Computing in an Energy Constrained Environment

Mick Walker
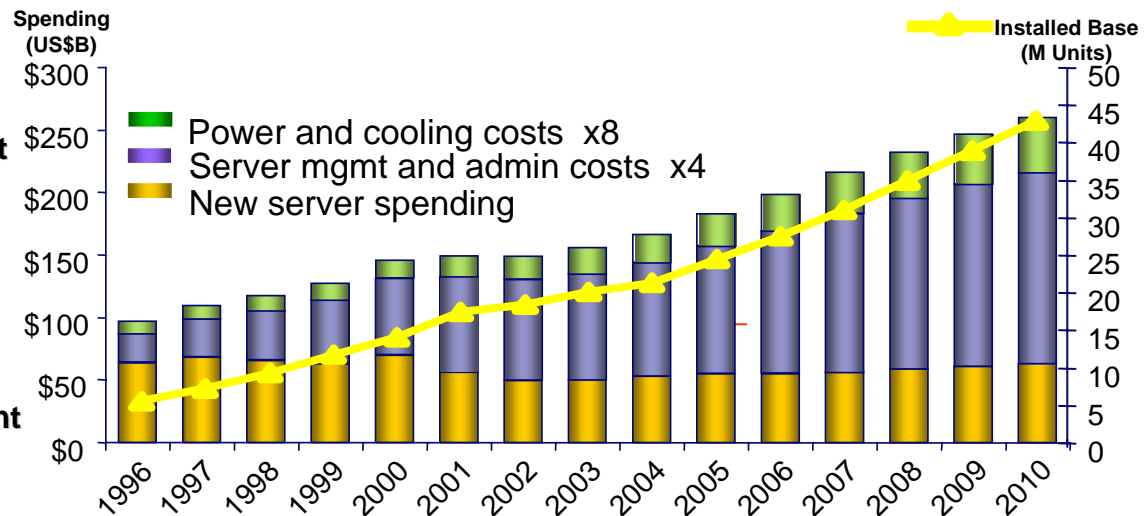
IBM Systems & Technology Group
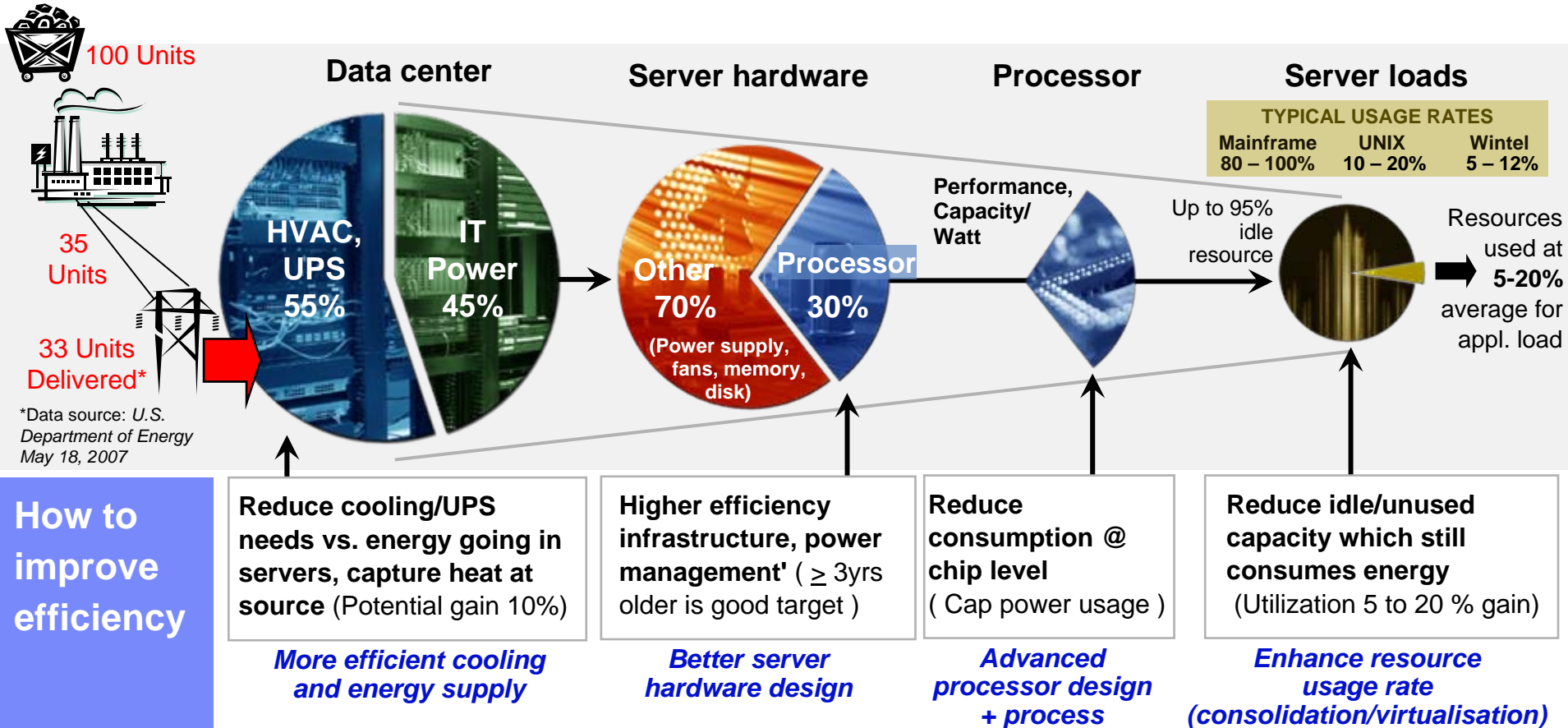
UKISA

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
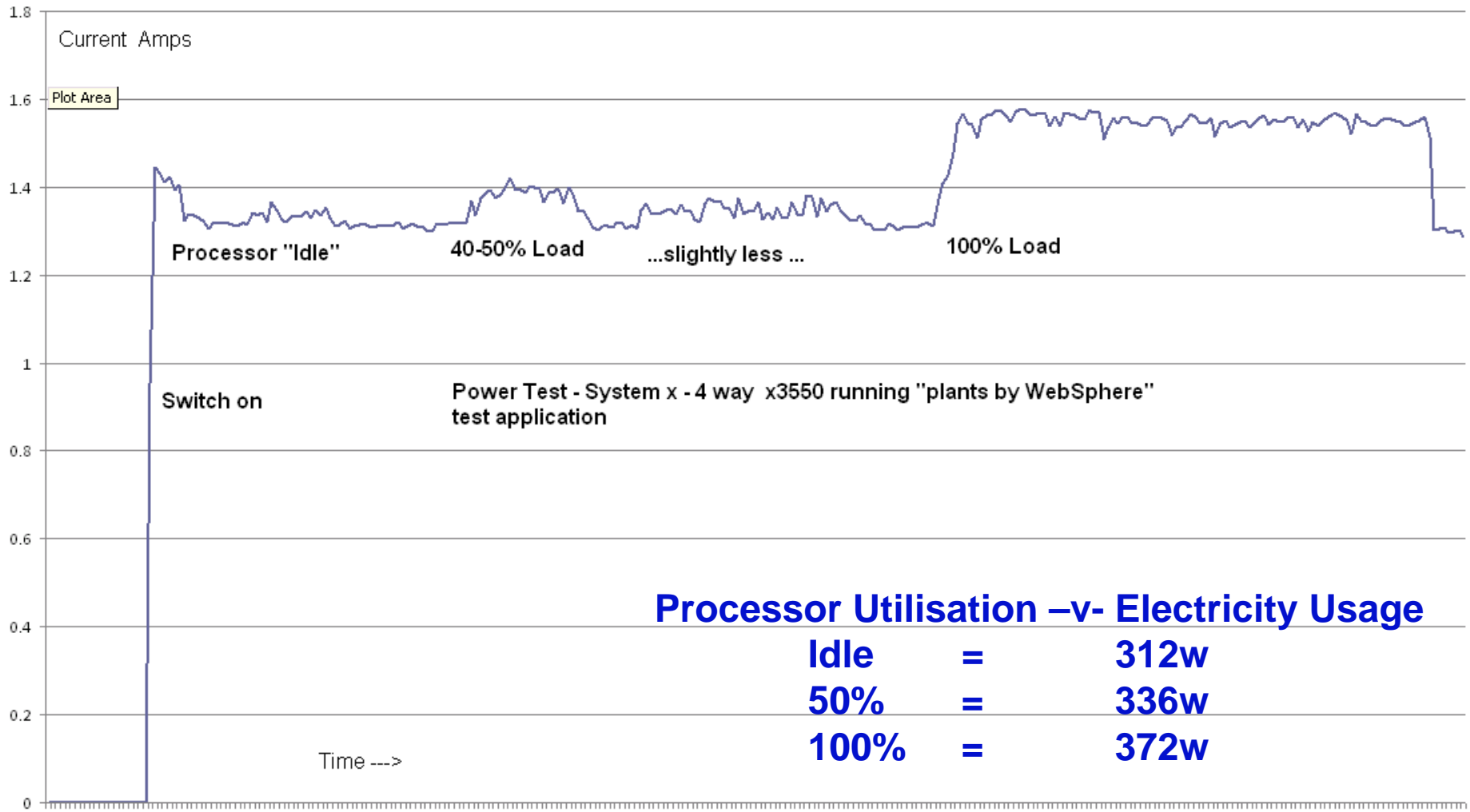
Spending (US$B)

Installed Base (M Units)

■ Power and cooling costs x8
■ Server mgmt and admin costs x4
■ New server spending

Energy has become significant part of the TCO, how is it consumed?

100 Units

35 Units

33 Units Delivered*

Data source: U.S. Department of Energy May 18, 2007

Data center

HVAC, UPS 55%

IT Power 45%

Server hardware

Other 70% (Power supply, fans, memory, disk)

Processor 30%

Processor

Performance, Capacity/ Watt

Up to 95% idle resource

Server loads

TYPICAL USAGE RATES

Mainframe 80 – 100%	UNIX 10 – 20%	Wintel 5 – 12%

Resources used at **5-20%** average for appl. load

How to improve efficiency

Reduce cooling/UPS needs vs. energy going in servers, capture heat at **source** (Potential gain 10%)	Higher efficiency infrastructure, power management' ($\geq$ 3yrs older is good target)	Reduce consumption @ chip level (Cap power usage)	Reduce idle/unused capacity which still consumes energy (Utilization 5 to 20 % gain)

More efficient cooling and energy supply

Better server hardware design

Advanced processor design + process

Enhance resource usage rate (consolidation/virtualisation)

Power consumption versus application load is measurable…

Processor Utilisation –v- Electricity Usage

Idle	**=**	**312w**
50%	**=**	**336w**
100%	**=**	**372w**

Within the chart:
- Current Amps
- Plot Area
- Processor "Idle"
- 40-50% Load
- …slightly less …
- 100% Load
- Switch on
- Power Test - System x - 4 way x3550 running "plants by WebSphere" test application
- Time --->

Storage Power Landscape

Components of Data Center Power Consumption

Legend:
- Cooling
- Server&Storage
- Conversion
- Network
- Light
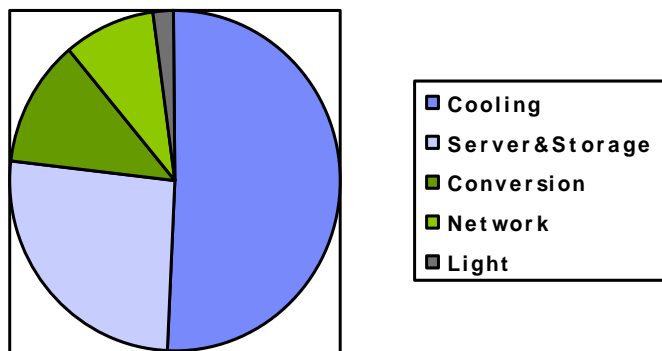
Source: IBM

Storage Power Consumption/GB

(Bar chart, years 2005–2010)
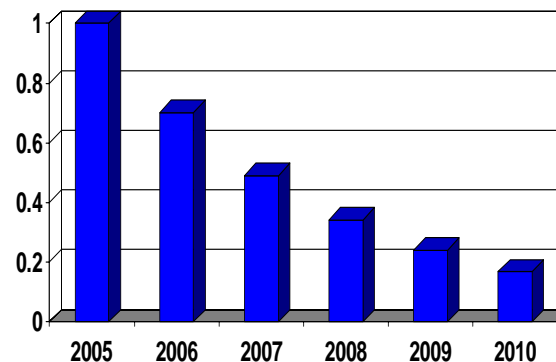
Source: IBM

Data Center Storage Usage External PB Shipped

(Bar chart, years 2005–2010, scale 0 to 20000)
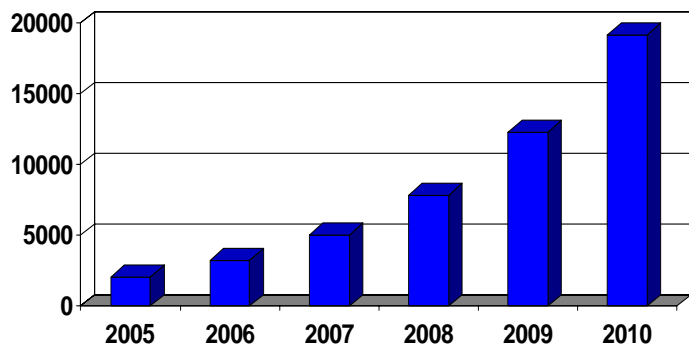
Source: IDC

Data Center Storage Power Growth

(Bar chart, years 2005–2010, scale 0 to 1.6)
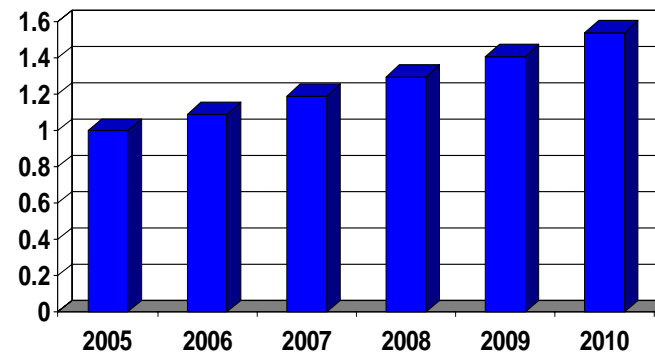
Source: IBM

How energy efficient is the data center today?
A simple standard can determine how much improvement is possible

- 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

Most energy-efficient		*Objective*	*Current*	Least energy-efficient
1.5	2.0	2.5	3.0	3.5
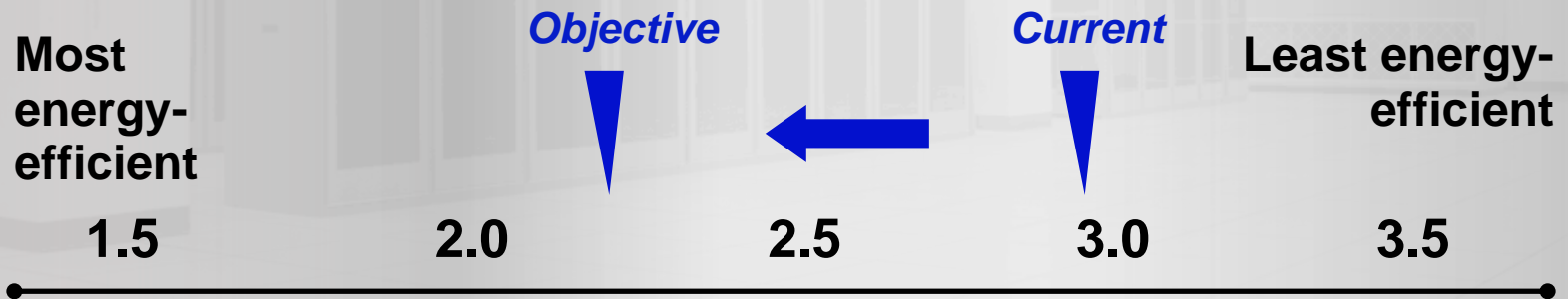
Environmental responsibility is a core IBM value

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

The Climate Group 2005

CLIMATE LEADERS U.S. Environmental Protection Agency — 2005

WWF climate savers — 2005

USEPA Climate Protection Award 1998 and 2006

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 U.S. Environmental Protection Agency

ClimateVISION

PEW CENTER Global CLIMATE CHANGE — Business Environmental Leadership Council

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

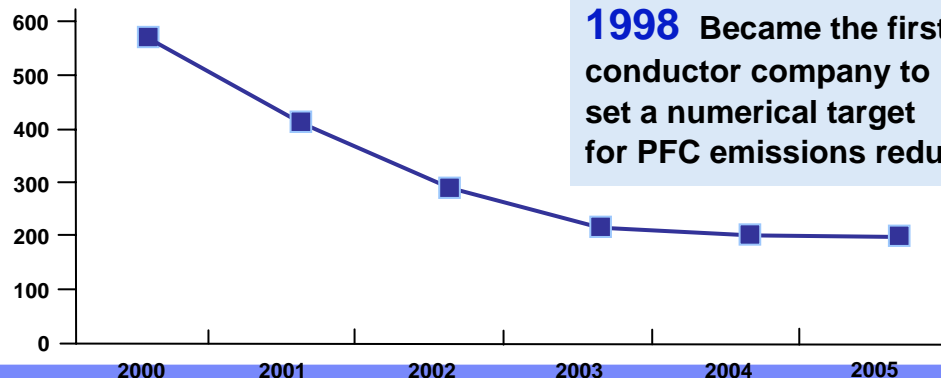WRI Green Power Market Development Group Charter member 2000

1605(b) voluntary emissions reporting since 1995

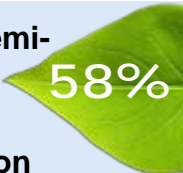CARBON DISCLOSURE PROJECT — Since inception

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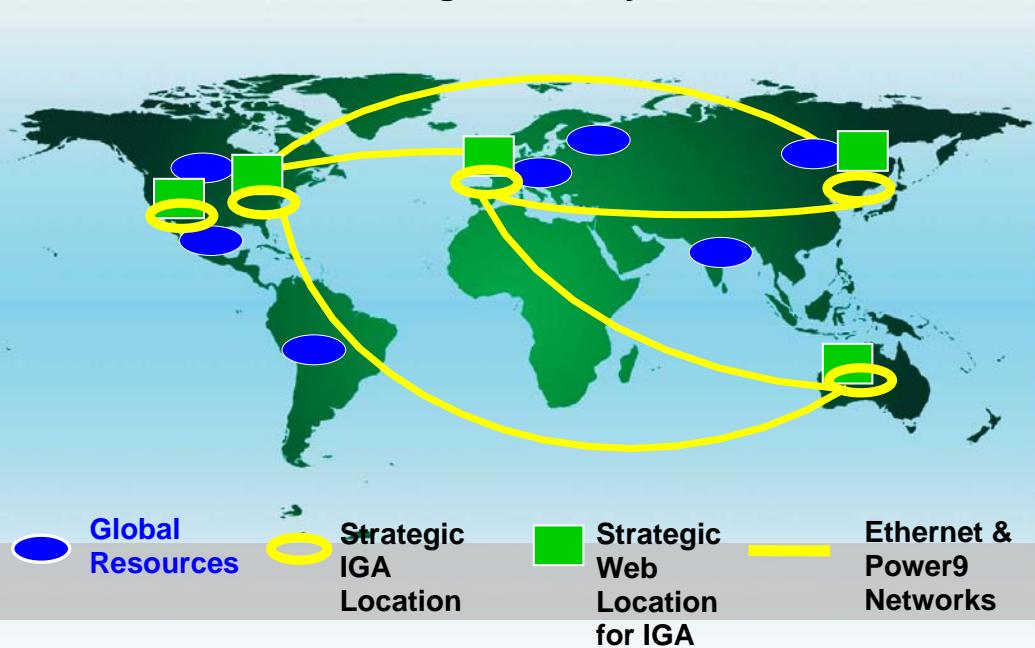
1998 Became the first semi-conductor company to set a numerical target for PFC emissions reduction

58%

Chart values: 2000: ~570, 2001: ~415, 2002: ~290, 2003: ~215, 2004: ~200, 2005: ~200
(Y-axis: 0, 100, 200, 300, 400, 500, 600)

IBM's Data Center Energy Efficiency History

A decade of improvement

IBM Strategic Delivery Model

Global Resources — Strategic IGA Location — Strategic Web Location for IGA — Ethernet & Power9 Networks

TECHNOLOGY

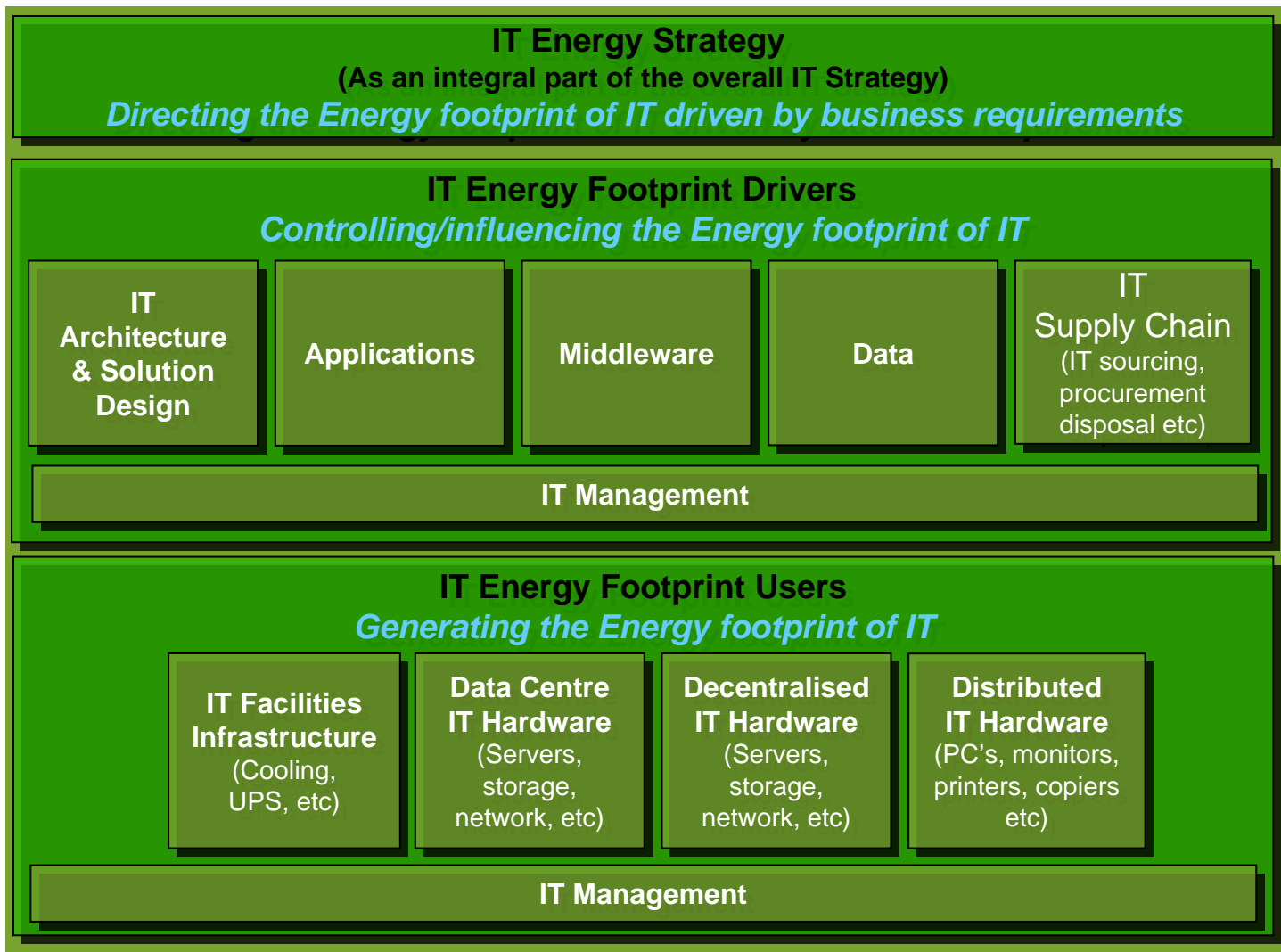| IBM Metrics	1997	Today
CIOs	128	1
Host data centers	155	7
Web hosting centers	80	5
Network	31	1
Applications	15,000	4,700

Tactical and operational efficiencies

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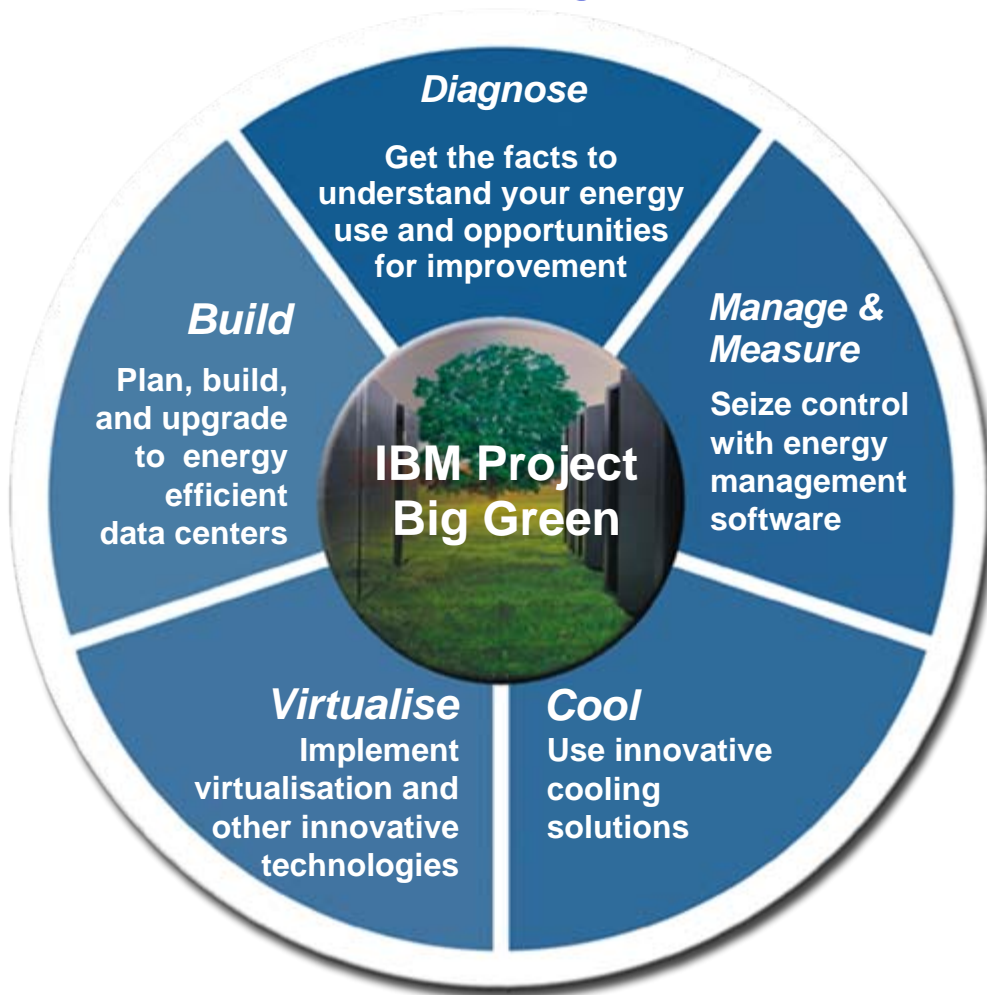- Enterprise end-to-end architecture optimisation

IBM Energy and Environment Framework

Strategy

Customer and product

Supply chain

People

IT

Property

Information

IT Room Structure

IT Energy Strategy
(As an integral part of the overall IT Strategy)
Directing the Energy footprint of IT driven by business requirements

IT Energy Footprint Drivers
Controlling/influencing the Energy footprint of IT

| IT Architecture & Solution Design | Applications | Middleware | Data | IT Supply Chain (IT sourcing, procurement disposal etc) |

IT Management

IT Energy Footprint Users
Generating the Energy footprint of IT

| IT Facilities Infrastructure (Cooling, UPS, etc) | Data Centre IT Hardware (Servers, storage, network, etc) | Decentralised IT Hardware (Servers, storage, network, etc) | Distributed IT Hardware (PC's, monitors, printers, copiers etc) |

IT Management

Five building blocks provide the tools to operational savings and business growth

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

IBM Project Big Green

Virtualise

Implement virtualisation and other innovative technologies

Cool

Use innovative cooling solutions

Double your IT capacity

- In the same energy footprint

Reduce operational costs

- 40-50% energy savings

Positive environmental impact

- Tons of CO_2 reduction and avoidance

Going green saves money.

Cooling Innovations from Processor to Facility
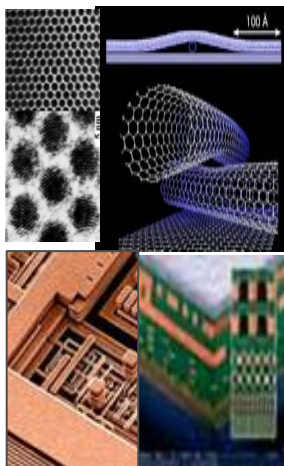
Atomic level cooling techniques

Power off un-used slots, variable fan speed based on ambient temperature

The Cool Battery can improve cooling system efficiency by 40-50%

80% heat load to water 40% energy savings via improved cooling and power efficiencies

Rear Door Heat eXchanger Can remove up to 100% of heat load

Compute Resource Innovations

IBM System z10 EC

IBM System x3950

IBM POWER Systems

IBM BladeCenter

IBM System Storage

IBM iDataPlex

Up to 93% savings in energy costs and 46% less space than some Single Core servers

64-core scalability, now for x86 large scale virtualisation

IBM Power™ 550 uses 91% less energy and 98% less space than a 64-core competitors product.

Uses up to 24% less energy than some competitors Bladecentres.

DS8000 can consume up to 31% less power than competitive solutions

Cuts energy costs 40% compared to equivalent compute power in an enterprise rack

Cool Blue: IBM Active Energy Manager

Measure/Trend Power Consumption
- Determine the power (watts) is being consumed now
- Why assume label power?
- Power meter (internal) or PDU with watt meter (external)

Cap or Allocate Power Correctly
- Power consumed is a function of the HW options, OS, Apps and App footprint application and the application data footprint
- Allocate power based on past history using power measurements:
  - to match the need of each server
  - to match the P/T limits of the Data Centre

Reduce power consumed
- CPUs can reduce power in periods of low utilization
- Save power costs

Active Energy Manager will provide

- A view of power consumption across the Data Centre using your applications and workloads!
- Reducing your power/thermal requirements
- Reducing power consumption during periods of low utilisation

IBM

Manage, Measure & Cool - IBM Southbury

Implement IBM Energy Management Solution and IBM Rear Door Heat eXchanger for 10-30% energy savings

Manage
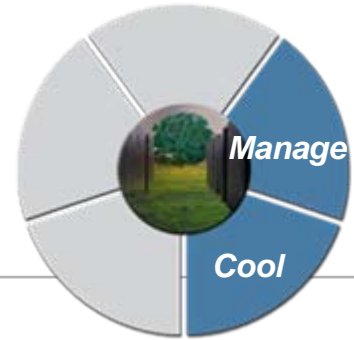
Cool

Client requirements

- **Improve how to meter, control, and cap power usage**

- **Actively moving workloads and power up/down resources**

Solution

- **Power density of 200 watts per square foot**
- **Use of 2-3 "Thermal Zones" for targeted power and cooling**
- **Power and thermal meters to measure baseline and changes**
- **Rack based thermal cooling**

Expected 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**
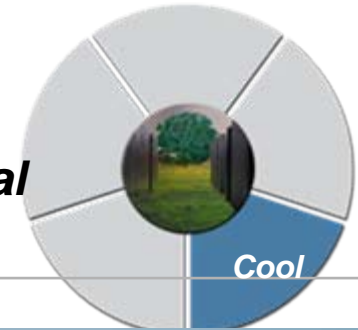- **Reduces Equipment Costs/More Flexible Facility**

IBM Active Energy Manager

Cool - Data Center Stored Cooling - IBM Bromont

Implement innovative cooling technology to reduce operational costs from the largest data center energy user by 45%

*Cool*

Client requirements

- **Identify and attach the largest areas of energy consumption**
- **Reduce energy consumption and operating costs of chiller plant supporting Bromont (Quebec, Canada) site**

Solution

- **Install "Cool Battery"**
- **Increase chiller utilisation by storing cold for use throughout the day**
- **Leverage environment - free cooling**

Benefits

- **Reduced chiller plant energy cost by 45%**
  - Over 5.3 million kwhr per year
  - Demand reduction of approximately 1 MW
- **Avoided need to install additional chiller**
- **Environmentally-friendly, non-toxic, no-maintenance**

COOLING SYSTEM WITH PCM

HEAT — HVAC UNIT — PCM STORAGE — CHILLER — COOLING TOWER — HEAT
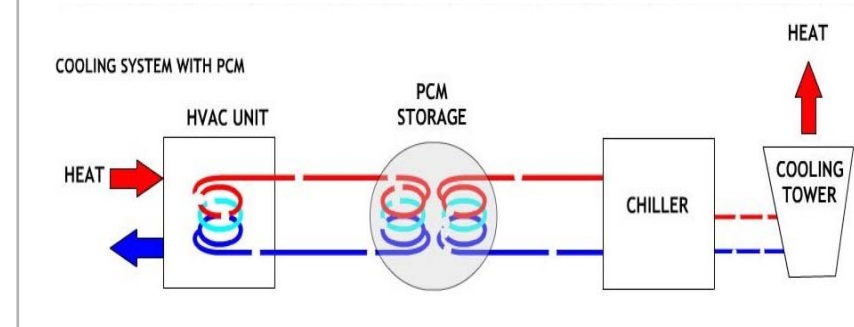
Energy Efficient Data Centre Summary

➢ *Consolidate* - Datacentre and distributed computing environments

➢ *Virtualise* - Maximise server, storage and network utilisation

➢ *Measure* - Holistic integration between IT and Facilities assets and energy

➢ **Exploit** - Innovative use of technology across the business to reduce energy and carbon in other areas

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