



Realizing the value of the green data center by integrating facilities and IT.



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Introduction

Although labor costs still dominate the expenses of operating a modern data center, energy costs, in the form of electrical power, typically are the second-largest expense.¹ The continuing increase in computing demand drives energy costs – both direct power consumption by servers and other IT equipment, and indirect consumption by facilities.

According to the U.S. Environmental Protection Agency, energy consumption by servers and data centers in the United States is expected to nearly double in the next five years to more than 100 billion kWh, costing about \$7.4 billion annually. Similar energy cost increases are expected in Europe, Asia and elsewhere. According to one study, worldwide spending on powering data centers is projected to triple by 2010.² To compound the problem, server utilization is typically less than 10 percent, driving a waste of \$140 billion in “excess” server capacity.³

This white paper – along with its companion white paper, “Greening the data center with IBM Tivoli software: an integrated approach to managing energy” – discusses the importance of managing energy consumption in data centers and how systems management technologies contribute to green management.⁴ The paper provides an overview of green data centers and the significant role played by direct and indirect power consumption in today’s data centers, as well as technology aspects of green data center management. It then describes the specific ways IBM Tivoli® solutions can help optimize energy use in the data center.

Moving toward green data centers

Beyond green initiatives such as reducing carbon footprint and environmentally friendly asset disposal, managing energy consumption is a major factor in achieving a “green” data center. In fact, Gartner Group reports that “green IT” will be the top strategic technology in 2008.⁵

Highlights

One major obstacle to efficient energy consumption is the common practice of separating IT and facilities information

One major obstacle to efficient energy consumption, however, is the common practice of separating IT and facilities information. Traditionally there has been little aggregation of facilities energy information with IT equipment energy information. Yet facilities account for more than half of the energy consumption in a typical data center.³ With cooling equipment requiring a large amount of electrical power and comprising a large amount of the total energy usage, any improvement in airflow management or power savings from IT equipment (for example, less heat generated) can have additional benefits by reducing the power required for cooling.⁴ Components such as humidifiers, UPS units and lighting also offer opportunities for energy management and optimization of the data center.

Breaking down the traditional walls between IT and facilities can provide a critical enabler for managing the green data center. With the ability to aggregate IT and facilities information, organizations can readily provide answers to the questions that enable them to move toward a green data center, including:

- What is the energy impact by business service and resource type?
- How do specific resources affect overall facilities energy consumption?
- How can we maximize utilization while holding power usage constant?
- What is the financial impact of operating the data center more efficiently?
- How might hardware upgrades and consolidations reduce energy consumption?
- How can corporate power policies help minimize energy consumption without disrupting service level objectives (SLOs) and service level agreements (SLAs)?
- How can virtualization improve green efficiency?

Evaluating the technical factors

Physical resources, including servers, storage and network equipment, all consume power and present opportunities for reduced energy consumption. For example, virtualization is a significant technological consideration in today's data centers. Many organizations virtualize hardware and software resources

to help reduce costs and simplify management through consolidation. Using more efficient servers is another straightforward way to help decrease energy costs. To that end, many organizations have turned to blade servers, which deliver dense processing power in a small package.

However, each new energy measure can bring a significant new management challenge as the underlying IT and facilities infrastructure becomes more complex in the process. For instance, although blade centers can decrease energy costs, their higher density also can create power distribution, power availability and thermal management issues. These issues force a new examination of both power and thermal aspects of the data center design.

Realizing the benefits of consolidation and other cost-saving measures requires intelligent systems management technologies that can deliver end-to-end visibility of existing applications, services and facility relationships. For example, the ability to fully optimize virtualization benefits relies on a management system that can manage both physical and virtual systems and can respect existing SLAs.

Given the interdependencies between IT and facilities, the broader facilities of the data center should also integrate into an effective data center energy management program. Accordingly, systems and server management tools should be able to manage servers and facilities aspects such as cooling and power distribution equipment.

With the emergence of “IP enablement everywhere,” facilities components are becoming manageable either directly or indirectly. This technology can offer more choices about managing your overall data center and provides the aggregation and integration of data to levels never before possible.

Highlights

Managing energy consumption and associated costs can be relatively straightforward — however, it is a larger challenge when considering that business objectives must be met while controlling power consumption

Optimizing the green data center

Managing energy consumption and associated costs, by itself, can be relatively straightforward — modern IT equipment is more energy-efficient than older equipment, and some power reductions can be achieved with relatively simple steps such as server/equipment powering cycling. However, managing energy consumption and cost is a larger challenge when considering that business objectives (such as SLAs, organizational policies, governance and business processes) must be met while controlling power consumption. This challenge requires deep visibility into the utilization of energy resources across the organization and the ability to control energy consumption in relation to service levels.

Simply becoming aware of usage patterns in the data center is necessary, but not sufficient, to drive effective green management. Automation provides additional advantages to help organizations optimize their equipment and facilities, such as through server cycling or the ability to adjust server levels dynamically to meet user demand. In addition, capital expenditures (server replacement for efficiency) should be considered for total optimization of the data center.

These systems and services management capabilities can be grouped into three broad categories:

- Metric collection, analytics, thresholding and eventing
- Visualization and reporting
- Asset management and spatial awareness

The next few sections explore these capabilities in greater detail.

Metric collection, analytics, thresholding and eventing

Organizations can't manage what they can't measure. It's critical, therefore, to be able to determine the amount of energy being consumed in the data center and surrounding facilities. This requires management tools that can consolidate

energy data by integrating facilities, hardware and traditional IT software management into a single solution. The solution should be able to collect a range of IT and facilities data, create automated thresholding for energy-related actions and integrate with many of the world's leading infrastructure providers.

Managing energy events

A comprehensive event management solution incorporates energy-related events, such as critical component failures. Existing events and metrics, such as CPU utilization, can be exploited for energy management purposes. In addition, other events and metrics, such as momentary and time-averaged power and thermal data, can be monitored and analyzed in an energy management solution.

Understanding business impact

The IT infrastructure's role is to serve business needs. Accordingly, energy management decisions should be made within the context of delivering business services. Systems management should consider the relationships of the data center equipment (servers, storage, networks and so on) and facilities to the business services that operate on that infrastructure. Measures to reduce power costs by throttling server CPUs, for example, should take SLAs into account; business-critical applications must remain available even if servers are in standby mode.

A sophisticated business service management solution can visibly relate applications to the services and integrate facilities data for a clear understanding of potential business impacts.

Analytics and predictions

Transforming facilities data into knowledge is necessary for effective systems and services management. Analytics embedded in management tools can glean such knowledge by correlating events, detecting particular situations in the data

Highlights

Efficient energy management requires a solution with broad and deep analytics, including event filtering and correlation, threshold violations and policy monitoring for business processes

center environment, determining policy violations, detecting problems and performing causal analysis. Such analytics can also extend to detecting trends and predicting future system behavior as well as devising action plans to achieve the desired behavior.

Efficient energy management requires a solution with broad and deep analytics, including event filtering and correlation, threshold violations and policy monitoring for business processes. Each class of these analytics should encompass not only the traditional IT management perspectives but also energy management aspects of the data center facilities.

Visualization and reporting

Although management tasks are increasingly automated, humans still make determinations such as how and when to act on automated recommendations, what policies are appropriate for their business and which actions to delegate to automated tools.

Customizable management consoles enable “integration on the glass” capabilities that allow multiple management products to effectively manage, decide and create policies that result in effective systems management. In addition, a “launch in context” capability can enable seamless moving from one management domain to another.

A foundation of enhanced visibility drives deeper awareness of the green data center, enabling energy management disciplines and tools to be integrated seamlessly into the broader solution. This awareness, in turn, offers the ability for a deeper understanding of data center power consumption through standard yet customizable reports rich in data and based on a common reporting structure.

Asset management and spatial awareness

Efficient asset management enables organizations to track and maintain the optimal power status operating condition of assets. A sophisticated enterprise asset management solution can track both IT and facilities assets, including generators, pumps and other assets, which, despite considerable energy consumption, are not normally included in the IT infrastructure.

Spatial information – that is, information about the location of assets – is another important factor in data center energy management. Visualizing IT and facilities assets can promote more efficient data center planning and design, as well as help determine optimal device placement.

Optimizing power usage and cost

Once energy consumption information is monitored and consolidated, organizations can leverage this information to visualize and analyze assets to optimize resources and decision making. Greater visibility into energy consumption also enables organizations to better determine current IT and facility energy costs and expenditures.

Information about past and current power consumption and associated costs can lead to recommendations for optimizing energy consumption. Some examples include:

- *Helping reduce power drawn by resources:* When workload demands are low, many IT resources provide the ability to reduce the amount of power consumed. For example, server CPUs can be throttled to decrease power used per unit of time, or servers could be placed in “standby” mode. For example, data center resources, such as a server pool, can be managed to operate within a specified power “cap,” or storage networks can be managed to place data on the most energy-efficient storage devices based on the frequency of the data access.

Highlights

- *Reallocating workload:* Workloads could be moved to different resources, where optimization opportunities exist. Virtualization is one way to accomplish server workload consolidation. Workloads moved from less efficient to more efficient servers — or even to other data centers where energy costs are lower — may decrease energy consumption, associated costs or both.
- *Identifying energy-inefficient assets:* Besides operational costs, capital costs are a significant part of the IT budget. Energy-inefficient assets, whether IT equipment such as servers or facilities equipment, often have more efficient alternatives available. Once energy costs are known, capital costs to replace equipment with more efficient equipment would determine the “payback period” and potential long-term savings from more energy-efficient assets.

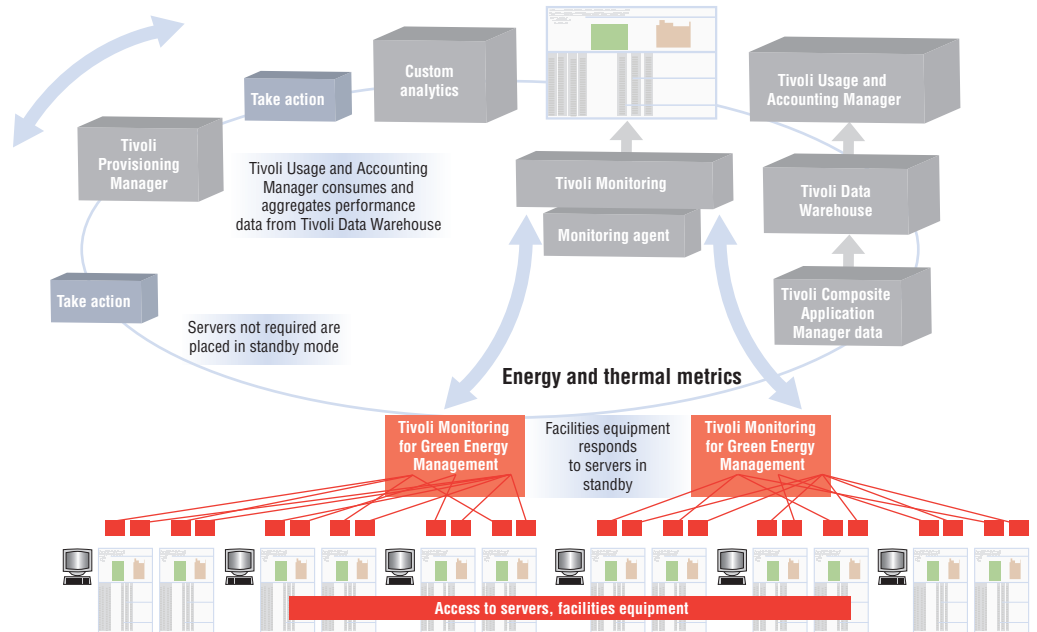
These sample techniques used in combination to optimize power consumption and data center costs can be effective ways to decrease energy consumption while retaining alignment with management policies and SLAs.

IBM Tivoli solutions for the green data center

After exploring key capabilities for green data center management, we turn to IBM Tivoli solutions that can help you manage your data center. Tivoli software has a long history of managing IT resources with a wealth of capabilities, including monitoring, managing, thresholding and eventing, combined with extensive visualization and reporting capabilities. Integration with facilities equipment as part of the managed infrastructure enables organizations to leverage these same capabilities to integrate and aggregate facilities data, providing management and correlation among facilities and IT equipment.

Even though management tools exist for facilities infrastructure from many facilities equipment vendors and some level of aggregated information is available at the facilities level, IBM Tivoli software is among the first IT management providers to integrate facilities, hardware and traditional IT software management into a single solution. The solution provides the ability to collect a range of data, create automated thresholding and actions, and enable seamless integration with many of the world’s leading infrastructure providers.

IBM Tivoli software is among the first IT management providers to integrate facilities, hardware and traditional IT software management into a single solution



IBM Tivoli software for green data center management

IBM Tivoli Monitoring for Green Energy Management

IBM Tivoli Monitoring is a standard-bearer for systems management monitoring. IBM Tivoli Monitoring for Green Energy Management enables a focus on power management and augments traditional performance data with power and thermal information. A corresponding Active Energy Manager data provider for the IBM Director product, also shown in the diagram above, interacts with hardware management modules, monitors power usage and thermal data, and feeds that data to Tivoli Monitoring.

Event integration

As illustrated above, power and thermal event information aggregated with other performance events can be consolidated in IBM Tivoli Data Warehouse. The information can then be visualized through IBM Tivoli Enterprise Portal and managed with IBM Tivoli Event Console.

Facilities and business service management

IBM Tivoli Change and Configuration Management Database (CCMDB) can store information about power and cooling resources and their relationships

to IT equipment. Tivoli CCMDB, along with IBM Tivoli Business Services Manager, enables facilities equipment to be related to business services.

Asset management

IBM Tivoli Maximo[®] Asset Management helps track and ensure energy-consuming assets are properly maintained for energy-efficient operations.

Spatial visualization

IBM Tivoli Maximo Spatial enables spatial visualization of IT and facilities assets, including GIS-based graphical zooming from site to floor.

Usage and accounting

IBM Tivoli Usage and Accounting Manager can consume the aggregated historical performance and power information stored in Tivoli Data Warehouse and can calculate associated charges for resource usage. In a green data center, Tivoli Usage and Accounting Manager can determine charges for power consumption associated with IT and facilities equipment.

IBM Tivoli Data Center Optimization for Energy Management

This capability of Tivoli Monitoring for Green Energy Management determines financial costs and potential savings associated with power management and saves the data to Tivoli Data Warehouse. This includes data from the IT equipment and facilities equipment. Tivoli Data Center Optimization for Energy Management analyzes the monitored data to produce knowledge and recommendations to help organizations better understand and control their data center operations with respect to energy consumption.

Provisioning in an on demand manner

IBM Tivoli Provisioning Manager offers capabilities to automate workload movement, server power on or off, and tools for automated tasks.



Summary

Energy management is critical for today's data centers. As supply and costs continue to skyrocket, achieving a green data center is expected to become even more imperative. This paper has explored key capabilities to look for when investing in data center power management and discussed the associated business value that can be derived from energy management solutions.

With a broad portfolio of systems and service management offerings that address key capabilities, IBM is at the forefront of data center energy management execution, delivering leading-edge technology with new capabilities that enable green data center management. Through energy management innovation, a vibrant ecosystem of business partners and execution with the Tivoli product portfolio, IBM is making green data center management a reality. IBM continues to build on this momentum by implementing energy management within architectures, products, offerings, services and products.

For more information

To learn more about how Tivoli solutions can help you manage energy more efficiently, contact your IBM representative or IBM Business Partner, or visit ibm.com/itsolutions/service/management

About IBM Service Management

IBM Service Management helps organizations deliver quality service that is effectively managed, continuous and secure for users, customers and partners. Organizations of every size can leverage IBM services, software and hardware to plan, execute and manage initiatives for service and asset management, security and business resilience. Flexible, modular offerings span business management, IT development and IT operations and draw on extensive customer experience, best practices and open standards-based technology. IBM acts as a strategic partner to help customers implement the right solutions to achieve rapid business results and accelerate business growth.

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¹ Morgan Stanley Research, 2007.

² U.S. Environmental Protection Agency, EPA Reports Significant Energy Efficiency Opportunities for U.S. Servers and Data Centers, August 3, 2007, yosemite.epa.gov/opa/admpress.nsf/0de87f2b4bcbe56e852572a000651fde/4be8c9799fbceb028525732c0053e1d51OpenDocument

³ Jonathan G. Koomey, Lawrence Berkeley National Lab/Stanford University, "Estimating Total Power Consumption by Servers in the U.S. and the World," February 15, 2007, available from enterprise.amd.com/Downloads/svrprurusecompletefinal.pdf

⁴ IBM Corporation, "Greening the data center with IBM Tivoli software: an integrated approach to managing energy," May 2008.

⁵ Greenercomputing.com, "Green IT will be 2008's Top Strategic Technology: Gartner", October 12, 2007, www.greenercomputing.com/news_third.cfm?NewsID=36071