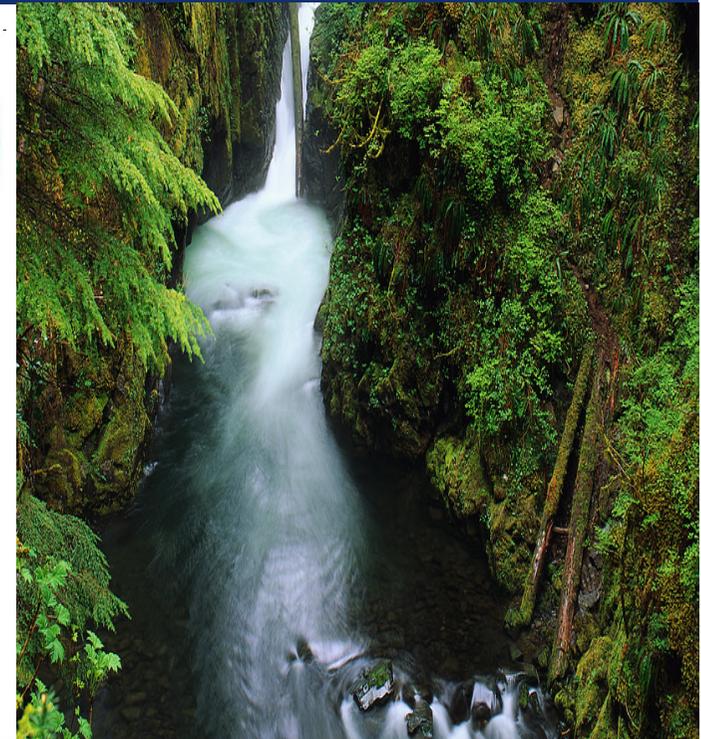


## *The Greening of IT...*



**Andreas Bieswanger**

**STSM, Firmware Development & GreenIT  
IBM Deutschland Research & Development GmbH**





# *agenda*

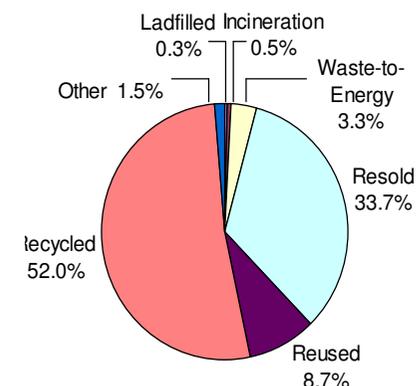
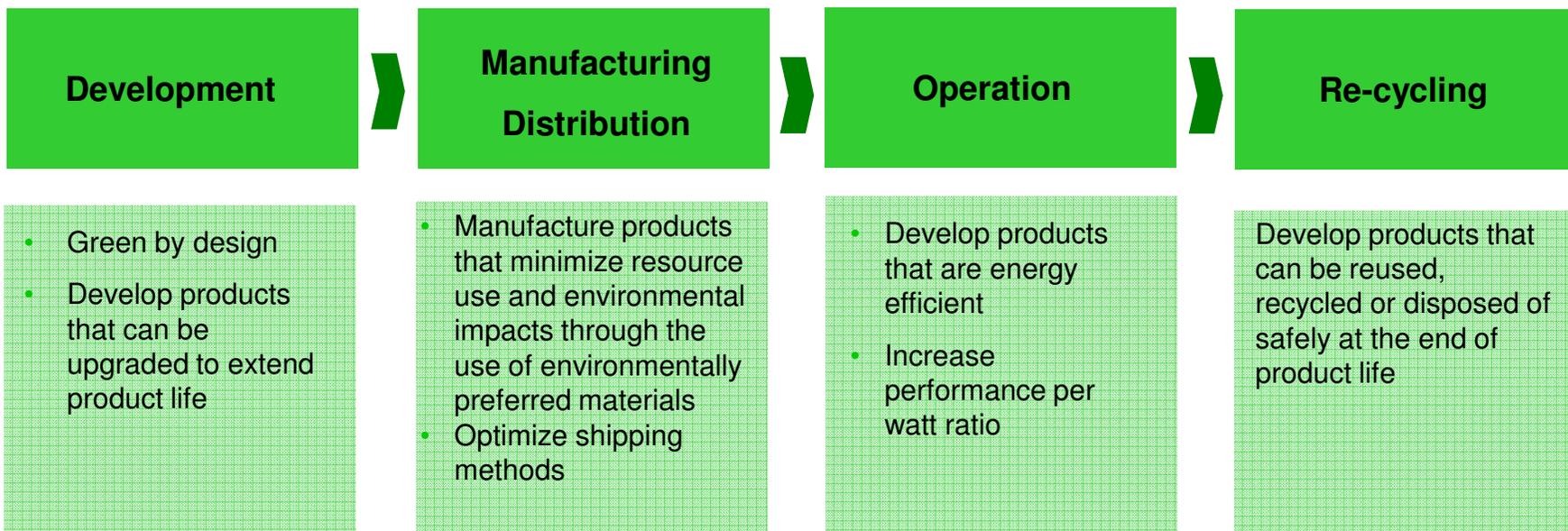


- |          |   |
|----------|---|
| <b>1</b> | <b>Greening of IT</b>                     |
| <b>2</b> | <b>Energy Efficiency Levers</b>           |
| <b>3</b> | <b>Data Center Services</b>               |
| <b>4</b> | <b>Systems &amp; Technology</b>           |
| <b>5</b> | <b>Management Systems</b>                 |
| <b>6</b> | <b>Integrated Energy Management Stack</b> |



# The Greening of IT: Overview

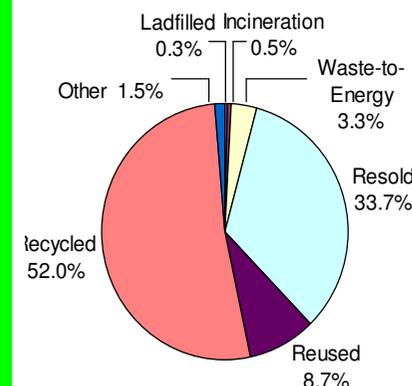
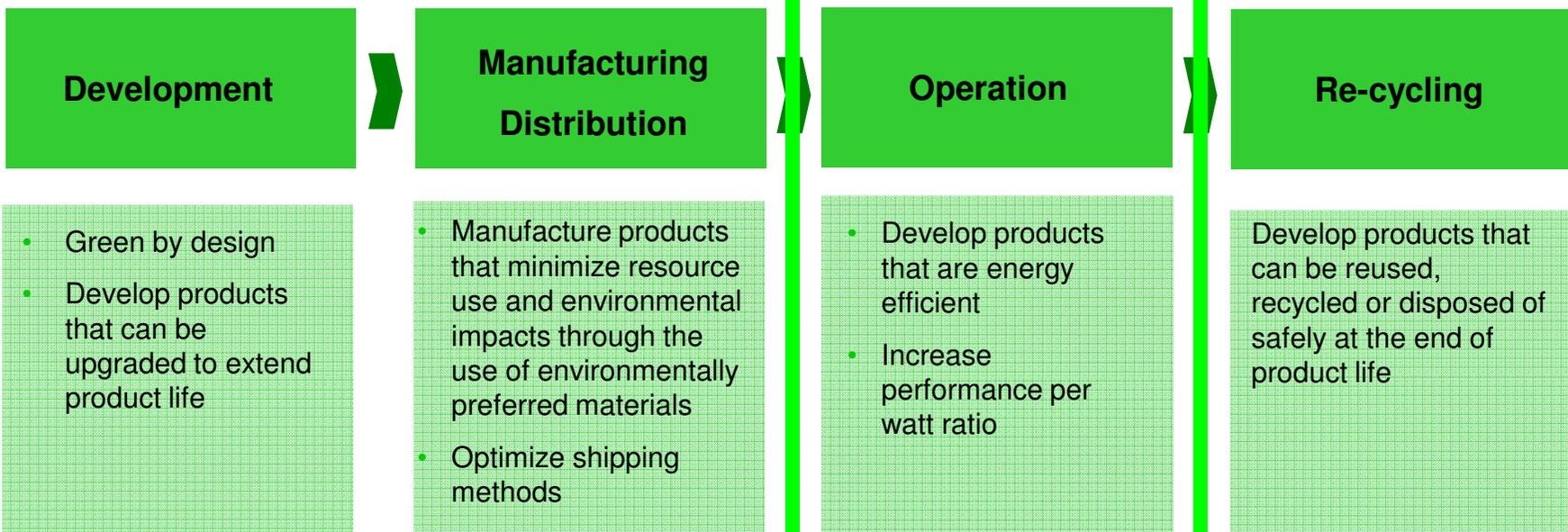
Environmental Protection driven through IBM's Product Stewardship Program  
(Part of the IBM's environmental management system)



**49,083 metric tons (108 million lbs) processed in 2007**

# The Greening of IT: Overview

Environmental Protection driven through IBM's Product Stewardship Program  
(Part of the IBM's environmental management system)



**49,083 metric tons (108 million lbs) processed in 2007**

## ***Data Center Energy Consumption***

Computer data centers consume approximately 2% of all the electricity produced around the world and it is growing 12% each year

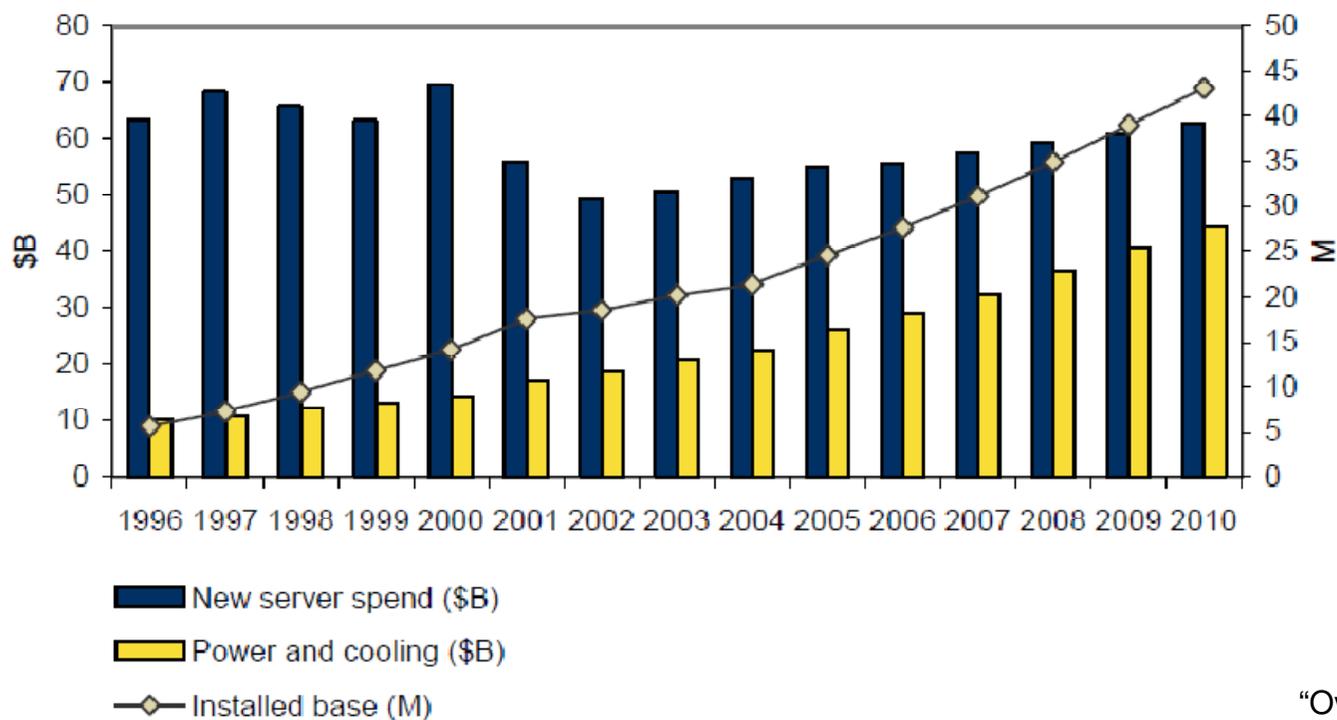


Data Centers are Burning  
73.8B Kilowatt Hours in the US  
and 183.5B around the world

Sources: Estimated consumption for 2007 based on Koomey 2007 and IBM Research analysis

## Growing Power and Cooling Cost

Worldwide Expense to Power and Cool the Server Installed  
Base, 1996-2010



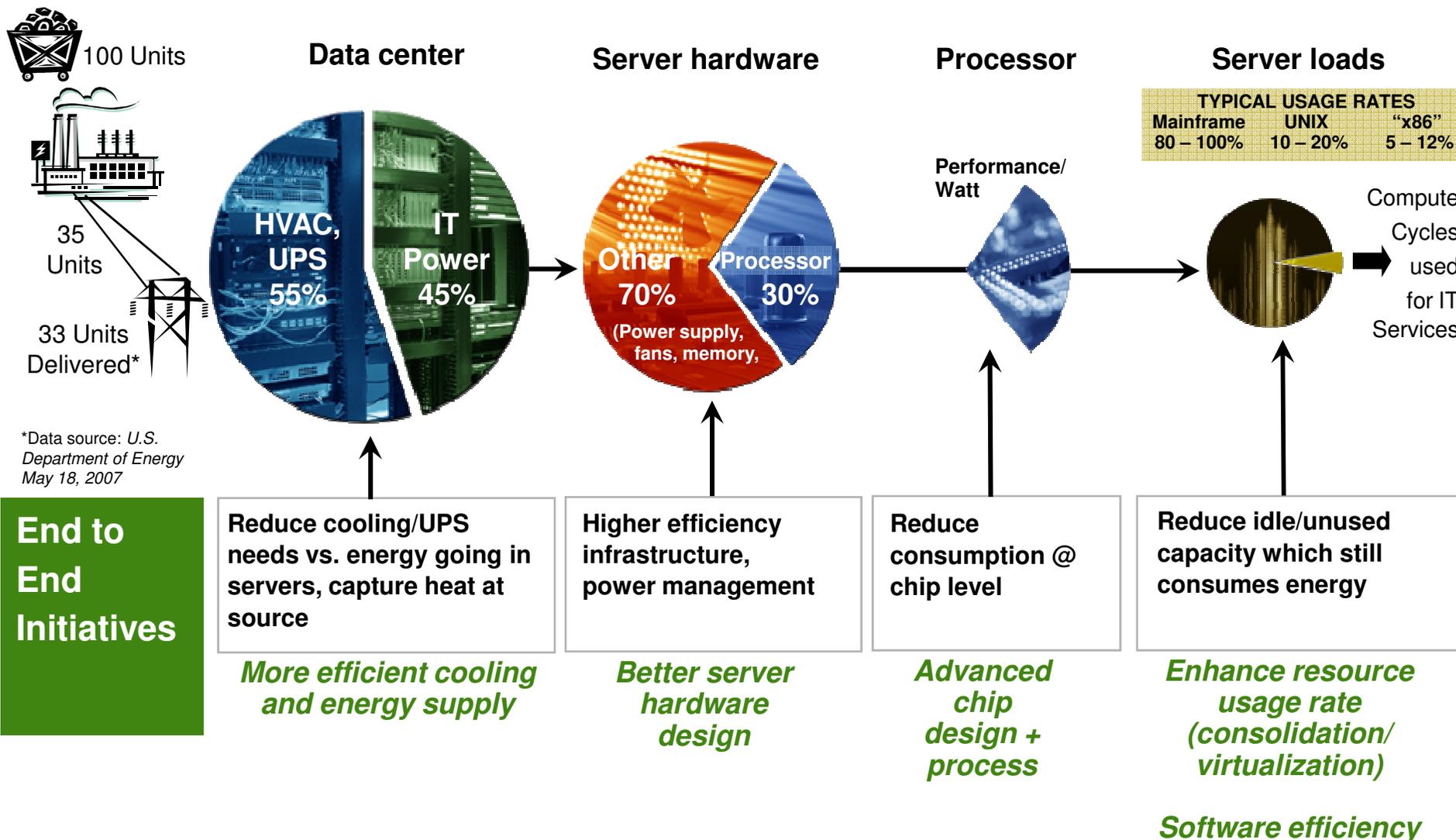
- Cost doubled in last 10 years
- Server power and cooling costs expected to increase at 11.2% annually

“Over 40% of datacenter customers report **power demand outstripping supply**, while **cooling capacities** at their threshold have become a **limiting factor in deploying new systems.**”

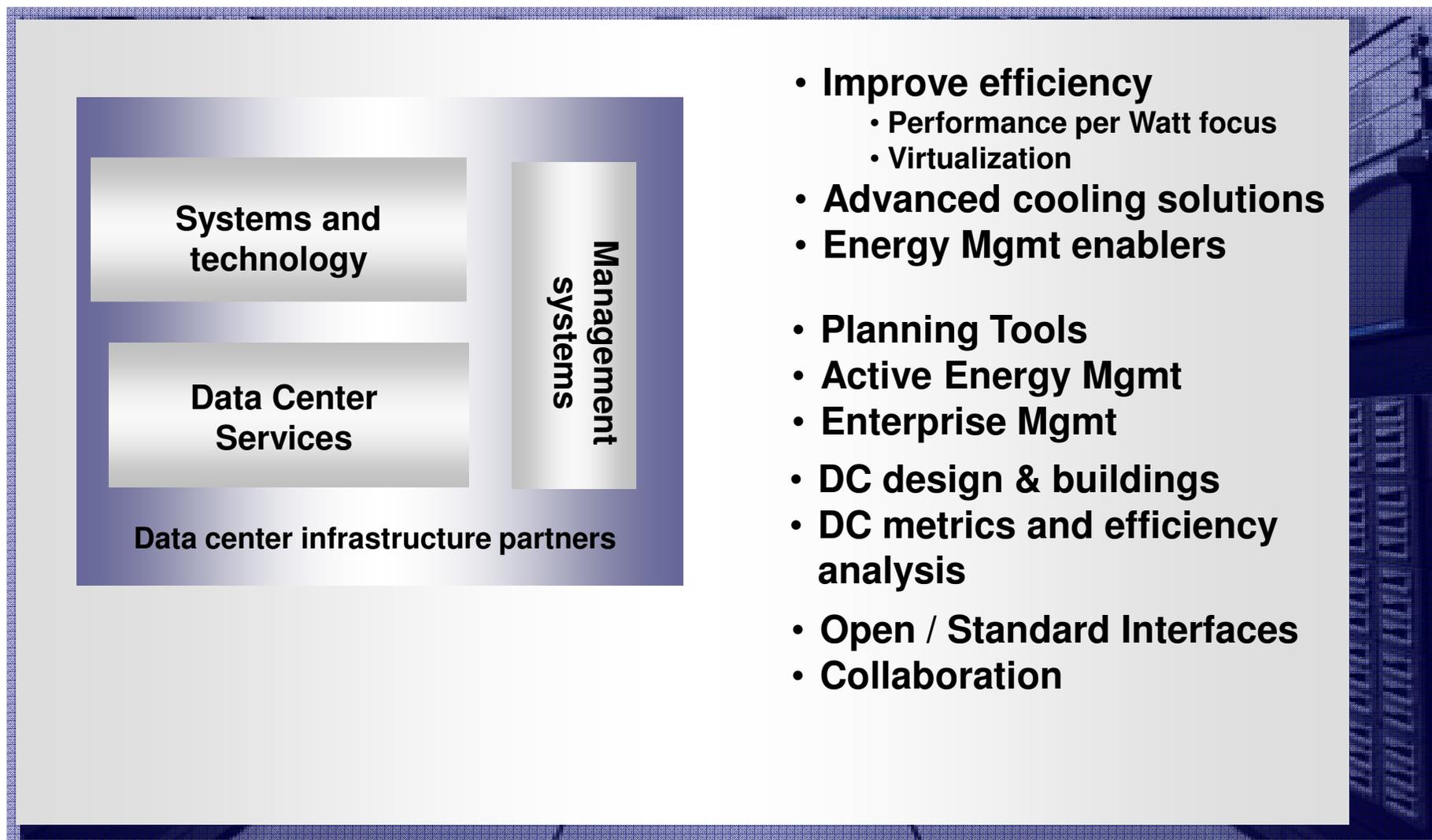
Source: IDC, 2006

**Many Servers, Much Capacity, Low Utilization = \$140B unutilized server assets**

# Efficiency gains needed at all levels



## Data Center Energy Efficiency levers

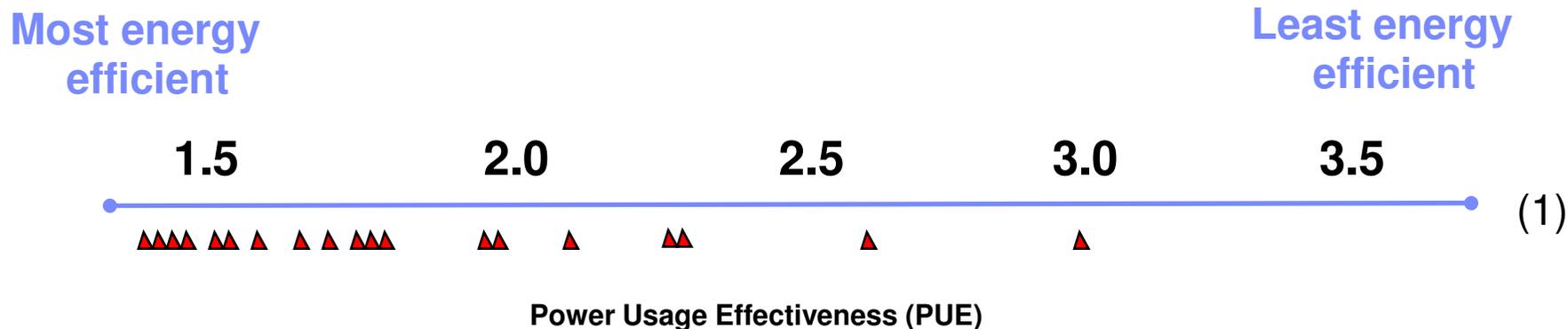


## Data Center Services: Metrics

**Power Usage Effectiveness (PUE) and Datacenter Efficiency (DCiE)**

$$\text{PUE} = \frac{\text{Total Facility Power}}{\text{IT Equipment Power}}$$

$$\text{DCiE} = \frac{\text{IT Equipment Power}}{\text{Total Facility Power}}$$

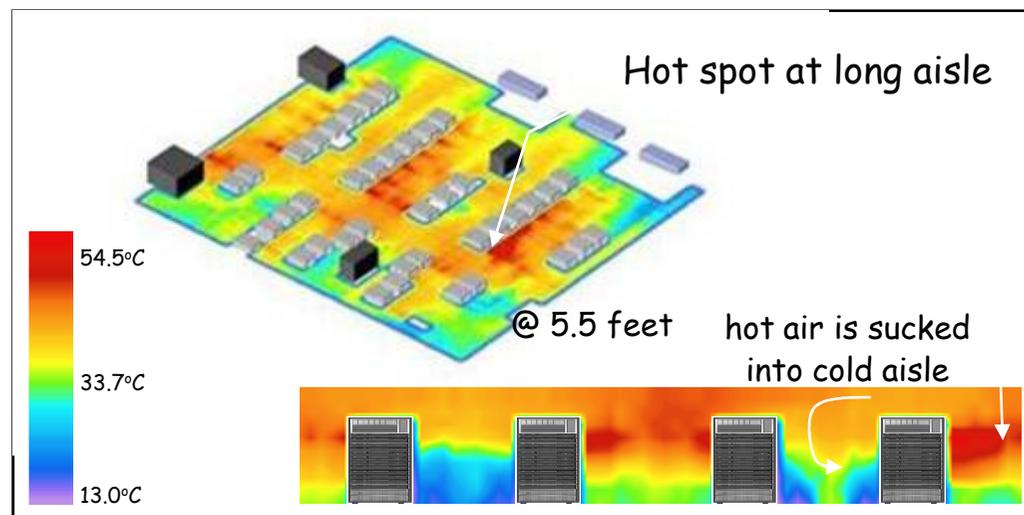


(1) Standard supported by Green Grid, originally published by Lawrence Berkley National Laboratory, 2003

## Data Center Services: Efficiency Analysis and Optimization

**Optimize data center thermal profile to eliminate hot spots and reduce data center energy consumption.**

- Digitize rapidly physical environment of a data center
- Creates detailed 3D heat maps of data centers
- Post-processing creates metrics and identify solutions for hotspots and energy efficiency improvements



*Mobile Measurement Technology*

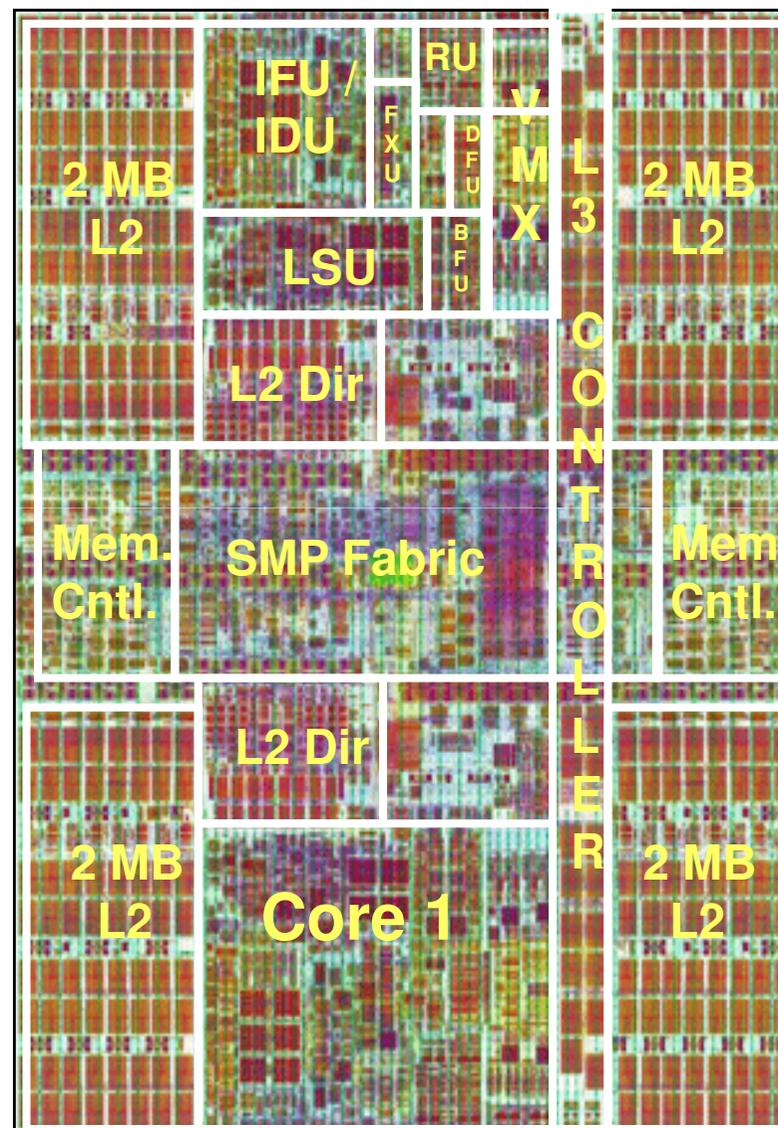
# Systems&Technology: Advanced chip design and technology

## POWER6: Processor doubles speed without adding to energy footprint!

At 4.7 GHz the POWER6™ processor doubles the speed of the previous generation POWER5™ while using nearly the same amount of electricity to run and cool it. This means customers can use the new processor to either increase their performance by 100 percent or cut their power consumption virtually in half.

### POWER6 facts:

- 5+ GHz operation
- Dual core design
- >790M transistors, 341mm<sup>2</sup> die
- 65nm SOI process with 10 levels of Cu interconnect and low-k dielectric on 1<sup>st</sup> 8 levels
- 2 superscalar, SMT cores
- 8 MB Level-2 cache
- Support for 32MB L3
- 2 memory controllers
- Extensive power management controls
  - Clock Gating
  - Wide voltage/frequency range
  - Architected idle state (Nap) for increased clock gating
  - Sensors and actuators for advanced out-of-band power management
- Advanced virtualization capabilities

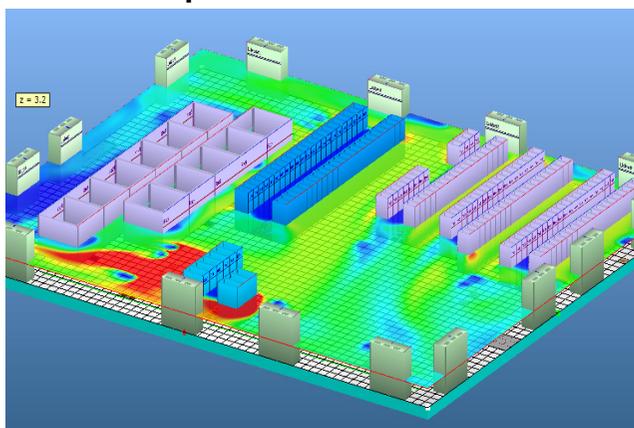


## ***Systems&Technology: Advanced cooling solutions***

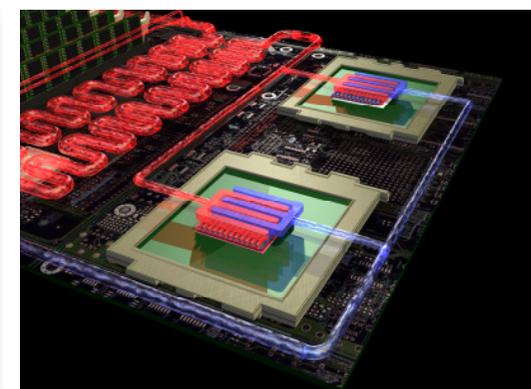
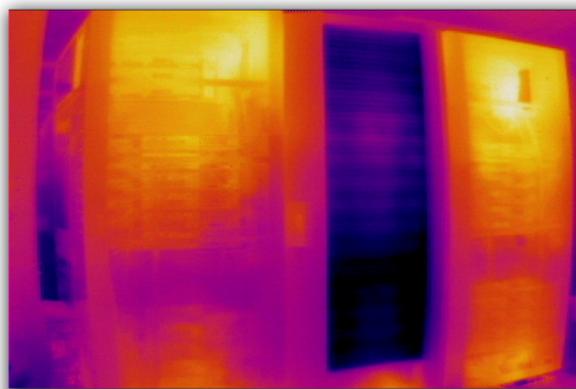
- Datacenters convert all electrical energy to heat.
- Air cooling is limited in capacity and shows many inefficiencies.
- Water cooling is 4000x more effective than traditional air cooling.
- Future vision: Zero emission data center
  - Cool datacenter with hot instead of chilled water
  - “Heat 700 homes with re-use of waste heat from 10 MW datacenter”



**Hot spots in the data center**



**Rear Door Heat Exchanger**



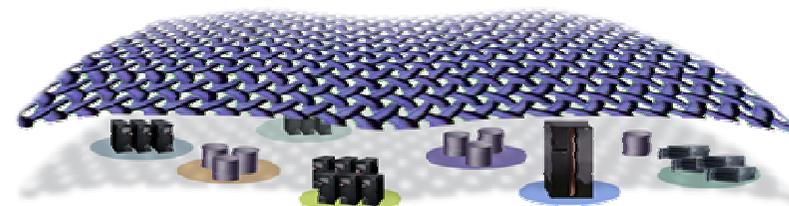
## Systems&Technology- Virtualization enables high utilization

- **Consolidation: Improves server and storage utilization**

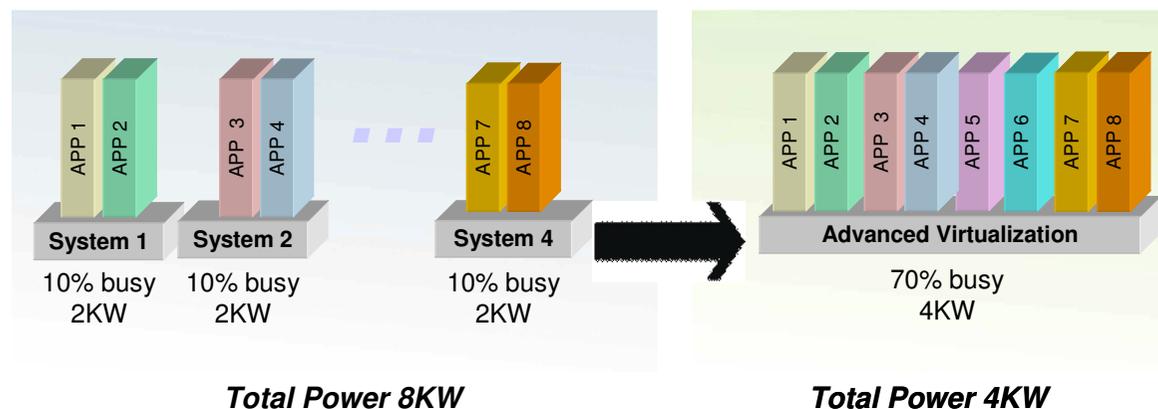
- Reduces the number of servers
- Allows for targeted thermal solutions for efficiencies
- Allows for more efficient power distribution, backup, and regulation

- **IBM is consolidating thousands of servers onto approximately 30 IBM System z mainframes**

- Consolidated environment will use 80% less energy

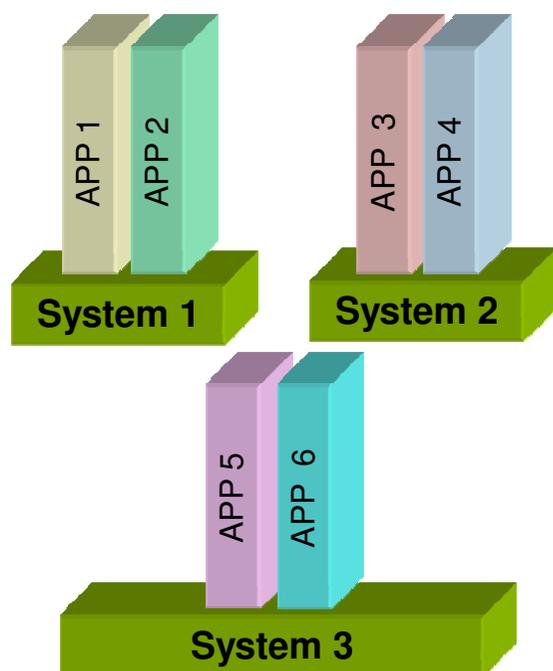


Power savings: 100%  
Cooling Savings: 100%  
More Space



## Management: Dynamic Virtualization Solutions

Transparent 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.

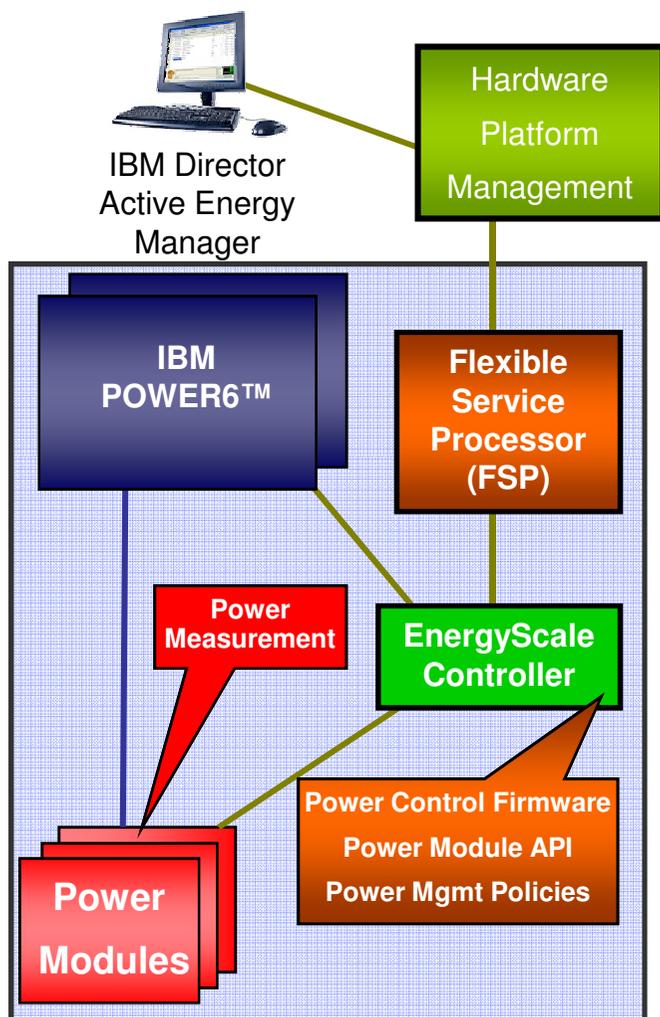
### Automate Energy Control

- Policy-based automation

### Control Energy Consumption

- Consolidate workloads to reduce

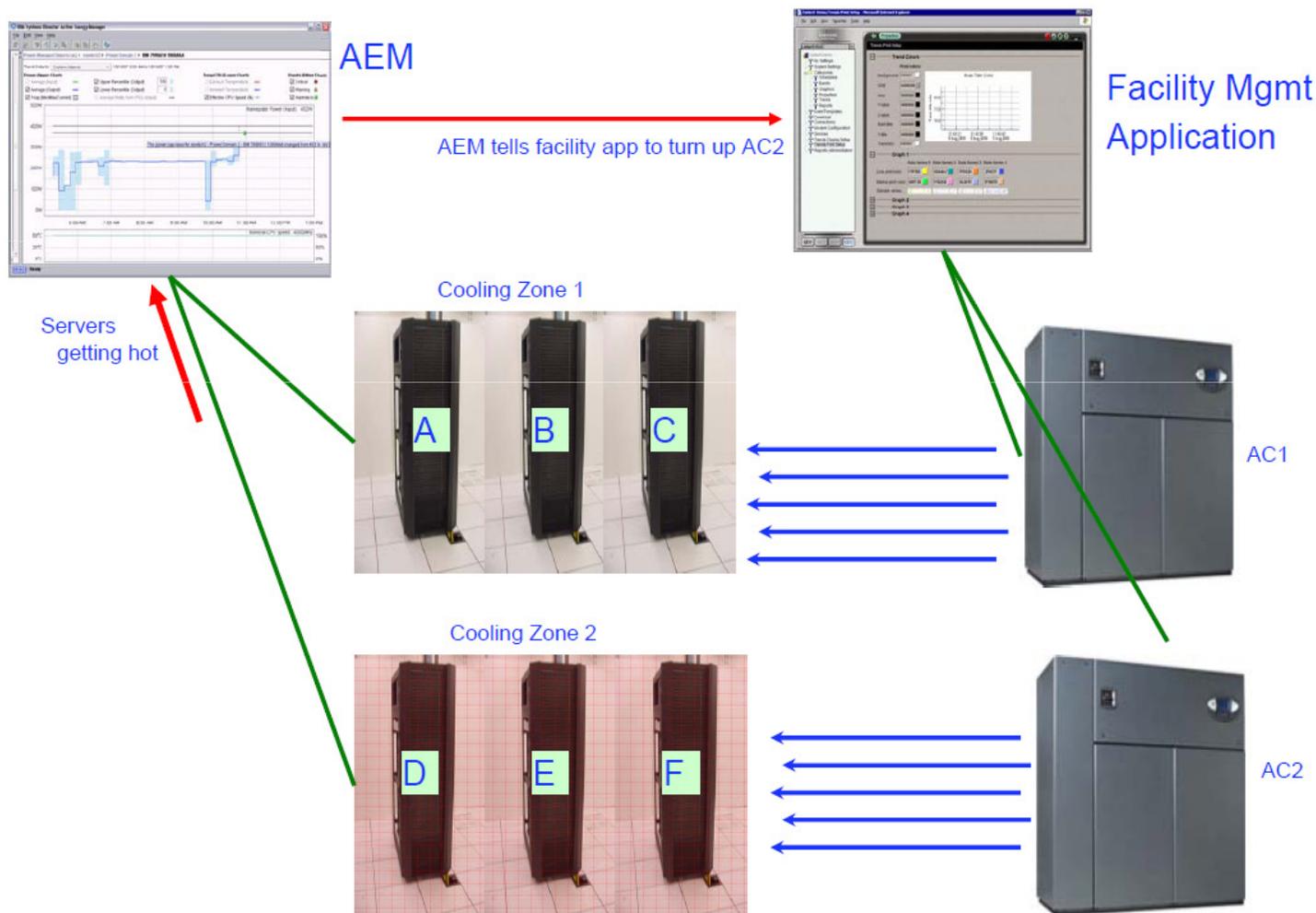
## Management: POWER6 EnergyScale™ Functions



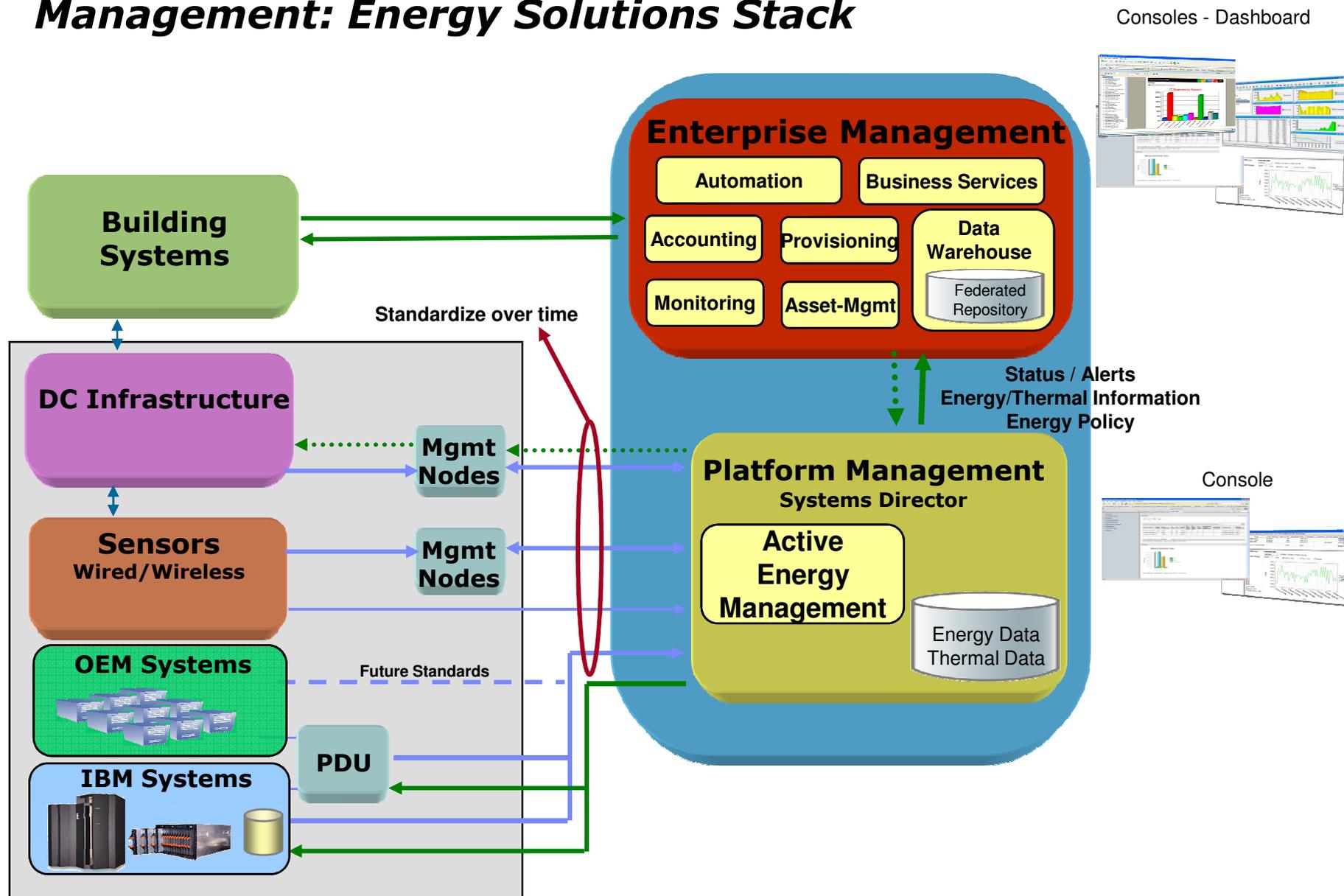
- **Measure**  
Collect and report power consumption, inlet and exhaust temperature
- **Power Capping**  
Precision control to keep system power under a specified limit
- **Power Saving**  
Save energy in periods of lower utilization. Control performance to just offer sufficient capacity required by the IT services.

# Management: Integration of IT and Facility Mgmt

Automatically control cooling based on feedback from IT equipment



# Management: Energy Solutions Stack



# Energy Management: Integrated Vision

**Issues:** Available Power and Cooling have become a barrier to business growth, and the ability to increase either one is a major investment that clients want/need to delay or avoid.

## System Level Efficiency



- Improved Performance / Watt
- Energy efficient components
- Energy Monitoring & Trending
- Energy Management enablers
- Improved System Utilization

## IT Efficiency & Reliability



- Workload Packing
- Dynamic Workload re-distribution
- Multi-platform Optimization
- Thermal Monitoring & Mgmt

## Data Center Efficiency & Reliability



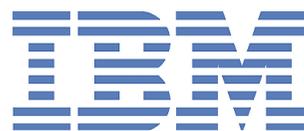
- Active ties between IT and Data Center Infrastructure
- Integration with Enterprise Management
- Data Center Efficiency Services



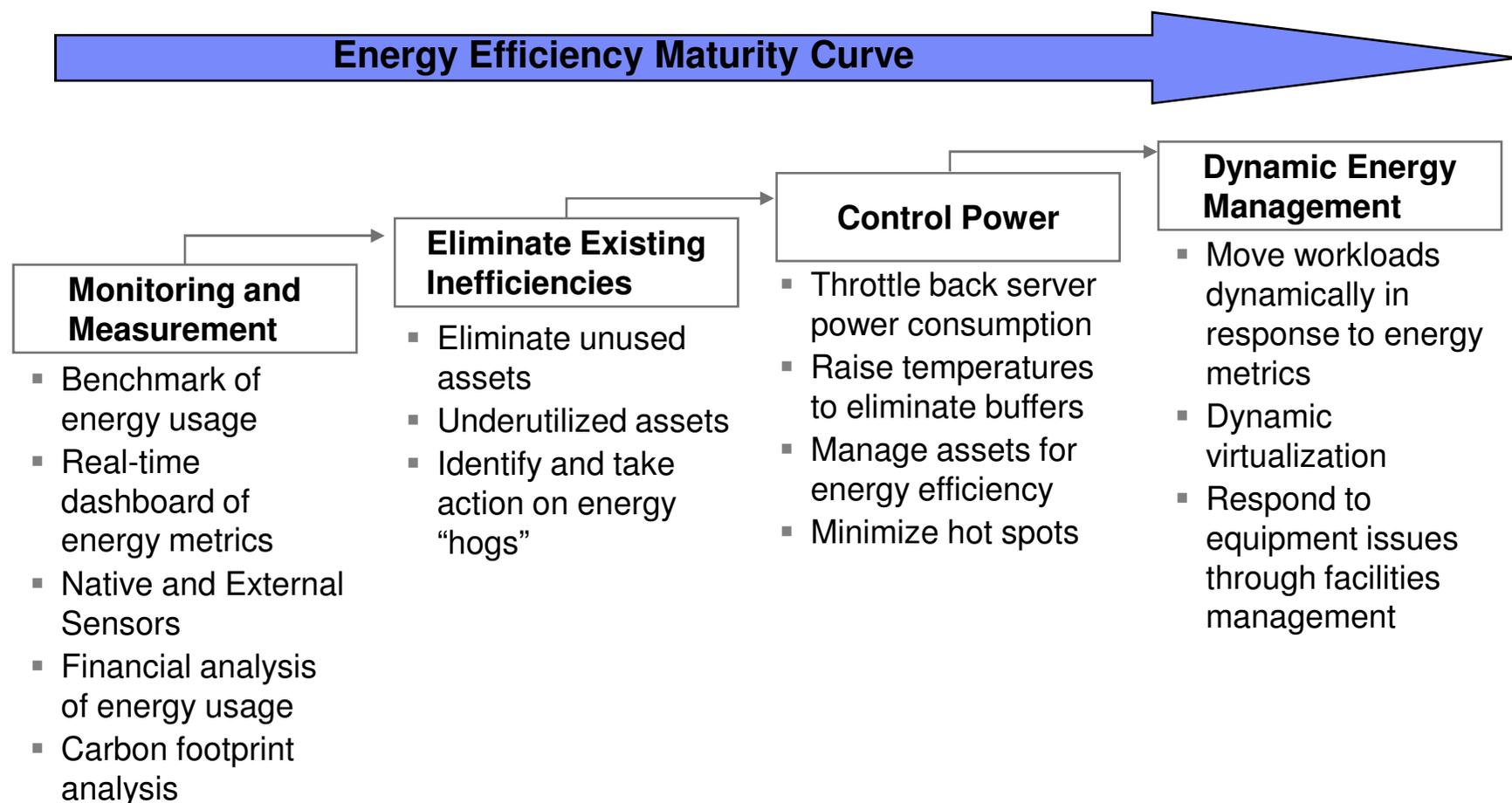
**“You can’t make a product greener,  
whether it’s a car, a refrigerator or a city,  
without making it smarter:  
smarter materials, smarter software  
or smarter design.”**

**(Thomas Friedman, New York Times)**

**Thank You**

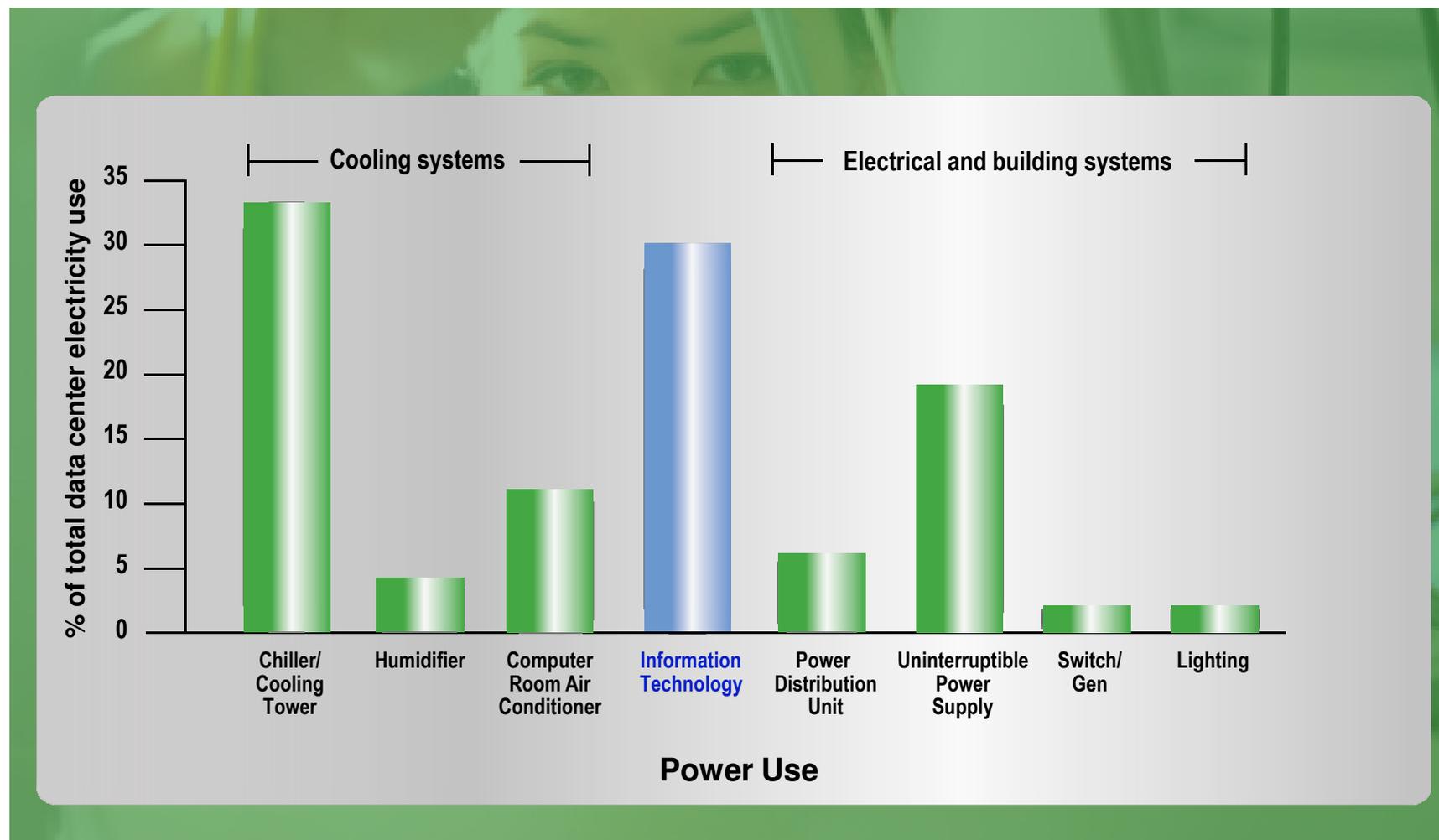


## Evolutionary paths toward greater energy efficiency



<sup>1</sup>Revolutionizing Data Center Efficiency – McKinsey & Company

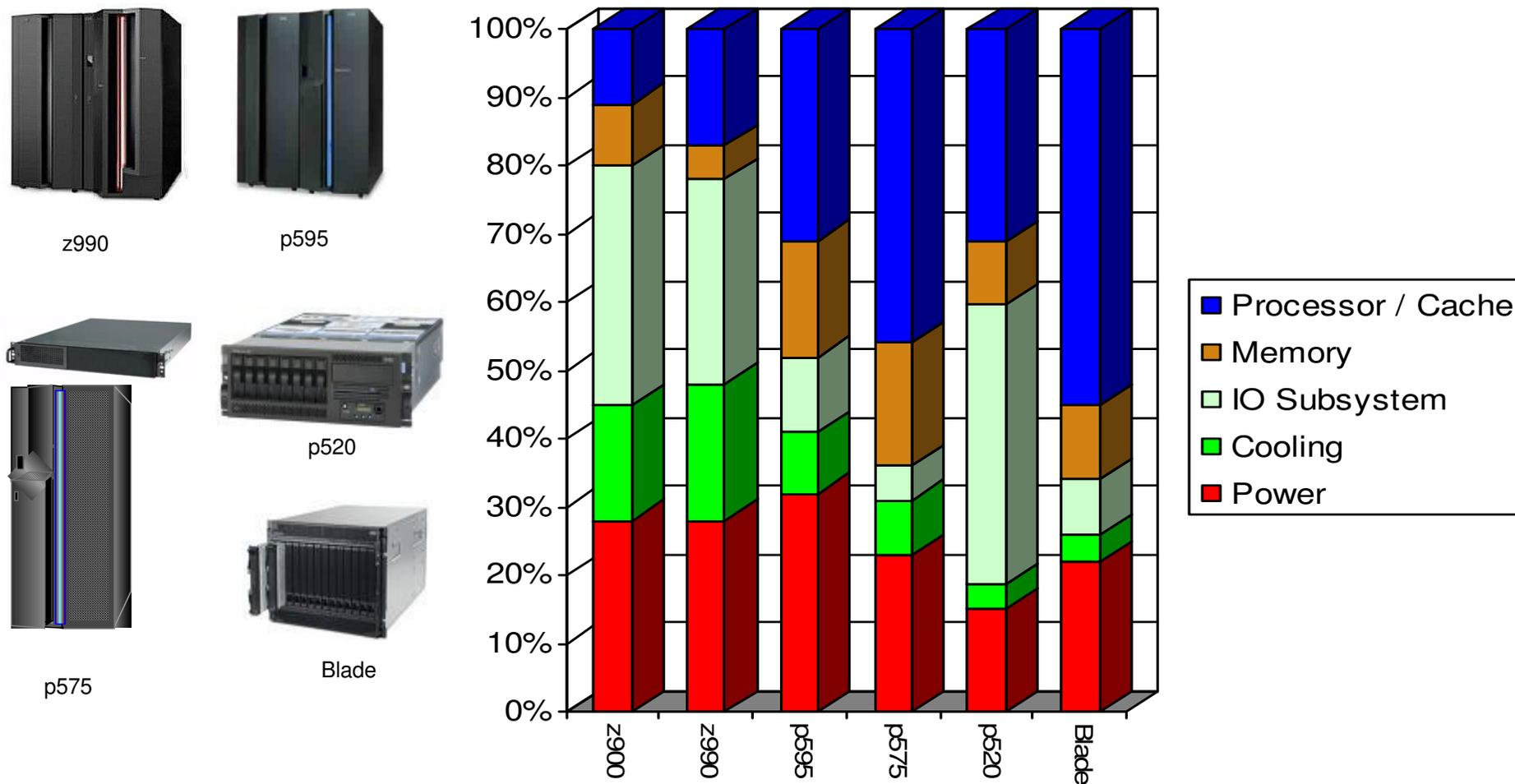
## Data Center Energy Distribution



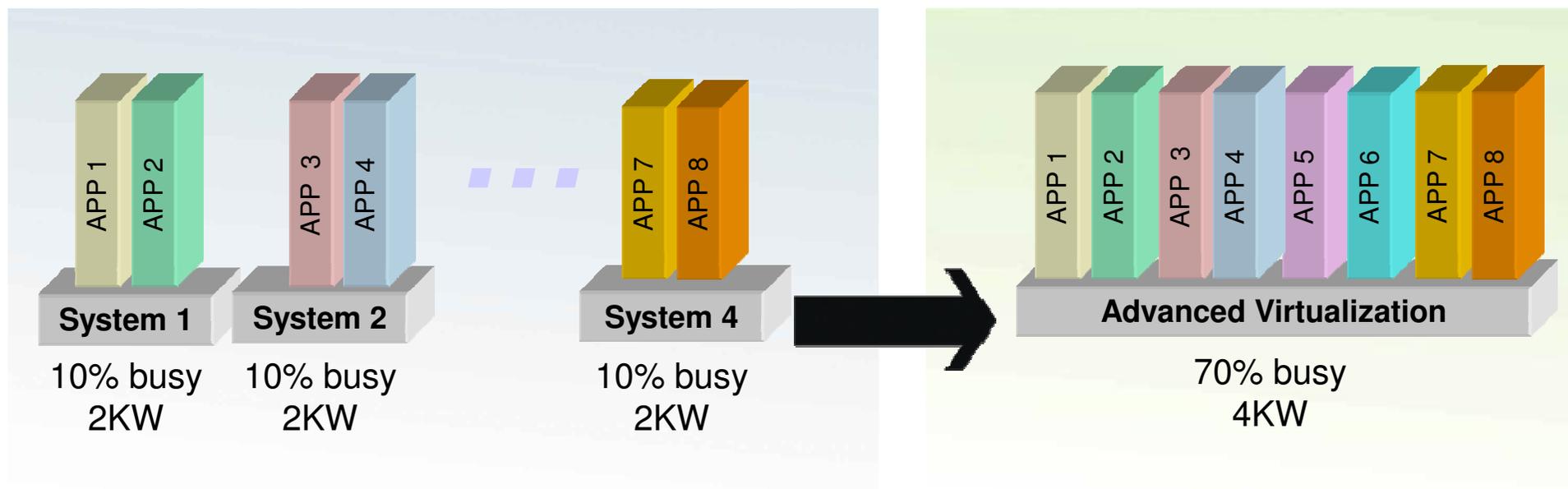
The data center energy challenge affects both the physical data center and the IT infrastructure

# System Power Distribution

System Power Varies as a Function of Architecture, Configuration and Workload



## Systems&Technology: Virtualization



**Total Power 8KW**

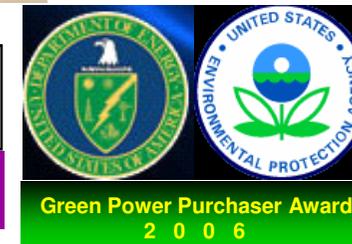
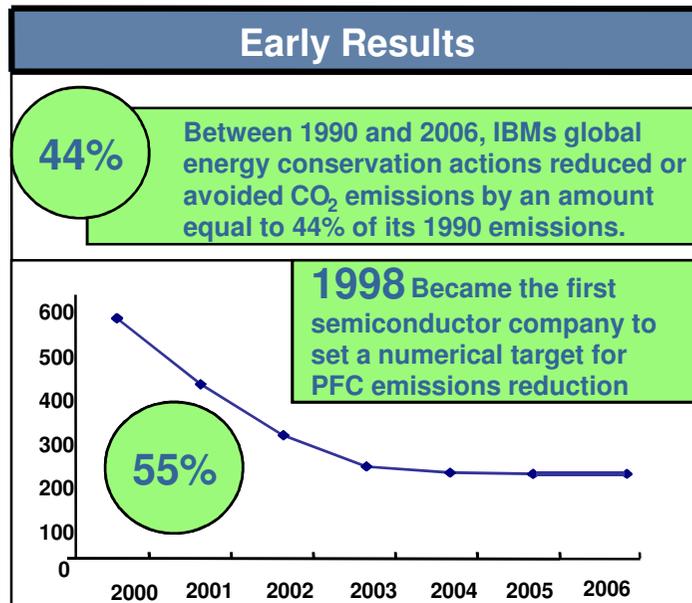
**Total Power 4KW**



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

# Highlights of IBM's Leadership in Climate Protection

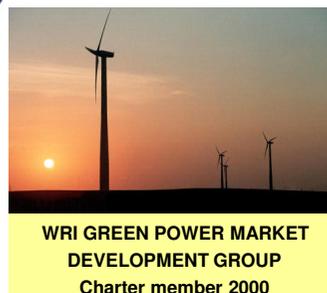
## Awards & Recognition



### Present Goal

Further extend IBM's early accomplishments by reducing CO<sub>2</sub> emissions associated with IBM's energy use 12% from 2005 to 2012 via energy conservation, use of renewable energy, and/or funding CO<sub>2</sub> emissions reductions with Renewable Energy Certificates or comparable instruments.

## Collaboration and Partnership



## Early Support for Disclosure



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Revised September 26, 2006

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