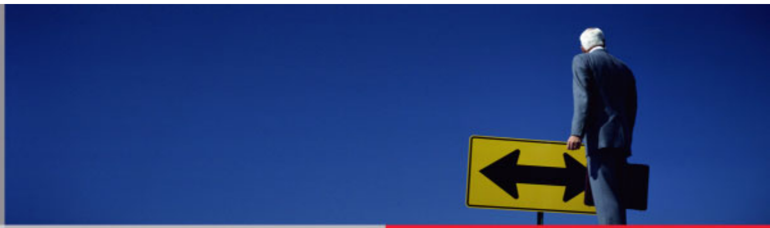
Smarter Data Centers: Accelerating the Move to a Smarter Planet



Redguides for Business Leaders

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- Improving energy efficiency and reducing costs
- Minimizing stranded space, power, and cooling
- Monitoring, managing, and reporting across operations facilities and IT

Executive overview

"Many CEOs admitted that they felt overwhelmed by data while still being short on insight. They believe a better handle on information and mastery of analytics to predict consequences of decisions could go a long way in reducing uncertainty and in forging answers that are both swift and right."

- 2010 IBM® Global CEO Study[1]

Meeting the demands of a smarter planet

As we endeavor to use scarce resources wisely and control rising costs, we look for smarter ways to carry out our daily processes. A smarter planet requires a smarter data center.

The trends are unmistakable. As global populations climb, growth markets expand, and as we digitally connect all aspects of our world, the demand for data management and processing continues to skyrocket.

At the same time, technological advances continue to enable more work to be done in a smaller physical footprint. As a result, data center capacity is no longer dictated simply by spatial availability. Power, cooling, networking, storage, and other capacity metrics must be managed as well, and environmental concerns and associated governmental regulations can place additional focus on carbon emissions, water consumption, and waste management.

The exhaustion of any single capacity can leave other capacities stranded, limiting your growth, increasing your operational costs, and resulting in lost opportunities for additional business.

Meanwhile, the expense associated with operating data centers continues to rise, as shown in Figure 1 on page 2. Although new server spending has plateaued, the costs associated with data center management and administration, along with power and cooling, have continued to climb. Despite an economic downturn, global data center power use grew 56% between 2005 and 2010, and data centers now account for between 1.1% and 1.5% of total global power consumption.[2]

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[1] http://www.ibm.com/ceostudy

[2] Koomey, Jonathan. Growth in Data center electricity use 2005 to 2010. Oakland, CA: Analytics Press, August 2011. http://www.analyticspress.com/datacenters.html

Our data centers must become immensely more efficient and flexible to meet the need for energy while keeping costs in check as the demand for and price of resources continue to rise.

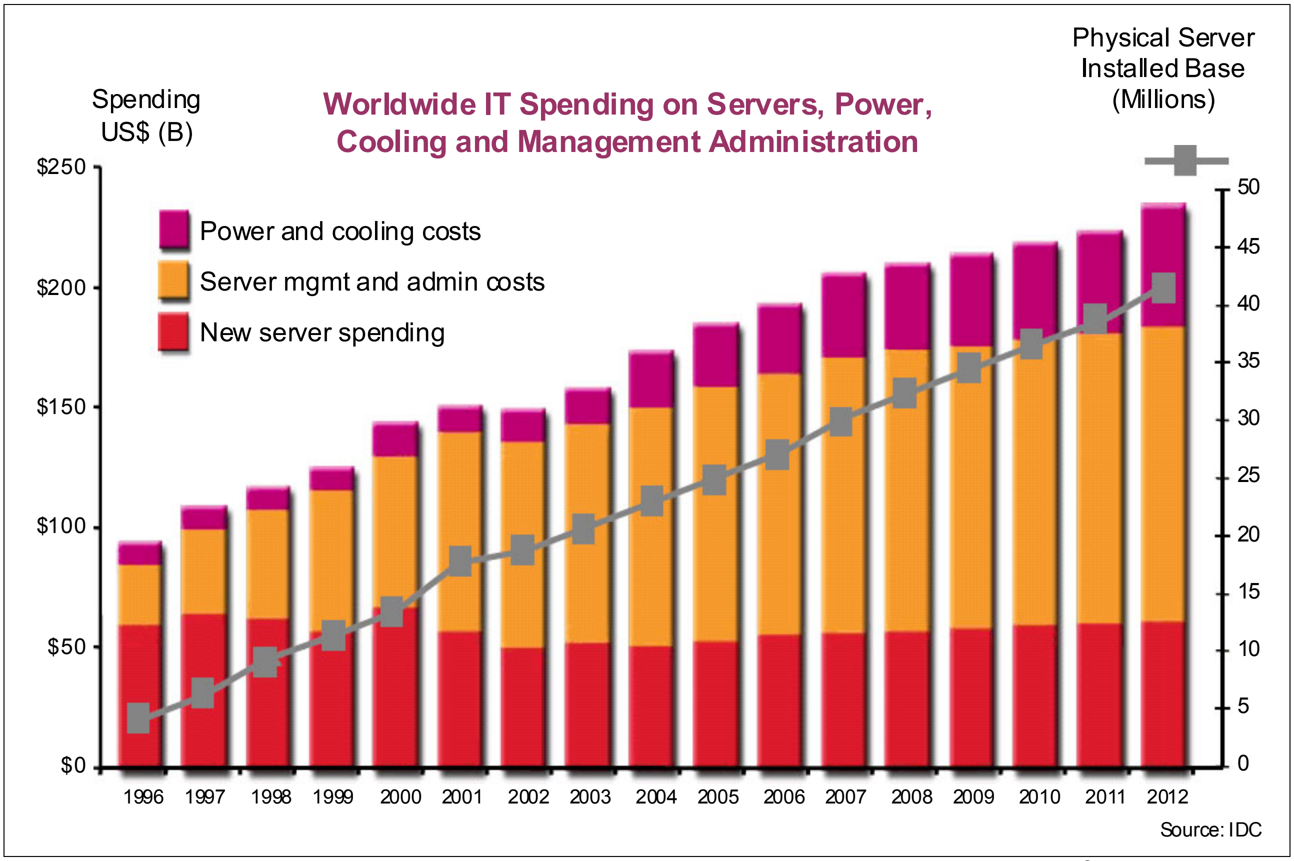


Figure 1 New server spending has plateaued while management and cooling costs continue to climb[3]

Transforming for efficiency

Achieving efficiency requires a deep and pervasive transformation in how data centers are designed, managed, operated, populated, and billed. Thus a unified and coordinated effort is required across organizational and functional boundaries toward a common set of goals.

It is no longer sufficient to address facilities and IT operations as separate and distinct entities. Although significant efficiency opportunities exist in both facilities and IT, a comprehensive smarter data center strategy must treat the data center as a single, cohesive whole.

[3] http://www.idc.com/ and http://www-05.ibm.com/si/ibmforum/presentations/2011/1day_ModrejsaInfrastruktura_1735_1815.pdf

Developing your strategy with IBM as your partner

You can increase efficiency by applying a number of techniques to your facility and IT data center operations and use various methods to integrate across these operations for a comprehensive view of your data center environment.

This IBM Redguide™ publication lists many of the efficiency techniques that can be applied to your data center facility and IT operations and methods to integrate across them for a comprehensive view of your data center environments. Also included are several case studies where IBM has applied many of these solutions for large-scale, real-world savings, both within IBM and among our customers.

In a companion IBM Redpaper™, *The Green Data Center: Steps for the Journey*, REDP-4413, you will find many of these techniques described in more detail, along with guidance on creating your own smarter data center strategy and pointers on how IBM can help you succeed.

As the manager of over 8 million square feet of data center space worldwide and with over 100 years in business, IBM can be a vital partner to help you save energy, cut costs, improve utilization, adapt to change, and make your data centers *smarter*.

Identifying the challenge and the opportunity

Rising demands for data processing, coupled with escalating resource costs, necessitate that data centers become immensely more efficient. Use of physical space, power, and cooling capacity must be managed together to avoid stranding capacity and the resultant higher operational business expenses. Governmental regulations and the need for environmental sustainability introduce additional focus on areas like carbon emissions, water consumption, and waste management. But how do you address all of these requirements at the same time?

Sorting through your options

There are many separate options for improving the efficiency of your data center facility and IT operations from exploiting environmental free cooling to cloud computing. Deciding which ones to implement depends on the specifics of your individual data center environments: the type of work being performed, the age and state of your infrastructure, the environmental conditions inside and outside of your data center, your internal business processes, economic conditions, and so on. There is no one-size-fits-all solution.

A successful efficiency transformation of your data centers requires a comprehensive strategy, one that bridges organizational and functional boundaries, assesses the current state of your data centers, establishes a cost-effective and realistic set of goals, and documents a course to achieve those goals.

In the associated Redpaper, we describe many of your efficiency options in greater detail, provide essential guidelines in creating your smarter data center strategy, and detail how IBM can be a vital partner at every step along the way, enabling you to extend the life of your existing facilities, increase your computing capabilities while maintaining or even lowering your energy consumption, adapt quickly and effectively to change, and gain the analytical knowledge needed for future planning.

Let IBM help you succeed

Services provided by IBM Global Technology Services and the IBM Systems and Technology Group[4] can help you develop your data center strategy, assess the current conditions of your data center, and help you implement new and efficient infrastructure, consolidate sites and servers, transition workloads to IBM cloud computing solutions[5], and more. New technologies like the IBM zEnterprise System[6] can provide the cornerstone for your high performance and large scale server consolidation needs, and offerings from IBM Tivoli®[7] can empower you to monitor, manage, and report across all of your data center operations and beyond.

This Redguide is your launching point, providing an overview of many of your options and examples of how IBM has applied them in our own operations and with our customers. A review of the associated Redpaper provides the next steps with additional detail on what is possible along with what is required. The final step is to contact your IBM representative and allow us to help you develop and implement your own smarter data center strategy for a healthier bottom line and a foundation for the future.

Efficiency methods

There are many efficiency methods that can be applied to your data center IT and facility operations separately and in an integrated fashion to obtain a holistic data center perspective. In this section, we briefly describe several of these methods and provide a high-level assessment of their complexity of implementation, use, and associated payback. Detailed techniques are provided for each case study in this Redguide (see "Monitoring and managing environmental conditions" on page 9).

Note: Assessments of complexity and payback are inherently subjective. The actual complexity of implementation or utilization and associated payback of any particular methodology will be dependent upon the specific characteristics of the operational environment to which it is applied.

IT techniques

In Table 1, we list several IT-related efficiency techniques that can be applied to your data center operations.

Table 1 IT efficiency techniques

IT technique and description	Complexity	Payback
Server consolidation Reduce the total number of physical servers.	High	High
Server virtualization Replace physical servers with virtual server images.	High	High
Cloud computing Utilize services that provide computational capacity as needed.	Low	Medium to High

4 Smarter Data Centers: http://www.ibm.com/services/smarterdatacenter
5 IBM Cloud Computing: http://www.ibm.com/cloud-computing/
6 IBM zEnterprise System: http://www.ibm.com/systems/z/
7 Tivoli Energy Management: http://www.ibm.com/software/tivoli/solutions/green/

IT technique and description	Complexity	Payback
Localized liquid cooling Use a contained water circulation loop located at the physical server to reduce generated heat.	Medium	High
Rear door heat exchangers Reduce heat at the rack level using a chilled water loop attached at the rear door of the rack.	Low	Low
Storage virtualization Replace localized storage with a centralized virtual pool of storage.	High	High
Hardware power management Take advantage of hardware capabilities to reduce asset power consumption.	Low	Medium
Software power management Take advantage of software capabilities to reduce asset power consumption.	Medium	Medium
Asset level power and thermal monitoring Monitor power and thermal conditions at the individual asset level.	Medium	Low
Asset level IT utilization monitoring Monitor utilization of asset level capacities such as CPU, disk space, and database storage.	Medium	Medium
Data storage management Apply storage optimization techniques.	Low	Low
Deployment of high efficiency IT hardware Utilize IT hardware that is particularly efficient for space, power, or cooling.	Low	High

Facilities techniques

Table 2 lists several efficiency techniques that can be applied to your data center facility operations.

Table 2 Facilities efficiency techniques

Facilities technique and description	Complexity	Payback
Site consolidation Consolidate multiple physical locations into a reduced number of strategic locations.	High	High
Direct rack duct cooling Use rack-attached ducting to guide cool air through the rack front.	Low	High
Hot and cold aisle configuration Orient racks to direct hot and cold air into designated aisles.	Low	High
High or low density zone configuration Configure specified areas of the data center to accommodate server placement in high or low densities.	Medium	Medium
Environmental conditions analysis Monitor environmental conditions such as temperature, pressure, humidity, air flow, and particulate concentrations throughout a data center environment.	Low	Medium to High

Facilities technique and description	Complexity	Payback
Deployment of high efficiency facility hardware Utilize facility hardware that is particularly efficient for space, power, or cooling.	High	High
Autonomic cooling adjustment Utilize an adjustable facility infrastructure to automatically respond to environmental variations such as temperature and humidity.	High	Medium
In-row cooling Deploy cooling capabilities that are specific to a particular aisle in the data center.	Medium	Medium
Free cooling Take advantage of external environmental conditions to provide supplemental cooling capacity to the data center.	High	High
Alternative power supply Utilize alternative facility level power supplies such as solar or wind.	High	High
Scalable modular data center Take advantage of a data center infrastructure that enables rapid and simplified scaling of available capacity.	Medium	High
Structured cable management Provide and use designated cabling pathways to prevent interference with cooling air flow.	Low	Low
High DC voltage Power equipment using high voltage direct current to avoid losses in power transformation.	High	Low

Integration techniques

Table 3 lists several efficiency integration techniques for gathering information that spans both your IT and facilities operations, allowing you to gain a comprehensive perspective of your entire data center environment.

Table 3 Integration efficiency techniques

Integration technique and description	Complexity	Payback
3D inventory management Track data center asset inventory in three dimensions down to rack slot placement.	High	High
Branch circuit monitoring Monitor power consumption down to each branch circuit in the data center.	High	Medium
IPDU level power monitoring Use Intelligent Power Distribution Units (IPDUs) to monitor power consumption at the outlet level.	Medium	Medium
Integrated facility and IT dashboards Generate role-based dashboards that consolidate data gathered from both facility and IT assets contained within the data center.	High	High
Integrated facility and IT historical trend reports Generate role-based historical trend reports utilizing consolidated facility and IT data from the data center.	High	High

Integration technique and description	Complexity	Payback
Asset data access from environmental analysis Drill down to asset level information from an overall environmental conditions assessment of the data center environment.	High	Medium
Alert and event management Generate and manage asset and facility level alerts and events based on operational conditions.	High	High
Monitoring data and service association Associate gathered operational data with provision of services.	High	High

Smarter data center case studies

In this section, we detail several real-world case studies from IBM and at our customers' facilities, in which many of the techniques listed in Table 1 on page 4 through Table 3 on page 6 have been applied.

IBM Leadership Data Center, Research Triangle Park, North Carolina, USA

The Leadership Data Center (LDC) at Research Triangle Park (RTP) is the first IBM data center in the United States to achieve Leadership in Energy and Environmental Design (LEED) Gold certification. This cutting edge facility includes 60,000 square feet of raised floor space supporting 6 MW of IT capacity (expandable to 100,000 square feet and 15 MW of IT capacity), featuring the best in IBM energy efficient technology and design.

Associated business needs and challenges

To keep pace with the intense demand for data center capacity by IBM clients, the LDC was designed to optimize the space, power, and cooling systems needed to support a large and diverse IT environment while providing flexibility to increase capacity quickly as needed. To maximize the reuse of materials and infrastructure, the LDC occupies a refurbished RTP manufacturing building that was constructed over 30 years ago.

Techniques in use

Several of the efficiency techniques used in this case study are listed in Table 4.

Table 4 Efficiency techniques in use at the LDC

IT techniques	Facilities techniques	Integration techniques
► Server consolidation ► Server virtualization ► Cloud computing ► Localized liquid cooling ► Rear door heat exchangers ► Storage virtualization ► Hardware power management ► Software power management ► Deployment of high-efficiency IT hardware	► Site consolidation ► Hot and cold aisle configuration ► High-density and low-density zone configuration ► Environmental conditions analysis ► Deployment of high-efficiency facility hardware ► Autonomic cooling adjustment ► Free cooling ► Scalable modular data center ► Structured cable management	► 3D inventory management ► Branch circuit monitoring ► Integrated facility and IT dashboards ► Integrated facility and IT historical trend reports ► Alert and event management

Environmental highlights

The following list indicates environmental highlights mentioned in the LDC LEED application package:

- 95% of the original building shell was reused
- 91% of the original materials were recycled (on a tonnage basis)
- 25% of new construction materials were from recycled sources
- LDC roofing was chosen to eliminate a “heat island” effect
- Construction materials used regional materials, minimizing transportation energy
- Rainwater harvesting is used to reduce water consumption
- Landscaping is all water-efficient
- Interior materials (paint, carpet, and so forth) are all low emitters of volatile organic compounds

Benefits and savings

This LEED certified data center showcases IBM technologies and solutions alongside those of our partners while providing strategic outsourcing clients with a highly available and cost-effective infrastructure. With its modular design and hosted cloud computing services, the LDC can quickly scale both physical and logical capacity in response to customer demands.

IBM systems, software, and services

The following IBM systems, software, and services were used in this case study:

- IBM System x® - iDataplex
- IBM and non-IBM equipment based on strategic outsourcing client need
- IBM Scale Out Network Attached Storage
- IBM PowerVM™
- IBM Systems Director
- IBM Tivoli Storage Manager
- IBM ILOG®
- IBM Tivoli Monitoring
- IBM Tivoli Monitoring for Energy Management
- IBM Systems Director Active Energy Manager™
- IBM Maximo® Data Center Infrastructure Management
- IBM Maximo Asset Management for Energy Optimization
- IBM Measurement and Management Technologies (MMT)
- IBM IT Facilities Assessment, Design, and Construction Services: Enterprise modular data center
- IBM Global Technology Services: Worldwide Strategic Outsourcing

Vendor solutions

The following vendor solutions were used in this case study:

- Coolcentric: Coolant Distribution Unit
- Carrier: Redundant chiller solution
- Schneider Electric: Electrical distribution
- Emerson/Liebert: High-efficiency UPS systems
- Caterpillar: High-speed and efficient generators

Additional resources

Listed here are additional resources for information specific to this use case:

- IBM positions itself as a cloud leader with a state-of-the-art data center

  http://public.dhe.ibm.com/common/ssi/ecm/en/xsc03081usen/XSC03081USEN.PDF

- IBM Research Triangle Park Leadership Data Center

  http://www.ibm.com/cio/smarterdc/

Monitoring and managing environmental conditions

Tools like Maximo Asset Management for Energy Optimization[8], shown in Figure 2, and services like IBM Measurement and Management Technologies (MMT)[9] can be used to monitor your data center environmental conditions, including temperature, pressure, humidity, air flow, particulate concentration, and computer room air conditioning use, providing insight into cooling optimization options and significantly reducing energy costs.

[8] Maximo Asset Management for Energy Optimization:
http://www.ibm.com/software/tivoli/products/maximo-asset-mgmt-energy-optimize/

[9] Measurement and Management Technologies:
https://researcher.ibm.com/researcher/view_project.php?id=2377

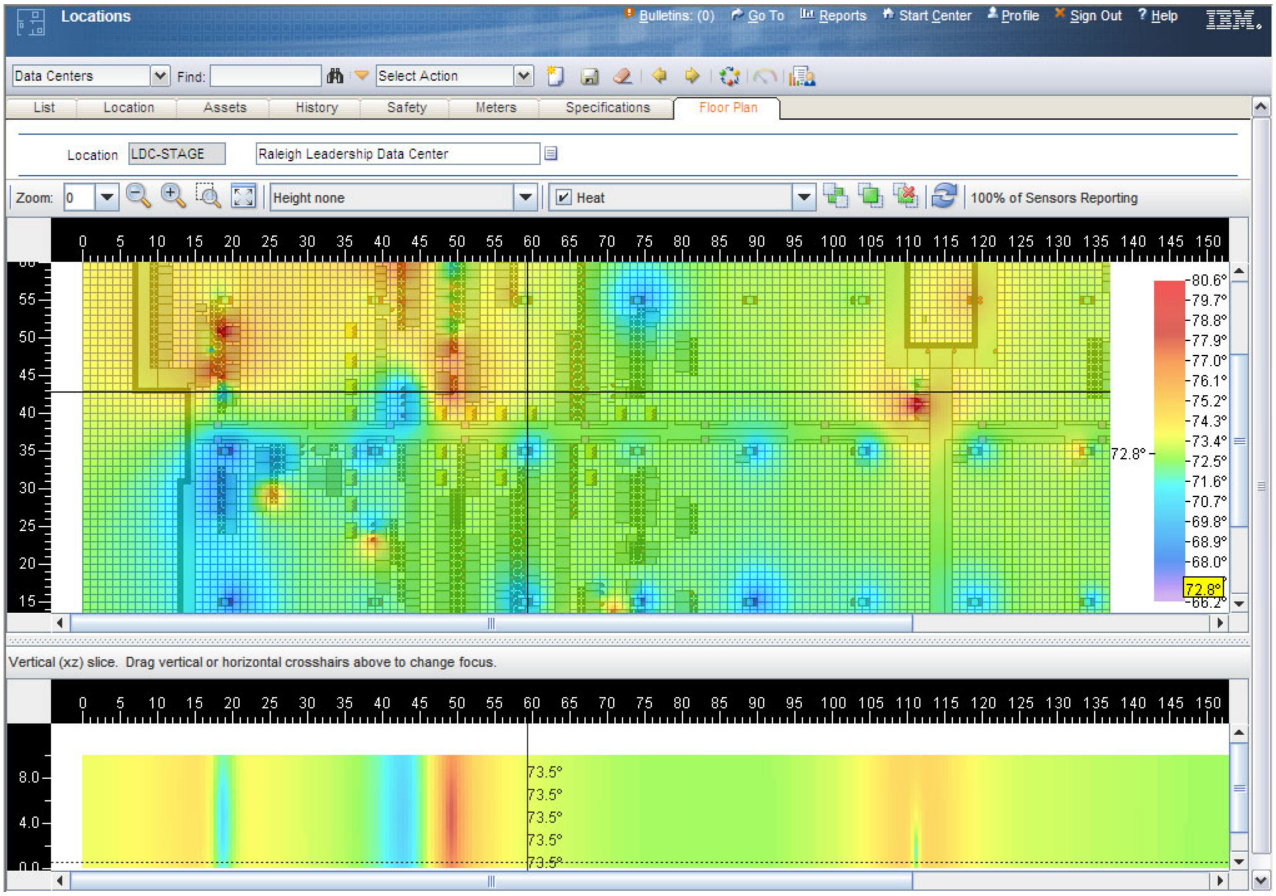


Figure 2 Data center heat map using Maximo Asset Management for Energy Optimization

Xcel Energy: High-density zone data center, Minneapolis, Minnesota, USA

Based in Minneapolis, Minnesota, Xcel Energy provides electricity and natural gas to millions of customers across eight states in the western and midwestern United States. With a focus on using innovative methods to provide power, Xcel Energy is the nation's number one provider for wind energy and ranks fifth in solar capacity, reflecting the company's commitment to natural resource conservation and environmental stewardship.[10]

[10] http://www-01.ibm.com/software/success/cssdb.nsf/CS/BNAE-8AP5KC?OpenDocument&Site=default&cty=en_us

Associated business needs and challenges

Xcel Energy noticed that their data center server and storage infrastructures were outdated. Energy consumption, maintenance, and a high risk of system failures were key points in the company's decision to rethink their designs and implement technological changes in the data center. The customer decided to consolidate and virtualize their current systems onto high-density blade servers (40 IBM BladeCenter® Server racks) and storage systems. To manage the generated heat while avoiding downtime, a new cooling system was put in place. IBM deployed a high-density zone (HDZ) solution featuring a *hot and cold* aisle configuration, along with closely coupled chilled water (CCCW) cooling. The project was completed in a three-month period.

Techniques in use

Several of the efficiency techniques used in this case study are listed in Table 5.

Table 5 Efficiency techniques in use at Xcel Energy

IT techniques	Facilities techniques
► Server consolidation ► Server virtualization ► Localized liquid cooling ► Storage virtualization	► Hot and cold aisle configuration ► High and low density zone configuration ► In-row cooling ► Scalable modular data center

Benefits and savings

The entire implementation took place without any downtime of the old system infrastructure. The new configuration enabled Xcel Energy to save 5% on their energy costs, freeing up 2,000 square feet of floor space, and benefit from 5% fewer applications operating in the data center resulting in reduced licensing costs. The modular design also enables the company to adapt to changing demands.

IBM systems, software, and services

The following IBM systems, software, and services were used in this case study:

- IBM BladeCenter
- IBM System p®
- IBM Global Technology Services--Integrated Technology Services
- IBM Site and Facilities Services

Vendor solutions

This facility used the APC Schneider vendor solution of In-row cooling

Additional information

In this use case, a solution from IBM helped reduce energy use.

http://public.dhe.ibm.com/common/ssi/ecm/en/sfc03015usen/SFC03015USEN.PDF

St. Lawrence College: Energy-efficient data center, Ontario, Canada

Since 1967, St. Lawrence College (SLC) has provided its students with a comprehensive educational experience. With campuses in Brockville, Kingston, and Cornwall, Ontario, SLC delivers relevant, in-demand programs across state-of-the-art facilities that are supported by a growing IT infrastructure.[11]

Associated business needs and challenges

To accompany its rapid 23% growth over a few short years, SLC needed to increase its IT capacity to support its growing student base while minimizing risk, reducing energy costs, and demonstrating a commitment to environmental sustainability. SLC needed to centralize technologies while taking advantage of virtual servers to reduce the total amount of equipment. The college also wanted a modular, scalable solution that would enable it to add more green technology in the future. Finally, to achieve energy savings in a meaningful way, the college needed to bridge the gap between IT and facilities operations.

Techniques in use

Several of the efficiency techniques used in this case study are listed in Table 6.

Table 6 Efficiency techniques in use at St. Lawrence College

IT techniques	Facilities techniques
► Server consolidation ► Server virtualization ► Storage virtualization	► Site consolidation ► In-row cooling ► Scalable modular data center

Benefits and savings

The built-in efficiency of a Scalable Modular Data Center (SMDC) allows SLC to save energy and capital costs, pay only for what it needs, and easily expand the data center as demand for IT services increases. The built-in flexibility makes adding capacity and equipment fast, inexpensive, and nondisruptive. The energy efficiency resulted in SLC having seven times the power and required a smaller space, allowing it to meet availability needs. In the process, SLC consolidated two data centers into one and reduced the number of servers from 70 to 12. The project was funded from the operating budget with a only a three-year to five-year expected payback window.

IBM systems, software, and services

The IBM IT Facilities Assessment provided by Design and Construction Services was used in this case study.

Additional information

An additional resource for information available to this use case is “St. Lawrence College Goes Green with Energy-Efficient Data Centre.”

http://public.dhe.ibm.com/common/ssi/ecm/en/sfc03014caen/SFC03014CAEN.PDF

[11] http://www-01.ibm.com/software/success/cssdb.nsf/CS/JHUN-8AGS4E?OpenDocument&Site=default&cty=en_us

IBM Rochester: Solution for Smarter Buildings, Minnesota, USA

The IBM Rochester campus consists of 3.2 million square feet of space and over 35 interconnected buildings, including manufacturing facilities, testing labs, office buildings, and a worldwide data center. It is the sixth highest energy consumer in the IBM global facilities portfolio.

Associated business needs and challenges

With rising energy consumption and the overall economic environment, IBM Rochester had to improve energy conservation and facilities management practices to promote sustainable and cost-effective operations while maintaining reliability and efficiency.

Techniques in use

Several of the efficiency techniques used in this case study are listed in Table 7.

Table 7 Efficiency techniques in use at IBM Rochester

Facilities techniques	Integration techniques
► Environmental conditions analysis ► Deployment of high-efficiency facility hardware ► Autonomic cooling adjustment	► Integrated facility and IT dashboards ► Asset data access from environmental analysis ► Alert and event management ► Monitoring data and service association

Benefits and savings

The IBM Intelligent Building Management solution[12] delivered new economic, operational, and environmental bene•ts to IBM facilities. Initial pilot observations have indicated an 8% annual savings in yearly equipment operating costs. IBM Rochester achieved the ability to manage energy use with more efficiency, lower costs, and a decrease in emissions by monitoring and analyzing heat generation, air conditioning utilization, and power consumption. It can also maintain equipment proactively and prevent breakdowns by identifying emerging problems and operational trends. The solution improved staff productivity and asset reliability, provided a longer asset lifespan, and decreased operational costs by streamlining problem diagnosis and resolution. The organization estimates a 5% year-over-year incremental energy savings for a facility that has undergone years of continuous energy efficiency improvements.

IBM systems, software, and services

The following IBM systems, software, and services were used in this case study:

- IBM Mashup Center
- IBM Maximo Asset Management
- IBM Tivoli Access Manager
- IBM Tivoli Data Warehouse and Monitoring
- IBM Tivoli Netcool/OMNIbus
- IBM Global Business Services®, Smart Buildings solution implementation

[12] IBM Intelligent Building Management: http://www.ibm.com/software/tivoli/products/intelligent-building-mgmt/

Vendor solutions

The following vendor solutions were used in this case study:

- Johnson Controls Metasys Building Management System
- Johnson Controls Sustainability Manager/EnNet
- Johnson Controls Dashboard & Mash-Up Widget
- Johnson Controls Systems & Integration Services
- Johnson Controls Energy & Sustainability Solution Services

Note: This is a broader smarter building application of solutions that also apply to *smarter data centers*.

Additional Information

The following list indicates additional resources for information specific to this use case.

- IBM Rochester, MN implements solution for Smarter Buildings

  http://public.dhe.ibm.com/common/ssi/ecm/en/tic14156usen/TIC14156USEN.PDF

- IBM Redguide: *Smarter Cities Series: Understanding the IBM Approach to Efficient Buildings*, REDP-4735

  http://public.dhe.ibm.com/common/ssi/ecm/en/tic14156usen/TIC14156USEN.PDF

IBM Poughkeepsie Green Data Center, New York, USA

The IBM Poughkeepsie Green Data Center has experienced enormous growth over the years and has upgraded its existing systems with new higher performance, energy efficient models to keep pace. However, as the data center continued to increase processing capacity and deliver more services, it became apparent that re-assessing hardware placement and cooling capabilities is critical to data center operations.

Associated business needs and challenges

Although new systems provided greater energy efficiency, the overall increase in processing power created a demand for additional cooling capacity within the data center. High temperature alarms from computer room air conditioning units signaled the environment's proximity to its cooling limits, pushing hosted equipment closer to potential failure.

Techniques in use

Several of the efficiency techniques used in this case study are listed in Table 8.

Table 8 Efficiency techniques in use in the IBM Poughkeepsie Green Data Center

IT techniques	Facilities techniques	Integration techniques
► Rear door heat exchangers ► Hardware power management ► Software power management ► Asset level power and thermal monitoring ► Deployment of high-efficiency IT hardware	► Environmental conditions analysis ► Deployment of high-efficiency facility hardware ► Autonomic cooling adjustment	► 3D inventory management ► IPDU level power monitoring ► Integrated facility and IT dashboards ► Asset data access from environmental analysis ► Alert and event management ► Monitoring data and service association

Benefits and savings

Rear door heat exchangers, new cooling distribution units, and the use of IBM and industry best practices for a raised floor data center resulted in a 50% decrease in cooling rack power consumption. This, in turn, lowered the probability of equipment failures and delivered continuous service. An analysis performed using IBM Measurement and Management Technologies (MMT) provided insight into the impact of changes within the environment, and the Integrated Service Management solution for the data center provided holistic visibility, control, and automation of energy usage and environmental conditions. The solution achieved a data center infrastructure efficiency (DCiE) level of 84% and doubled the amount of processing power available without increasing square footage.

IBM systems, software, and services

The following IBM systems, software, and services were used in this case study:

- IBM Cool Blue™ Rear Door Heat Exchangers
- IBM Measurement and Management Technologies (MMT)
- IBM System z®
- IBM Power
- IBM BladeCenter
- IBM System x
- IBM System Storage®
- IBM Systems Director Active Energy Manager
- IBM Tivoli Monitoring for Energy Management
- IBM Tivoli Data Warehouse
- IBM Tivoli Business Service Manager
- IBM Tivoli Netcool/OMNIbus
- IBM Systems and Technology Group - Lab Services

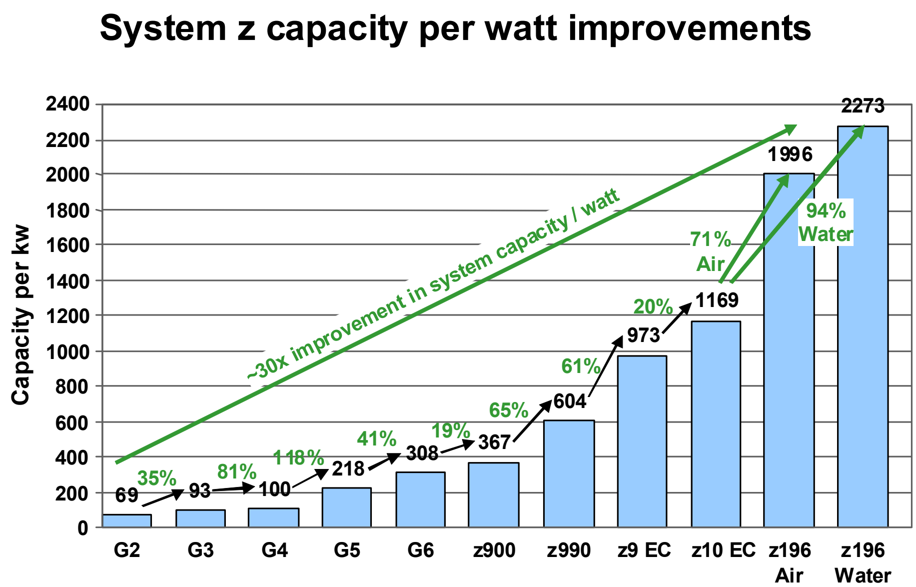
Additional Information

An additional resource for information specific to this use case is the IBM Poughkeepsie Green Data Center website.

http://public.dhe.ibm.com/common/ssi/ecm/en/tic14173usen/TIC14173USEN.PDF

IBM System z: Ongoing performance improvements

As shown in Figure 3, the IBM System z continues to make large performance gains related to its power consumption and heat generation, making it an ideal option for large scale performance and server consolidation efforts.



15 years of CMOS: G2 to z196		Net Effect: G2 to z196	
Power increase:	17% per year	Performance increased by:	~300x
Performance increase:	46% per year	Performance / watt increased by:	~30x
Power density increase:	13% per year	Performance / floor area increased by:	~190x

Figure 3 System z capacity per watt improvements chart

Note: Consolidating on IBM System z can save you up to 50% on your applicable IT costs. Obtain more information at the following website.

http://www.ibm.com/systems/smarter/facts/consolidation/systemz1.html

IBM Products & Solutions Support Center, Montpellier, France

As a green data center, the IBM Products & Solutions Support Center (PSSC) in Montpellier was established to demonstrate how IBM can help customers to address their energy efficiency challenges. This opportunity enables them to expand their IT capabilities and reduce their energy bills while concurrently benefiting the environment.

Associated business needs and challenges

The goal of the PSSC was to demonstrate IBM global solutions by building an energy efficient data center with an innovative, dynamic infrastructure. Considering that energy efficiency is a key factor in influencing many organizational roadmaps worldwide and that physical conditions of a data center directly influence the performance of the IT infrastructure, it is imperative to establish facilities that run efficiently and operate reliably.

Techniques in use

Several of the efficiency techniques used in this case study are listed in Table 9.

Table 9 Efficiency techniques in use at the IBM PSSC

IT techniques	Facilities techniques	Integration techniques
► Server consolidation ► Server virtualization ► Rear door heat exchangers ► Hardware power management ► Software power management ► Asset-level power and thermal monitoring ► Asset-level IT utilization monitoring ► Deployment of high-efficiency IT hardware	► Hot and cold aisle configuration ► High-density and low-density zone configuration ► Environmental conditions analysis ► Deployment of high efficiency facility hardware ► Autonomic cooling adjustment	► Integrated facility and IT dashboards ► Integrated facility and IT historical trend reports ► Alert and event management ► Monitoring data and service association

Benefits and savings

- Improved Power Usage Effectiveness (PUE) rating from 2.5 in 2007 (non-optimized environment) to 1.6 in 2011 (Green Data Center Phase 2)
- Energy savings of 33%
- 590 MW power savings per year
- Average of $510.29 per square meter of savings versus a total yearly cost of $2162.25 per square meter

IBM systems, software, and services

The following IBM systems, software, and services were used in this case study:

- IBM Systems Director with Active Energy Manager
- IBM Tivoli Monitoring for Energy Management
- IBM Tivoli Monitoring
- IBM WebSphere®
- IBM System z
- IBM System p
- IBM System x
- IBM BladeCenter
- IBM Measurement and Management Technologies (MMT)
- IBM Rear Door Heat eXchanger

Vendor solutions

The following vendor solutions were used in this case study:

- APC Schneider: In-row cooling
- Emerson Liebert: Cooling Units
- Ubisense: RFID solution
- Synapsense with Synapsoft solution

Additional information

Here are additional resources for information specific to this use case.

- IBM Design Centers

  http://www-03.ibm.com/systems/services/designcenter/

- IBM Benchmark Centers

  http://www-03.ibm.com/systems/services/benchmarkcenter/

Tivoli role-based dashboards can span facilities and IT

Dashboards from Tivoli Business Service Manager (TBSM) with data provided by IBM Tivoli Monitoring for Energy Management[13], like the example in Figure 4, can provide insight across both data center facility and IT operations. Facility power consumption can be assessed alongside asset utilization to identify optimization opportunities. Association of conditions with provided services can increase resiliency and availability.

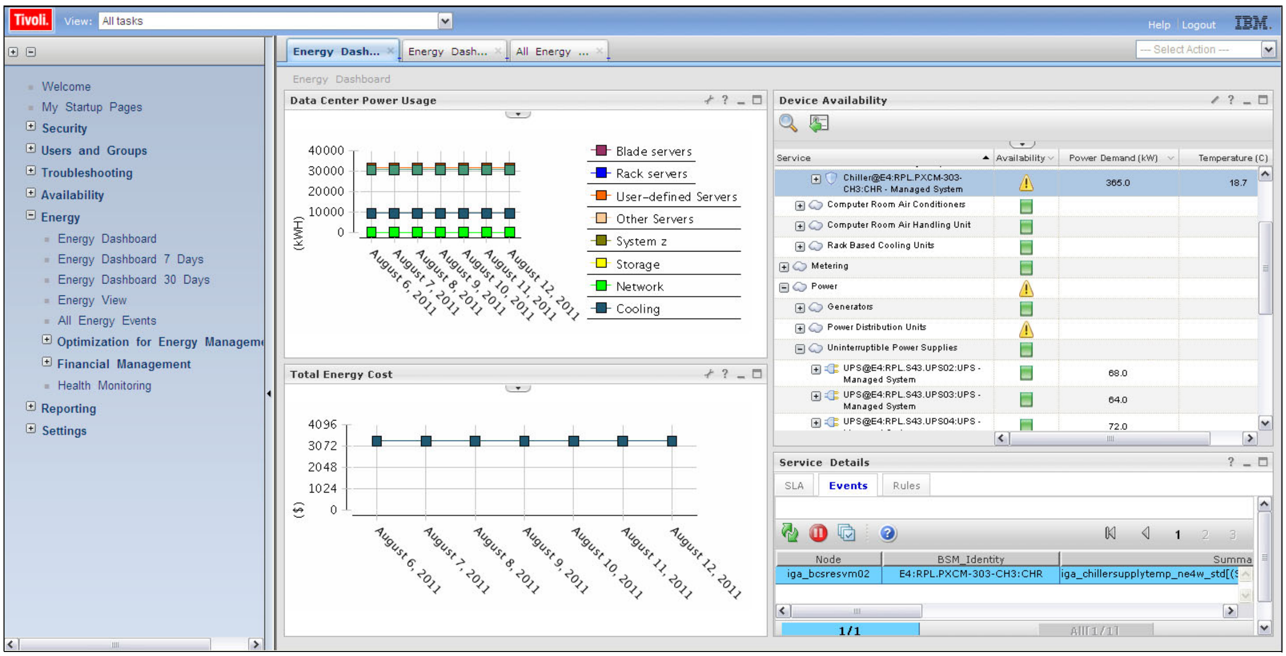


Figure 4 Energy dashboard using IBM Tivoli Monitoring for Energy Management

13 Tivoli Monitoring for Energy Management:
http://www.ibm.com/software/tivoli/products/monitor-energy-management/

IBM Chip and Design Data Center, Boeblingen, Germany

The IBM Chip and Design Data Center is a compute cluster for technical applications in a global environment. The cluster is used internally and supplies development resources for chip design, simulation, and verification.

Associated business needs and challenges

The age of the data center and its associated cooling infrastructure resulted in floor and cooling capacities to be consumed near their limits. In addition, computing and storage resources were being underutilized. To address these issues, a technology upgrade became necessary.

IBM decided to optimize the data center floor with several energy efficient infrastructure measures to overcome the cooling problems and save energy. This was followed by the implementation of state-of-the-art IT technologies and solutions that increased hardware utilization without interrupting data center operations. As a final step, a proper monitoring and management system for facility infrastructure and IT systems was established.

Techniques in use

Several of the efficiency techniques used in this case study are listed in Table 10.

Table 10 Efficiency techniques in use at the IBM Chip and Design Data Center

IT techniques	Facilities techniques	Integration techniques
► Server consolidation ► Server virtualization ► Rear door heat exchangers ► Storage virtualization ► Asset-level power and thermal monitoring ► Hardware power management ► Software power management ► Data storage management ► Deployment of high efficiency IT hardware	► Direct rack duct cooling ► Hot and cold aisle configuration ► Environmental conditions analysis ► Autonomic cooling adjustment ► Scalable modular data center	► IPDU level power monitoring ► Alert and event management

Benefits and savings

Overall energy consumption at this site was reduced by 12%. As a result of consolidation and virtualization activities, systems and storage utilization increased drastically, freeing floor space for new systems. The implemented monitoring and cooling techniques relieved the cooling bottleneck and made it possible to increase the supplied air temperature from 16.0° C (60.8° F) to 22.5°C (72.5°F).

IBM systems, software, and services

The following IBM systems, software, and services were used in this case study:

- IBM Power Systems™
- IBM System x
- IBM BladeCenter
- IBM System Storage DS®
- IBM Storage Area Networks
- IBM SAN Volume Controller
- IBM Measurement and Management Technologies
- IBM Systems Director Active Energy Manager
- IBM Tivoli Netcool/OMNIbus

Vendor solution

Rittal Rimatrix is the only vendor solution used.

Innovative cooling solutions

The IBM Chip and Design Data Center uses an innovative duct solution, shown in Figure 5, to direct adjustable amounts of cool air directly into the front of installed racks.

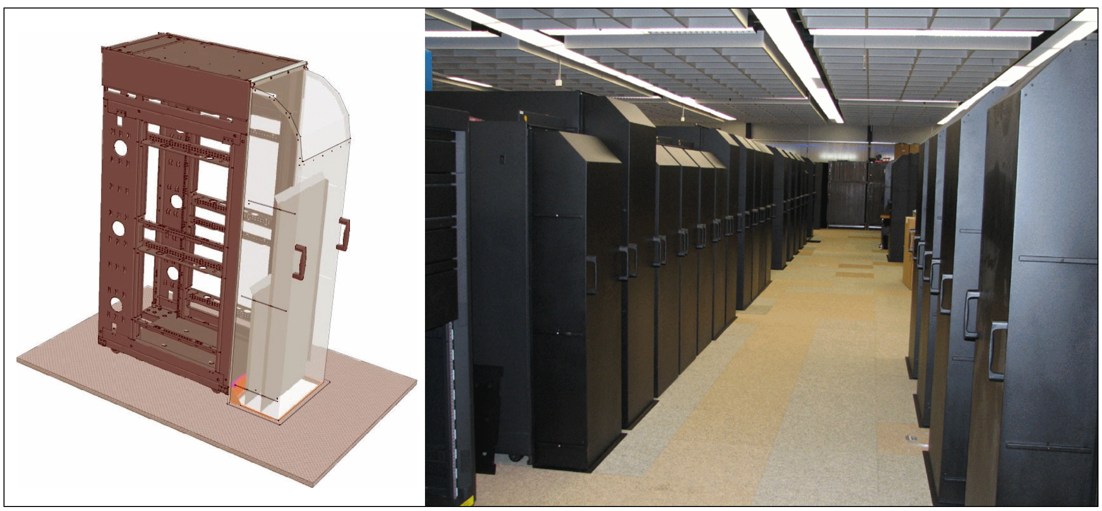


Figure 5 Air duct installation at IBM Chip and Design Data Center at Boeblingen

IBM India Software Lab, Bangalore, India

Similar to many data centers, the IBM India Software Lab (ISL) faced issues coping with growing compute power and data storage demands, resulting in increasing energy and operations costs. During mid 2008, with its *Blue Going Green* initiative, ISL pursued optimizing its data center environment.

Associated business needs and challenges

Under this initiative, ISL sought to optimize the use of data center floor space, reduce energy and carbon footprints without adverse impact to business growth, and create a unique showcase of products, technologies, and solutions for green transformation.

Techniques in use

Several of the efficiency techniques used in this case study are listed in Table 11.

Table 11 Efficiency techniques in use at IBM ISL

IT techniques	Facilities techniques	Integration techniques
► Server consolidation ► Server virtualization ► Cloud computing ► Rear door heat exchangers ► Storage virtualization ► Asset level IT utilization monitoring ► Deployment of high-efficiency IT hardware	► Site consolidation ► Hot and cold aisle configuration ► High-density and low-density zone configuration ► Environmental conditions analysis ► Alternative power supply	► Integrated facility and IT historical trend reports ► Alert and event management

Benefits and savings

The following list indicates several of the key benefits achieved during this green transformation:

- Release of 20,000 square feet of raised floor space
- Savings of 27 MWh of energy since project kickoff three years ago
- Increased use of Bangalore data center by roughly 15%
- Reduced physical server room count by 70%
- Reduced ISL data center energy footprint by roughly 1.1 MW
- Partial supply of alternate clean energy source in Bangalore green data center
- Implementation of a multi-city integrated building management system
- Positioning of the Bangalore data center as a unique, innovative data center that showcases IBM technologies and solutions alongside partner solutions

IBM systems, software, and services

The following IBM systems, software, and services were used in this case study:

- IBM System p Power 7
- IBM System x iDataplex, eX5 enterprise systems
- IBM XIV® Storage System, IBM Storwize V7000, IBM System Storage TS7650G
- IBM Tivoli Service Automation Manager
- IBM Tivoli Monitoring
- IBM Tivoli Application Dependency Discovery Manager
- IBM Tivoli Storage Manager
- IBM Tivoli Storage Productivity Center
- IBM COGNOS Business Intelligence

Vendor solutions

The following vendor solutions were used in this case study:

- Johnson Controls: Building Management System
- Coolcentric: Coolant Distribution Unit

Rear door heat exchangers address data center hot spots

Rear door heat exchangers[14] can eliminate data center hot spots by leveraging liquid cooling to efficiently remove heat from densely packed server environments, reducing the workload on computer room air conditioning units. In the example shown in Figure 6, the rear door heat exchanger reduces the rack's interior temperature of 46.9° Celsius (114.8° Fahrenheit) to 25.1°C (77°F) on its outside.

Figure 6 Rear door heat exchanger in action

IBM Green Innovation Data Center, Southbury, Connecticut, USA

The IBM Green Innovation Data Center (GIDC) is a 2,000-square-foot installation that hosts several hundred applications for IBM employees. It is also a customer showcase data center presenting the latest in energy efficiency technologies. The GIDC also provides the facilities to develop and test new innovative solutions aimed at creating a smarter data center.

Associated business needs and challenges

In stage 1, four geographically dispersed data centers were running out of power and space, encountering a need for additional capacity. These four data centers were consolidated into a single 2,000-square-foot facility with optimized power and resource utilization.

[14] Rack and power infrastructure portfolio:
http://www.ibm.com/systems/x/options/rackandpower/cooling.html

In stage 2, a network of over 150 sensors was installed to obtain knowledge about how new technology affects energy consumption. These sensors supply energy, thermal, and IT data that is displayed on near real-time dashboards and analyzed for further optimization of energy efficiency.

Techniques in use

Several of the efficiency techniques used in this case study are listed in Table 12.

Table 12 Efficiency techniques in use at the IBM GIDC

IT techniques	Facilities techniques	Integration techniques
► Server consolidation ► Server virtualization ► Rear door heat exchangers ► Storage virtualization ► Hardware power management ► Software power management ► Asset level IT utilization monitoring ► Deployment of high efficiency IT hardware	► Site consolidation ► Hot and cold aisle configuration ► High-density and low-density zone configuration ► Environmental conditions analysis ► Deployment of high efficiency facility hardware ► Autonomic cooling adjustment	► Integrated facility and IT dashboards ► Alert and event management ► Monitoring data and service association

Benefits and savings

By consolidating four existing data centers into one with a focus on the use of efficiency techniques spanning the facility and IT, the GIDC freed up over 1,000 square feet of space while providing twice the amount of processing power. The updated facility houses 300 servers, both physical and virtual, within the same physical space previously used for 50 servers. Detailed environmental condition monitoring and autonomic management quadruples server capacity with almost flat power consumption. Environmental data can be used either to improve the energy efficiency of new products or to discuss options with customers for optimizing their own data centers to achieve greater efficiency.

IBM systems, software, and services

The following IBM systems, software, and services were used in this case study:

- IBM Power Systems
- IBM System x
- IBM System x iDataPlex™
- IBM BladeCenter
- IBM XIV Storage
- IBM System Storage DS technology
- IBM Maximo Asset Management for Energy Optimization
- IBM Systems Director Active Energy Manager
- IBM Tivoli Business Service Manager
- IBM Tivoli Common Reporting
- IBM Tivoli Data Warehouse
- IBM Tivoli Directory Server
- IBM Tivoli Identity Manager
- IBM Tivoli Integrated Portal
- IBM Tivoli Monitoring for Energy Management
- IBM Tivoli Provisioning Manager

- IBM Tivoli Storage Manager
- IBM Tivoli Storage Productivity Center
- IBM Measurement and Management Technologies (MMT)
- IBM Rear Door Heat eXchanger/Cooling Distribution Unit

Additional information

The following sites provide additional information specific to this use case:

- IBM Green Innovation Data Center provides a showcase for energy efficiency and optimized innovation hosting

  http://www-01.ibm.com/software/success/cssdb.nsf/CS/LWIS-7MS6YL

- IBM Green Innovation Data Center helps developers build green technology

  http://www-01.ibm.com/software/success/cssdb.nsf/CS/LWIS-83ZS26

Summary

In a world of rising costs and increasingly scarce resources, applying efficiency techniques can control costs and save resources. In this Redguide, we have provided a high-level overview of several efficiency methods that can be applied to your IT and facility operations and be utilized to monitor, manage, and report across your entire data center environment. In the case studies, we have documented real world applications of many of these techniques and described the large efficiency gains for both IBM and our customers.

In an associated Redpaper, *The Green Data Center: Steps for the Journey*, REDP-4413, we discuss these techniques in more detail, provide guidance on creating a smarter data center strategy for your own business, and show the ways that IBM can help you succeed.

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