Energy Efficiency in the Data Center

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Energy Efficiency in the Data Center
Green today for better tomorrow

IBM Project Big Green

1	Data center challenges
2	Project Big Green
3	Solutions … services, technologies, systems management
4	Getting started …. By fixing today's problems

Facing new pressures: Data centers are at a tipping point

Increased Computing Demand

▪ **Between 2000 and 2010 server installations will grow by 6x and storage by 69x** – *IDC 2007*

▪**Per square foot, annual data center energy costs are 10 to 30 times more than those of a typical office building.** [2] *- William Tschudi, March 2006*

Changing Cost Dynamics

▪ **Data centers have doubled their energy use in the past five years.**[3] *- Koomey, February 2007*

▪**US commercial electrical costs increased by 10 percent from 2005-06.**[4] *- EPA Monthly Forecast, 2007*

Data Center Lifecycle Mismatch

▪ **Energy costs for server will match acquisition costs by 2012** – *IDC 2007*

▪**"Eighty-seven percent of data centers were built before 2001"**[5]

▪**"Twenty-nine percent of clients identified" data center capability affected server purchases** "*- Ziff Davis*

IBM Project Big Green
Green today for better tomorrow

"IBM to reallocate $1 billion a year"

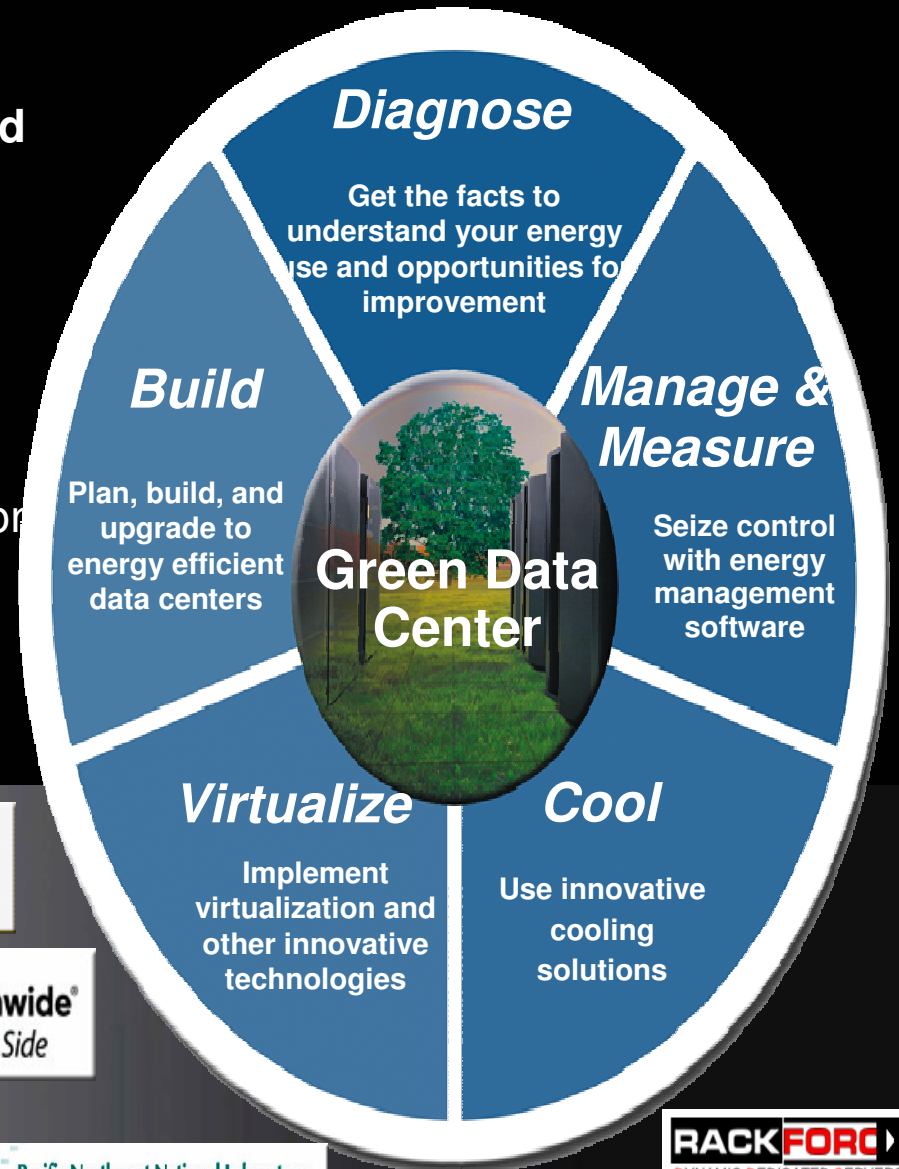**...NEW YORK – May 10, 2007 – IBM (NYSE: IBM)**

- To guarantee the research and development funding for IT energy efficiency technology.

- Create an 850 member worldwide IBM "Green Team" of energy efficiency specialists.

- Plan, build or prepare our facilities to be Green Data Centers based on IBM best practices and innovative technologies in power and cooling.

- Use virtualization as the technology accelerator for our Green Data Centers –to drive utilization up and our annual power cost per square foot down.

Re-affirmed IBM's long standing commitment to environmental responsibility

1. IBM energy conservation efforts from 1990 – 2005 resulted in a 40% reduction in CO_2 emissions and $250 billion energy savings. IBM commits to an additional 12% CO_2 savings by 2012.

2. IBM will double the compute capacity of our Green Data Centers by 2010 —without increasing power consumption or carbon footprint, thus avoiding 5 billion kilowatt hours per year.

What is a green data center?

- **Green data centers are energy efficient and environmentally responsible using five building blocks**

- **IBM client are seeing results:**
  - 40-80% reduction in power and cooling
  - 20-50% increase in server/storage utilization
  - Up to 80% reduction in data center space

Diagnose
Get the facts to understand your energy use and opportunities for improvement

Build
Plan, build, and upgrade to energy efficient data centers

Manage & Measure
Seize control with energy management software

Green Data Center

Virtualize
Implement virtualization and other innovative technologies

Cool
Use innovative cooling solutions

JCPenney

PG&E Corporation

Georgia Tech

Hannaford

MAYO CLINIC

Nationwide
On Your Side

BRYANT UNIVERSITY
The Character of Success

Devon

Pacific Northwest National Laboratory
Operated by Battelle for the U.S. Department of Energy

RACKFORC
DYNAMIC DEDICATED SERVERS

Where does the energy go? The data center energy challenge is driven by the physical data center and the Information Technology infrastructure
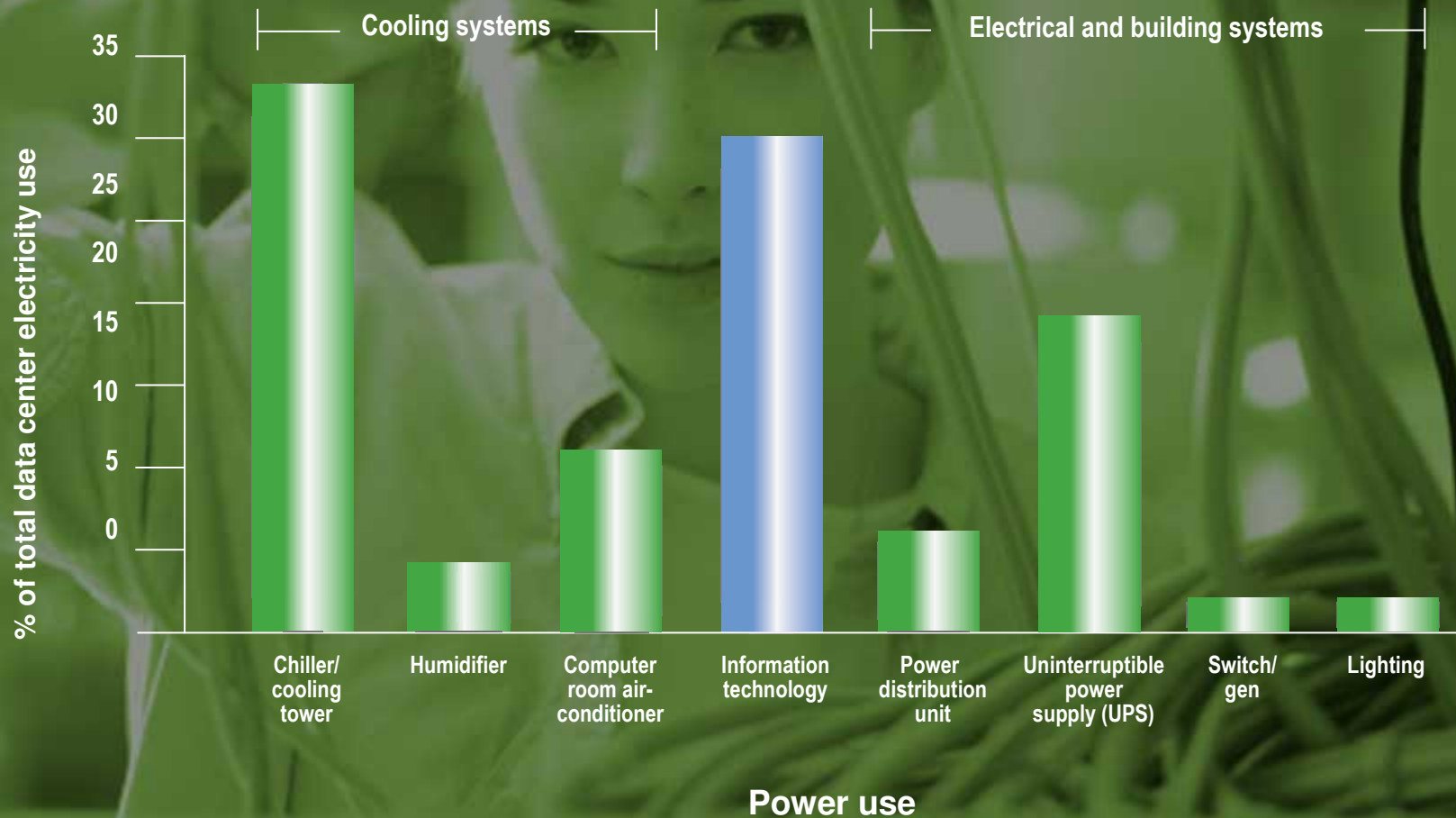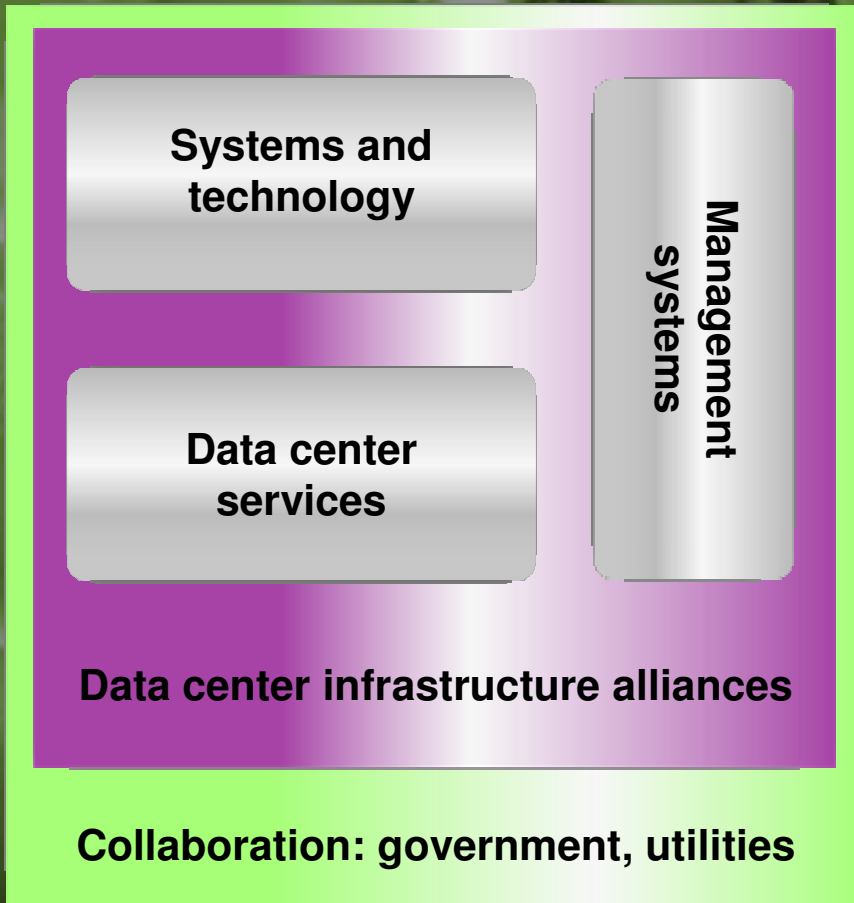

Chart showing % of total data center electricity use by Power use category.

Cooling systems | Electrical and building systems

- Chiller/cooling tower: ~33
- Humidifier: ~3
- Computer room air-conditioner: ~6
- Information technology: ~29
- Power distribution unit: ~1
- Uninterruptible power supply (UPS): ~15
- Switch/gen: ~1
- Lighting: ~1

Y-axis: % of total data center electricity use (0, 5, 10, 15, 20, 25, 30, 35)
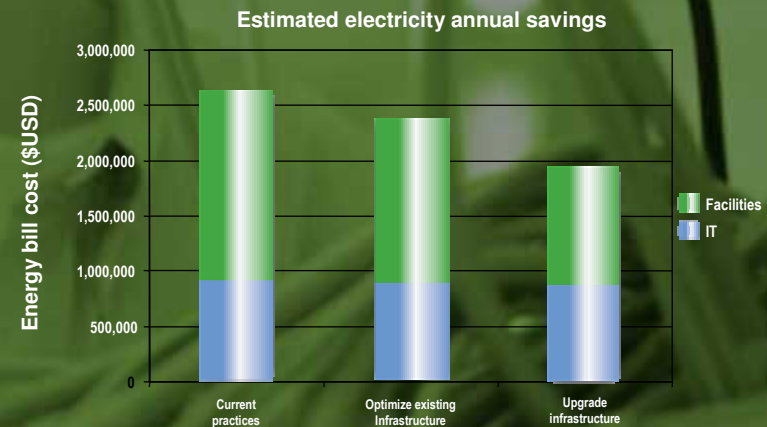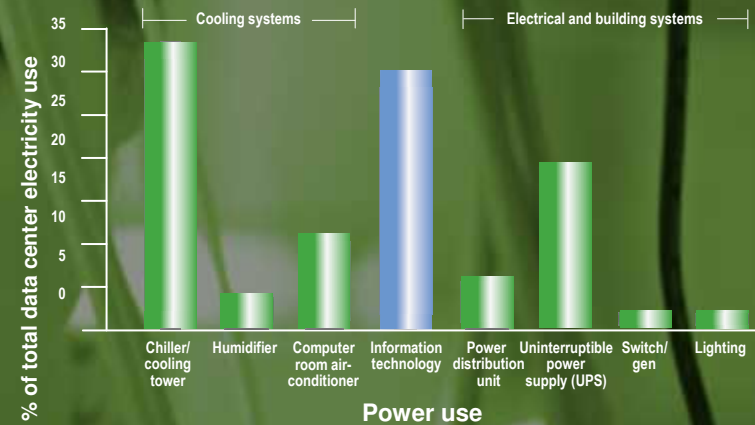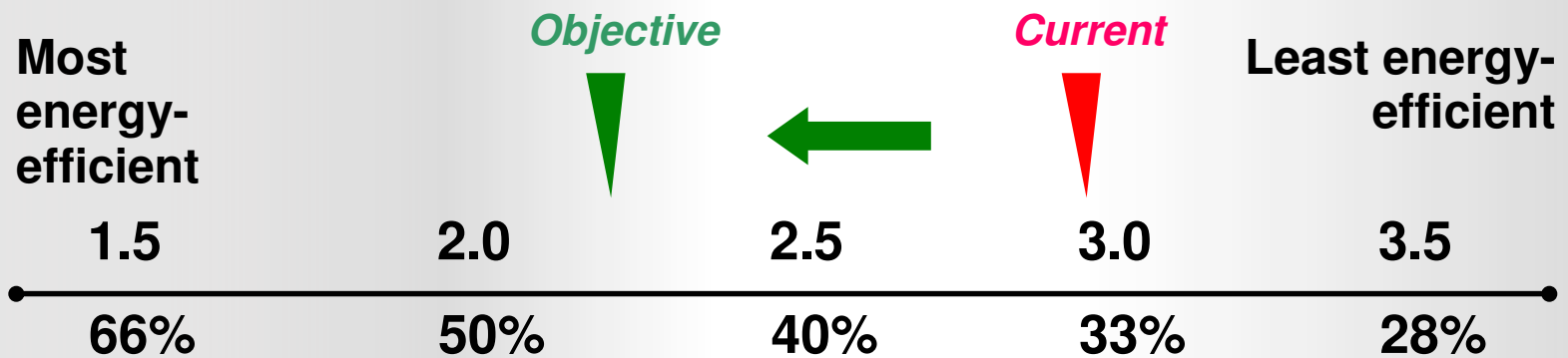
X-axis label: Power use

Chart and data source: American Power Conversion Corporation (APC) white paper, Implementing Energy Efficient Data Centers, #114, by Neil Rasmussen, 2006.

Project Big Green is a comprehensive set of capabilities from IBM, our alliances and the communities in which we live.

Systems and technology

Data center services

Management systems

Data center infrastructure alliances

Collaboration: government, utilities

Schneider Electric

APC | MGE
Critical Power and Cooling Services

EMERSON

Liebert®
Keeping Business in Business

EAT•N

ANIXTER

GE

Energy efficiency awareness, programs and incentives

Data center energy efficiency assessment—facts you need

Description:
- IBM provides a comprehensive, fact-based analysis that prioritizes tactical plans across your data center to help improve efficiency and reduce costs

Potential benefits:
- Energy savings: infrastructure upgrades can provide 15–40 percent savings
- Recommendations include:
  - Standard comparison
  - Low performance areas
  - Actions for improvement
  - Business cases to prioritize investments

Power use

Estimated electricity annual savings

Chart and data source: American Power Conversion Corporation (APC) white paper, Implementing Energy Efficient Data Centers, #114, by Neil Rasmussen, 2006.

Data center energy efficiency assessment—using a simple standard to determine how much improvement is necessary

- **Compares total power used by the data center to the power used by the technology**
- **Provides a marketplace comparison that is gaining wide acceptance**
- **Demonstrates range for opportunity improvement**

		Objective		*Current*	
Most energy-efficient					**Least energy-efficient**
1.5	**2.0**		**2.5**	**3.0**	**3.5**
66%	**50%**		**40%**	**33%**	**28%**

Web-based tool provides an energy efficiency self-assessment

A free self-assessment is available on the Web that can highlight opportunities for energy efficiency improvement

Assessment process
- **Twelve questions on energy usage**
- **Three main categories**
  - **Awareness of power-related issues**
  - **Deployment of tactical quick hitters**
  - **Extent of the strategy for data center planning**
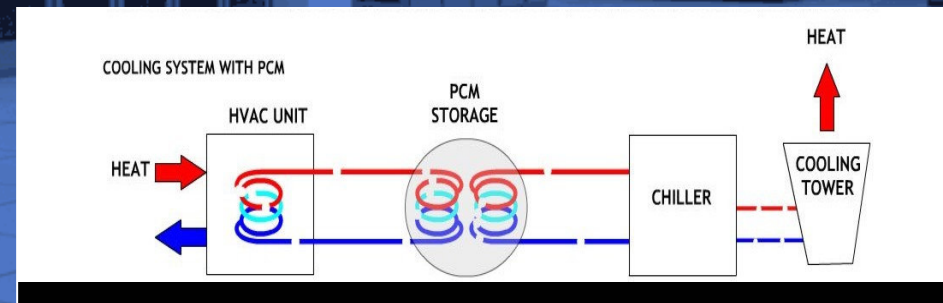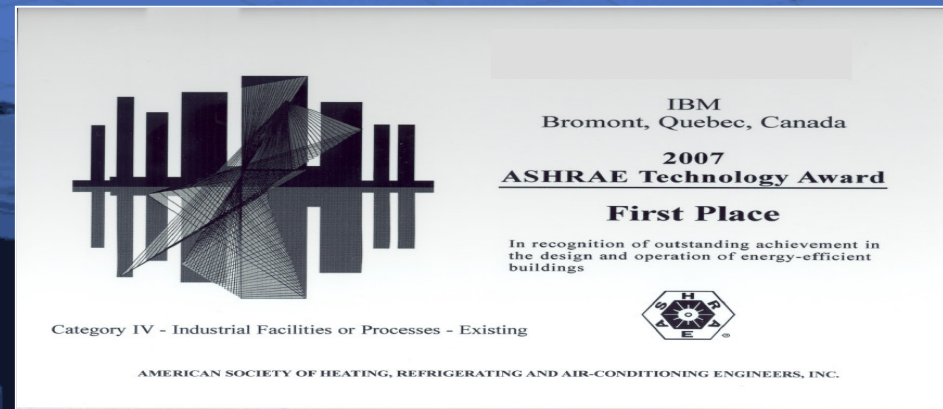- **Report on improvement areas**
- **IBM service recommendations**
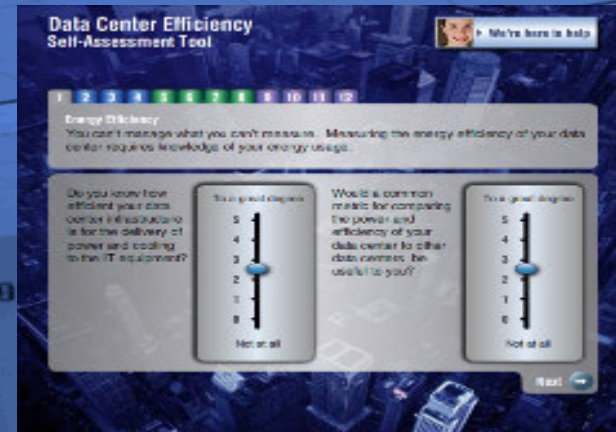
Data center stored cooling solution—the cool battery

Description:

- **IBM provides a turnkey, patented thermal storage solution designed to help improve the efficiency of the cooling system and reduce energy costs**

Potential benefits:

- **Improved efficiency: 40–50 percent greater cooling system energy efficiency**

- **Cost savings: up to 30 percent of peak energy usage by shifting energy usage to off-peak hours**

IBM
Bromont, Quebec, Canada
2007
ASHRAE Technology Award
First Place
In recognition of outstanding achievement in the design and operation of energy-efficient buildings

Category IV - Industrial Facilities or Processes - Existing

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS, INC.

COOLING SYSTEM WITH PCM
HVAC UNIT
PCM STORAGE
CHILLER
COOLING TOWER
HEAT
HEAT

Optimized airflow assessment for cabling—under-floor savings

Description:

- **A comprehensive assessment of the existing data center cabling infrastructure provides an expert analysis of the overall cabling actions. The service is designed to improve airflow for optimized cooling, simplified change management and improved cabling resiliency.**

Potential benefits:

- **Improved airflow under raised floor: helps create a more energy-efficient data center**

- **Fewer "hot spots" due to bypass airflow**

- **Improved manageability for all cabling systems**

- **Savings on operational costs—reductions associated with cable installation and change management**

- **Improved resiliency—elimination of potential for points of failure**

Before
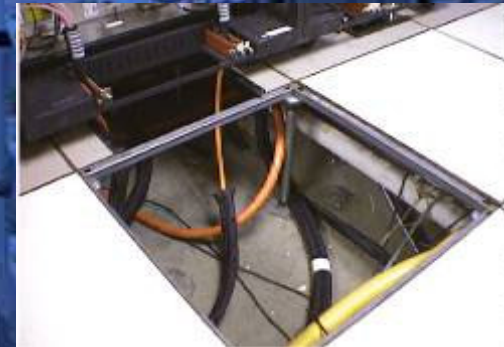
After

IBM has helped companies around the globe increase their energy efficiency and reduce expenses across their data center infrastructure

IBM Data Center and Facilities Strategy Services

- **Supercomputing:** built the #1 supercomputing center (MareNostrum) for high redundancy in an extremely dense computing environment
- **Financial:** Built more than 50 large Chinese data centers—including at the country's top five banks

IBM IT Facilities Assessment, Design and Construction Services

- **Deep experience**: built more than 30 million square feet of raised floor
- **Global breadth:** built the largest data centers for Egypt Telekom and telecom company in India
- **Wide array of assessments:** provides assessment of energy use, resiliency and new technology adoption
- **All size businesses**

IBM IT Facilities Consolidation and Relocation Services

- **From many to few**: consolidated Bank of China data centers from 38 to 2; annual savings US$180 million
- **Without interruption**: consolidated from four centers to one with no interruption; annual savings ~US$11 million
- **When uptime is critical**: helped relocate WakeMed's hospital data center—without patient impact

IBM Specialized Facilities Services

- **A green leader**: designed and built more than 35 percent of the top-rated green/intelligent buildings in Japan
- **When precision matters**: designed and built clean room facilities for chip fabrication and pharmaceutical companies

Build

MareNostrum—the Barcelona supercomputing center

Client requirements
- **Build the largest supercomputing center in Europe**
- **Install 2,560 blades - 94.21 terra flops**
- **4 months - construction start to functional center**
- **Support 2-3 generations of technology changes**

Solution:
- **Build it in only 1,600 square feet**
- **Design the power and cooling within the constraints of an 18th-century church**
- **Support state-of-the-art, high-density IT**
- **Provide flexible design to allow for technology upgrades**
- **And … make it beautiful**

Benefits
- **Supports 21KW/rack (400 W/sq ft) of cooling**
- **Flexibility for the future – supercomputing performance upgrade underway**
- **World's most beautiful supercomputing center**
- **On our third system upgrade in the same facility**
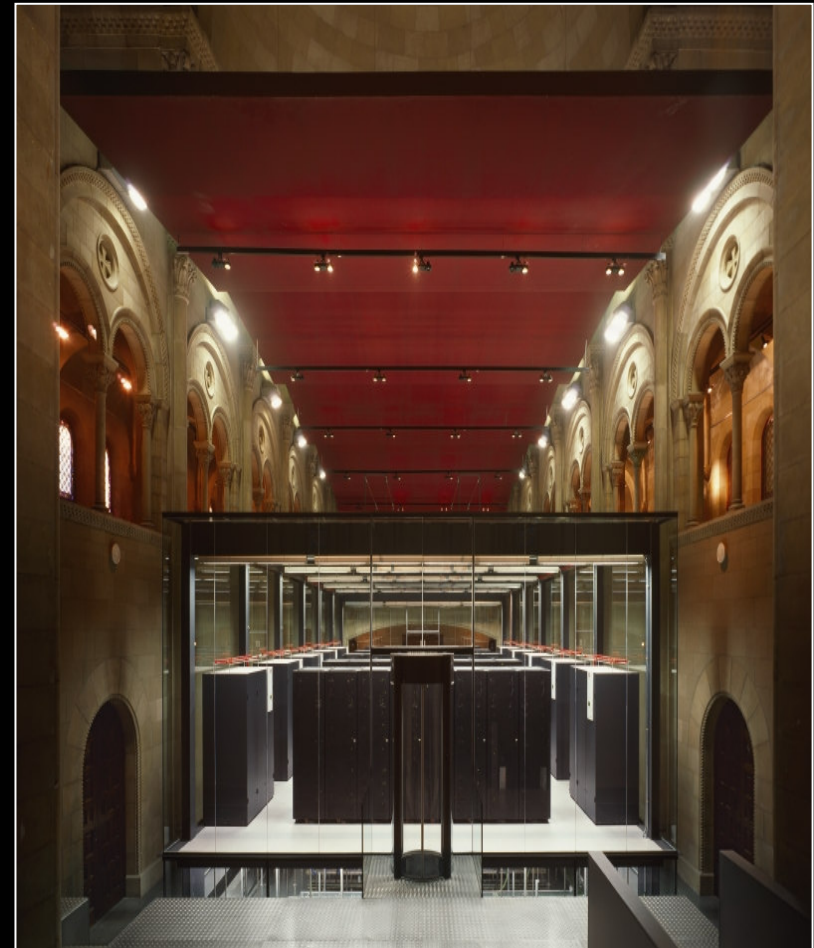
IBM can help you optimize your technology, your data center infrastructure or both
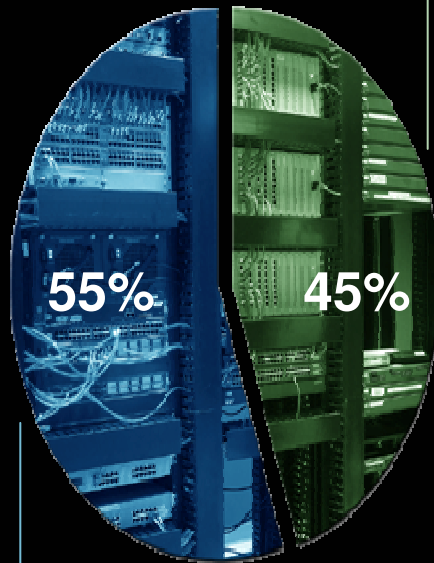
Data Center Energy Efficiency Assessment

Cooling systems | Electrical and building systems

Server and storage consolidation assessments

% of total data center electricity use

35
30
25
20
15
10
5
0

Chiller/Cooling Tower | Humidifier | Computer Room Air Conditioner | Information Technology | Power Distribution Unit | Uninterruptible Power Supply | Switch/Gen | Lighting

Power Use
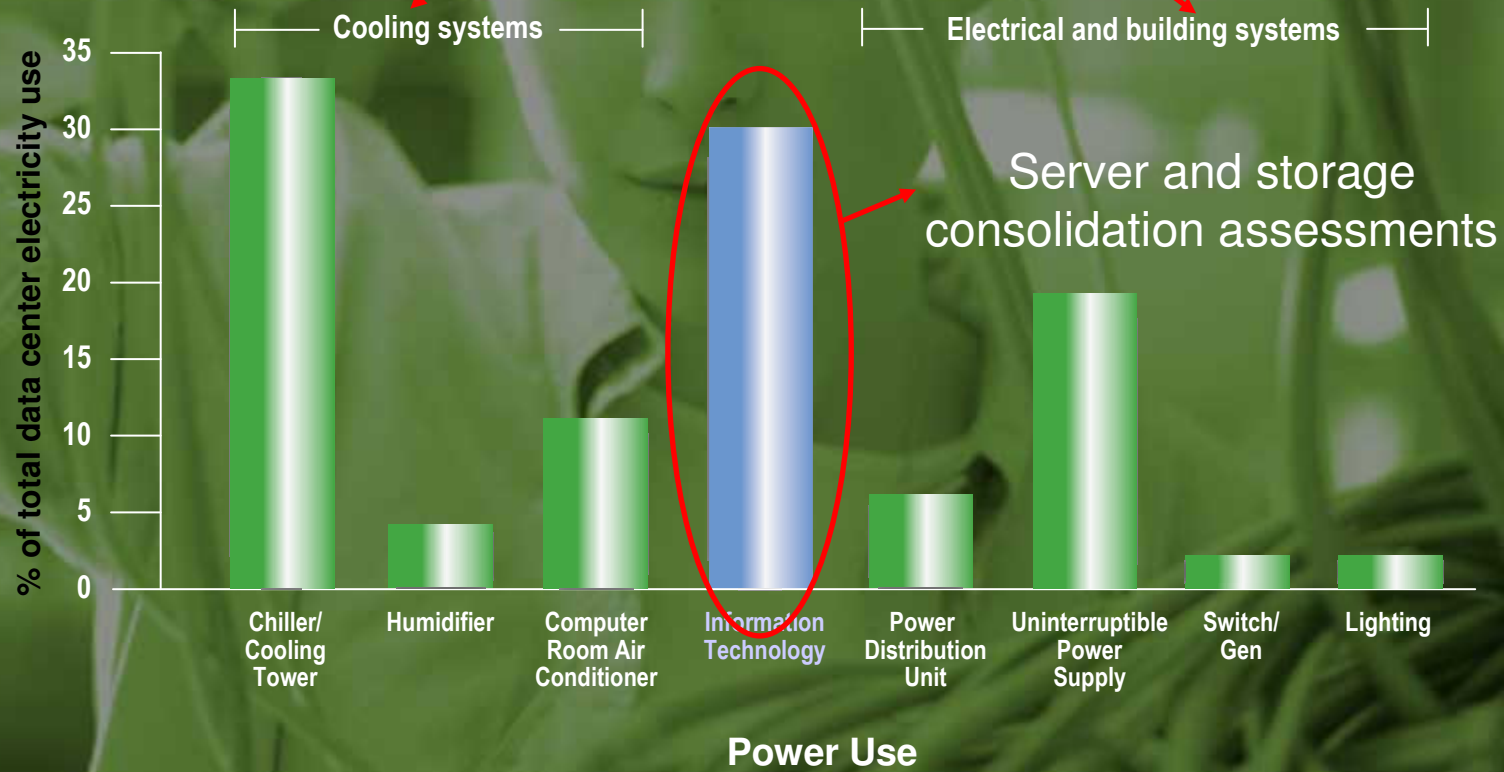
How is energy typically used in the data center?

Data center	Server/storage hardware	Compute resources

IT Load

55% | 45%

Power and Cooling

Processor

70% | 30%
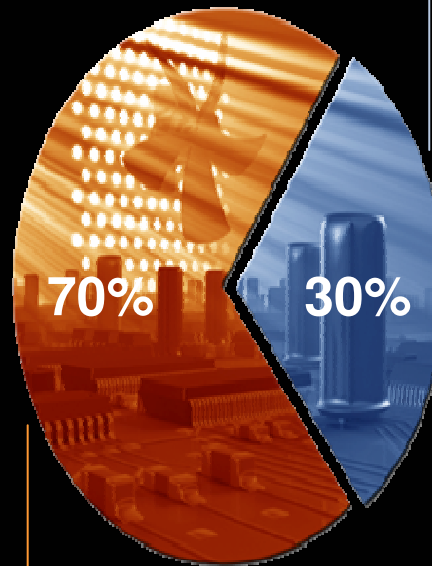
Power supply, memory, fans, planar, drives . . .

Resource usage rate

80% | 20%
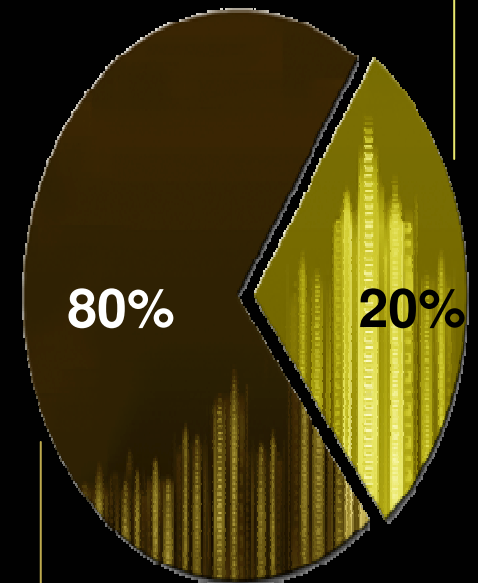
Idle

Data source: Creating Energy-Efficient Data Centers, U.S. Department of Energy , Data Center Facilities and Engineering Conference, May 18, 2007
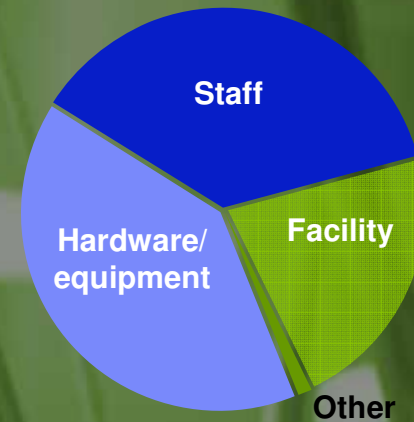
Accelerator for Rationalization – Starting on the path to a consolidated and virtualized your infrastructure

Consolidation savings can come from:

IBM helps clients define scope of server and storage consolidation engagements to improve efficiency and reduce operational costs.

Offering benefits
- **Save up to an average of 72% in datacenter operational costs***
- **Recommendations include:**
  - **High-level business case**
  - **Estimated savings based on consolidation**
  - **Satisfaction criteria**
  - **Inventory of server & storage landscape**

Pie chart: Staff, Facility, Hardware/equipment, Other

Categories	Savings
Maintenance	86% - 94%
Software support	82% - 84%
Personnel	36% - 50%
Facilities	65% - 70%
Average	72%

IBM has helped companies optimize their server and storage environments through consolidation and virtualization practices

Accelerator for Server and Storage Consolidation

- **Large reduction in server numbers:** Helped global consumer products company go from over 150 to 25 server assets
- **Business results:** Lowered cost of owning, maintaining and operating IT infrastructure by 25%
- **Solution approach:** IBM combined services (including migration) with storage and server hardware, providing a total solution

Storage design and build

- **Best practices – standardized storage practices, consolidation and virtualization:** Solution for global electronics company combined techniques for optimal results
- **Significant financial benefits:** Efficiency and cost reduction of 30%+ over 2 years operation
- **IT alignment:** Addressed storage and server optimization together, providing a strong foundation for ongoing simplified operations

Server Consolidation

- **Establish a unified IT Platform:** Consolidated environment onto four IBM System p5™ 570 systems leveraging High-Availability Cluster Multiprocessing (HACMP™) technology to provide failover between the two data centers
- **Business Results:** Saved more than 50 percent in hardware costs with new platform and improved the company's ability to track, understand and manage sales data

Storage consolidation

- **Efficiency and backup / resiliency gains:** Consolidated storage infrastructure for bank with 350+ branches, while improving disaster recovery and management control
- **Full scope, to reduce client risk and provide and end-to-end solution**: IBM provided project management, design, implementation and data migration services

Energy Management Solutions

1. **Measure**/Trend Power use … to help customers control power consumption
2. **Allocate** or cap power …Use power measurement history and service levels to optimize the energy
3. **Automate** power reduction management systems aligned server and application utilization - "Cruise control" for power consumption of servers
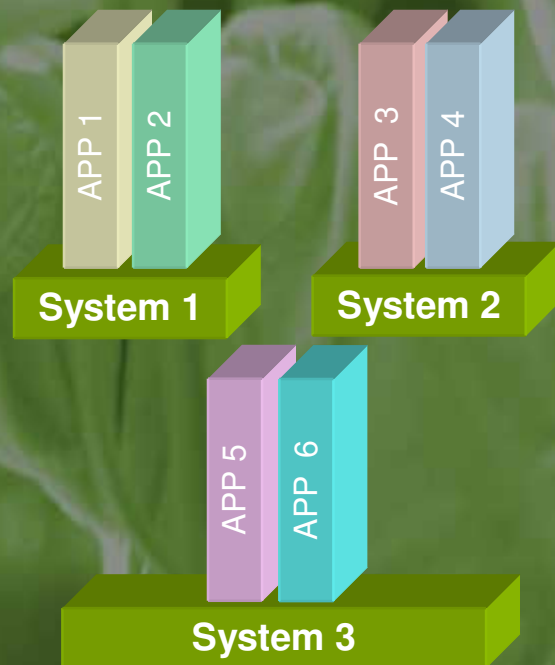
Now available on all IBM servers and storage

Workload Migration
Enables Dynamic Server Consolidation

APP 1 APP 2
System 1

APP 3 APP 4
System 2

APP 5 APP 6
System 3

Use of hibernation, powering off servers, and other low power states in combination with other workload balancing and provisioning tools can provide a valuable tool in management of Power and Thermal issues.

Automate Energy Control
Policy-based automation

Control Energy Consumption
Consolidate workloads to reduce

I have limited power and cooling capacity for new technology to support business requirements. What do I do?

Get the facts

- Understand your real power and cooling consumption and highlight what actions will provide the most leverage… energy efficiency assessments, thermal mapping, cabling assessments, etc.

## *Technology – savings up to 80%*

- Install energy efficient technologies that meet the need of your business – servers and storage … Blades, ISM,

- Consolidate and virtualize your server and storage environments

Data center infrastructure – savings up to 50%

- Consolidate the data centers you have today

- Optimize existing sites for energy efficiency and growth for additional technology
  - Align power and cooling approaches with the different requirements of the technologies
    - Supplemental cooling devices ….rear door heat exchanger, snorkels, directing cooling systems
    - Enclosed racking systems …. IBM integrated racking solution, APC pods,
  - Improved chiller systems …. Stored cooling solutions
  - Upgrade older systems …. UPS, Lighting, etc.

Rear Door Heat Exchanger – removes 50-60% of the heat from high density technologies significantly reducing the cooling demand on existing structure
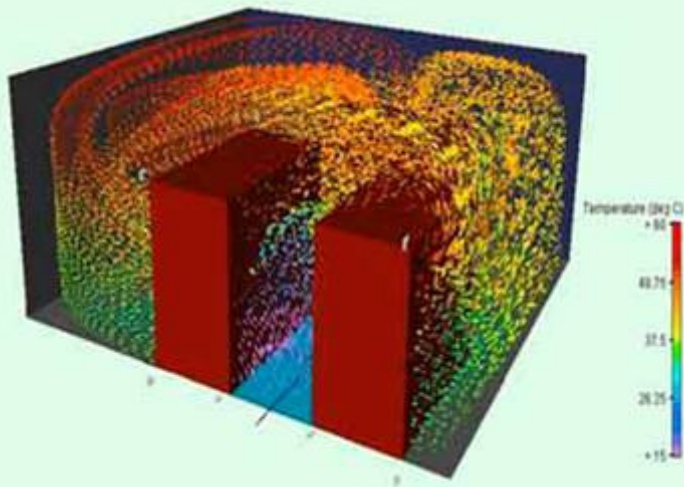
Before
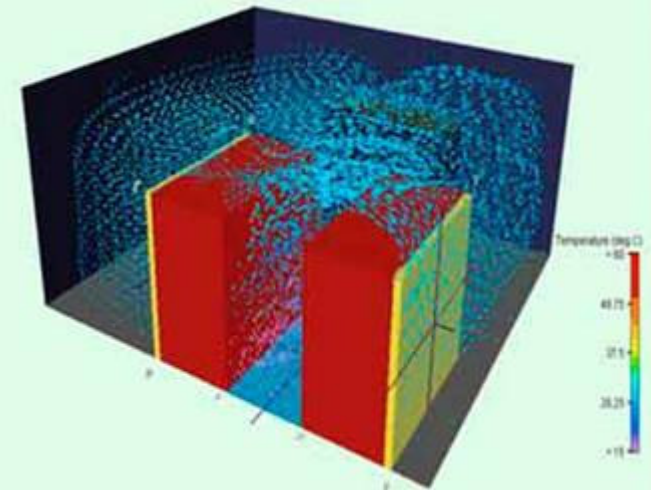
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Integrated Racking Solution – supports high density technologies using the existing data centers capabilities

Client requirements
- High density blade deployment for compute intensive financial applications
- Limited floor space and limited power availability
- High availability and resiliency
- Cost and energy efficient

Solution
- 2,100 blades in 102 sq m
- IBM Integrated Rack Solution for High Density
- Integrated networking, power management and environmental monitoring

Benefits
- Center enclosed cold aisle layout enables 6,500 Watts /sq m or 25KW/rack
- Significant reduction in data center size and number of air conditioning units – cooling efficiency increased by 40-60%
- Reduction of 15-25% in space needed for cabling; improves air flow distribution
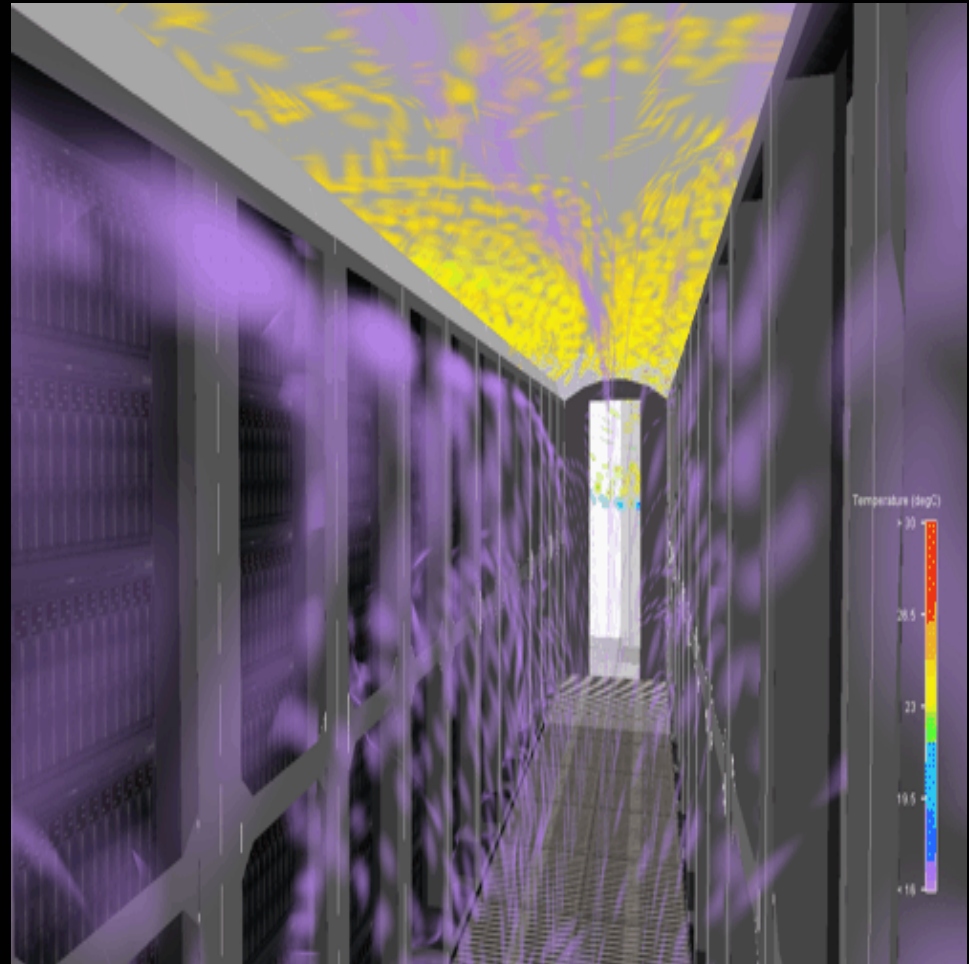
Key Analysts are Recognizing IBM's Leadership Position

""This is a significant statement of unification that should offer users a more comprehensive set of solutions, including products, services and financing. The announcement also shows that **IBM sees the power and cooling issue at the data center level whereas both HP and Sun see it at a product level**." Rakesh Kumar, Gartner "'Big Blue' Goes Green With Energy Efficiency Initiative" (15 May 2007)

"'What's significant is **IBM's emphasis on using a range of technologies and on planning, design and user practices. It's not just about selling new, more efficient chips and computers.** And that is in contrast to some of its peers in the industry." -- Forrester analyst Christopher Mines, New York Times, May 10,2007

"**IBM is in an ideal position to help customers examine energy efficiency problems, propose options, and implement solutions**, a combination that should prove profitable to the company and its Eco-System Partners" -- Charles King, Pund-IT"IBM Launches "Project Big Green"" (11 May 2007)

""Several vendors also announced … partnerships with IBM…these include Anixter, GE, Eaton, Liebert/Emerson Network Power, Schneider Electric…in addition to comments from PG&E and the EPA ..**IBM pulled together some significant muscle to announce its formal foray into EcoEfficiency for IT**. David Yokelson, the451 "Green and bear IT: IBM's new 'EcoEfficiency'Program" (10 May)

"**One of the** more innovative element of IBM's 'big green' strategy is a patented "stored cooling" solution **that allows customers to store cooling capacity in a chemical solution which can be altered to change state from solid to liquid at a wide range of temperatures. IBM claims that this solution makes existing chilled water cooling infrastructures run 40-50% more efficiently. --Matt Eastwood, IDC : "Big Blue Focuses Attention on "Big Green" (11 May 2007)**

Environmental responsibility is a core IBM value

Raising the Bar Next 7 Years

Further extend IBM's early accomplishments by reducing CO_2 emissions associated with IBM's energy use 12% from 2005 to 2012 via energy conservation, use of renewable energy, and/or funding CO_2 emissions reductions with Renewable Energy Certificates or comparable instruments.

Awards & Recognition

BEST Workplaces for Commuters™
FORTUNE 500 Top 20 2004, 2005, 2006

CLIMATE LEADERS U.S. Environmental Protection Agency — 2005

ENERGY STAR — 1998, 1999, 2001

WWF climate savers — 2005

USEPA Climate Protection Award 1998 and 2006

The Climate Group 2005

Green Power Purchaser Award 2006

IBM Efforts are Public and Verified

Computer Program Charter Member 1992 — **ENERGY STAR**

Charter Member 2000 — **WWF climate savers**

CCX Chicago Climate Exchange — Charter member 2003

SmartWay Transport Partnership U.S. ENVIRONMENTAL PROTECTION AGENCY

PEW CENTER on Global CLIMATE CHANGE — Business Environmental Leadership Council

CLIMATE LEADERS U.S. Environmental Protection Agency — Charter Member 2002

WRI Green Power Market Development Group Charter member 2000

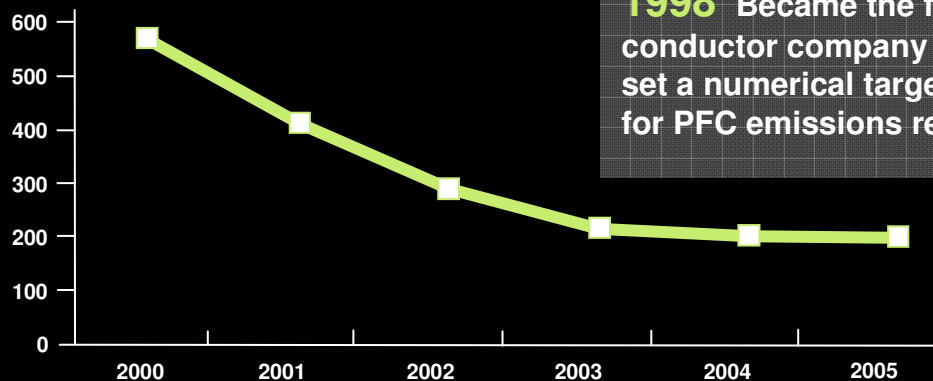**ClimateVISION** — 1605(b) voluntary emissions reporting since 1995

CARBON DISCLOSURE PROJECT — Since inception

Early Actions & Results

40%

Between 1990 and 2005, IBM's global energy conservation actions reduced or avoided CO_2 emissions by an amount equal to 40% of our 1990 emissions.

1998 Became the first semiconductor company to set a numerical target for PFC emissions reduction

58%

Chart (y-axis: 0 to 600; x-axis years 2000–2005):
- 2000: ~570
- 2001: ~410
- 2002: ~290
- 2003: ~210
- 2004: ~200
- 2005: ~195

Thank you