Saving Energy in Data Centers Applying Best Practices

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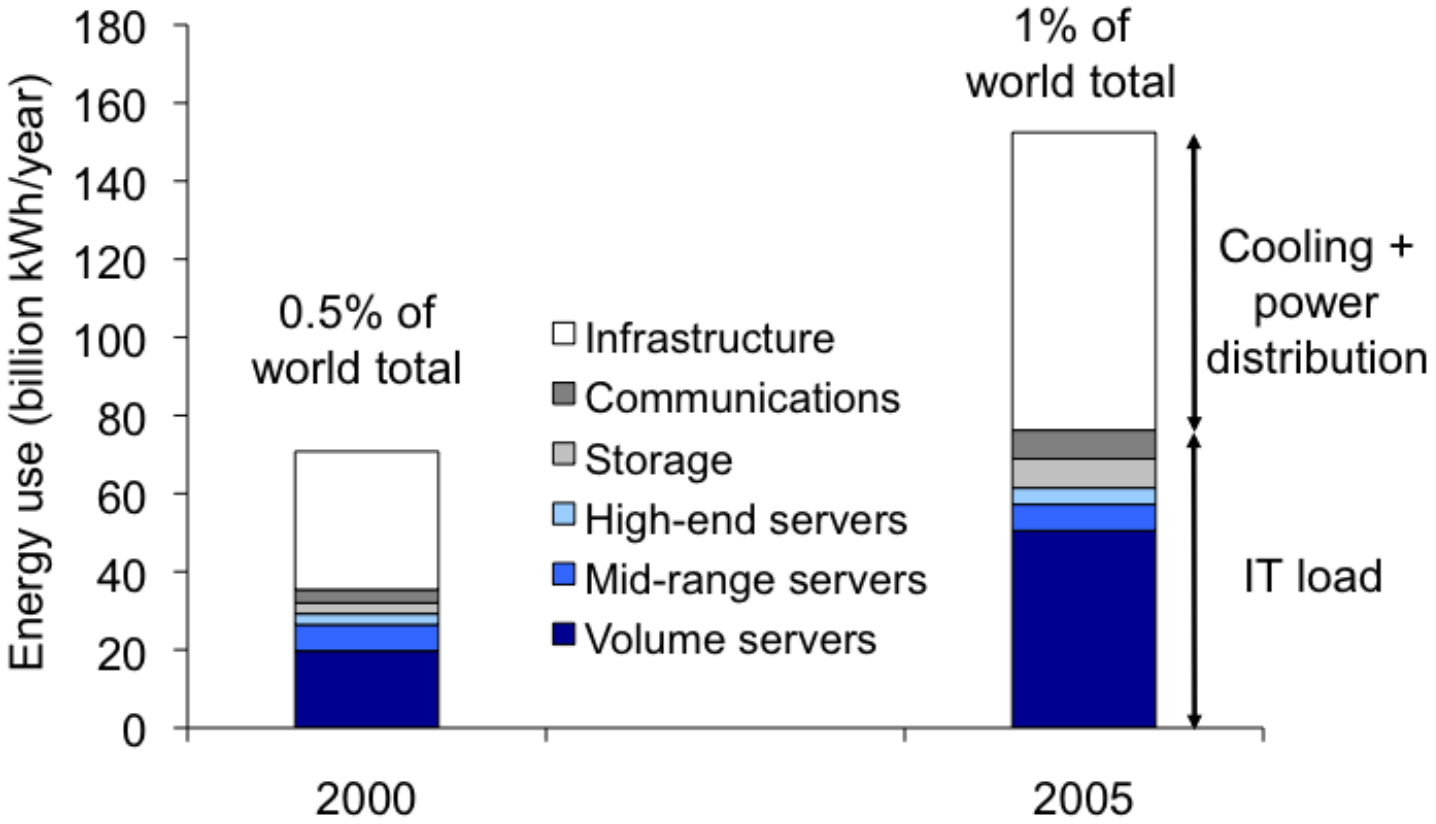
Data Center Energy

- Data centers are energy intensive facilities
  - 10 to 100+ times more energy intensive than other commercial space
  - Server racks now designed for more than 25+ kW
  - Surging demand for data storage
  - Typical facility ~ 1MW, can be > 20 MW
  - 1.5% of US Electricity consumption in 2006
  - Projected to double in next 5 years
- Significant data center building boom
  - Power and cooling constraints in existing facilities
  - Utility distribution constraints

World Data Center Electricity Use - 2000 and 2005



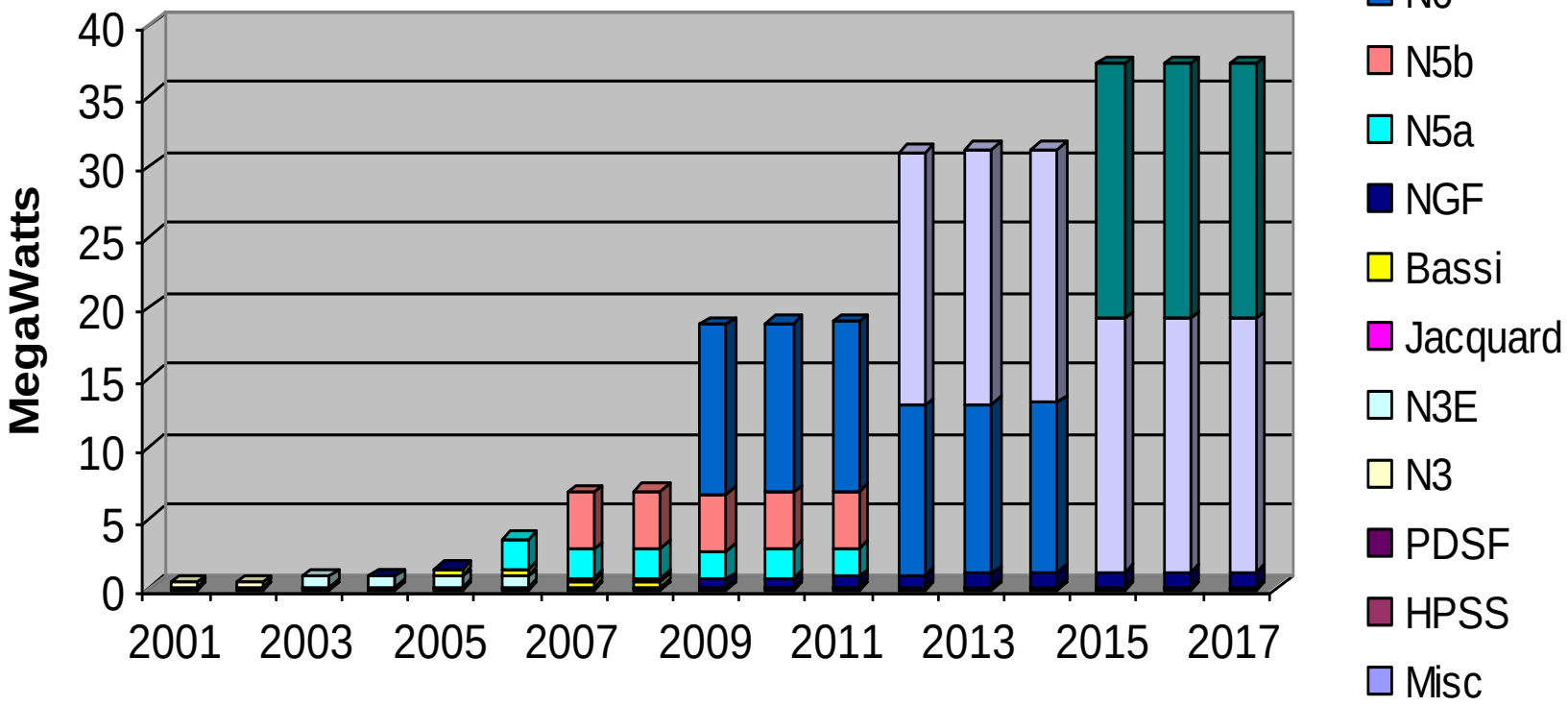
Source: Koomey 2008

The Second U.S.-China Energy Efficiency Forum

LBNL Feels the Pain!

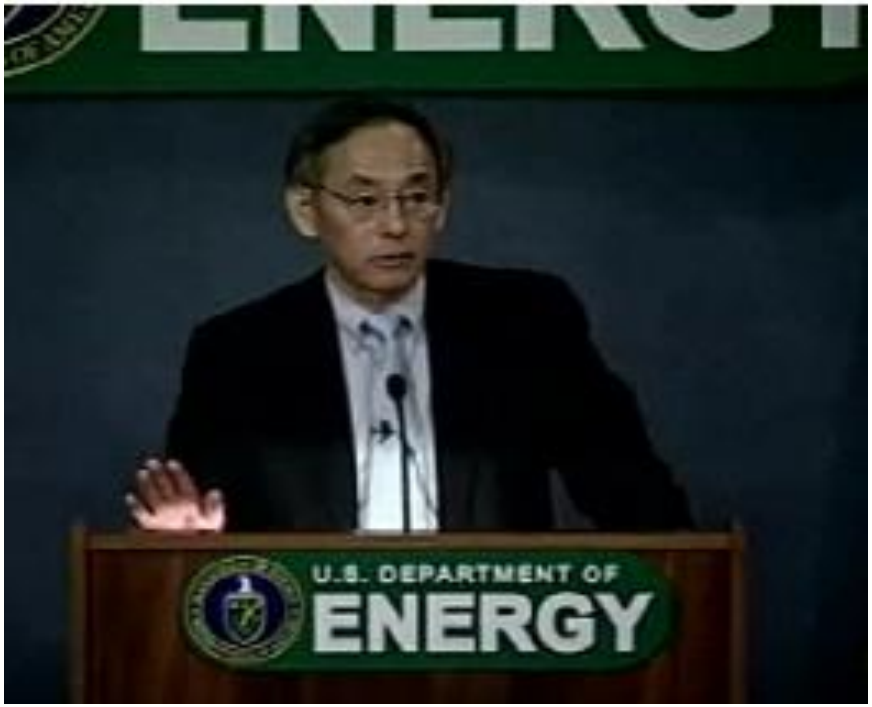
LBNL Super Computer Systems Power

NERSC Computer Systems Power
(Does not include cooling power)
(OSF: 4MW max)



First, a Few Words from our Leader

- "We're certainly in a mess right now."
- "The environment... is the reason I joined the Dept of Energy."
- "We simply cannot fail."

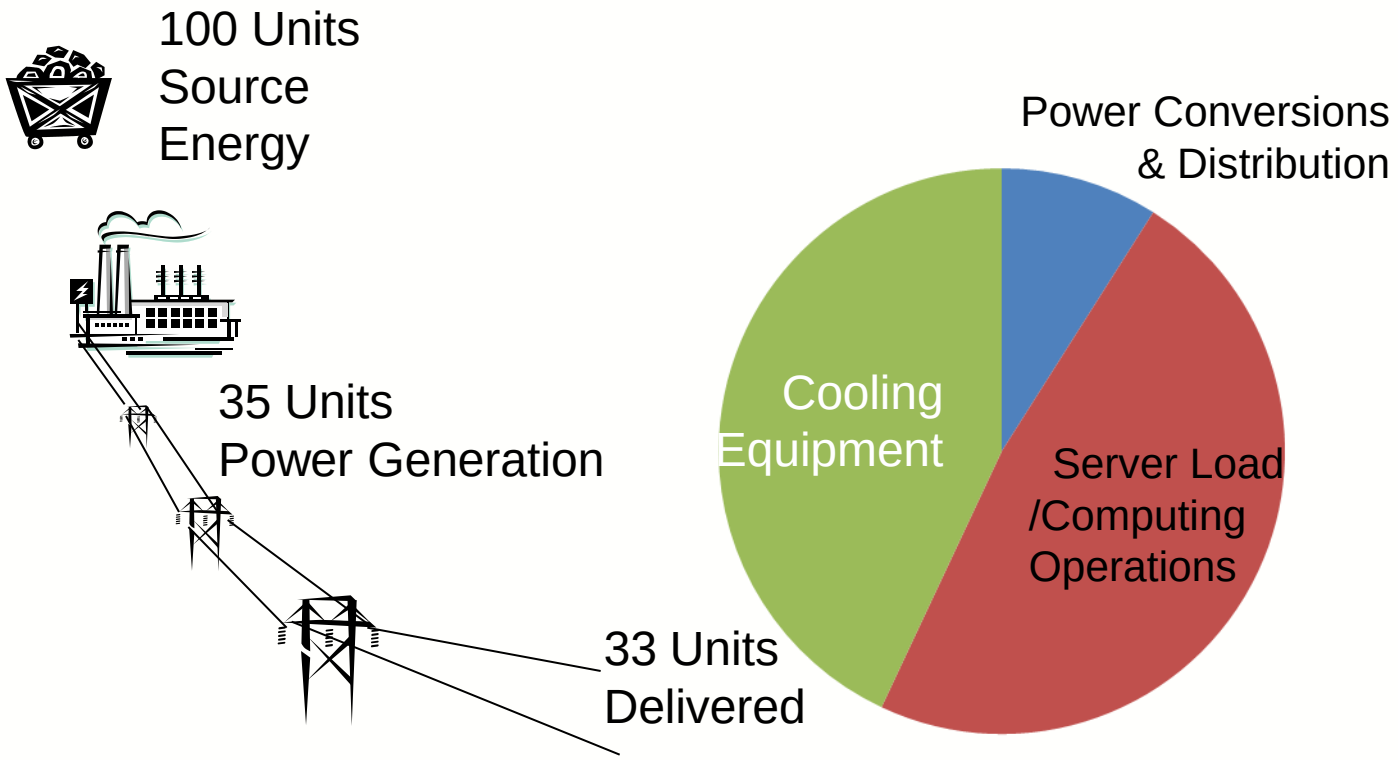


Source: Secretary Chu's address to DOE staff 1/22/09

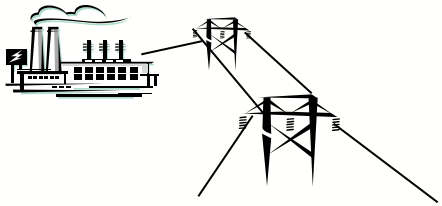
Typical Data Center Energy End Use

Data Center Energy Efficiency = 15% (or less)

(Energy Efficiency = Useful computation / Total Source Energy)



Energy Efficiency Opportunities



- Server innovation
- Virtualization
- High efficiency power supplies
- Load management

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

Power Conversion & Distribution → Server Load/ Computing Operations → Cooling Equipment

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

Alternative Power Generation

- On-site generation Including fuel cells and renewable sources
- CHP applications (Waste heat for cooling)

Potential Benefits of Data Center Energy Efficiency

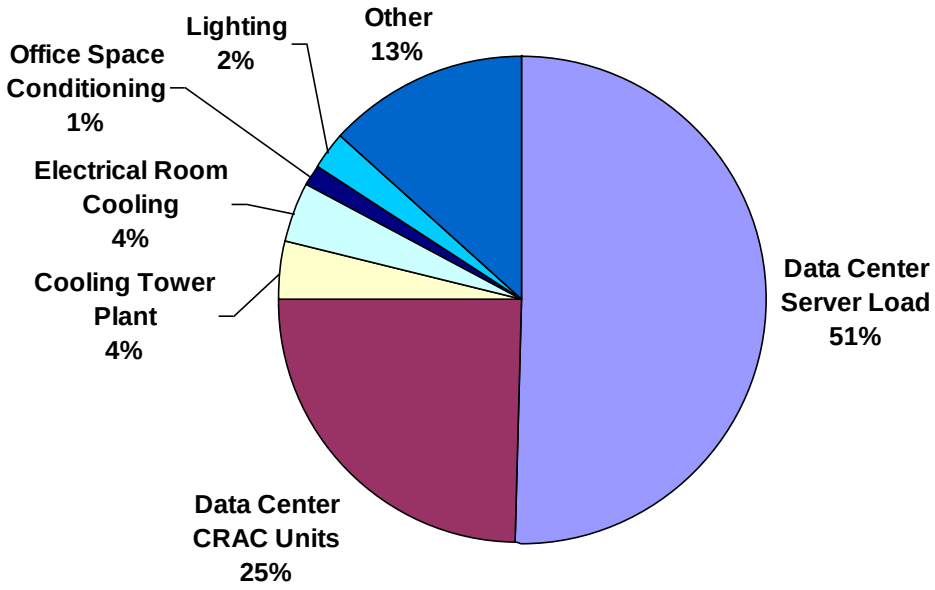
- 20-40% savings typical
- Aggressive strategies can yield 50+% savings
- Extend life and capacity of infrastructures
- But is mine good or bad?

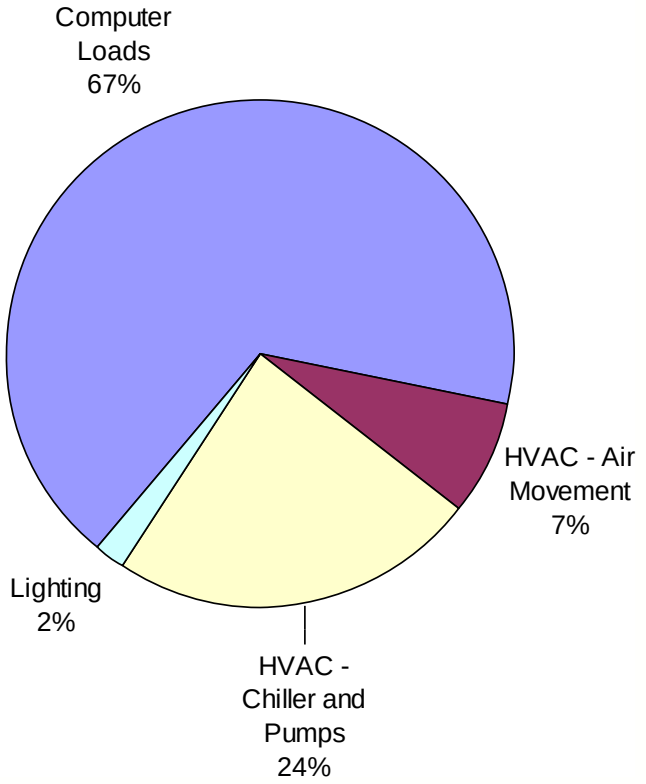
Benchmarking for Energy Performance Improvement

- Energy benchmarking can allow comparison to peers
- LBNL conducted studies of over 30 data centers:
  - Found wide variation in performance
  - Identified best practices

Your Mileage Will Vary

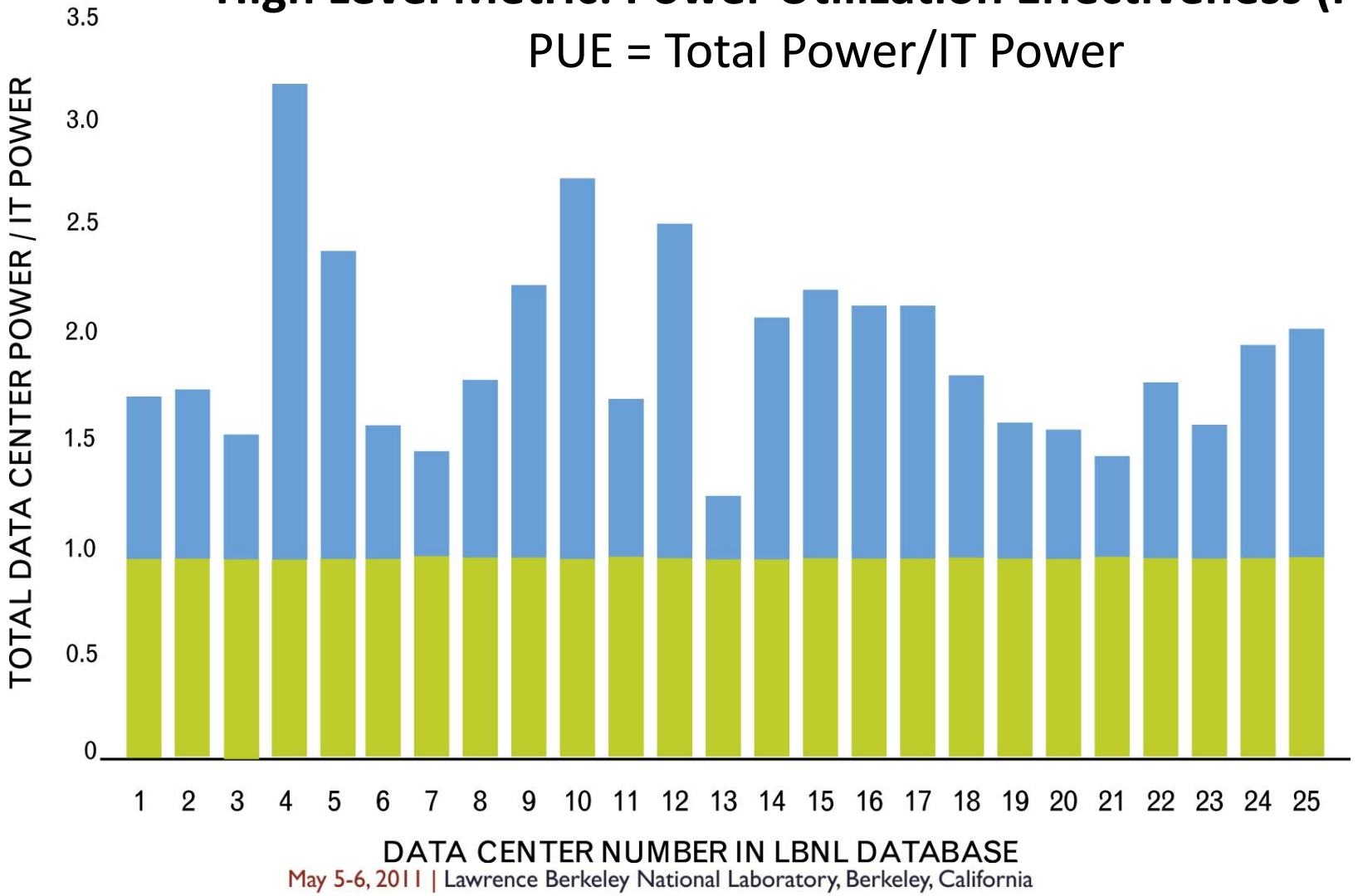
The relative percentages of the energy actually doing computing varied considerably.





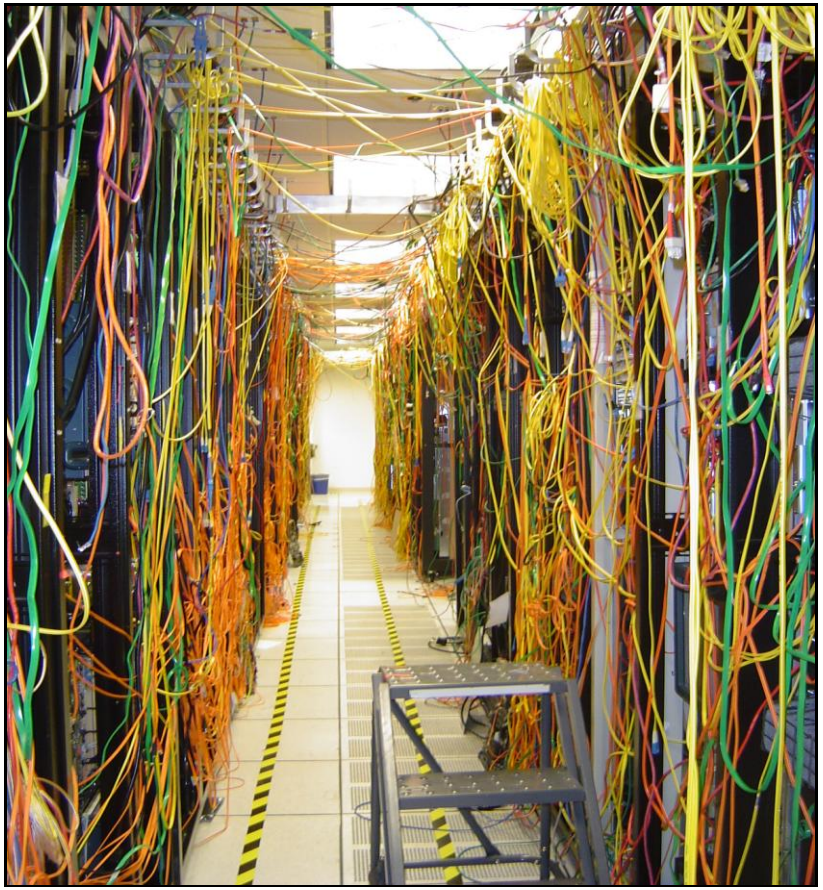
High Level Metric: Power Utilization Effectiveness (PUE)

PUE = Total Power/IT Power



Best Practices Based on Research and Benchmark Results

- IT equipment efficiency
- Use IT to save energy in IT
- Environmental conditions
- Air management
- Right-sizing
- Central plant optimization
- Efficient air handling
- Liquid cooling
- Free cooling
- Humidity control
- Improve power chain
- On-site generation
- Design and M&O processes



Areas for Potential Collaboration

- Capacity building for design and operation of energy efficient data centers
  - Training programs
  - Information clearinghouse on technologies, products, professionals, and best practices
  - Certification program for data center energy professionals
- Assessment framework and standards
  - Case studies on existing and new data center facilities
  - Evaluation metrics, performance indicators, and benchmarking system
  - Standardized profiling and assessment tools
  - Guideline and standards for the design and operation
  - Certification program for energy efficient data centers
- Advanced technology demonstrations

Resources

FEMP Federal Energy Management Program

http://www1.eere.energy.gov/femp/program/data_center.html

BERKELEY LAB

http://hightech.lbl.gov/datacenters.html

ENERGY STAR

http://www.energystar.gov/index.cfm?c=prod_development.server_efficiency

Save ENERGY Now ®

http://www1.eere.energy.gov/industry/datacenters/

U.S. DEPARTMENT OF ENERGY | National Development and Reform Commission (NDRC)

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