Computing in a Carbon Sensitive Environment

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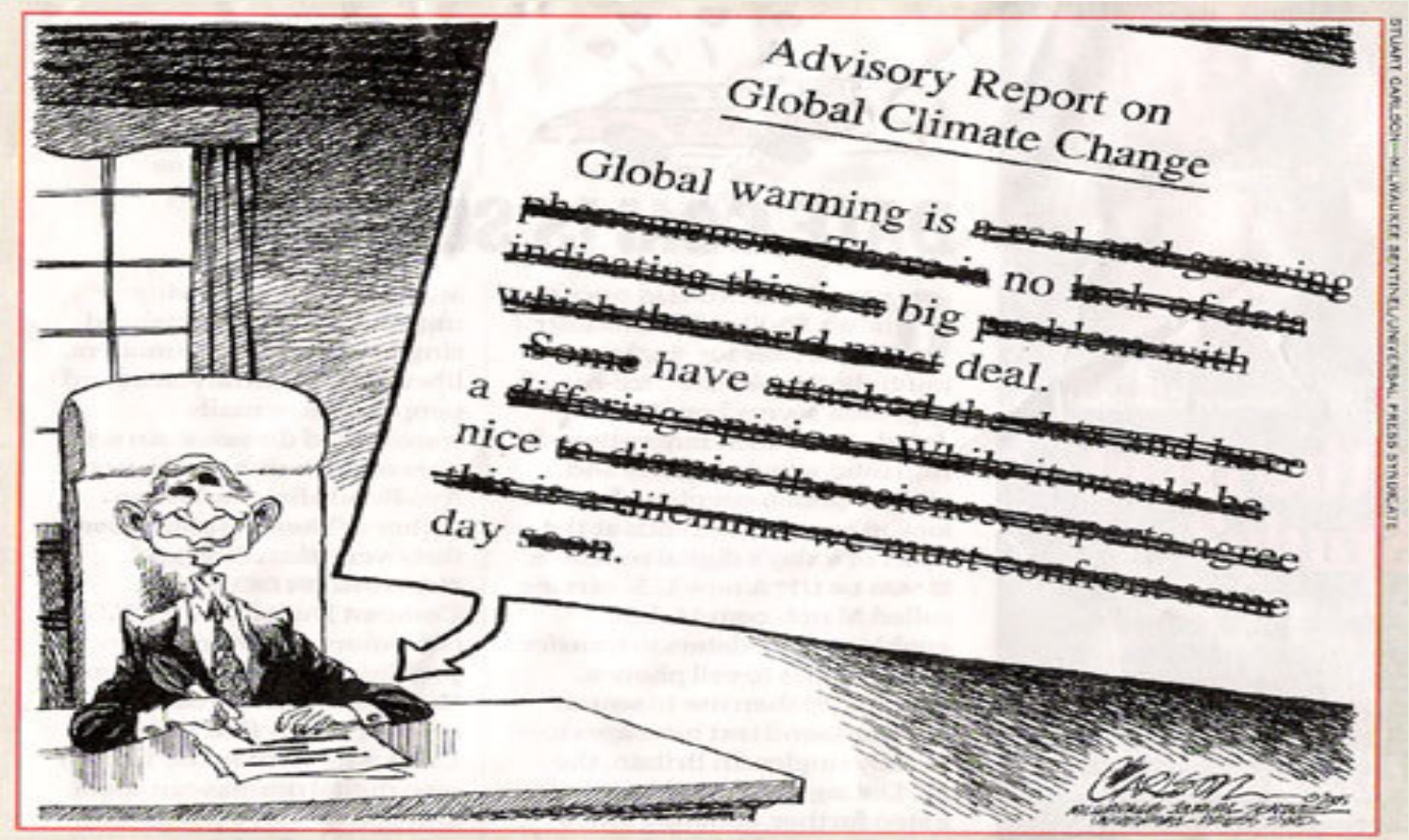
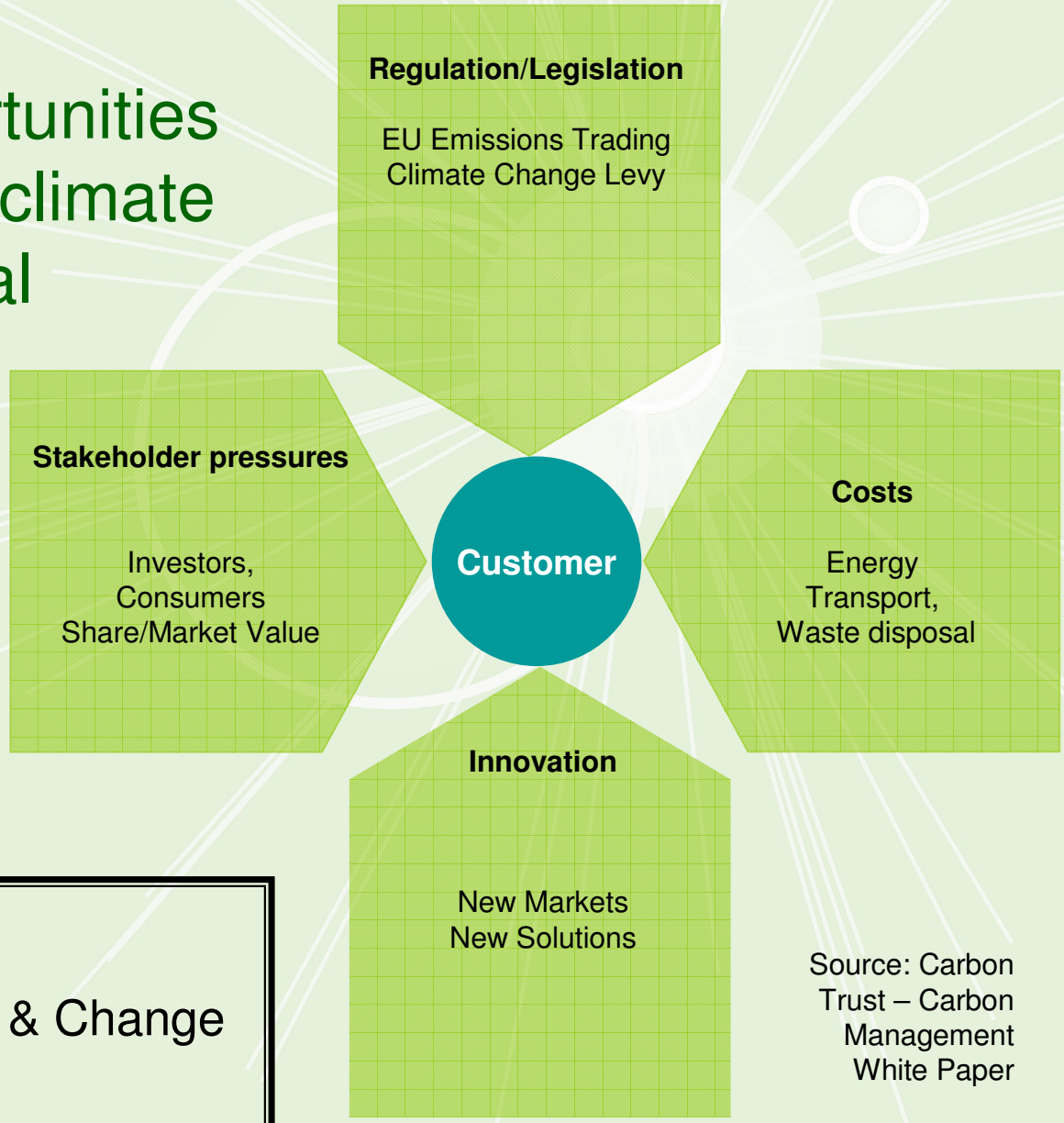
Why should clients care?

Is climate change happening and is human activity the cause?
This is business sense not politics…



The business opportunities and risks related to climate change have several interrelated drivers



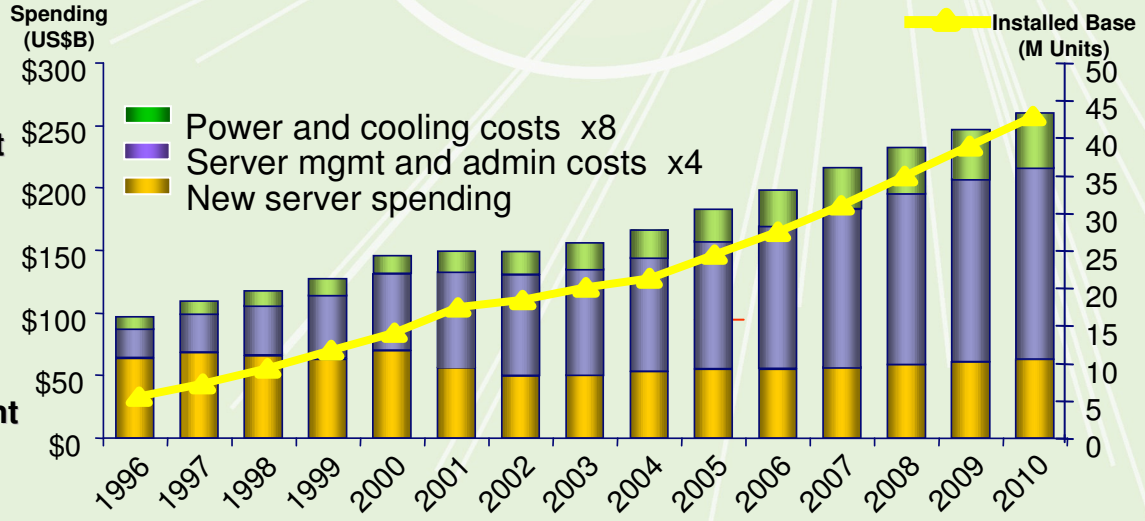
Source: Carbon Trust – Carbon Management White Paper

Data centers are at a tipping point

- Left unchecked, the cost to power and cool servers in the future may well equal the cost of acquisition.
- If IDC 2010 forecast holds, the cost to power and cool servers in the data center will increase by 54%.
- IT executives now rank power and cooling in the top 5 among current concerns.

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

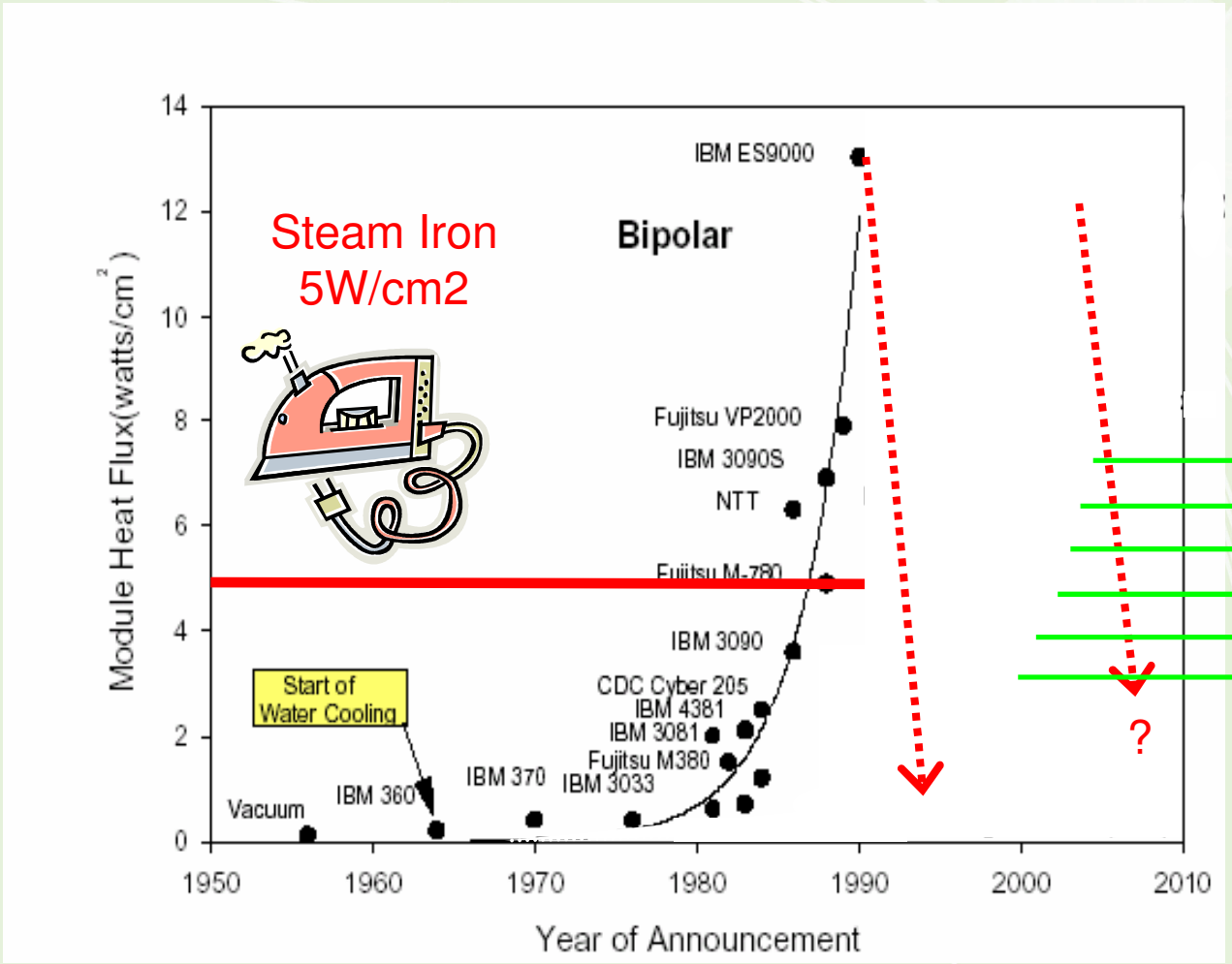
2006 – Raw processing "horsepower" is a given, but the infrastructure to support deployment is a limiting factor



SOURCE: IDC, 'Worldwide Server Power and Cooling Expense 2006-2010,' Document #203598, Sept. 2006

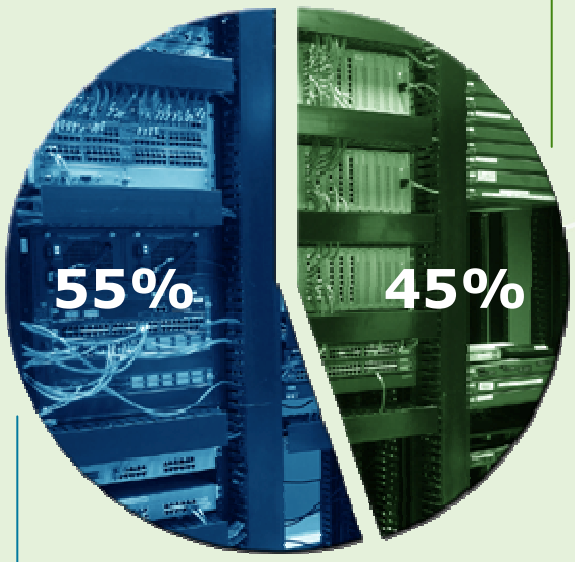
The Power Problem; an Industry Dilemma

After: R. Schmidt et al., IBM J. R&D, (2002).



How is energy typically used in the data center?

Data center



Data source: *Creating Energy-Efficient Data Centers, , U.S. Department of Energy , Data Center Facilities and Engineering Conference , May 18, 2007*

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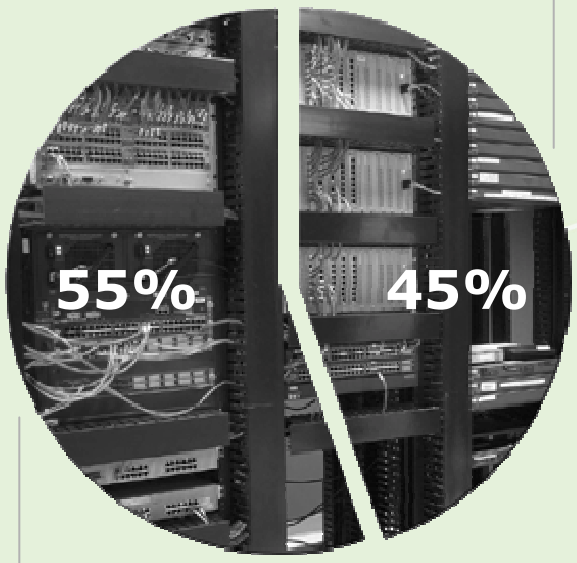
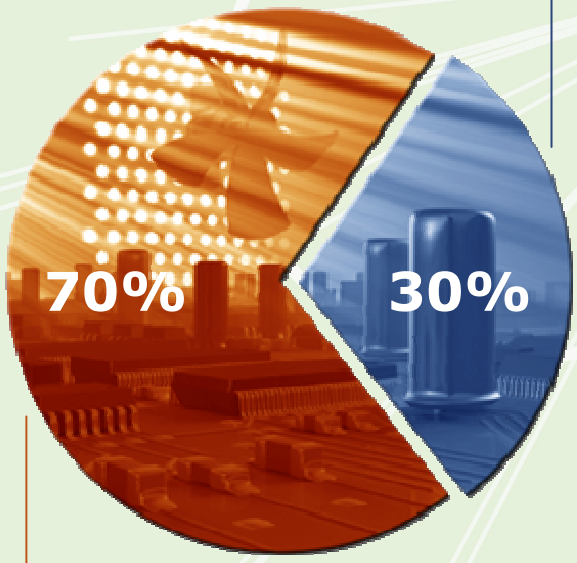


Server hardware



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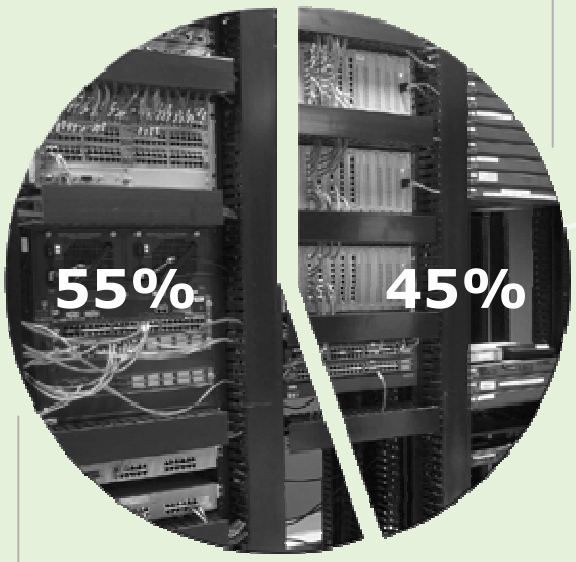
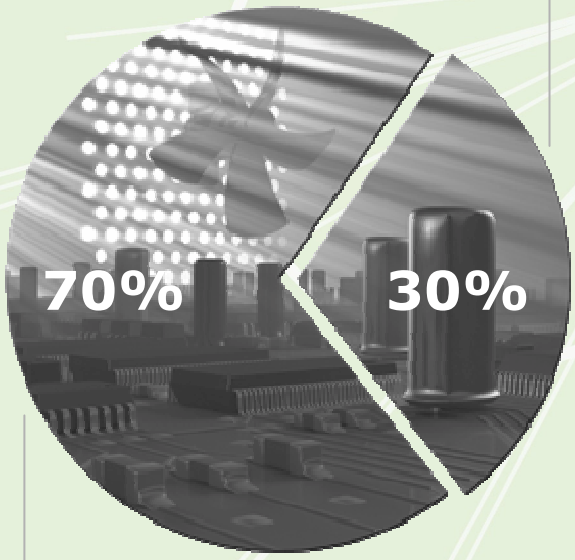
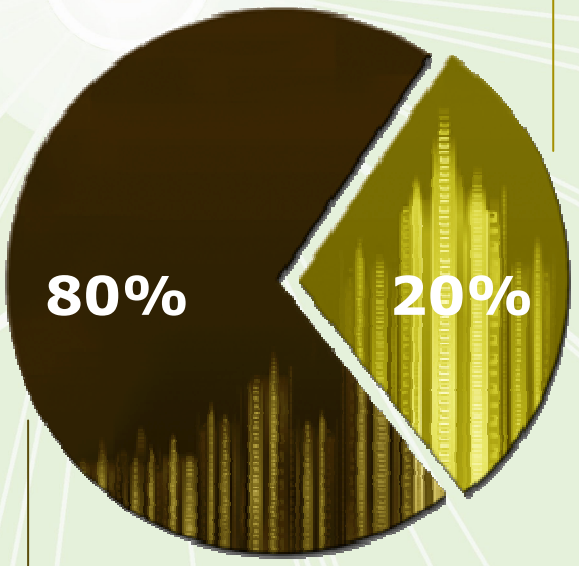


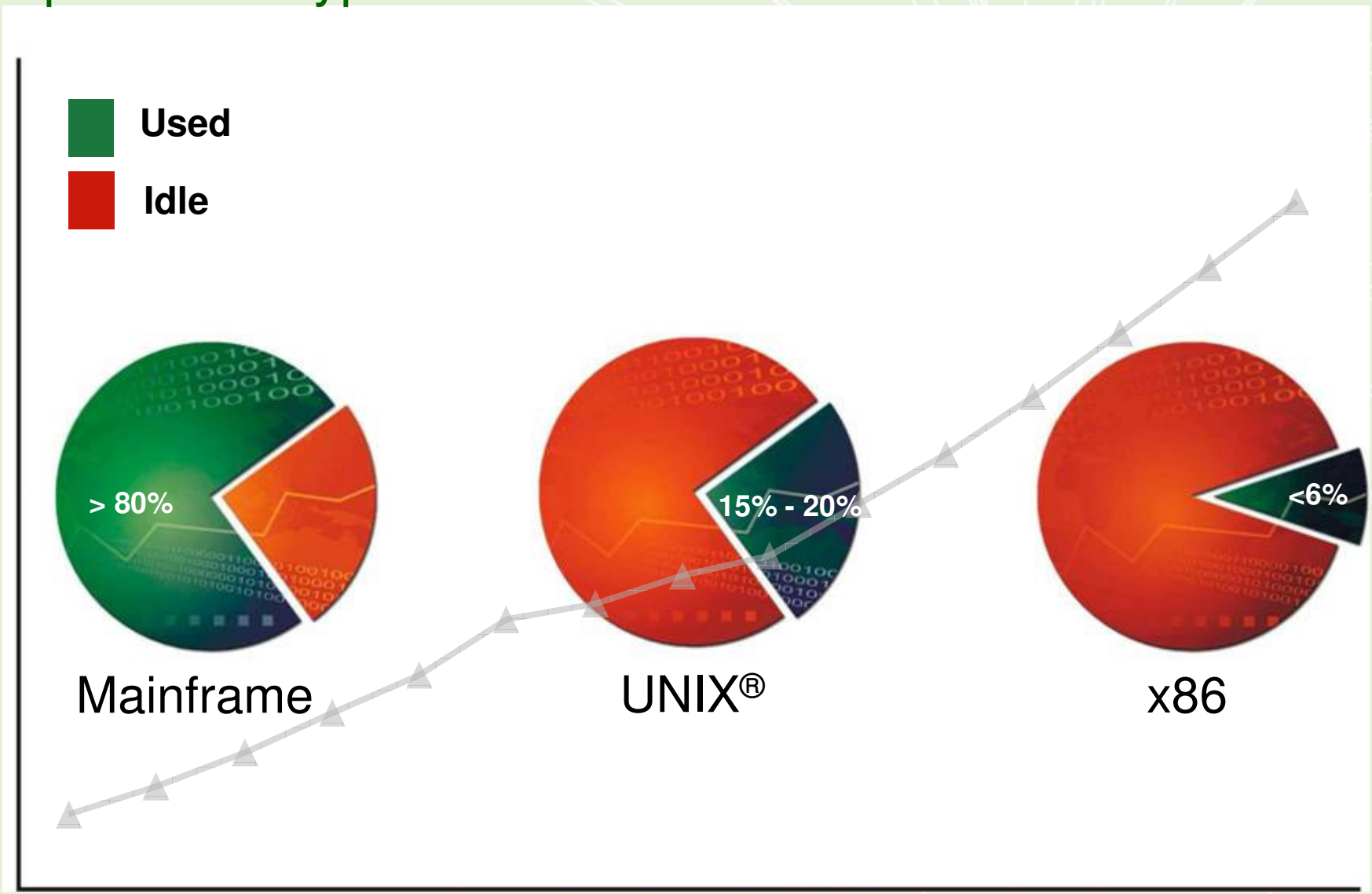
Server hardware



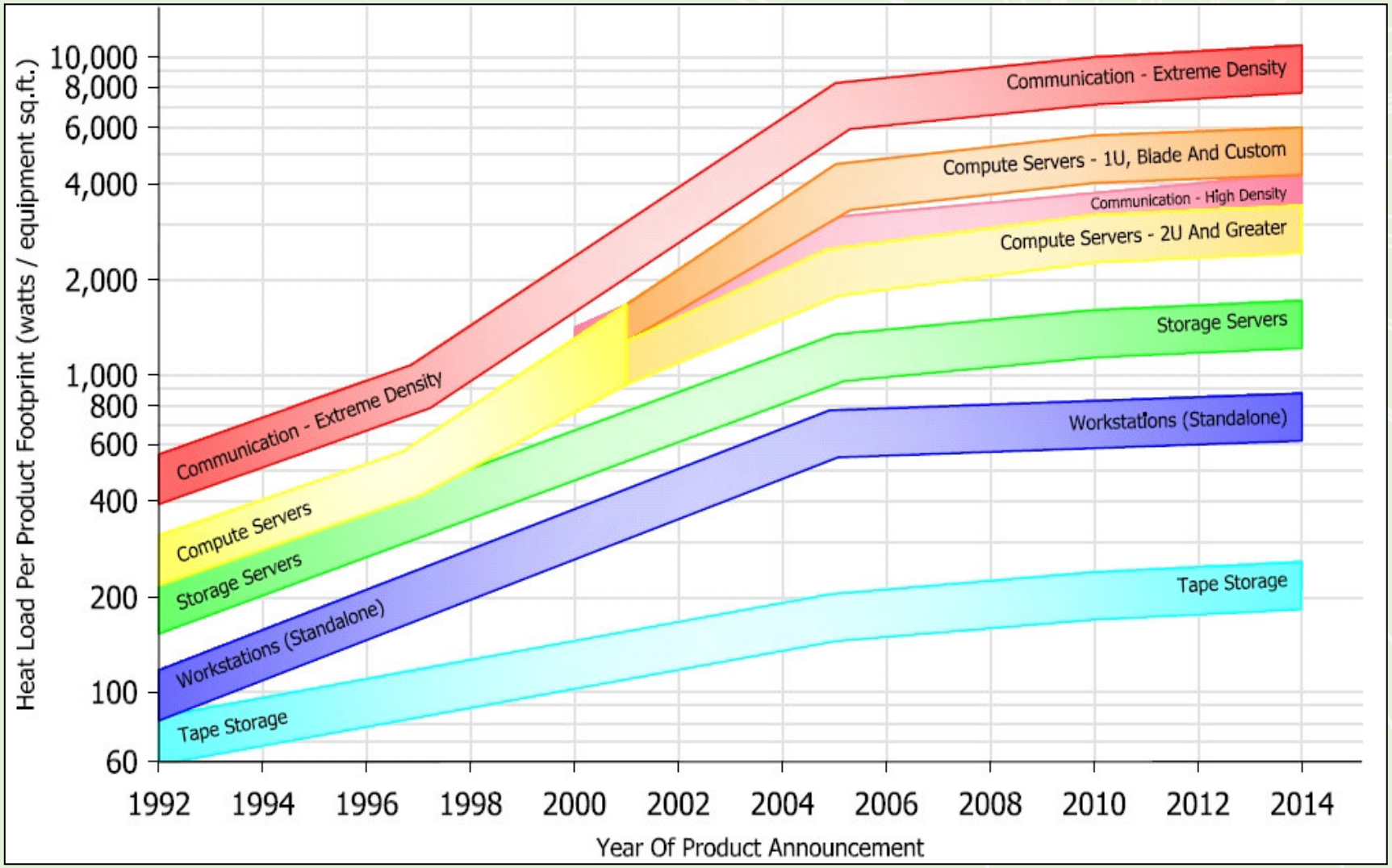
Server loads



Comparison of typical server utilisation rates



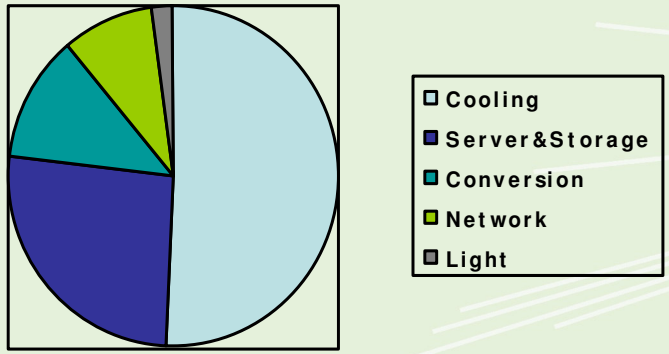
Storage Products are not the worst offenders - could do better



Source: IBM

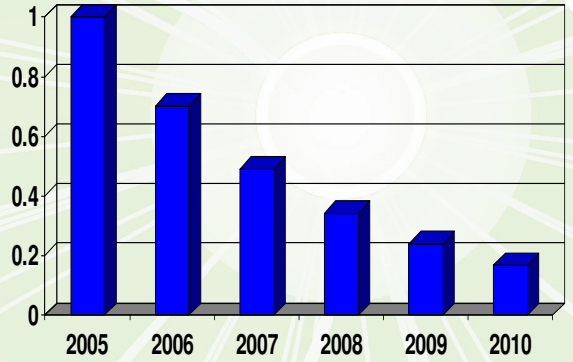
Storage Power Landscape

Components of Data Center Power Consumption



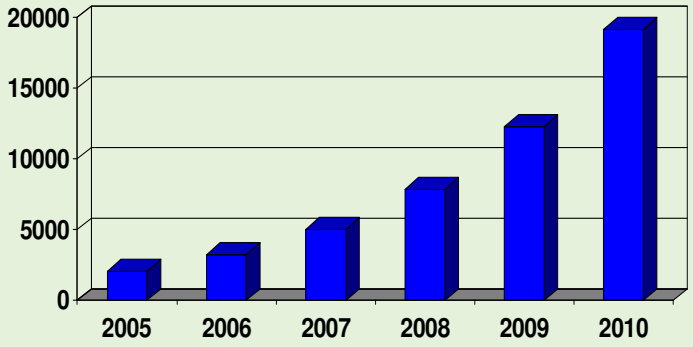
Source: IBM

Storage Power Consumption/GB



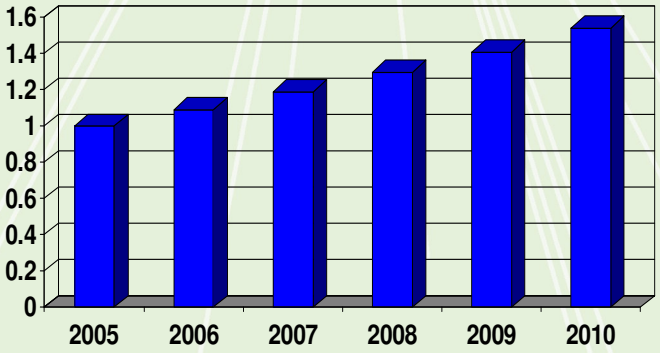
Source: IBM

Data Center Storage Usage External PB Shipped



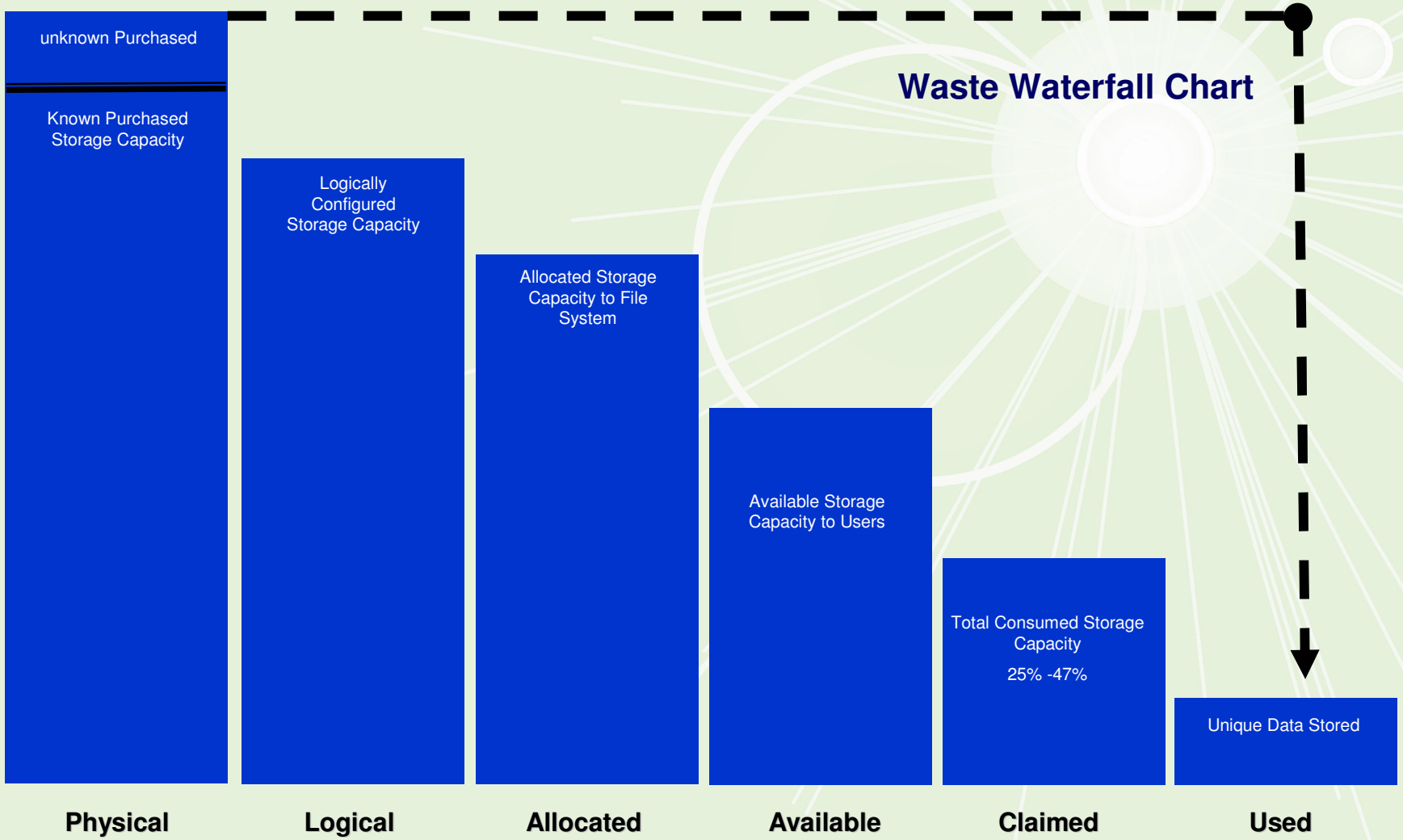
Source: IDC

Data Center Storage Power Growth



Source: IBM

Storage


Waste Waterfall Chart
unknown Purchased
Known Purchased Storage Capacity
Logically Configured Storage Capacity
Allocated Storage Capacity to File System
Available Storage Capacity to Users
Total Consumed Storage Capacity
25% -47%
Unique Data Stored
Physical
Logical
Allocated
Available
Claimed
Used

IBM Energy Efficiency Initiative *project Big Green*

Sharing with Clients

Applying 30 years of experience
Training a "Green-team"
Offering a 5 step "Green Plan"

Environmental Efforts At Big Blue

EPA's Top Awards
Reduced CO2 by 40%
$1B per year investment
Designing products with environmental consideration

Innovations in Energy Industry

Mobile Measurement Technology
Intelligent Oil Field
Intelligent Utility Networks
Integrated Mass Transit Info systems
Nano-technology Water Filtration

Collaboration with Energy Influencers

US—Alliance to Save Energy; EPA; GreenGrid / Europe—Green Power Market Development Group /Global—blade.org; World Wildlife Fund

Environmental responsibility is a core IBM value

New Goal Announced!

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

ENERGY STAR — 1998, 1999, 2001

CLIMATE LEADERS U.S. Environmental Protection Agency — 2005

WWF climate savers — 2005

USEPA Climate Protection Award 1998 and 2006

The Climate Group 2005

Green Power Purchaser Award 2006

Environmental Efforts at Big Blue

Computer Program Charter Member 1992 — ENERGY STAR

Charter Member 2000 — WWF climate savers

CCX Chicago Climate Exchange — Charter member 2003

SmartWay Transport Partnership

PEW CENTER 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

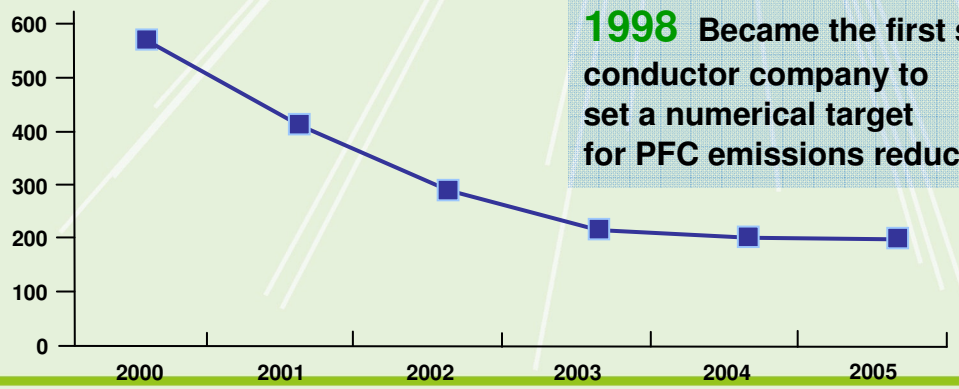
ClimateVISION — 1605(b) voluntary emissions reporting since 1995

CARBON DISCLOSURE PROJECT — Since inception

Early 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 its 1990 emissions.

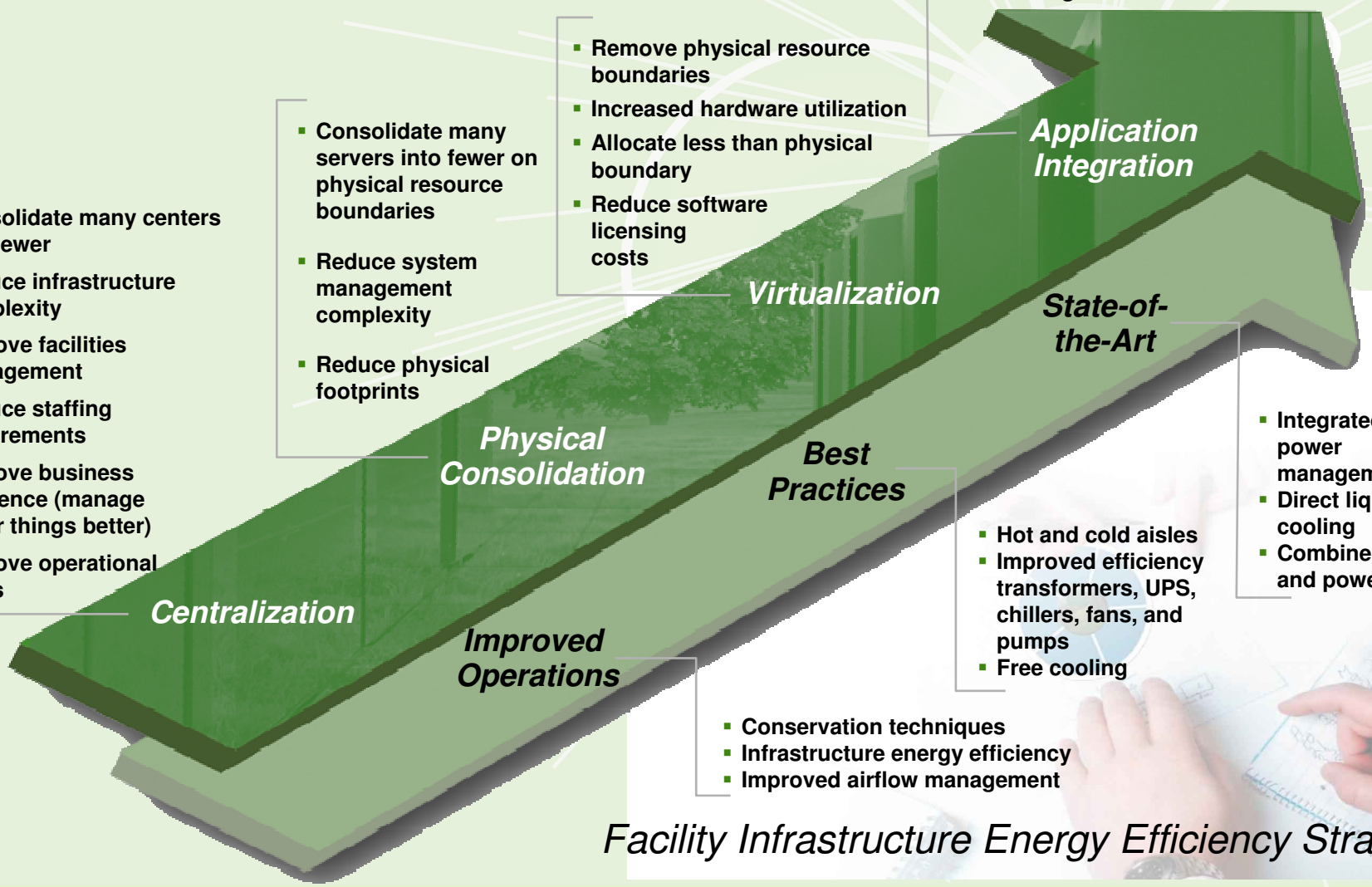


1998 Became the first semi-conductor company to set a numerical target for PFC emissions reduction

58%

IBM's Data Centers

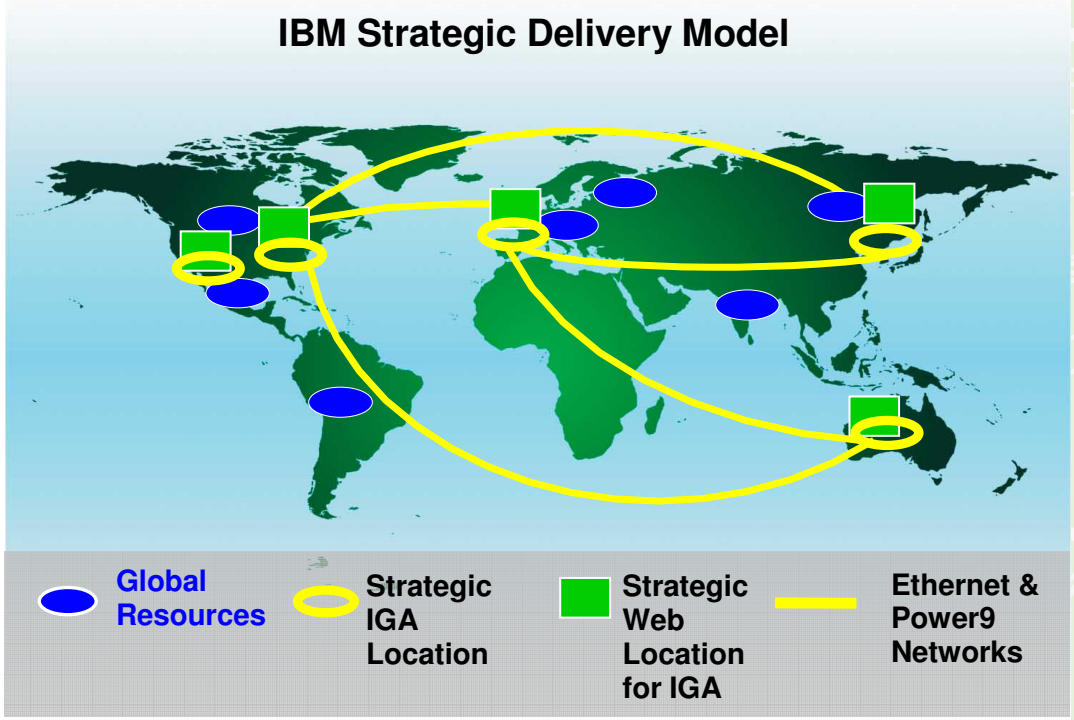
IT Infrastructure Energy Efficiency Strategy



Facility Infrastructure Energy Efficiency Strategy

IBM's Data Center Energy Efficiency History

A decade of improvement



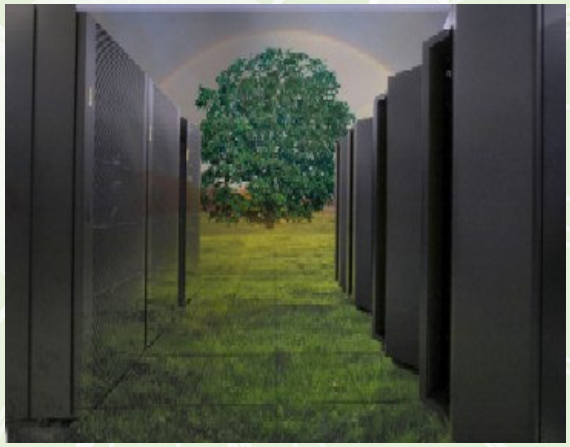
TECHNOLOGY

IBM Metrics	1997	Today
CIOs	128	1
Host data centers	155	7
Web hosting centers	80	5
Network	31	1
Applications	15,000	4,700

Tactical and operational efficiencies

- Consolidation of infrastructure
- Application consolidation/reduction
- Global resource deployment
- Enterprise end-to-end architecture optimization

IBM's Project Big Green Spurs Global Shift to Linux on Mainframe



- Consolidate approximately 3,900 servers.
- To 30 System z mainframes.
- Will run on Linux operating system.
- 80% reduction in energy consumption compared to existing base.
- Significant savings over five years in energy, software and support costs.

  – ***Invest in data centers we own or manage for clients to double compute capacity by 2010 without increasing power consumption or carbon footprint saving 5 billion kilowatt hours per year . . . equals energy consumed by Paris –"the City of Lights"***

Project Big Green Progression – The 5 Step plan

Green-Plan 5 Steps

1. ***Diagnose*** : Evaluate existing facilities and energy goals.

2. ***Build:*** Plan, build or update to an energy efficient data center.

3. ***Implement:*** Implement virtualisation or new technology

4. ***Manage & Measure:*** Use management software.

5. ***Cool:*** Exploit liquid cooling in the data center

Home Power Consumption!

Energy efficiency - Diagnose

What can be done:

- Server consolidation study which includes CO2 emissions.
- Environmental Study (Zodiac V5)
- Storage Priority Assessment.

The benefits:

Energy & Climate	Current	Alt.Case	Change	Difference
avg RackU / Server	1.7	2.7	58%	1.0
Total RackU	127.8	35.0	-73%	-92.8
30U Racks	4.3	1.2	-73%	-3.1
Total kW per hr	40.7	14.1	-65%	-26.5
1 yr Adjusted kWh	358,006.5	124,485.7	-65%	-233,520.8
Heat BTU/hr	92,986.3	32,333.1	-65%	-60,653.2
1 yr C02 tonnes	153.2	53.5	-65%	-99.6
1 yr Carbon tonnes	41.8	14.6	-65%	-27.2
RIPs /kW	1,457.0	3,544.0	143%	2,087
RIPS / tonne CO2	386.8	936.2	142%	549
W /m2	19,099.0	24,240.0	27%	5,141
Power Cost	£28,615.25	£9,950.07	-65%	-£18,665.18

energy&climate

CO2 needs 330 Trees p.a.
or 596,695 km p.a. @ 167 g/km

Virtualize

Improve operational efficiency and risk management while reducing energy usage and operational costs by 80%

Client requirements

- Needed to reduce systems management complexity
- Needed to increase stability, availability, and provide world-class security
- Improve operational costs and energy efficiency

Solution: Consolidate workload to System z

- Consolidate 3,900 servers to 30 System z mainframes
- Migrate servers delivering largest savings first
- Eliminate assets with lowest utilization first
- Aggregate by customer work portfolio to leverage strong customer buy-in
- Focus on freeing up raised floor space
- Provision new applications to the mainframe

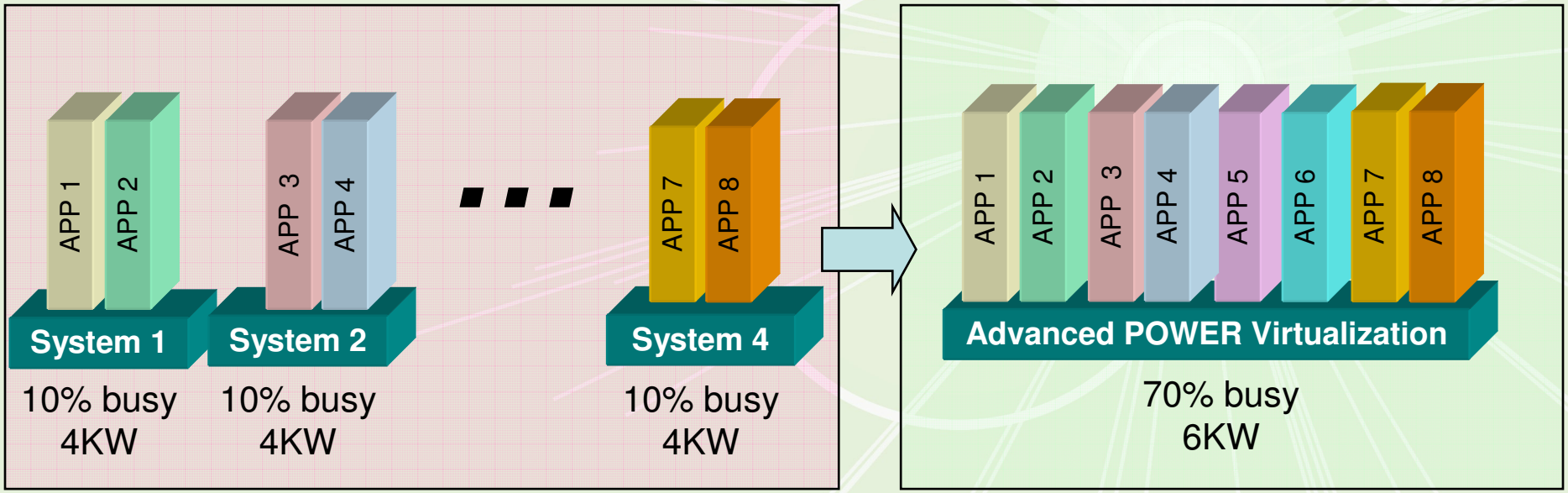
Benefits

- Annual energy usage reduced by 80%
- Total floor space reduced by 85%

Initial priority for consolidation to Linux on System z

Energy Management Policy

- Server Consolidation Conserves Energy



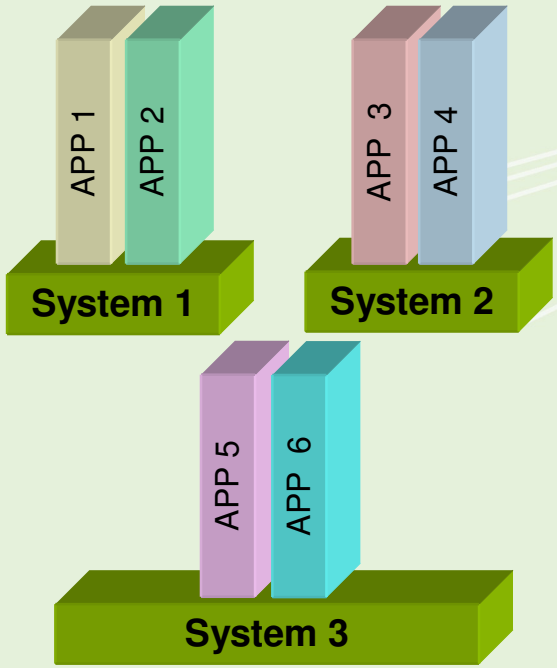
Total Power 16KW

Total Power 6KW

Server consolidation exploiting virtualisation is a very effective tool in reducing energy costs

Energy Management policy example

Workload Migration
Enables Dynamic Server Consolidation



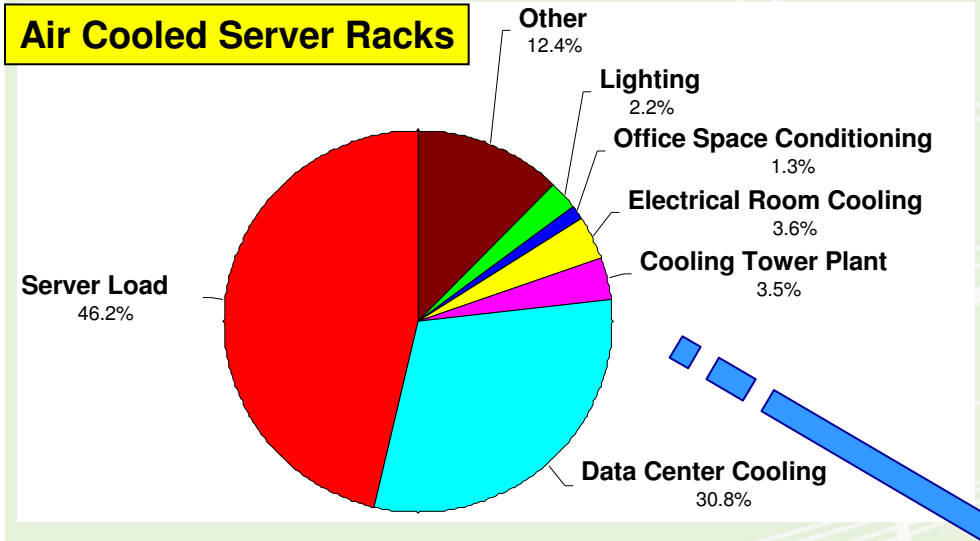
Use of hibernation, powering off servers, and other low power states in combination with other workload balancing and provisioning tools can provide a valuable tool in management of Power and Thermal issues.

Automate Energy Control
Policy-based automation

Control Energy Consumption
Consolidate workloads to reduce

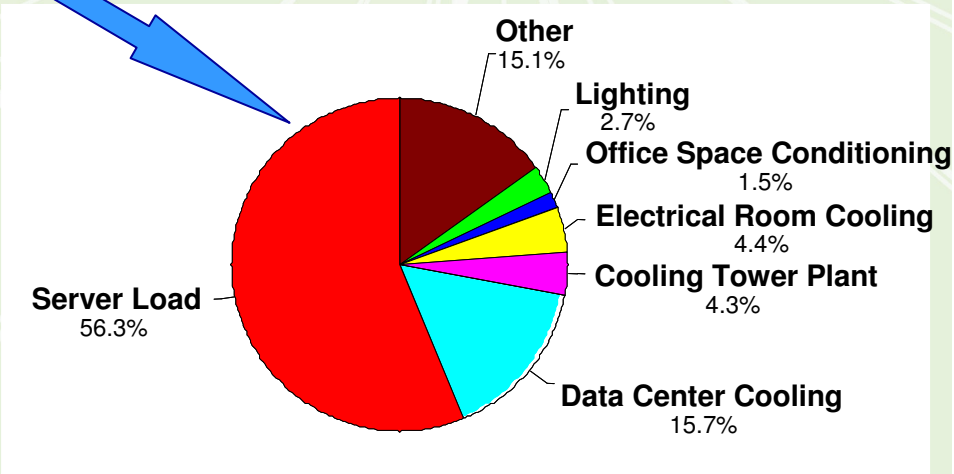
Datacenter Power Usage for Air versus Water Cooled Systems

Air Cooled Server Racks



Description	Electricity Consumption(kW) with Air Cooled Servers	Electricity Consumption(kW) with Water Cooled Servers
Other	402	402
Lighting	73	73
Office Space Conditi	41	41
Electrical Room Coo	118	118
Cooling Tower Plant	114	114
Data Center Cooling	1000	418
Server Load	1500	1500
Total Load	3248	2666

Water Cooled Server Racks
20% less total load



Savings of ½ million dollars/year at $0.10 / kw-hr

Manage and Measure & Cool

IBM Energy Management Solution and IBM Rear Door Heat eXchanger

Client requirements

- Improve how to meter, control, and cap power usage
- Actively moving workloads and power up/down resources

Solution: IBM Energy Management and IBM Rear Door Heat eXchanger

- Power density of 200 watts per square foot
- Use of 2 Thermal Zones for targeted power and cooling
- Power and thermal meters to measure baseline and changes
- Rack based thermal cooling

Benefits

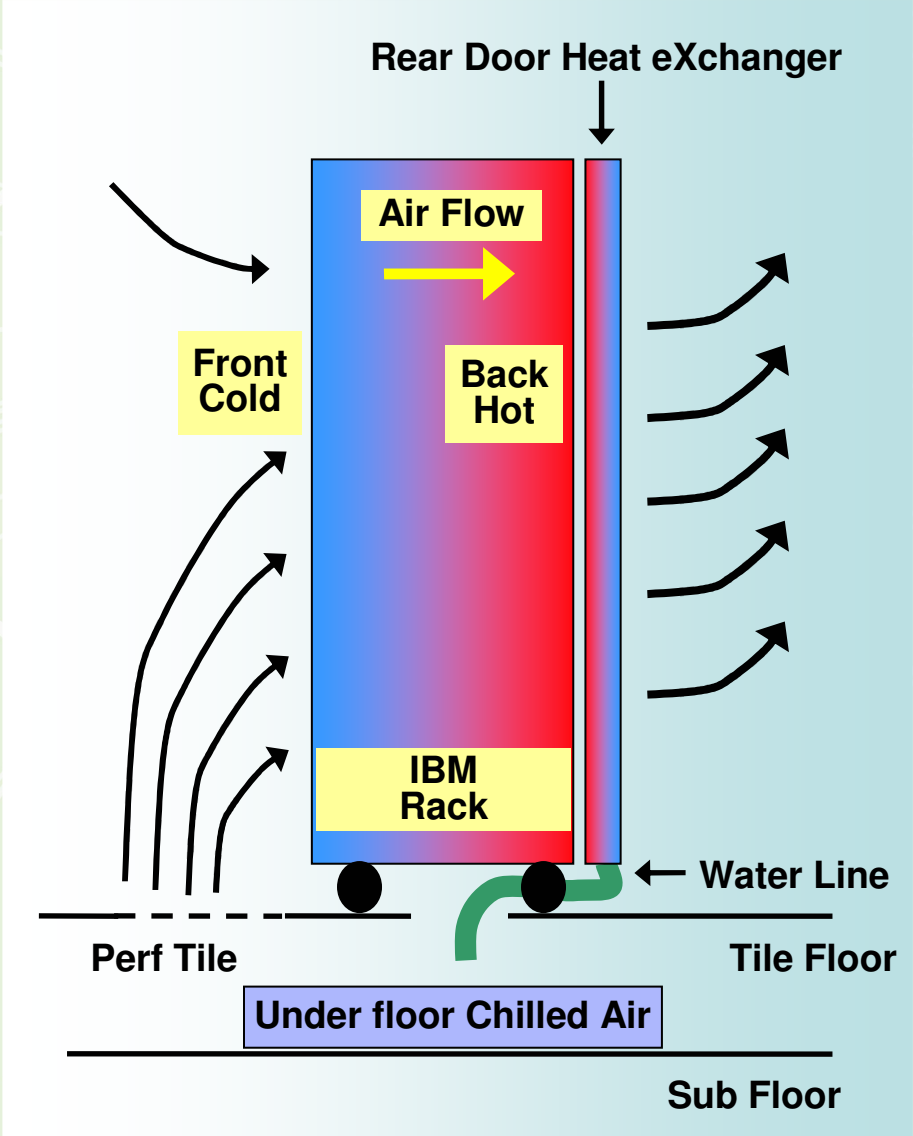
- Integrated Facilities and IT solution
- Rack Level Cooling Improves Efficiency 20-30%
- Match Cooling Load to Heat Load: 10-30% Savings
- Combined Air and Water or Refrigerant Cooling
- Reduces Equipment Costs/More Flexible Facility

Innovations Can Seem to be Deja-Vu All Over Again

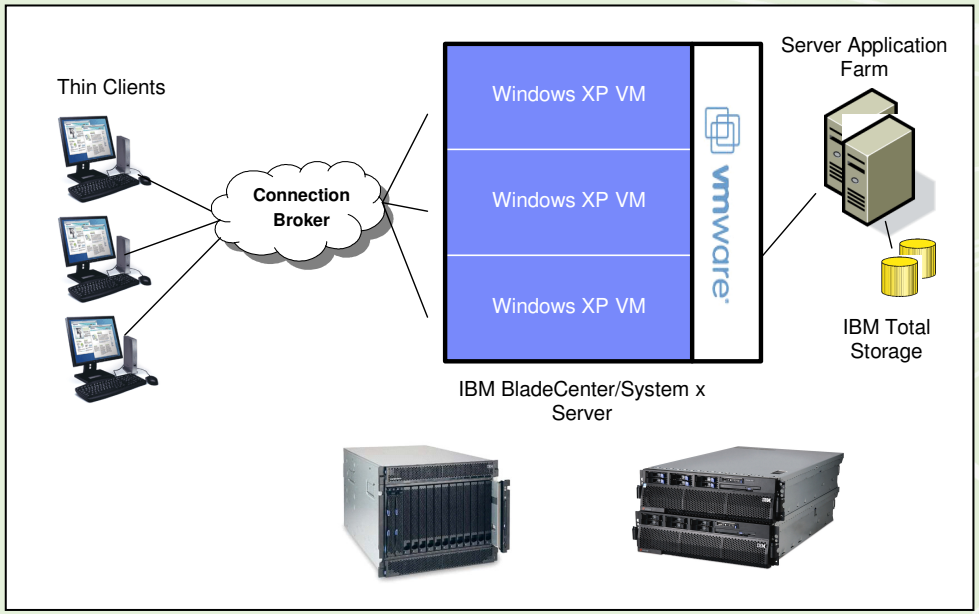
- **IBM's CoolBlue Initiative includes Rear Door Heat eXchanger which can remove over 50% of a rack's heat output**
  - No new fans or electrical load.
  - Attaches to back of rack (adds 5") No rearrangement of datacenter
  - Cost effective; 1KW cooling = €286

➲ **Rear Door Heat eXchanger adds cooling capacity at ~1/4 of the cost of traditional methods**

➲ **PS. Air is a lousy coolant**



Virtual Client Solution



Benefits

- Remote access to complete desktop environments,
- Improved client resource utilization & dynamic resource management
- Hardware flexibility (client and server)
- Software flexibility (OS and Apps)
- Access to multiple desktop environments/ user
- Complete Desktop / User / OS Isolation
- Fast, easy (template-based) desktop provisioning
- Easier, quicker, centralized desktop administration
- Full Desktop Recovery
- Lower Cost of Desktop Management & Support
- Improved Desktop Standardization
- Lower Security and Business risks

Limitations

- Protocol Limitations RDP more prevalent
- Higher Capital outlay on server farm
- End device typically needs to have RDP support
- Session density low vs citrix

Potential CO_2 & Power Savings

- Client consolidation uses much less power than traditional desktop deployments
- Example based on 200 users
  - **Traditional desktop power consumption:**
    - 200 users X average 150 watts per PC = **30,000 watts**
  - **Client Consolidation power consumption:**
    - (1 BladeCenter x 3,200 watts) + (200 Thin Clients x 20 watts) = 3,200 + 4,000 = **7,200 watts or**
    - (4 x3850 x 900 watts) + (200 Thin Clients x 20 watts) = 3,600 + 4,000 = **7,600 watts**
  - **Cost savings are estimated at 110 watts per desktop**
  - **Average Desktop today = 200Kg CO_2 per annum**

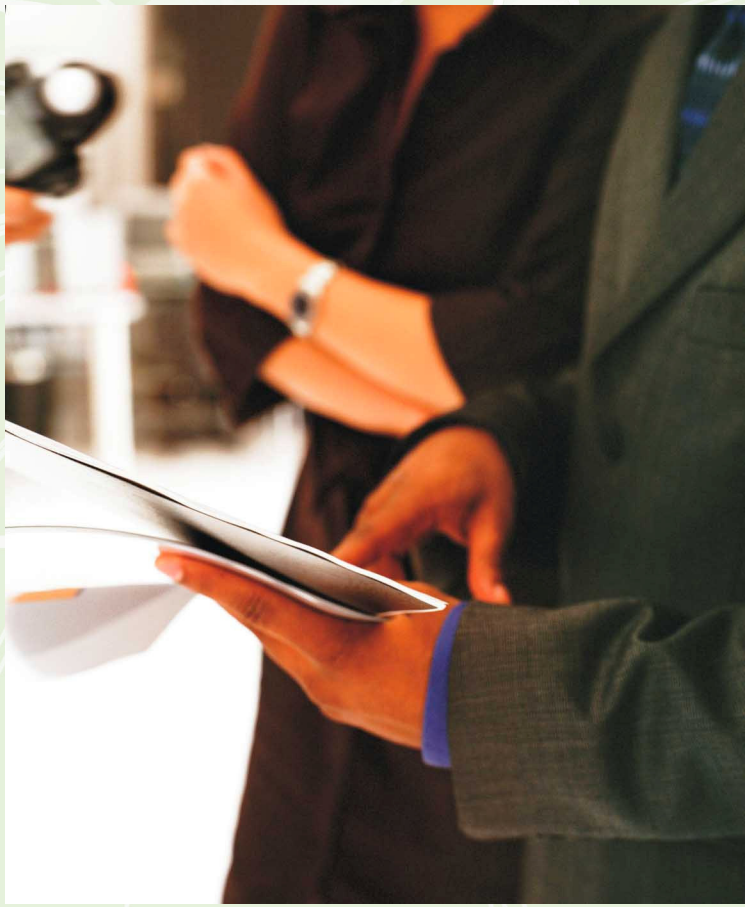
Estimated power savings of £80 per PC per year!
(assumes 8 pence per KW hour price for electricity and 24 hour power on – UK figures)

Benefits of a Green Data Center

	From	To
Financial 	Rising global energy prices	Ability to accurate view baseline energy cost
	Squeeze on IT budgets	Cost savings from more efficient energy use
	Constraints on IT growth	Relax budgetary pressures to allow growth
Operational 	High density server systems	More computing performance per kilowatt
	Exploding power & cooling cost	Shift energy to cool / energy to operate ratio
	Aging data centers	Extend the life of existing facilities
Environmental 	Corporate social responsibility	Meaningful energy conservation and reduced carbon footprint
	Lack public image	Improved public image
	Improve employee moral	Positive contribution to the Green movement creates a good place to work

Recommendations

- Get the facts on your data center energy use
- From an Facilities perspective
  - Perform a Data Center Energy Efficiency Assessment to establish baseline and initial recommended improvements for tactical control
- From an IT perspective
  - Implement an aggressive Server and Storage Consolidation and Virtualization for strategic impact



Thank You