing
- Leveraging online hosted services where appropriate
- Streamlining collaboration

Microsoft supports product features that encourage the rethinking of power usage.

For example, Windows 7 and Windows Server 2008 R2 introduce DirectAccess, which enables remote users to securely access enterprise shares, Web sites, and applications without connecting to a virtual private network (VPN). DirectAccess establishes bi-directional connectivity with a user’s enterprise network every time a user’s DirectAccess-enabled computer connects to the Internet, even before the user logs on. Users do not have to think about connecting to the enterprise network, and IT administrators can manage remote computers outside the office without a VPN connection.

Another example of how Microsoft is rethinking power usage is the implementation of a company-wide unified communications (UC) deployment to provide e-mail, IM, presence, conferencing, telephony, and unified messaging. This gives employees a full range of options to communicate effectively.

While technologies like DirectAccess and UC do not necessarily reduce the number of Watts a datacenter consumes, they do contribute to business’s ability to transform itself through reducing employee travel and commuting times—and thus reducing the environmental impact of the business.

UC at Microsoft has enabled employees to reduce their environmental impact. Employees can telework more frequently and reduce their automobile usage. Employees also frequently use Web conferencing as a substitute for traveling to meetings. Microsoft uses both Microsoft® Office Live Meeting and Microsoft® Office Communications Server Web conferencing to host approximately 60,000 conferences every month. Microsoft Travel estimates that employees avoided flying more than 100,000,000 miles in the past fiscal year, saving 17,000 metric tons of CO₂. Many Microsoft customers are using UC conferencing solutions to make Web, video, and audio conferencing widely available to large numbers of employees in their companies.

New Features Extend the Power Savings in Windows Server 2008 R2

Windows Server 2008 R2 builds on the foundation of Windows Server 2008, expanding existing technology and adding new features to extend an organization's ability to reduce the power consumption of individual servers and to manage power consumption across the entire server environment. These features include:

- Reduced power usage of individual servers
 - A new PPM engine
 - Storage power management
 - Additional incremental power saving features
- The ability to measure, manage, and budget power usage across the system

Microsoft has also added an additional, optional qualifier to the Designated for Windows Server 2008 R2 qualification logo to indicate enhanced power management support. Through use of the qualifier, OEMs can alert customers to servers that work in collaboration with Windows Server 2008 R2 power capabilities to provide optimal power efficiency.

Improve the Power Efficiency of Individual Servers

Windows Server 2008 R2 helps improve the power efficiency of individual servers through a variety of incremental improvements. To quantify the power savings, Microsoft measured power consumption of Windows Server 2003 and Windows Server 2008 R2 using a representative online transaction processing (OLTP) workload. Throughput was gradually throttled up across the utilization range of the systems, from idle up to 100 percent utilization.

Measuring power usage only when hardware is fully utilized does not reflect real-world usage; average utilization for many servers is 5 to 15 percent. Figure 5 shows the results, which demonstrate that the many servers that operate in a range of utilization levels will benefit from improved power efficiency of Windows Server 2008 R2.

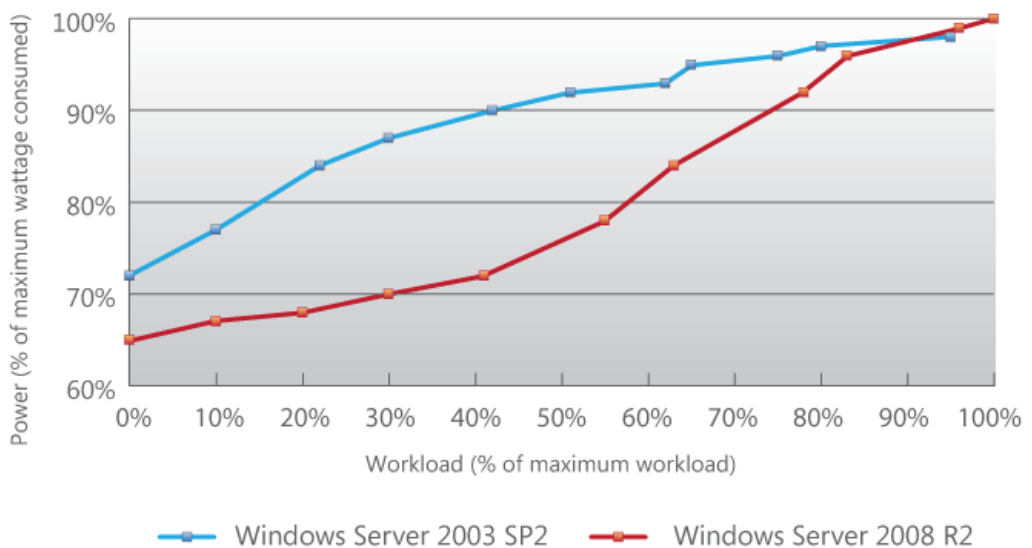


Figure 5 Power savings with Windows Server 2008 R2

Processor Power Management

The PPM engine in Windows Server 2008 R2 has been re-written and improved. It now provides the ability to fine-tune the processor's speed and power consumption to match current demands. New parameters for PPM—which are configurable by administrators—further improve power efficiency.

Core Parking

Core parking is a feature that enables Windows Server 2008 R2 to reduce multi-core processor power consumption by consolidating processing onto fewer processor cores and suspending the inactive cores. The workloads of every logical core in a server are tracked relative to all the others. The workloads of cores that are not being fully utilized can be suspended, and their workloads are then shifted to alternate cores. Keeping the unutilized cores in an idle state reduces the system power consumption. When additional processing power is required, the system activates the idle processor cores to handle the increased processing requirements. (See Figure 6.)

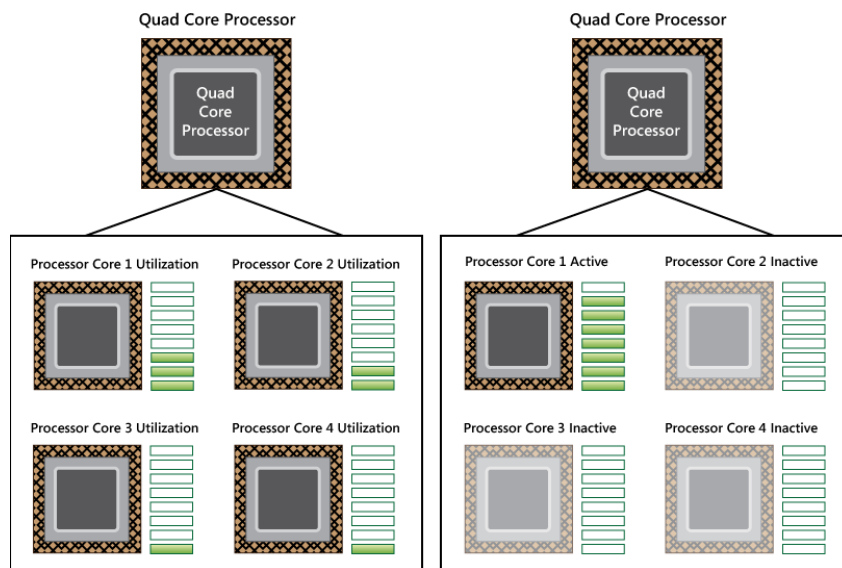


Figure 6. Core Parking

Core parking is “on” by default, but only takes effect at low system utilizations because a busy server relies on having running cores to accomplish its work. Note that the savings from core parking are incremental because servers at low utilization are already experiencing significant power savings from processor power management.

There is potential for OEMs to develop technologies that will enable core parking to provide additional power saving benefits in the next-generation of server hardware.

Storage Power Management

Another strategy for reducing power used by individual servers is to centralize their storage by using a Storage Area Network (SAN), which has a higher storage-capacity-to-power-consumption ratio than a typical server. A SAN also makes more efficient use of the available disk space, because any server can have access to the available storage on the SAN.

Windows Server 2008 R2 greatly improves access to storage on SANs, and also adds the following enhancements:

- **ATA Slumber feature**—This feature is integrated with the power management framework to use the new power states (partial and active).

- **Optimized link power management for SATA disks**—This feature helps reduce power usage for managing the communication bus link between the hard disk and the chipset.
- **Asynchronous notification of media change for optical devices**—Windows Server 2008 R2 provides asynchronous notification of drive media changes. This means that commands are not repeatedly being sent to check for media changes; less communication with the drive means less power is drawn.
- **Support for “remove on delete”**—Windows Server 2008 R2 includes support for storage devices that work with solid state drives that can power down unused RAM when a file system deletes files, thus saving power.

Windows Server 2008 R2 also supports the ability to boot from a SAN, which eliminates the need for local hard disks (local storage) in the individual server computers and decreases power consumption as a result. (See Figure 7.)

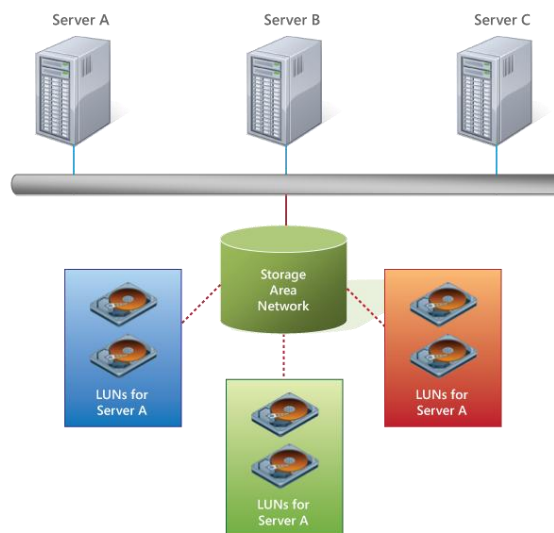


Figure 7. Each server without local storage, and each consuming less power

Additional Power Saving Features

Windows Server 2008 R2 introduces Intelligent Timer Tick Distribution (or Tick Skipping). This feature extends processor idle or deep C-states (processor sleep states within the ACPI specification, with C3 set as the deepest-sleep state and C0 as the operating state) by not activating the CPU unnecessarily, thus saving power. One processor handles the periodic system timer tick; other processors are signaled only as necessary. (Non-timer interrupts, however, will still activate sleeping processors.)

The amount of background work that is performed by the operating system has also been reduced in Windows Server 2008 R2. This also allows processors to better utilize the deep C-states, in which the processor consumes very little energy but requires time to return to an operational state.

Most of these technologies can also be leveraged in virtualization scenarios, letting you maximize the power efficiency of your virtualized environments as well as your physical systems.

Calculating the Potential Impact

So what might the impact of these improvements look like?

If every server running versions prior to Windows Server 2008 were upgraded to R2 and achieved an 18% improvement in power efficiency the savings achieved would be over 15 billion kilowatt-hours per year. This power has a value of over \$1.7 billion dollars – or 1.2

billion Euros. The carbon potentially saved through avoiding generating this power in the first place is the approximate equivalent of removing 2 million cars from the road.

<i>Factor</i>	<i>Source</i>	<i>Value</i>
Number of Servers running versions of Windows Server prior to Windows Server 2008	IDC Worldwide Windows Server Operating Environments 2009-2013 Forecast	19.4 million servers
Average per-server power consumption	EPA Report on Server and Data Center Energy Efficiency, August 2, 2007	251 watts
Power Utilization Efficiency (PUE)	EPA Report on Server and Data Center Energy Efficiency, August 2, 2007	2.0
Power Cost per kWh	A simple average of 2 sources: 10.25 cents/kWh – Average Retail Price of Electricity to Ultimate Customers by End-Use - Commercial, July 2009, EIA 13.25 cents/kWh – Eurostat	11.75 cents per kWh
Carbon equivalent due to power generation of a kWh	http://www.epa.gov/cleanenergy/energy-resources/refs.html	.000718 metric tons of CO2 per kWhr
Carbon equivalent of an automobile	http://www.epa.gov/cleanenergy/energy-resources/refs.html	5.46 metric tonnes of CO2 emissions per vehicle per year

Measure and Manage Power Usage Across the Organization

Windows Server 2008 R2 also helps provide businesses with the capability to better measure and manage power consumption, both locally and remotely across the enterprise. In conjunction with server OEMs, Microsoft is pursuing an ACPI standards-based approach to the features that provide these capabilities.

Remote Manageability of Power Policy

Key in Windows Server 2008 R2 is the greatly enhanced ability to measure, manage, and budget energy usage for individual servers and across the entire server environment.

For centralized power policy management, there are new features in Group Policy for Windows Server 2008 R2, including an improved user interface, additional policy settings, and Windows PowerShell™ cmdlets for Group Policy, which provide the ability to manage Group Policy from the Windows PowerShell command line and to run Windows PowerShell scripts during logon and startup.

Windows Server 2008 R2 supports the configuration of power policy, both locally and remotely, through Windows Management Instrumentation (WMI), providing a powerful and convenient way to capture and report information about power consumption, and in turn making power consumption data an actionable metric.

WMI, the infrastructure for management data and operations on Windows-based operating systems, exposes the data that is gathered to users, scripts, or management tools in a manner that is compliant with the Distributed Management Task Force (DMTF) management profiles, ensuring interoperability across the entire IT environment.

Windows Server 2008 R2 provides a new power namespace, `root\cimv2\power`, which enables code and scripts to query power data on compliant systems. (See Figure 8.) This is useful for IT administrators who use WMI queries in scripts to monitor and administer their infrastructure.

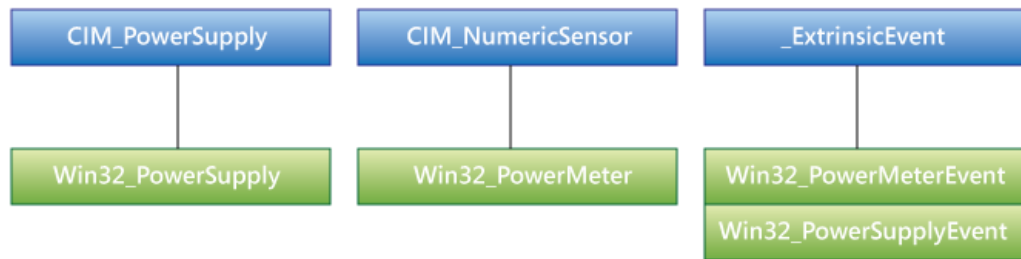


Figure 8. New power namespace

IT workers responsible for power management can control power policies and receive power condition events, providing them with the data they need to make informed and timely power management decisions.

Power metering and budgeting in Windows Server 2008 R2 require no additional drivers or hardware changes, only hardware platform support.

In-Band Power Metering and Budgeting

The new power features introduce new opportunities for managing power consumption. An administrator can use the performance monitor on a server to view the moment-by-moment power consumption, or, in a more likely scenario, the IT administrator can write a script or use Microsoft System Center to centrally collect and monitor power consumption data across the datacenter. Now that power consumption is measurable, it becomes an actionable metric for IT staff when appropriate hardware support is available.

Microsoft recommends a collaborative model between the server platform and the operating system for power metering and budgeting (the process that lets administrators set power limits, or caps, on datacenter components as small as a single server). The server platform reports information in-band to the Windows Server 2008 R2 through the use of ACPI. The WMI namespace additions for power meters and supplies mean that the user mode power service can provide data to the WMI namespace, and this means power data can be queried by Microsoft System Center and other management tools to budget and monitor power usage across the entire IT environment. An administrator can set power budgets for the servers and the system, and can configure the system so that it automatically takes action when the budget is exceeded.

Another set of metrics can be used for virtualization and consolidation. Based on the information gathered, the workloads of underutilized servers can be consolidated onto a smaller number of better-utilized physical machines using live migration (the ability to move virtual machines between servers with virtually no downtime) with Hyper-V. Fewer physical machines can lead to reduced costs through lower hardware and energy costs and through reduced management overhead.

New Additional Qualifier for the Designed for Windows Server 2008 R2 Logo Program

To help identify servers that have power-saving hardware capabilities, Microsoft has introduced an additional qualification for enhanced power management, the Enhanced Power Management Additional Qualifier (AQ) for the Windows Server logo.

The Windows Server Logo Program provides a way for OEMs, along with Microsoft, to help customers identify Windows-compatible products that are designed for ease of use, better performance, and enhanced security.

The Enhanced Power Management AQ ensures that power-saving features such as PPM, power metering and budgeting, and power on/power off via WS-Management (known as SMASH) capabilities are present on a server. Customers who want assurance that the hardware they are purchasing supports the additional power-saving features can look for the Enhanced Power Management AQ.

Summary

Windows Server 2008 R2 is designed to provide better energy efficiency and performance by reducing power consumption and lowering overhead costs.

Windows Server 2008 R2 helps reduce power usage at the server level, enabling server energy consumption to scale according to workload. It also helps reduce power consumption at the organizational level, enhancing measuring, monitoring, and budgeting of energy usage across system components, enabling the organization to scale infrastructure and computing according to business needs.

New features in Windows Server 2008 R2 deliver real energy savings opportunities for the enterprise:

- **Reduce** the power consumption of individual servers by deploying Windows Server 2008 R2 and by consolidating servers with Hyper-V, allowing more servers for the same power usage.
- **Manage** power consumption across the organization with Group Policy and WMI-based measuring, monitoring, and budgeting capabilities.
- **Rethink** business practices by deploying new IT capabilities, such as DirectAccess, that allow for reducing environmental impact outside the datacenter.

Organizations can look for the Enhanced Power Management AQ, which helps them easily identify Rethink systems that align with the Microsoft vision for energy savings.

Related Links

The following Web pages provide additional information.

For the Windows Server 2008 R2 home page, visit:

<http://www.microsoft.com/windowsserver2008/en/us/r2.aspx>

For information about Microsoft virtualization, visit:

<http://www.hyper-green.com/>

For the Windows Server 2008 Reviewers Guide, visit:

<http://technet.microsoft.com/en-us/windowsserver/2008/bb414776.aspx>

For the top 10 reasons to upgrade to Windows Server 2008 R2, visit:

<http://www.microsoft.com/windowsserver2008/en/us/R2-top-reasons.aspx>

For the “Windows Server 2008 Power Savings” white paper, visit:

http://download.microsoft.com/download/4/5/9/459033a1-6ee2-45b3-ae76-a2dd1da3e81b/Windows_Server_2008_Power_Savings.docx

For recommendations for power budgeting with Windows Server, visit:

http://www.microsoft.com/whdc/system/pnppwr/powermgmt/Svr_PowerBudget.mspix

For the Windows Hardware Developer Central power management Web site, visit:

<http://www.microsoft.com/whdc/system/pnppwr/>

For the “Power In, Dollars Out: How to Stem the Flow in the Data Center” white paper, see:

http://www.microsoft.com/whdc/system/pnppwr/powermgmt/Svr_Pwr_ITAdmin.mspix

For the “Processor Power Management in Windows Vista and Windows Server 2008” white paper, see:

<http://www.microsoft.com/whdc/system/pnppwr/powermgmt/ProcPowerMgmt.mspix>

For recommendations for power budgeting with Windows Server, visit:

http://www.microsoft.com/whdc/system/pnppwr/powermgmt/Svr_PowerBudget.mspix

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