Federal Government Initiatives to Reduce Data Center Energy Use

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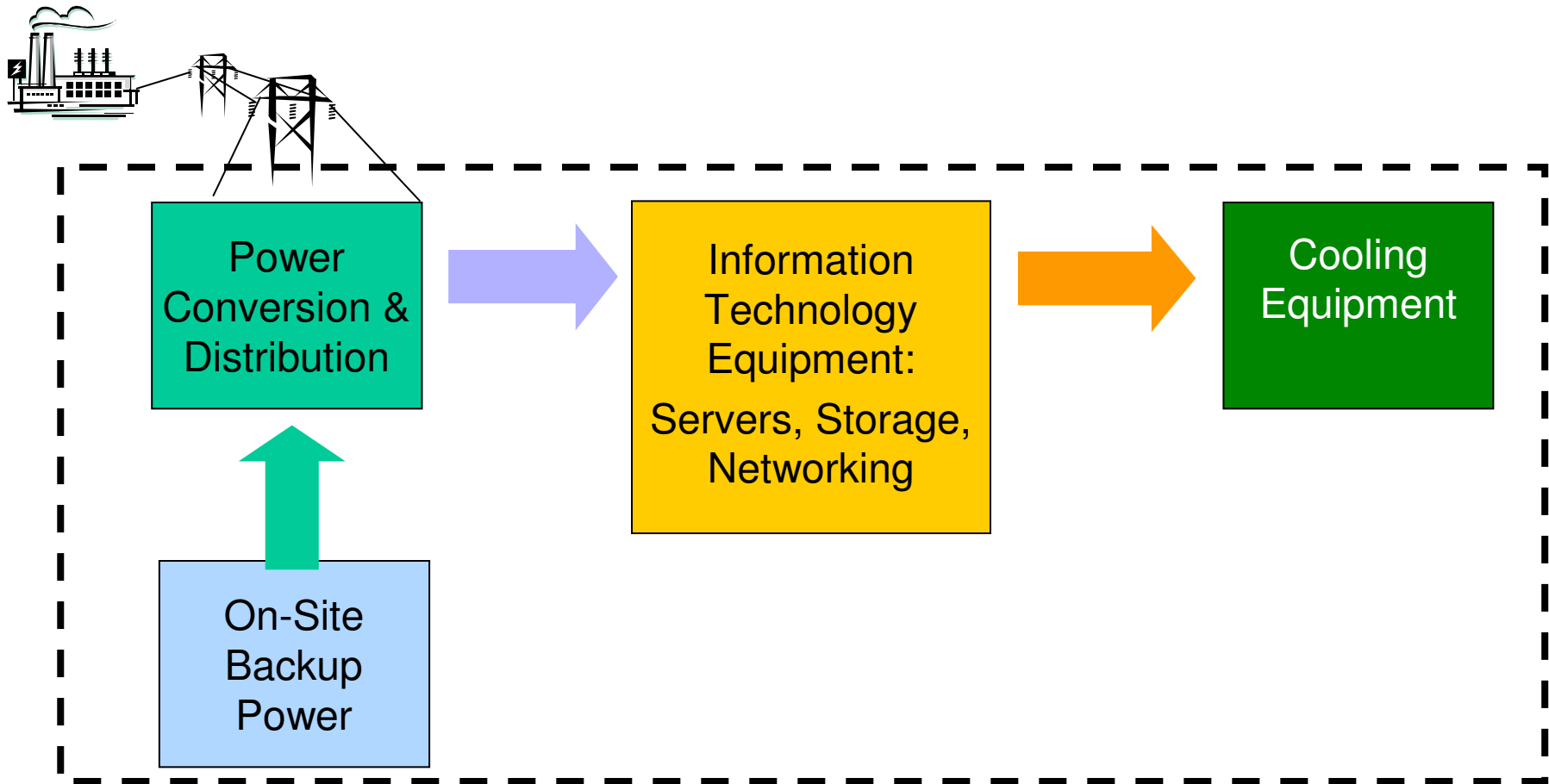# Data Centers are INFORMATION FACTORIES

- **Data centers are energy intensive facilities**
  - Server racks now designed to carry 25 kW load
  - Surging demand for data storage
  - Typical facility ~ 1MW, can be > 20 MW
    - Tier 3 datacenter ~ 4-5 MW
  - Nationally 1.5% of US Electricity consumption in 2006
    - Could double in next 5 years

- **Critical national and global infrastructure**
  - Few technology barriers to increased efficiency
  - Few options to go "off the grid" or diversify supply
  - Good candidates for efficiency investments by utilities to reduce peak loads
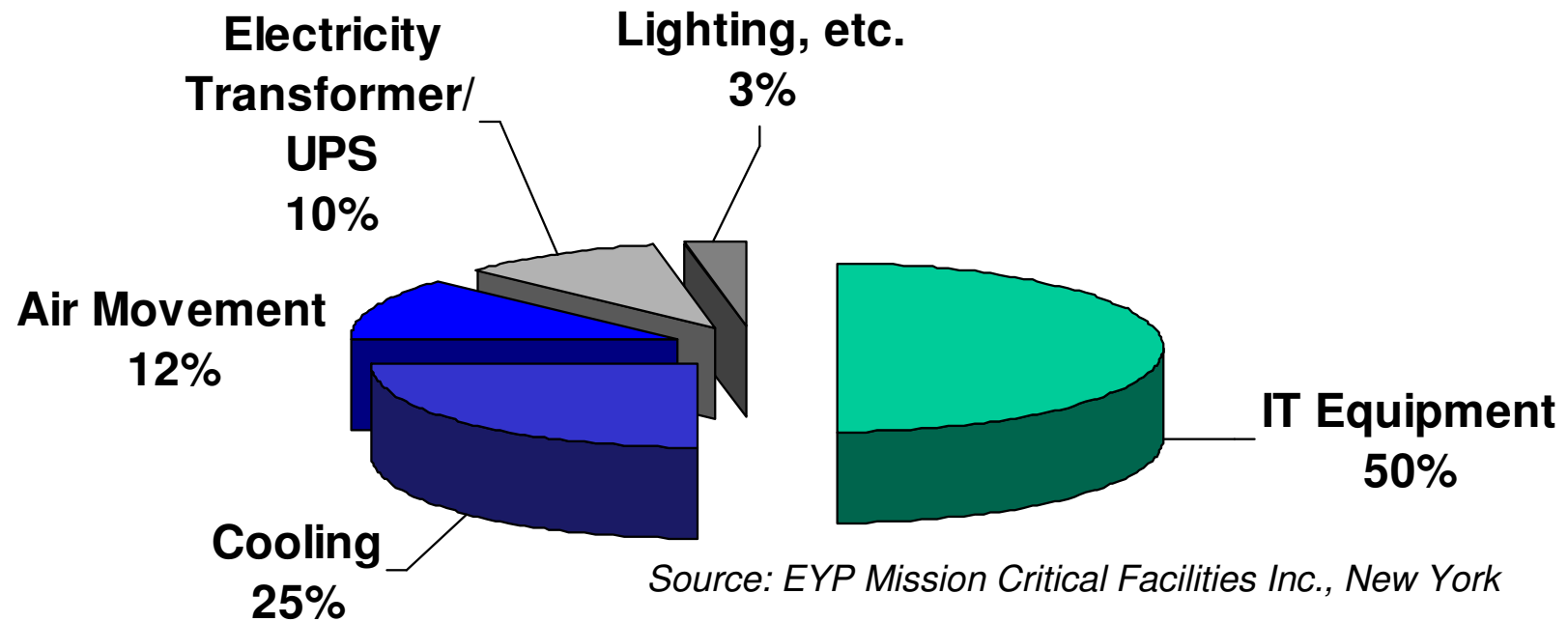
Recent Data Center Developments

- Significant data center building boom,
  - Power and cooling constraints in existing facilities
  - Growing demand for compute cycles
  - Growing computing performance
  - Commoditized hardware
  - Declining cost of computing

Major Data Center Energy Users

Power Conversion & Distribution → Information Technology Equipment: Servers, Storage, Networking → Cooling Equipment

On-Site Backup Power → Power Conversion & Distribution

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Where Data Center Power Goes

Electricity Transformer/ UPS 10%

Lighting, etc. 3%

Air Movement 12%

Cooling 25%

IT Equipment 50%

Source: EYP Mission Critical Facilities Inc., New York

Energy Issues Abound

- Over the next five years, power failures and limits on power availability will halt data center operations at more than 90% of all companies

  (AFCOM *Data Center Institute's Five Bold Predictions, 2006*)

- By 2008, 50% of current data centers will have insufficient power and cooling capacity to meet the demands of high-density equipment

  (Gartner press release, 2006)

- Survey of 100 data center operators: 40% reported running out of space, power, cooling capacity without sufficient notice

  (Aperture Research Institute)

The Rising Cost of Ownership

- From 2000 – 2006, computing performance increased 25x but energy efficiency only 8x

  – Amount of power consumed per $1,000 of servers purchased has increased 4x

- Cost of electricity and supporting infrastructure now surpasses capital cost of IT equipment

- Perverse incentives -- IT and facilities costs separate

Source: The Uptime Institute, 2007

Industry Action: Climate Savers

- Global non-profit consortium of industry, business, universities, conservation groups, governments, consumers

- Goals:
  – Accelerate production/distribution of energy efficient computers
  – Increase use of power management tools

- Desired Results:
  – Reduce the computing industry's carbon footprint
  – Lower TCO for computer users
  – Make high efficiency the norm for the industry

- Web site: www.climatesaverscomputing.org

Industry Action: Green Grid

- Global consortium dedicated to developing and promoting energy efficiency for data centers by:
  - Defining meaningful, user-centric models and metrics
  - Developing standards, measurement methods, best practices and technologies to improve performance against the defined metrics
  - Promoting the adoption of energy efficient standards, processes, measurements and technologies

What's the Government's Role?

- Federal agencies (EPA & DOE) can be catalyst
  - Stimulate competition on energy efficiency
  - Foster discussions between key stakeholders
  - Provide key recommendations (EPA Report to Congress)
  - Developing standardized test procedures and metrics to measure energy consumption (e.g., ENERGY STAR)
- Take the lead on best practices and metering of federal datacenters
- Promote initiatives globally (Canada, EU, UK, China, India, Australia)

Public Law 109-431: EPA Report

- **Purpose**: assess energy impacts <u>on</u> and <u>from</u> datacenters, identify energy efficiency opportunities, and recommend strategies to drive the market for efficiency

- **Goals**:

  – Inform Congress & other policy makers of important market trends, forecasts, opportunities

  – Identify and recommend potential short and long term efficiency opportunities and match them with the right policies

  – Identify areas for additional strategic research *outside the scope* of the report

EPA Report Findings

Trends in Data Center Energy Use

- Sector consumed about 61 billion KWh in 2006
  - Equates to ~1.5% total U.S. electricity consumption and ~$4.5 billion
  - Federal sector: ~6 billion kWh and ~$450 million

- Projected to increase to 100 billion kWh in 2011
  - Equates to ~2.5% of total U.S. electricity consumption and ~$7.4 billion

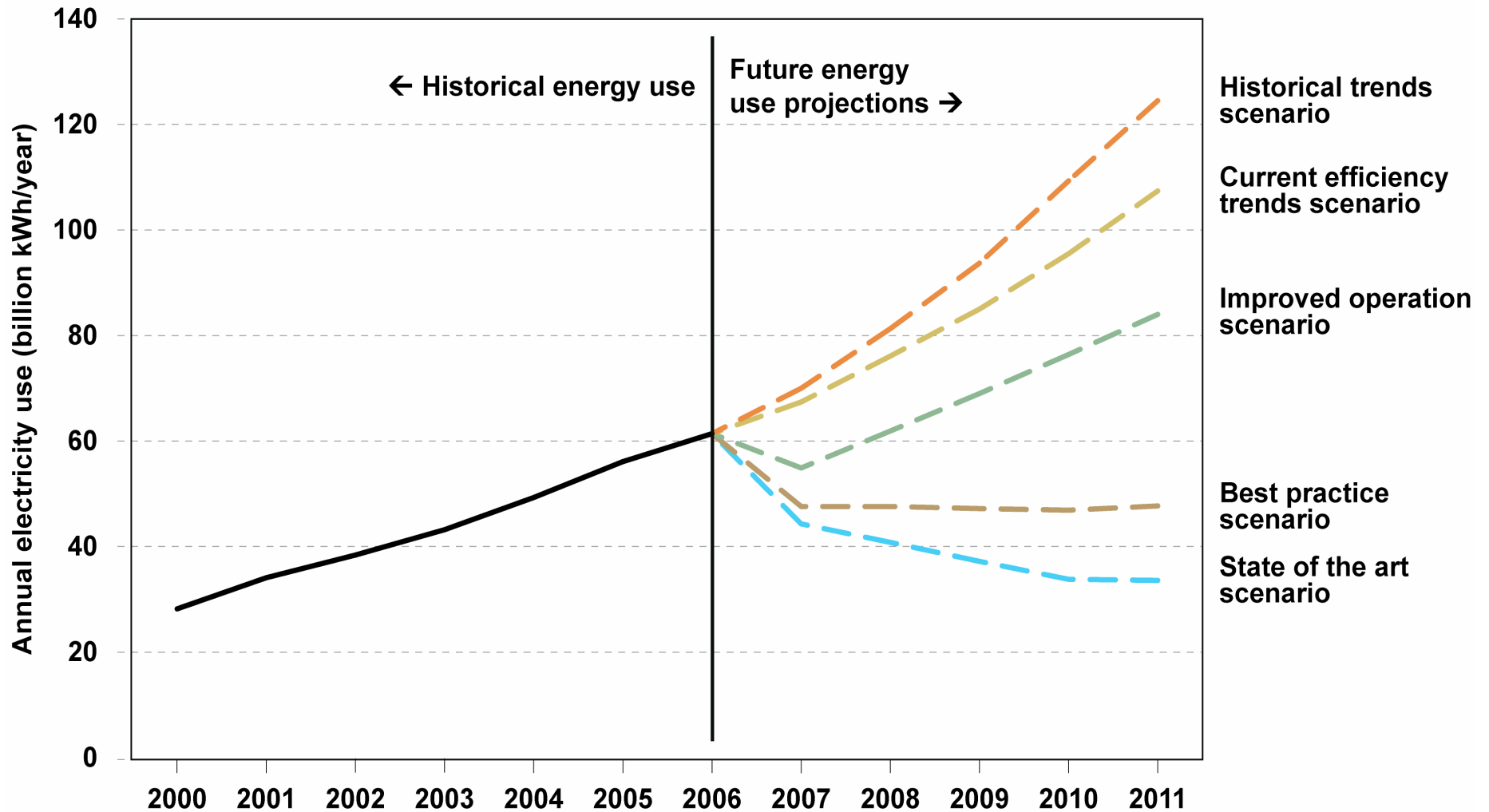# Electricity Use by End-Use
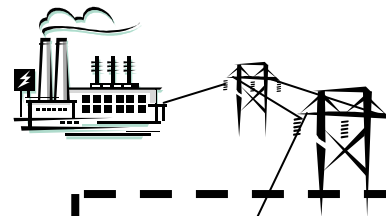## 2000 to 2006

ENERGY STAR
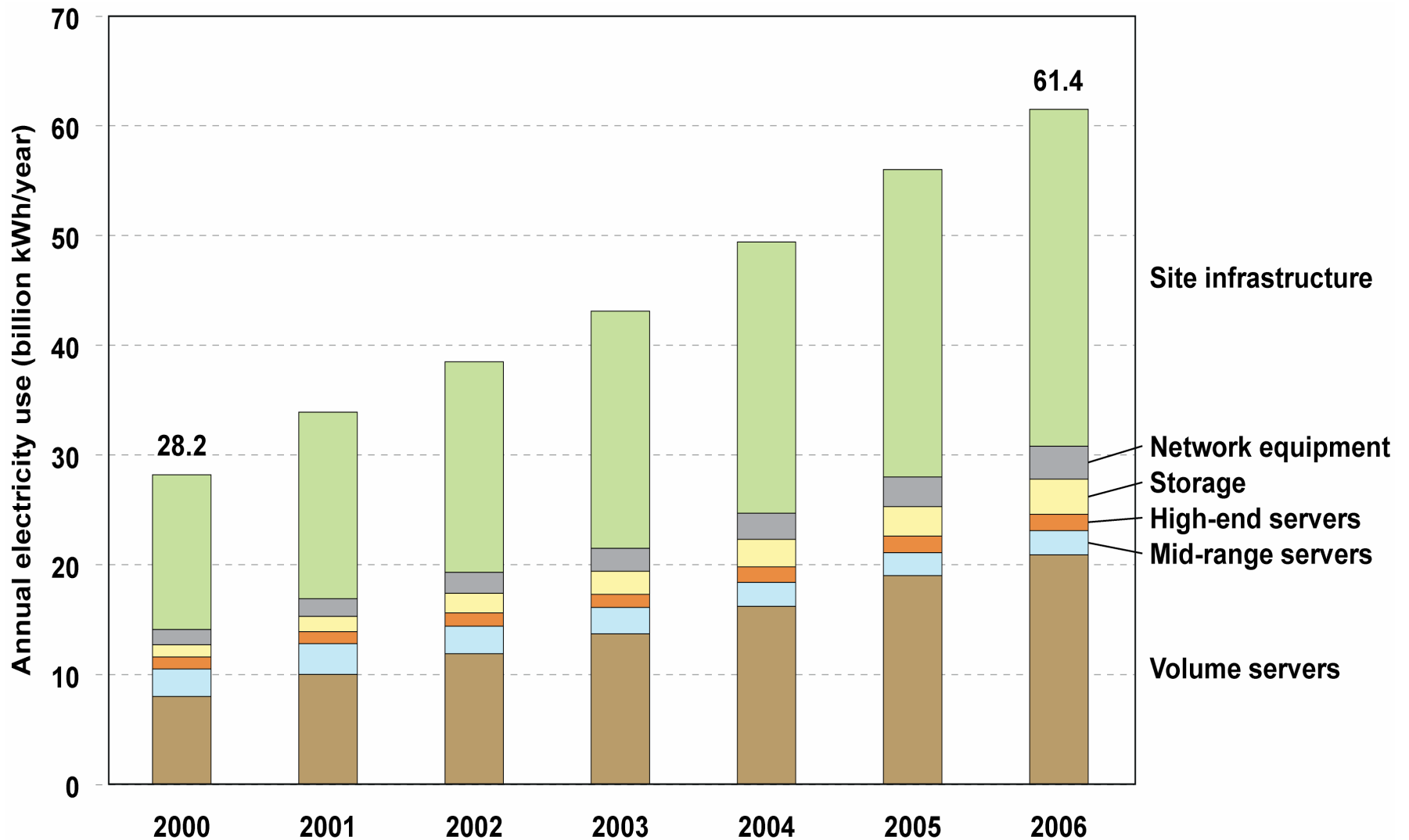
Comparison of Projected Electricity Use
All Scenarios 2007 - 2011

Energy Efficiency Opportunities Are Everywhere

- Improved hardware
- Software innovations
- Load management

- Better air management
- Move to liquid cooling
- Optimized chilled-water plants
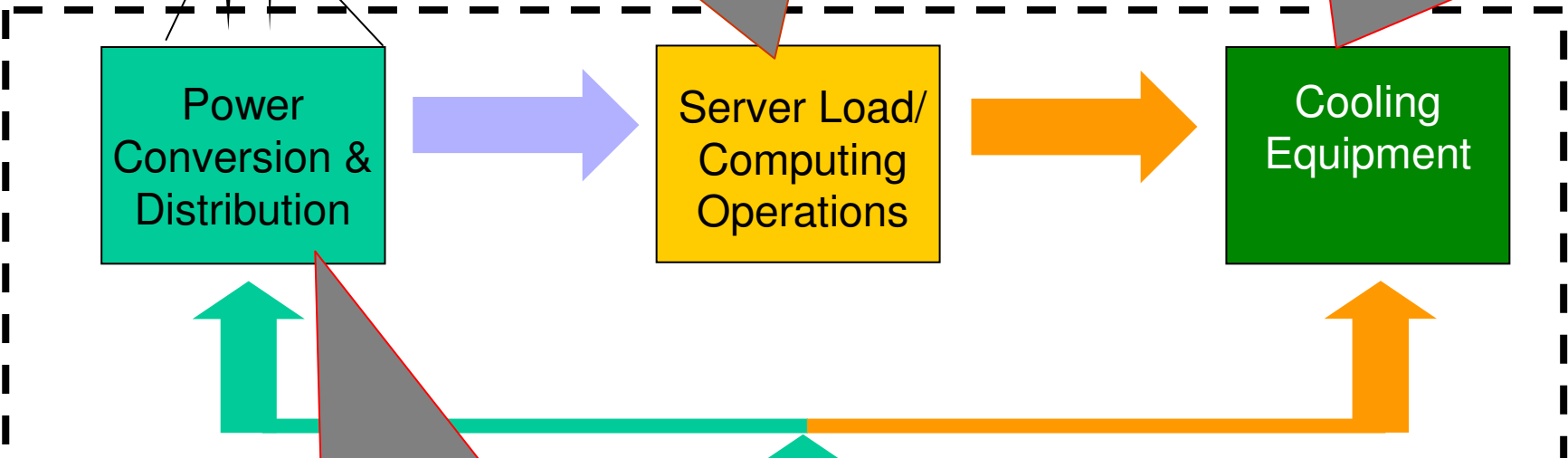- Use of free cooling

Power Conversion & Distribution

Server Load/ Computing Operations

Cooling Equipment

Alternative Power Generation

- High voltage distribution
- Use of DC power
- Highly efficient UPS systems
- Efficient redundancy strategies

- On-site generation
- Waste heat for cooling
- Use of renewable energy/fuel cells

Identified Key Barriers to Energy Efficiency

- Lack of efficiency definitions for equipment and data centers

  – Service output difficult to measure, varies among applications

  – Need for metrics and more data: *How do we account for computing performance?*

- Split incentives

  – Disconnect between IT and facilities managers

- Risk aversion

  – Fear of change and potential downtime – energy efficiency perceived as a change with uncertain value and risk

Report Recommendations

- Standardized performance measurements for IT equipment and data centers

  – Development of benchmark/metric for data centers

  – ENERGY STAR label for servers, considering storage and network equipment

- Leadership by federal government

  – Publicly report energy performance of datacenters

  – Conduct energy efficiency assessments in all datacenters in 2 – 3 years

  – Architect of the Capital, implement server- related recommendations in Greening of the Capital report

Recommendations cont.

- ## Private Sector Challenge
  - CEOs conduct **DOE Save Energy Now** energy efficiency assessments, implement measures, and report performance

- ## Information on Best Practices
  - Raise awareness and reduce perceived risk of energy efficiency improvements in datacenter
  - Government partner with private industry: case studies, best practices

- ## Research and Development
  - Develop technologies and practices for datacenter energy efficiency (e.g., hardware, software, power conversion)

Federal Government Activities

- Benchmark for data centers was core recommendation of the EPA report

  - Provides opportunity to compare and measure impacts of changes made to facility

  - Government can help forge consensus on industry accepted benchmark

  - DOE focusing on data center energy assessments through its Save Energy Now industrial program

  - EPA considering a whole-building ENERGY STAR benchmarking tool for data centers

Federal Government Activities

ENERGY STAR Specification for Servers

- Server energy demand drives DC power & cooling needs

- <u>Goal</u>: Create protocol to measure server energy efficiency to allow fair competition

- Technical specification would have several key elements:

  – Definitions of product types eligible for ENERGY STAR

  – Test procedure for energy efficiency & computing performance

  – Proposed levels to set the bar: near term (i.e. Tier 1) may include power supply efficiency; longer term (i.e. Tier 2, replacing Tier 1) would be a more holistic metric (system efficiency)

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ENERGY STAR for Servers

Power Supply Efficiency -- Possible Tier 1

- Why higher efficiency for server power supplies??
  - Common hardware denominator
  - Lower HVAC costs >> **1 to 1.5 kWh** HVAC savings for every kWh saved at the plug
  - More computing space – increase computational density
  - Reduce CO_2 emissions [**1kWh ~ 1.6 lbs of CO_2**]

- Test Procedure developed by Electric Power Research Institute (EPRI)
  - Testing and verifying power supply efficiency and reliability performance
  - Developing recommendations for 80 Plus program

Source: Brian Fortenbery, EPRI, Digital Power Forum 2007

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ENERGY STAR for Servers

Server Performance Benchmark

- No metric available to compare server energy efficiency
- January 2006 **SPEC Power and Performance** Committee began development of benchmark for evaluating energy efficiency of servers
- Working prototype has been developed --- final product by the end of 2007
- **EPA will review benchmark for possible Tier 2**
- More info on progress: www.spec.org/specpower

Next Steps for Servers

- Draft framework discussion document posted for stakeholder review; comment period closed August 31

- **September:** review of comments and information gathering

- **October 31**: ENERGY STAR stakeholder meeting to discuss Draft 1 specification requirements

  - Following the Uptime Institute 2007 Charette in Santa Fe, NM October 28 – 31 www.uptimeinstitute.org/charette

- Goal – Tier 1 specification finalized by early 2008

Data Center Need		Federal Role
Standardized Measurements	**Metrics to effective use of energy and identify energy efficient components for the data center**	EPA ENERGY STAR specifications for data centers and IT equipment DOE assessment of data center efficiency
Leadership by Fed. Government	**Real life examples of best practices in efficient data center design with benchmark numbers for comparison**	EPA/DOE measure federal data centers and publicly report results Leadership in designing efficient DCs
Private Sector Challenge	**Impetus to convince management to improve the efficiency of facilities**	EPA/DOE challenges industry and provides an opportunity for companies to compete on efficiency of facilities
Research and Development	**Further investigation into methods of increasing the efficiency of data centers**	EPA/DOE support for research and development
Information on Best Practices	**Examples of currently available technology and solutions to improve data center performance and reduce power usage**	EPA/DOE collects information on best practices and makes public for industry

Take Aways

- Rising energy supply / security & climate change concerns

  – Emergence of green economy but standard metrics & energy transparency needed

- Financial and reputational risk associated with status quo

  – Boardrooms, investors, and customers taking notice

  – Energy efficiency should be a first resource in any action plan

- Data centers a key economic and CO_2 reduction opportunity

- *Stay tuned for EPA & DOE plan to implement recommendations*

- Track progress at www.energystar.gov/datacenters and http://hightech.lbl.gov/datacenters.html