The green data center.

More than social responsibility: a foundation for growth, economic gain and operating stability

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Introduction

After years of being viewed by many as a concern for a relative few, environmental issues are now front-page news around the world. Faced with increasingly urgent warnings about the consequences of the projected rise in both energy demands and greenhouse gas emissions, governments and businesses alike are now focusing more attention than ever on the need to improve energy efficiency.

For most CEOs, whose sights are firmly fixed on business growth and expansion, energy consumption and environmental concerns can take on a whole new meaning when they begin to impede the company's ability to grow. Corporate data centers are well known as significant power users. If the company's data center cannot accommodate new servers or storage because of power availability or infrastructure constraints, bringing new capabilities online can become a major challenge in terms of both time and money.

For CIOs, that translates into finding ways to expand the capacity of data operations to meet the growth requirements of the business. A growing number of CIOs are realizing that environmental concern and business success can go hand in hand — and that a green, or environmentally friendly, data center may actually be one of the best ways to both accommodate growth and make a positive impact on their business's bottom line.

With energy costs rising and information technology (IT) equipment stressing the power and cooling infrastructure—which, in turn, threatens operating resiliency—many see an economic and operational crisis looming. CIOs today are being challenged to rethink their data center strategies, adding energy efficiency to a list of critical operating parameters that already includes serviceability, reliability and performance. A green initiative can help a company regain power and cooling capacity, recapture resiliency and help meet business needs—while, at the same time, dramatically reducing energy costs and the total cost of ownership. To further reward companies for energy-conscious behavior, many local utility and state energy funds are offering economic incentives or rebates for measures that reduce energy consumption.

While creating a green data center can be a complex undertaking, there are many solutions and techniques available to support the transition.

Transitioning to a green data center and optimizing operating efficiency can be a complex undertaking. There are multiple components to factor into the equation—and best results can often be achieved by integrating improvements from multiple fronts. The good news is that there are many solutions and techniques available to support such a transition. Furthermore, the process can occur in a step-wise manner, reducing risks and helping to realize benefits along the way. Going green is becoming more than an altruistic aspiration to save the planet. It's now clear that going green is a necessity that companies will need to embrace—sooner rather than later—to survive economically.

Highlights

High-density rack-mounted servers can increase hot spots and tax cooling systems, making it difficult for aging data centers to keep up with today's demands.

Challenges facing CIOs

Responding to customer demand for better performance at lower prices, the information technology industry has delivered faster servers, lower-cost storage and more flexible networking equipment. While these new components can often deliver ever-greater performance per unit of power, they can also be increasingly power hungry. In addition, the evolution of high-density, rack-mounted servers has typically increased heat density, creating hot spots and taxing cooling systems. The excessive heat can also threaten operating stability, resiliency and staff productivity.

Many of the data centers housing this "hot" new technology are now 10 to 15 years old. As a result, their critical infrastructure equipment is likely to be growing inefficient and reaching the end of its useful life. These aging data centers are having a hard time keeping up with today's demands. Typical data centers draw approximately two to three times the amount of power required for the IT equipment because conventional data center designs are oversized for maximum capacity and older infrastructure components can be very inefficient. The cost associated with this level of power consumption can significantly impact the total cost of ownership for data center facilities and IT systems.

Cooling and electrical costs represent up to 44 percent of a data center's total cost of ownership, although some companies are finding that they can't buy extra electricity at any price.

The rising cost of a kilowatt of electricity has further compounded the problem. Cooling and electrical costs currently represent up to 44 percent of a data center's total cost of ownership. According to The Uptime Institute, the three-year cost of powering and cooling servers is currently one-and-a-half times the cost of purchasing server hardware.[1] As a high-level university administrator recently discovered, "With the growing demand for cheaper and ever-more-powerful high-performance computer clusters, the problem is not just paying for the computers, but determining whether we have the budget to pay for power and cooling."

Meanwhile, some companies can't even deploy more servers because extra electricity isn't available at any price. Many utilities, especially those in crowded urban areas, are telling customers that power feeds are at capacity and they simply have no more power to sell.

A study by Jonathan Koomey, Lawrence Berkeley National Laboratory and Stanford University, has indicated that server energy demand has doubled from 2000 to 2005. The study estimates that power used by servers, cooling and ancillary infrastructure in 2005 accounted for about 1.2 percent of the United States' electrical usage—the equivalent in capacity terms of about five 1,000 MW power plants.[2]

Energy costs are rising, supply is limited, the data center infrastructure is being taxed, and its ability to meet business demands is at stake.

This issue hasn't escaped the attention of power companies or government organizations. In the U.S., over 80 local utility and state energy efficiency programs are offering rebates for increasing energy efficiency. One of the first utilities to offer such a program is Pacific Gas and Electric (PG&E) of California. The company has approved a plan to reimburse part of the costs of server and storage consolidation projects, including software, hardware and consulting, up to a maximum of US$4 million per customer. Marc Bramfitt of PG&E said, "We don't want to build any more power plants. We want our customers to save energy and we'll pay them to do so."[3]

In addition, governments at both the country and regional levels are initiating energy efficiency programs. For example, in the U.S., a recently passed bill authorizes the U.S. Environmental Protection Agency (EPA) to analyze the growth of energy consumption in data centers. The European Union has established a directive to drive a 20 percent reduction in energy usage by 2020. And Australia requires all companies using more than 150,000 MWH of electricity per year to prepare an assessment and action plan.

The message is clear: Energy costs are rising, supply is limited, the data center infrastructure is being taxed, and its ability to meet business demands is at stake. CIOs who want to solve these problems will need to focus on data center

innovation. Fortunately, green strategies and technologies exist today to help optimize space, power, cooling and resiliency while improving operational management and reducing costs—at the same time, helping to position companies for growth and enabling CIOs to meet expanding business needs.

Transitioning to a green data center

How do you go about creating an energy-efficient green data center? IBM's 30-plus years of extensive, hands-on experience in designing, supporting and operating data centers has allowed it countless opportunities to learn what works and what doesn't. It's also provided us with a unique perspective on how to apply that learning to help create workable strategies for improving energy efficiency.

The technologies and strategies for improving data center energy efficiency span the data center ecosystem.

As the following graphic shows, the technologies and strategies for improving data center energy efficiency span the data center ecosystem. Companies typically achieve the best results by integrating power and cooling changes with advanced technologies such as virtualization, energy efficient hardware and software, and power and workload management initiatives.

Data center energy efficiency opportunities
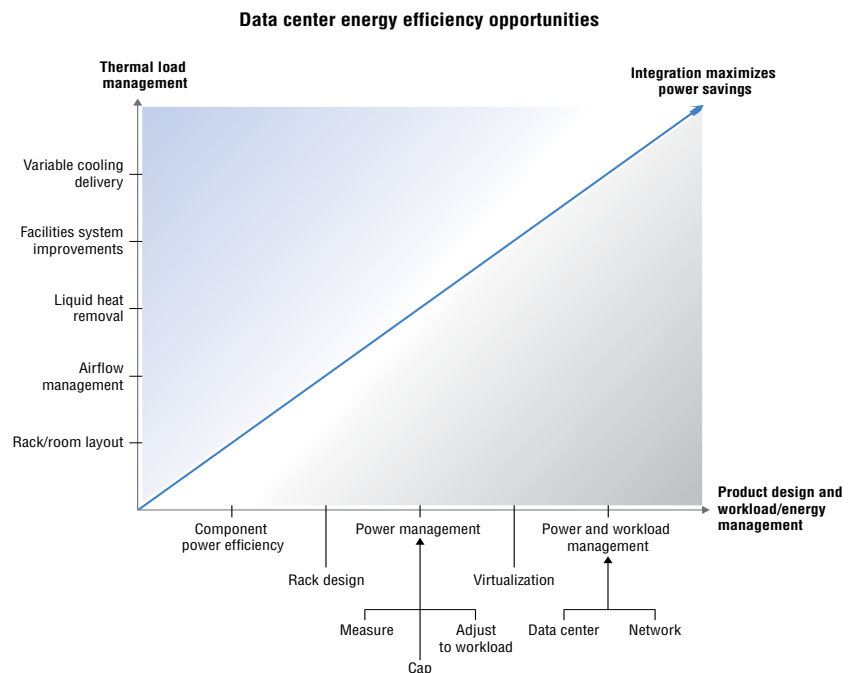
Although there is clearly no single "right way" to create a green data center, experts believe that the most productive first step for CIOs is to conduct a best practices assessment and energy audit. This systematic checkup offers a real-time profile and model of the data center's energy use conditions and makes it possible to pinpoint areas of high energy use, while establishing a baseline for further planning.

At the same time, CIOs should develop a holistic view of the environment, taking the following factors into account:

- *An inventory of your current systems, their power usage and locations*
- *Your company's business and growth plans—to help forecast future needs*
- *Current or planned governmental energy efficiency regulations in your area*
- *Available energy efficiency rebates or economic incentives from government sources or your energy provider*
- *Any already established goals for reducing your company's carbon footprint—and the timeframe set for achieving those goals*

A careful review of the assessment and profile will allow a CIO to build a list of opportunities to drive maximum energy efficiency in the data center. If the team hasn't yet looked closely at the thermal characteristics of the company's data center, it's likely that they'll find many opportunities to improve energy efficiency. They can range from major infrastructure upgrade projects such as upgrading chillers or uninterruptible power supplies (UPS) to simple and inexpensive measures, including:

- *Blocking cable openings to prevent cold air waste in the hot aisle*
- *Removing under-floor cable blockages that impede airflow*
- *Turning off servers that are not doing any work*
- *Turning off computer room air conditioning (CRAC) units in areas that are overprovisioned for cooling.*

Of course, any analysis of your current situation needs to recognize the likelihood that business needs will change. For example, it would be wise to employ a modular approach to the design of future power and cooling capacity, allowing for easy expansion or modification. Factoring in local conditions and time periods can also be important. While IT equipment and UPS usage probably

Facilities and IT departments need to collaborate — sometimes with the addition of outside help — in finding ways to meet environmental and energy challenges.

will be fairly constant, chiller or heating, ventilation and air conditioning (HVAC) energy usage will vary with outdoor temperature and humidity conditions. In addition, it's important to ensure that power and cooling scenarios are designed for recovery, and not just for steady-state operation.

Whose job is it?

Until recently, environmental management and energy expenditures were typically the responsibility of facilities departments. But rising energy costs and evolving IT demands are changing all that. It's becoming critical that the facilities and IT departments form a partnership and collaborate in this area. Even then, many companies will not have the skills or the tools to profile and model thermal conditions and appropriately apply the information to data center planning or upgrades. Because these are highly specialized skills, obtaining outside help during this part of the process may be well worth the investment.

Reducing cooling requirements

There are a number of factors that should be considered in developing a plan for improving power and cooling efficiency by reducing the heat generated in the data center. Improvements in rack and room layout can increase energy efficiency with relatively low upfront investment. The opportunities include:

- *Organizing IT equipment into a hot aisle and cold aisle configuration*
- *Positioning the equipment so that you can control the airflow between the hot and cold aisles and prevent hot air from recirculating back to the IT equipment cooling intakes*

- *Leveraging low-cost supplemental cooling options — such as water or refrigerant heat exchangers*
- *Improving rack cooling efficiency by employing a rear door heat exchanger or an enclosed racking system to dissipate heat from high-density computer systems before it enters the room.*

Similarly, relatively simple airflow management improvements can boost energy efficiency. For example, you can:

- *Take advantage of the current capacity by clearing under-floor blockages and implementing effective cable management*
- *Ensure that floor openings match the equipment thermal load by adding or removing perforated tiles at the equipment air intakes*
- *Consider adding ducted returns.*

Organizing data centers into thermal zones can eliminate hot spots that challenge cooling systems and enhance system reliability by helping to avoid heat-related hardware failures.

Ultimately, companies should consider organizing their data centers into thermal zones — assigning a defined set of IT equipment and floor space to specific HVAC or CRAC units. This type of space and thermal planning will eliminate hot spots that challenge cooling systems and will enhance system reliability by helping to avoid heat-related hardware failures.

Increasing facilities system efficiency

Energy efficiency for infrastructure equipment has significantly improved in recent years. Replacing chiller or UPS systems that have been in service for 15 years or more can result in substantial savings. New best-in-class UPS systems

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New chiller systems, thermal storage systems and air delivery systems can help reduce both energy requirements and costs.

can experience as much as 70 percent less loss than legacy UPS equipment. New chiller systems can improve efficiency by up to 50 percent. New chiller plants also can be installed with variable-speed drives, reducing pumping system energy usage and allowing better integration of the liquid cooling system into the chilled water infrastructure. Water-side economizers, which utilize outside air to directly cool the chilled water, can further reduce the energy required to run the chillers.

The capacity and efficiency of chilled water systems can be augmented with thermal storage systems that store energy generated at night, when chillers typically operate more efficiently, and then release this energy during the day, when energy costs are higher.

Air delivery to the data center also can be made more efficient, either through central HVAC systems or through CRAC units with variable speed drives. Central HVAC tends to be more efficient, as the systems are larger and more amenable to taking advantage of no-cost cooling when outside air temperatures are sufficiently low to provide some or all of the cooling requirements. CRAC units, on the other hand, provide greater flexibility in managing the data center.

Even without upgrading facilities equipment, companies can save energy and gain cooling capacity by relaxing stringent relative humidity and temperature requirements for their data centers. Since these specifications are usually driven by the presence of hot spots, removing those hot spots will allow temperature and relative humidity requirements to be relaxed, helping to reduce the energy required to operate the data center.

In addition to cutting back on power usage inside its data center, a company can also reduce its carbon footprint by taking advantage of options for more eco-friendly sources of power. Integrating renewable energy into the power supply — including solar, wind, hydro and bio-mass generated energy — is a good way to reduce dependency on fossil fuels. Companies with the flexibility to relocate or open new data centers are even choosing locations that are rich in renewable energy sources as part of their corporate environmental strategy.

Reducing power consumption with innovative technologies

With IT equipment becoming more energy efficient and greener all the time, replacing older IT equipment with newer models can reduce overall power and cooling requirements.

Applying innovative technologies within the data center can yield more computing power per kilowatt. IT equipment is becoming more energy efficient and greener all the time. With technology evolution and innovation outpacing the life expectancy of data center equipment, many companies are finding that replacing older IT equipment with newer models can significantly reduce overall power and cooling requirements and free up valuable floor space. For example, IBM studies have demonstrated that blade servers reduce power and

A server that's only 15 percent utilized may cost as much to run as a server that's fully utilized, making virtualization an energy efficient and cost-effective option.

cooling requirements by 25 to 40 percent over 1U technologies. While it may seem financially unwise to replace equipment before it is fully depreciated, the advantages that new models can offer — lower energy consumption, plus two to three times more computing power than older models — combined with potential space, power and cooling recoveries are enough to offset any lost asset value.

Virtualization

Virtualization can be a tremendous ally in reducing heat and expense — simply because it means that you'll need fewer servers. Servers use energy and give off heat whether they're in use 100 percent of the time or 15 percent of the time, and the actual difference in electrical consumption and heat generated between those two points is not significant. This means a server that is only 15 percent utilized will cost as much to run as a server that is fully utilized.

Virtualization is a technology designed to enable multiple application work-loads — each having an independent computing environment and service level objectives — to run on a single machine. This eliminates the approach of dedicating a single workload to a single server — a practice that yields low utilization rates — and allows virtualized servers to function near maximum

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Just as server virtualization reduces the number of servers needed, storage virtualization reduces the number of spindles required.

capacity. A virtualized environment also is typically more resilient than a dedicated server environment. Component failures can be automatically managed, and the workload restarted. What's more, resources in a virtualized environment can be managed from a single point of control, improving operations.

The advantages of virtualization are not limited to servers. Storage virtualization can be used to combine storage capacity from multiple vendors into a single reservoir of capacity that can be managed from a central point. Just as server virtualization reduces the number of servers needed, storage virtualization reduces the number of spindles required, increasing the total amount of available disk space and optimizing utilization rates. Storage virtualization can also improve application availability by insulating host applications from changes to the physical storage infrastructure.

Virtualization, especially when coupled with the green design of new server and storage hardware, offers an effective solution for keeping power and cooling costs in check. The most energy efficient equipment is equipment that's no longer in use—whether it's a server, a router or a storage device.

New power management technology makes it possible to meter actual power usage and cap the amount of power used by a single server or group of servers.

With virtualization, you can consolidate the workloads currently on a multitude of underutilized devices onto fewer, more efficient pieces of equipment—and begin to realize possible savings and efficiencies that have been difficult to achieve through the design of even the greenest systems or buildings alone.

Power management in IT systems
Ideally, power usage in a data center should be proportional to the workload. One way to achieve this balance is to idle unneeded equipment. It's a technique that's effective but difficult to manage. New power management technology, however, gives data center managers full control over optimizing power consumption—thanks to workload management software and hardware capabilities.

This technology makes it possible to meter actual power usage and produce trend data for any single physical system or group of systems. The amount of power used by a single server or groups of servers can be capped—based on workloads and business trends—to optimize energy use and application performance without sacrificing productivity.

Eco-friendly disposal

To help accelerate the movement to greener equipment, environmentally responsible disposal offerings are available. These services dispose of systems in an eco-friendly manner, typically ensuring compliance with regulations and removing data before disposal. Best of all, some programs will pay market value for the old equipment.

Do you have a game plan?

Most companies expect that their CIOs will supply a reliable, high-performance infrastructure to support the business within their allocated budgets. Are you prepared to continue meeting this expectation in the changing environment? Do you know for sure that your data center can meet growing power and cooling demands? Do you have a plan to manage the impact of rising energy costs? Are you taking advantage of financial incentives or rebates? Are you prepared to contribute to corporate initiatives to reduce greenhouse gas emissions? Do you have a strategy for your data center to ensure that you can continue to meet your company's expectations? If your answer is not a resounding "yes" to most of these questions, perhaps the time has come to evaluate your strategy.

Highlights

Conclusion

As governments and corporations intensify their focus on reducing energy demands and greenhouse gas emissions, pressure to improve data center energy efficiency will continue to grow. We believe that the following "four Rs" must play an essential role in the development of any initiative to create a green data center:

- *Regain power and cooling capacity*
- *Recapture resiliency*
- *Reduce energy costs*
- *Recycle end-of-life equipment*

CIOs' ongoing efforts to think green will help keep their companies operating in the black.

Successful CIOs will make these four Rs their mantra. And in doing so, their ongoing efforts to think green will help keep their companies operating in the black.

For more information

For more information about creating a green data center, please call your IBM representative or visit:

ibm.com/cio

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