



IBM Deep Computing

Green Computing: Realities and Myths

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IBM Deep Computing

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Purposes and Caveats

- What does green computing mean to IBM
- What are some of the green IBM Solutions
- What are some of the claims
- What are some of the assumptions we have made
- What does our research show
- Conclusions

Environmental responsibility is a core IBM value

New Goal Announced!

Further extend IBM's early accomplishments by reducing CO₂ emissions associated with IBM's energy use 12% from 2005 to 2012 via energy conservation, use of renewable energy, and/or funding CO₂ emissions reductions with Renewable Energy Certificates or comparable instruments.

Awards & Recognition



FORTUNE 500
Top 20
2004, 2005,
2006



1998,
1999,
2001



2005



2005



USEPA
Climate
Protection
Award
1998 and 2006



Green Power
Purchaser
Award 2006

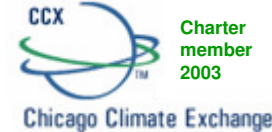
Environmental Efforts at Big Blue



Computer
Program
Charter
Member
1992



Charter
Member
2000



Charter
member
2003



Business Environmental
Leadership Council



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



WRI Green Power Market
Development Group
Charter member 2000



1605(b) voluntary
emissions reporting
since 1995

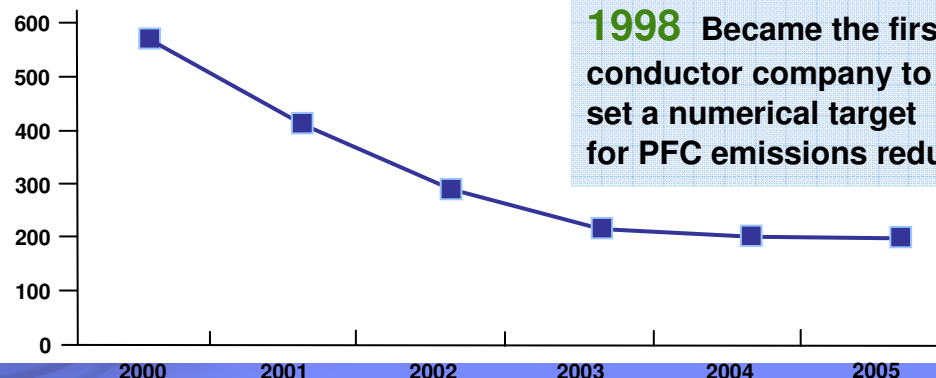
CARBON DISCLOSURE PROJECT

Since inception

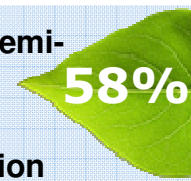
Early Results



Between 1990 and 2005, IBM's global energy conservation actions reduced or avoided CO₂ emissions by an amount equal to 40% of its 1990 emissions.



1998 Became the first semi-conductor company to set a numerical target for PFC emissions reduction



IBM offerings —Aimed at all aspects of energy efficiency

Energy Solutions

- Data Center Stored Cooling Solution
- Optimized Airflow Assessment for Cabling
- Scalable Modular Data Center
- Data Center Relocation and Consolidation Data Center Facilities Design

Energy Assessments

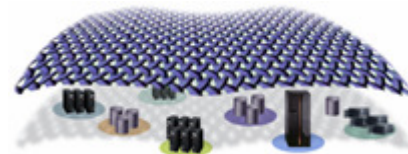
- Data Center Energy Efficiency Assessment
- Accelerator for Rationalization
- IBM Optimization and Integration Services: Server Consolidation
- Server and Storage Power/Cooling Trends and Data Center Best Practices
- Data Center Thermal Analysis and Optimization Facilities Integration
- Data Center Health Audit for IT

Energy Management



PowerExecutive
For trending and capping

Tivoli Provisioning and Monitoring
Actively moving workloads and power up/down resources and aligning workloads



Virtualization on IBM Systems and IBM System Storage drives utilization up and annual power cost down

Energy Technology

BladeCenter®
Open, Easy, Green



IBM power supplies
Measurement built in

IBM System Storage™
Increases utilization and energy efficient ILM

X-Architecture™
System x designed for efficiency

Rear Door Heat Exchanger
Thermal management innovation

Power Architecture™
Processor efficiency management for System i and System p

IBM z/Architecture™
System z™ lean and green leadership

IBM Blue Gene
#1 efficient system in Green 500 list

The Green500

Green500 Rank	MFLOPS/W	Site	Computer	Total Power (kW)	Top500 Rank
1	357.23	Science and Technology Facilities Council – Daresbury Laboratory	Blue Gene	31.10	121
2	352.25	Max-Planck	Blue Gene	62.20	40
3	346.95	IBM-Rochester	Blue Gene	124.40	24
4	336.21	Forschungszentrum Juelich	Blue Gene	497.60	2
5	310.93	Oak Ridge National Laboratory	Blue Gene	70.47	41
6	210.56	Harvard University	eServer Blue Gene	44.80	170
7	210.56	KEK	eServer Blue Gene	44.80	171
8	210.56	IBM -Almaden Research Center	eServer Blue Gene	44.80	172
9	210.56	IBM Research	eServer Blue Gene	44.80	173
10	210.56	IBM Thomas J Watson Research	eServer Blue Gene	44.80	174

Typical Power and Cooling Sales Chart

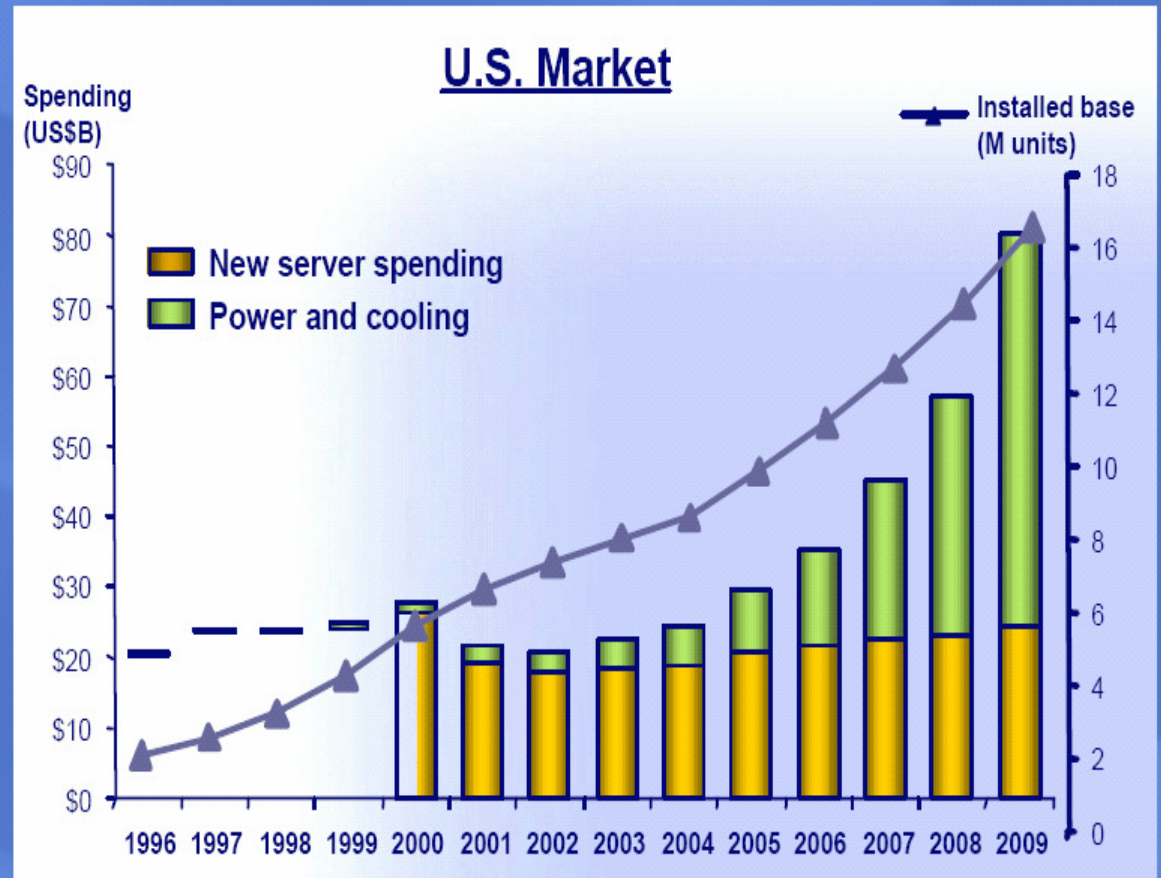
- Power and cooling spend will exceed new server spending (Gartner 2006)

2000 – Raw processing “horsepower” is the primary goal, while the infrastructure to support it is assumed ready

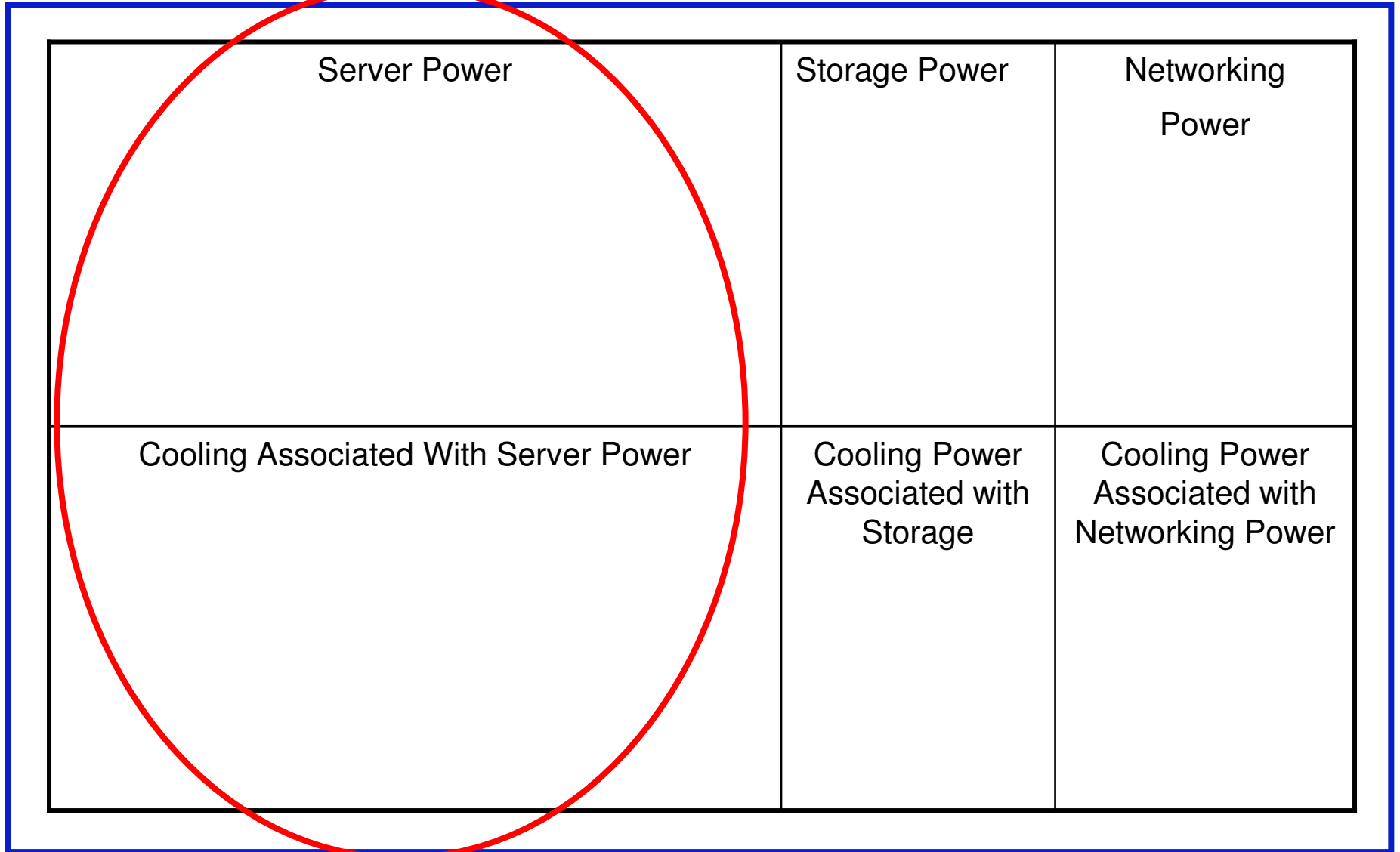
2006 – Raw processing “horsepower” is a given, but the infrastructure to support deployment is a limiting factor

Three Cooling Challenges

1. The System
2. The Rack
3. The Data Center



Scope of Study



What Does This Study Include and Assumptions

- Measured Power Consumption for Servers Running Linpack
- Power Usage Effectiveness
 - Ratio of Total Facility Power to IT Power
 - Range of numbers from 0.7 to 3.0
 - Used the number 2.1
- Common PUE for Air and Water Cooled Systems
- Average Cost of Electricity
 - Retail US Industrial Average Cost for 2007
 - Price 6.25 cents Kilowatt Hour
- Average Cost of Floorspace - \$200 per square foot

What Does This Study Omit

- The power for the complete compute infrastructure
 - Only Server Power Included
 - Network and Storage Not Included
 - Network included in Blue Gene/P but not in other solutions
- Service and Maintenance Costs in terms of Man Power
- Cost to bring power to the building
 - Estimate \$20K per Kilowatt
- Installation of Power and Cooling Infrastructure

Simple power & cooling cost analysis

<i>Rough figures, per Rack, based on purchase of large total system</i>	<i>System P Power 6 IH Cluster</i>	<i>Blue Gene/P</i>	<i>BladeCenter</i>	<i>iDataPlex</i>	<i>System X 1U Server</i>
<i>IT power & cooling costs, per year</i>	\$34,493	\$ 36,217	\$ 21,385	\$28,104	\$ 26,308
<i>Lifetime costs – 3 years of IT power, cooling, and floor space</i>	\$115,478	\$120,651	\$76,156	\$96,313	\$ 90,924
<i>Initial purchase price of rack</i>	\$1,625,000	\$1,600,000	\$625,000	\$250,000	\$422,000
<i>Number of TeraFlops Per Rack</i>	7.219	13.93	5.795	6.26	3.803
<i>“Lifetime costs” – as a percentage of initial purchase price</i>	7.1%	7.5%	12.2%	38.5%	21.5%

Simple power & cooling cost analysis – Modified

<i>Rough figures, per Rack, based on purchase of large total system</i>	<i>System P Power 6 IH Cluster</i>	<i>Blue Gene/P</i>	<i>BladeCenter</i>	<i>iDataPlex</i>	<i>System X 1U Server</i>
<i>IT power & cooling costs, per year</i>	\$71,744	\$ 89,681	\$ 52,954	\$69,592	\$ 65,144
<i>Lifetime costs – 3 years of IT power, cooling, and floor space</i>	\$227,233	\$281,042	\$170,863	\$220,776	\$207,432
<i>Initial purchase price of rack</i>	\$1,625,000	\$1,600,000	\$625,000	\$250,000	\$422,000
<i>Number of TeraFlops Per Rack</i>	7.219	13.93	5.795	6.26	3.803
<i>“Lifetime costs” – as a percentage of initial purchase price</i>	14.0%	17.6%	27.3%	88.3%	49.1%

BladeCenter Hard Drive Component Analysis

<i>rough figures, per rack, based on purchase of large total system</i>	<i>BladeCenter No Hard Drive</i>	<i>BladeCenter 8 GB Flash Drive</i>	<i>BladeCenter 73 GB 10K SAS Drive</i>	<i>BladeCenter 32 GB Solid State SATA</i>
<i>IT power & cooling costs, per year</i>	\$17,080	\$17,290	\$17,634	\$17,357
<i>Lifetime costs – 3 years of IT power, cooling, and floor space</i>	\$63,239	\$63,869	\$64,901	\$64,070
<i>Lifetime Costs – 3 years of IT Power, cooling and floor space for a PetaScale.</i>	\$10,912,667	\$11,021,369	\$11,199,457	\$11,056,062
<i>Cost Relative to 8 GB Flash Drive</i>	0.99	1	1.016	1.003

BladeCenter Hard Drive Component Analysis

<i>rough figures, per rack, based on purchase of large total system</i>	<i>BladeCenter 8 GB RAM</i>	<i>BladeCenter 16 GB RAM</i>	<i>BladeCenter 32 GB RAM</i>
<i>IT power & cooling costs, per year</i>	\$15,978	\$17,290	\$19,121
<i>Lifetime costs – 3 years of IT power, cooling, and floor space</i>	\$59,935	\$63,869	\$69,364
<i>Lifetime costs – 3 years of IT power, cooling, and floor space for a PetaFlop.</i>	\$10,342,556	\$11,021,369	\$11,969,626
<i>Cost Relative to Standard 2 GB/core</i>	.938	1	1.086

CONCLUSIONS

- Going green is very important.
- IBM understands the importance of going green.
- There is a lot of very marketing material out there.
- It is very important to look at the fine print in these claims.
- For large scale systems even small decisions can have large impacts.