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Phoenix, AZ

August 3-6, 2008

Save Energy Now in Data Centers:

GovEnergy2008
August 3-6, 2008

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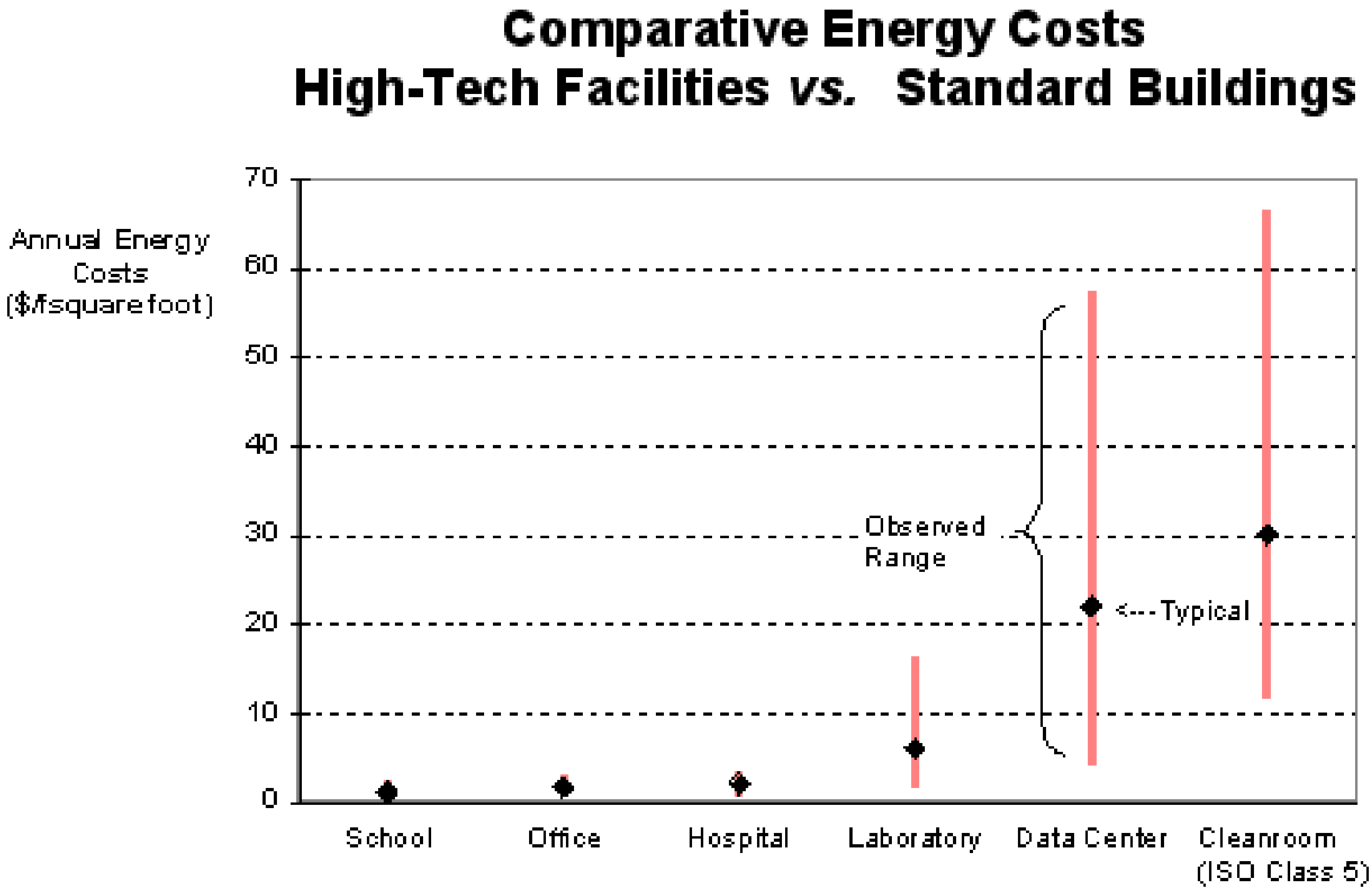
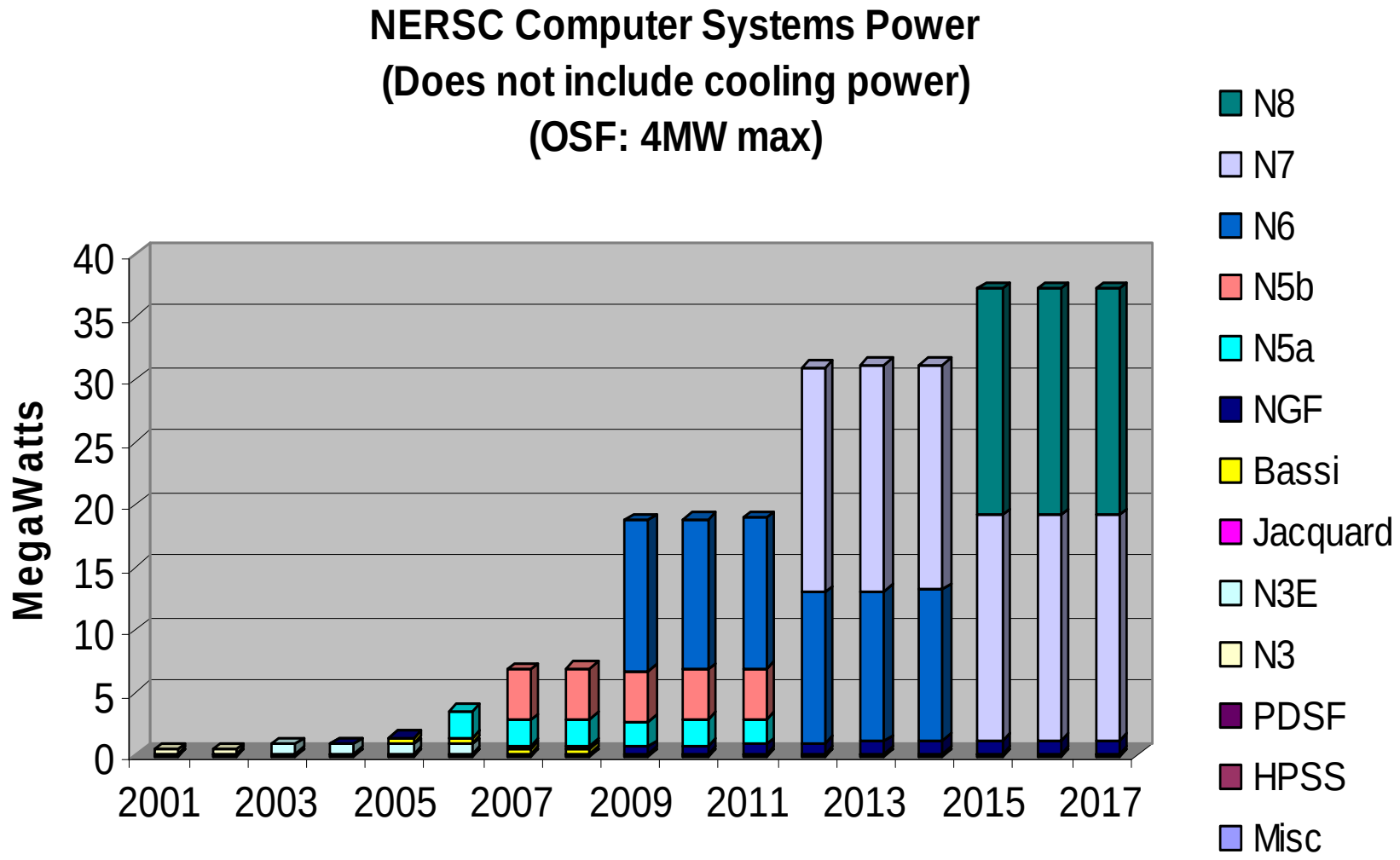
High Tech Buildings are Energy Hogs:



LBNL Feels the Pain!

LBNL Super Computer Systems Power:

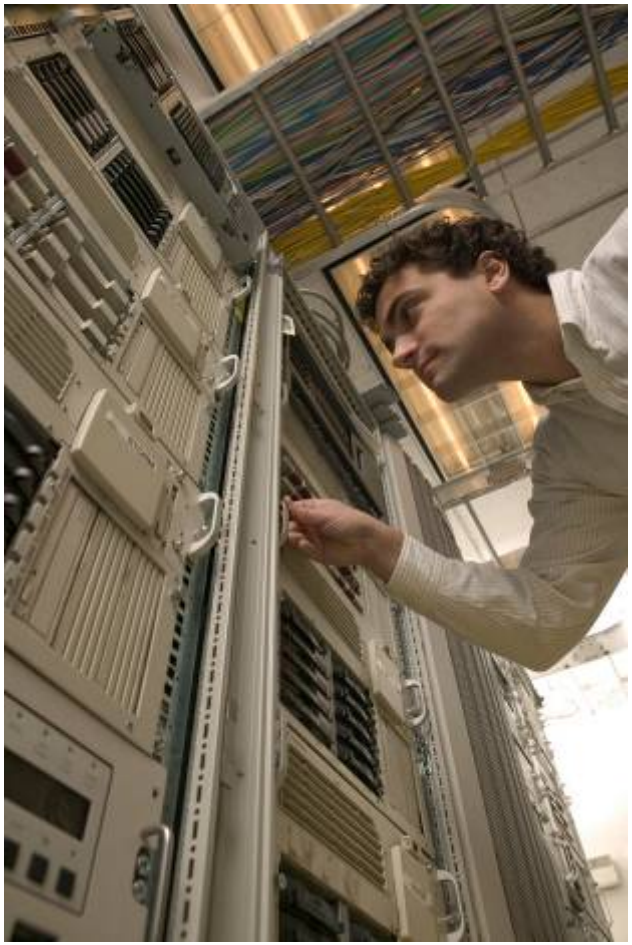


Lifetime electrical cost will soon exceed cost of IT equipment, but IT equipment load can be controlled

- Consolidation
- Server efficiency
  - Flops per watt
  - Efficient power supplies
- Software efficiency (Virtualization, MAID, etc.)
- Power management
  - Low power modes
- Redundant power supplies
- Reducing IT load has a multiplier effect
  - Equivalent savings +/- in infrastructure

Potential Benefits of Improved Data Center Energy Efficiency:

- 20-40% savings typically possible
- Aggressive strategies can yield better than 50% savings
- Extend life and capacity of existing data center infrastructures
- But is my center good or bad?



Benchmarking for Energy Performance Improvement:

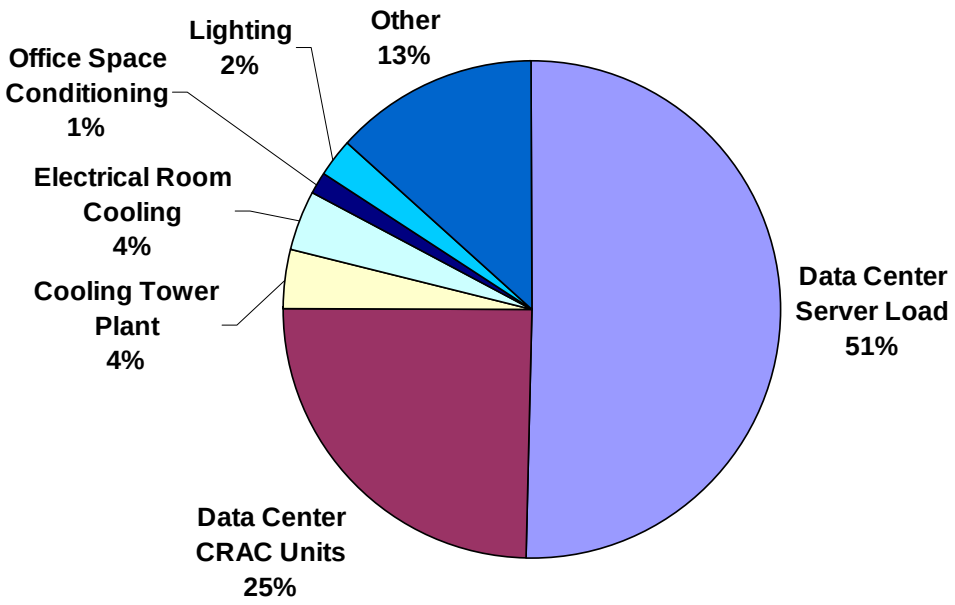
Energy benchmarking can allow comparison to peers and help identify best practices

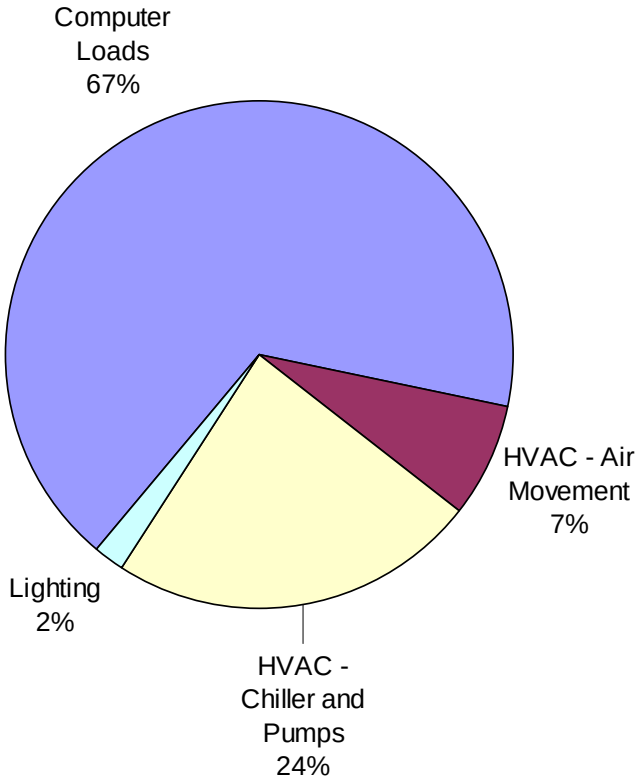
LBNL conducted studies of 22 data centers:

- Found wide variation in performance
- Identified best practices

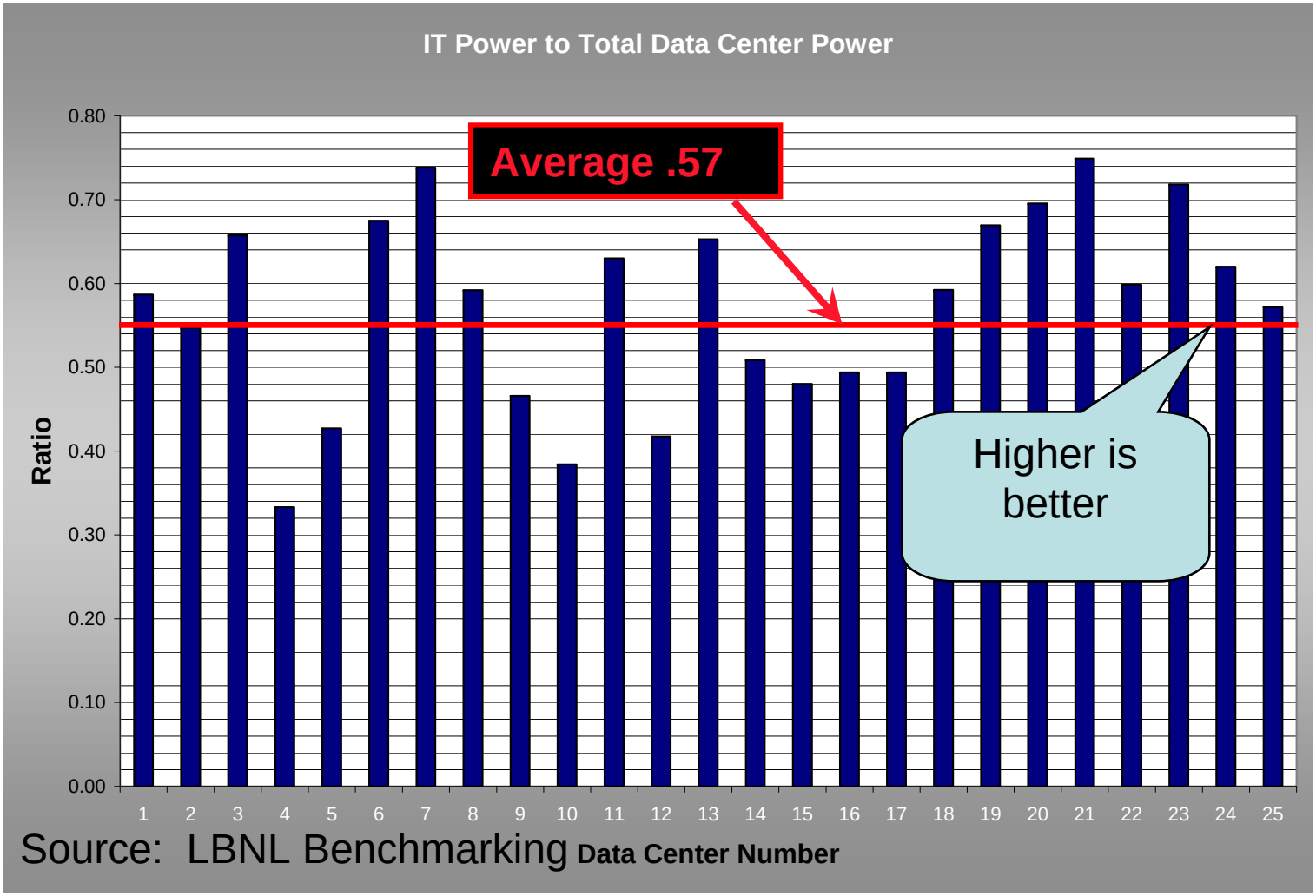
Your Mileage Will Vary

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



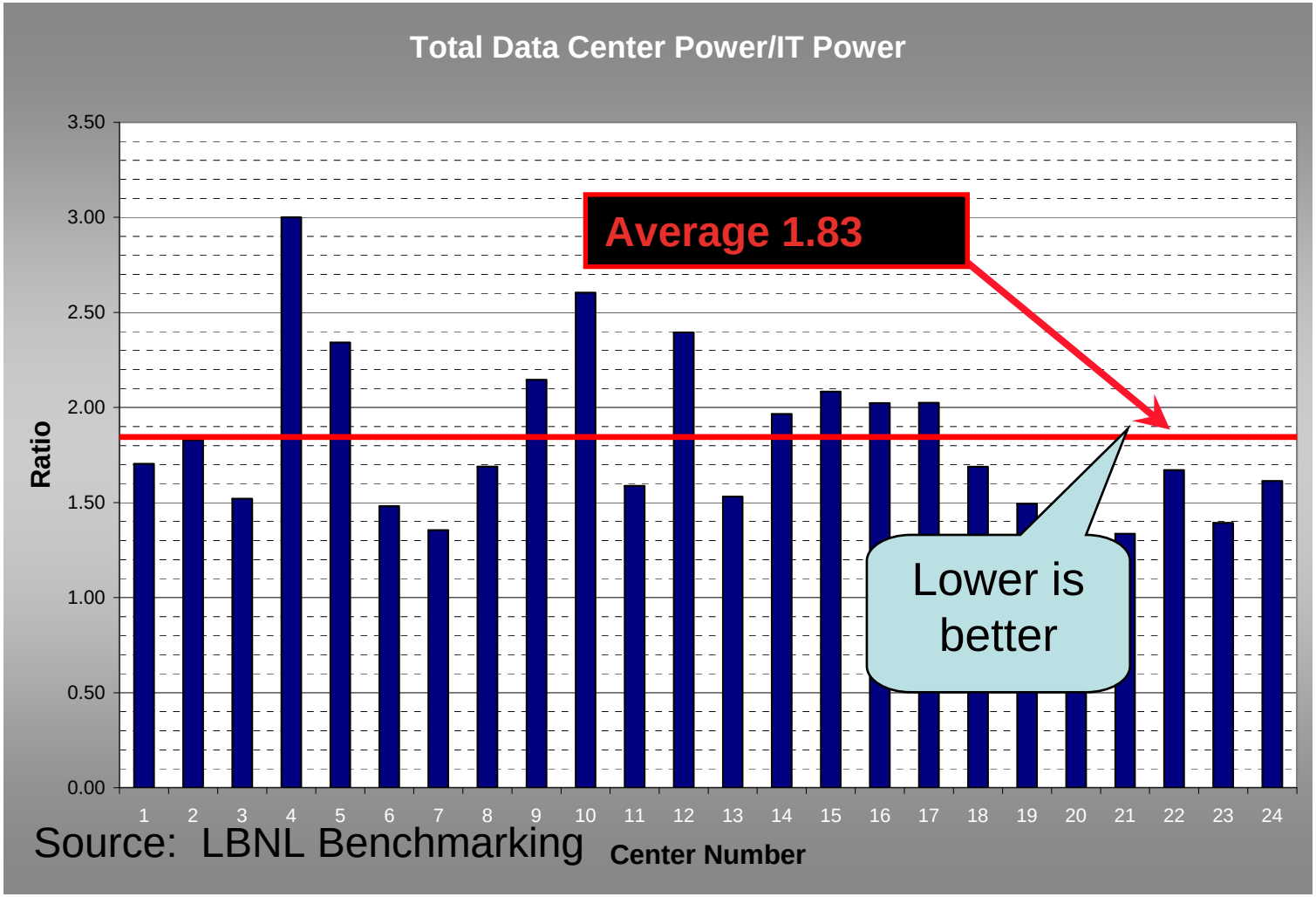


High Level Metric— Data Center Infrastructure Efficiency (DCiE) Ratio of Electricity Delivered to IT Equipment



Source: LBNL Benchmarking

Alternative High Level Metric – Data Center Total / IT Equipment (PUE)

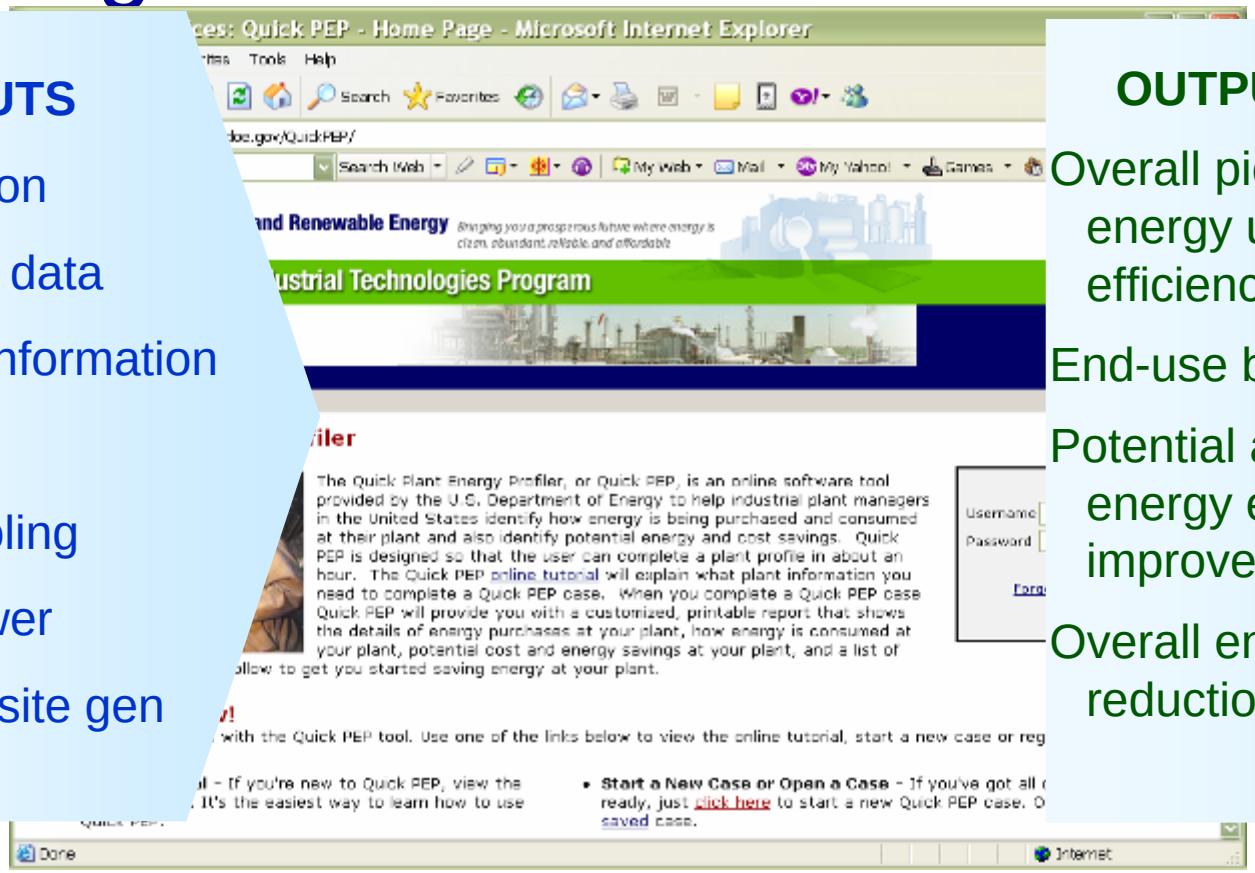


Source: LBNL Benchmarking

Save Energy Now On-line profiling tool: “Data Center Pro”

INPUTS

- Description
- Utility bill data
- System information
  - IT
  - Cooling
  - Power
  - On-site gen

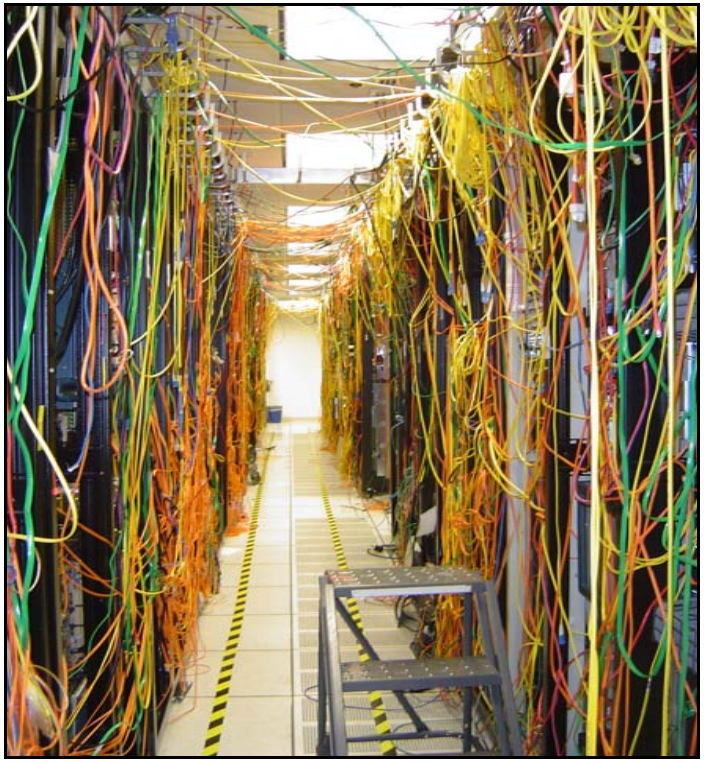


OUTPUTS

- Overall picture of energy use and efficiency
- End-use breakout
- Potential areas for energy efficiency improvement
- Overall energy use reduction potential

Using benchmark results to find best practices:

- **Air management**
- Right-sizing
- Central plant optimization
- Efficient air handling
- **Free cooling**
- **Humidity control**
- Liquid cooling
- **Improve power chain**
- On-site generation
- **Design and M&O processes**



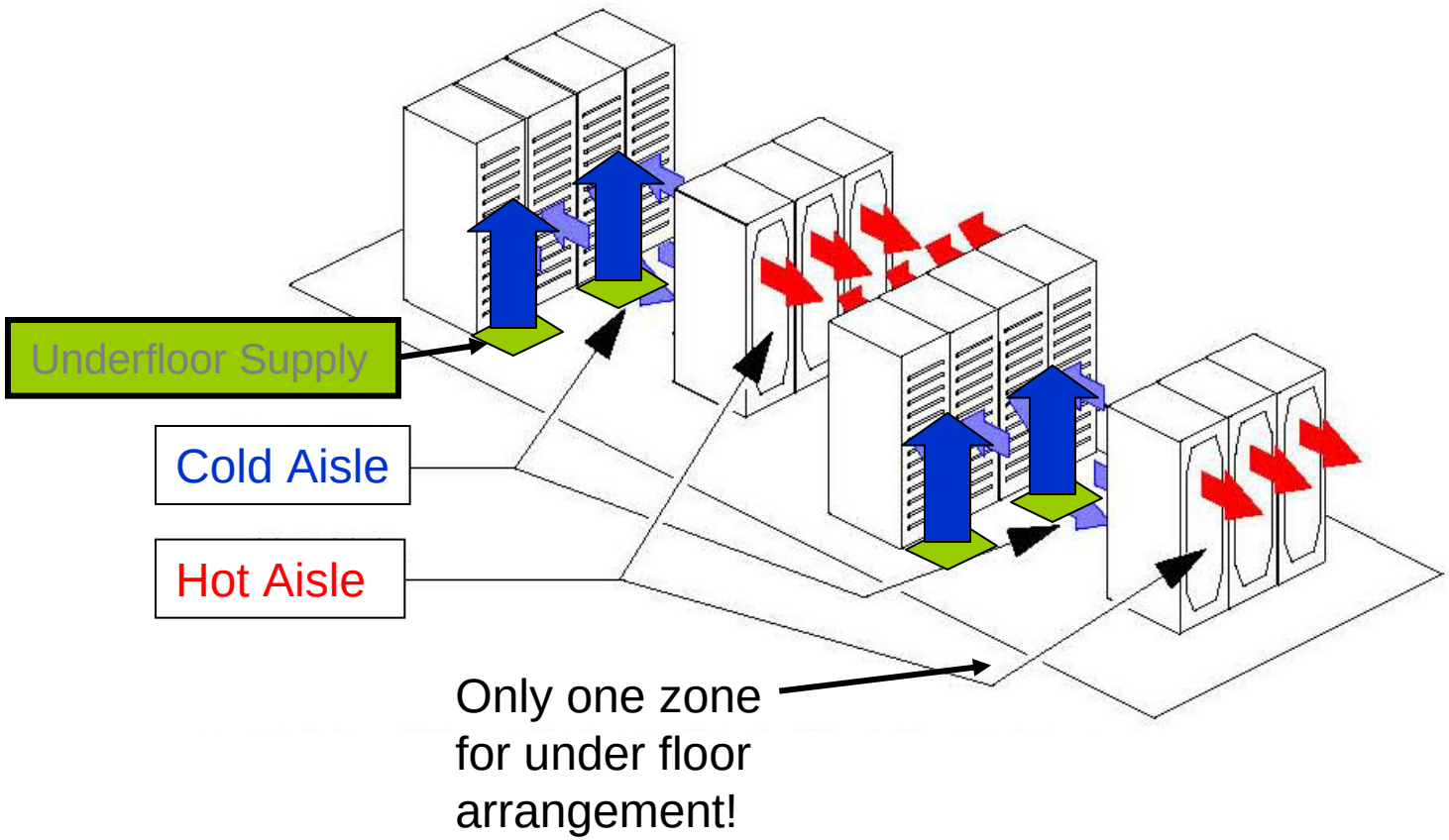
Air Management:

- Typically, much more air is circulated through computer room air conditioners than is required due to air mixing and short circuiting
  - Low supply temperature
  - Low Delta T

Isolate Hot and Cold Air:

- Establish hot and cold aisles
- Improve isolation to:
  - Reduce air short-circuiting
  - Reduce mixing (hot spots)
- Overall temperature can be raised
- Cooling system more efficient with higher temperature differences

Data Center Layout



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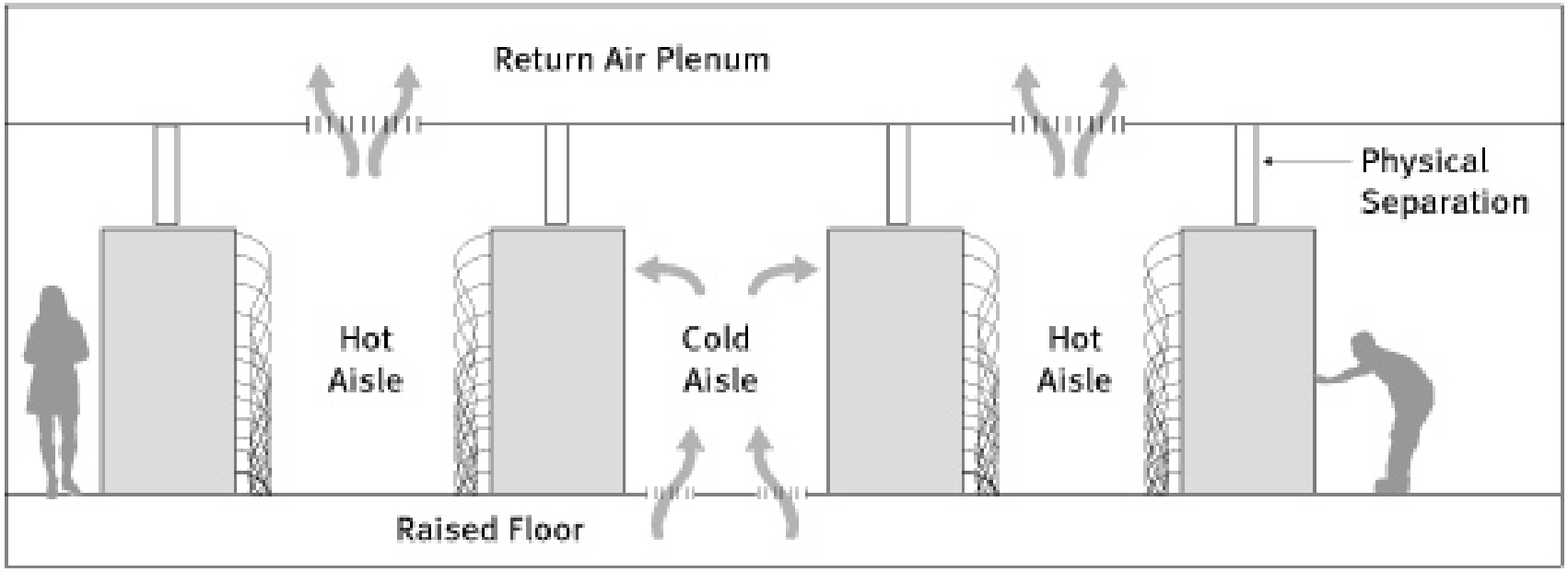
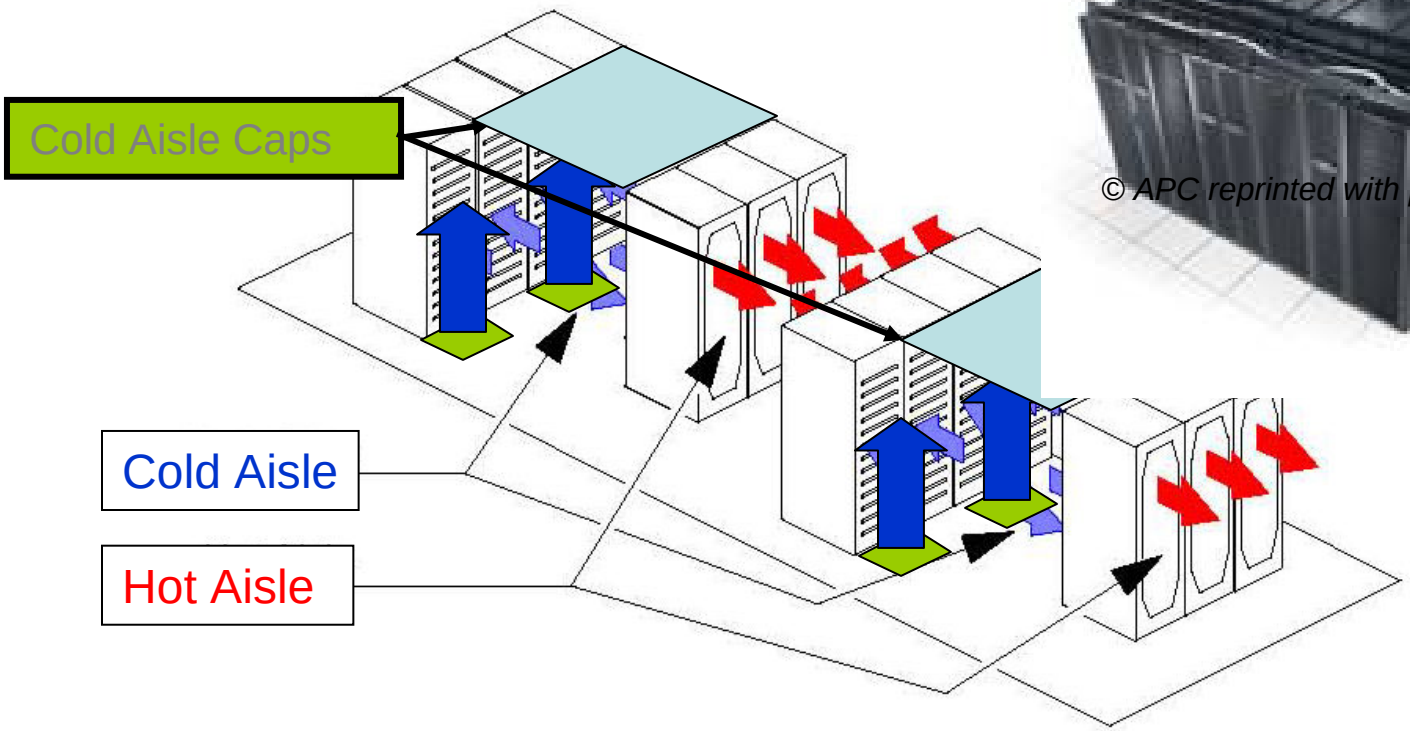
Optimize Air Management:

- Enforce hot aisle/cold aisle arrangement
- Eliminate mixing and short circuits



Aisle Air Containment:



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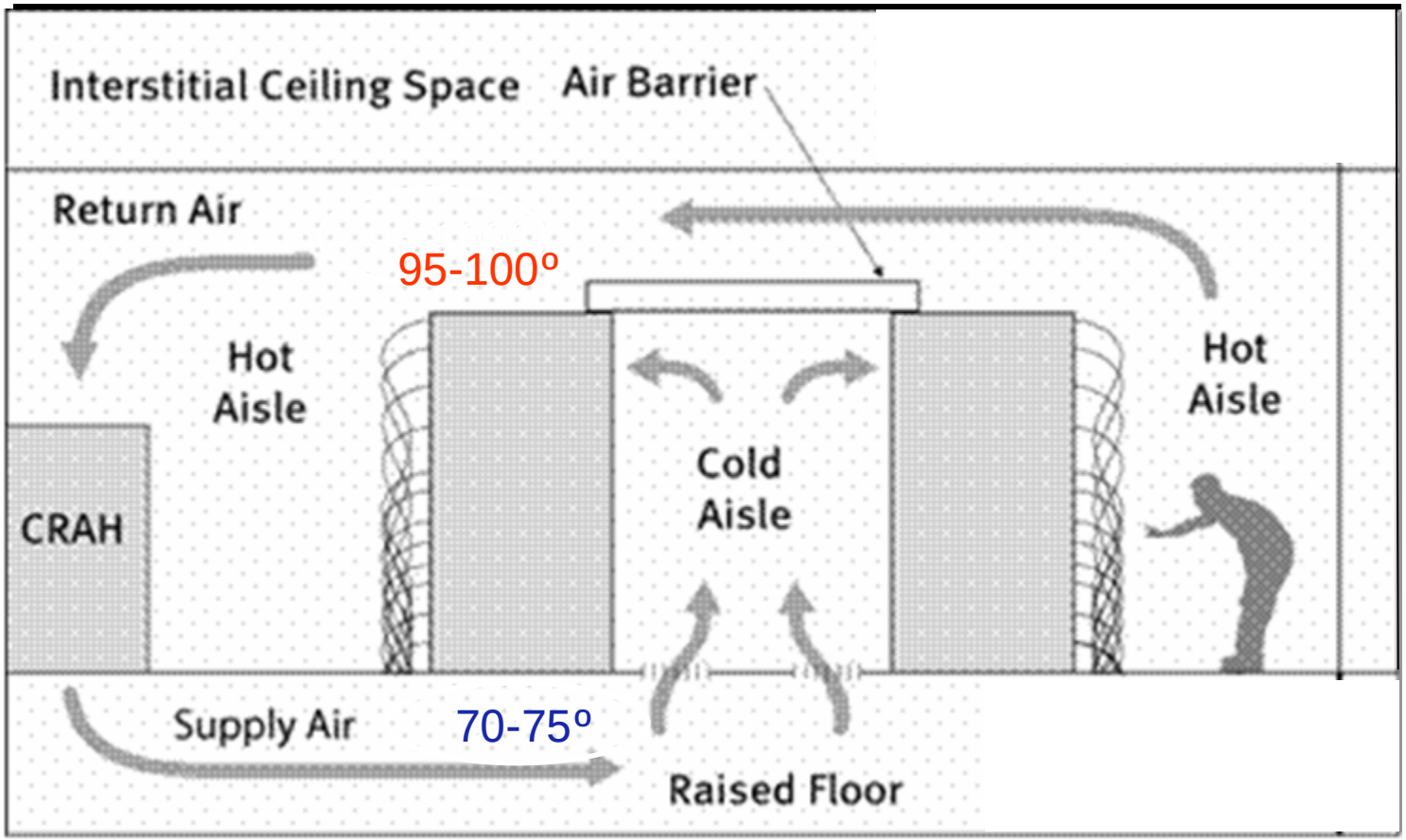
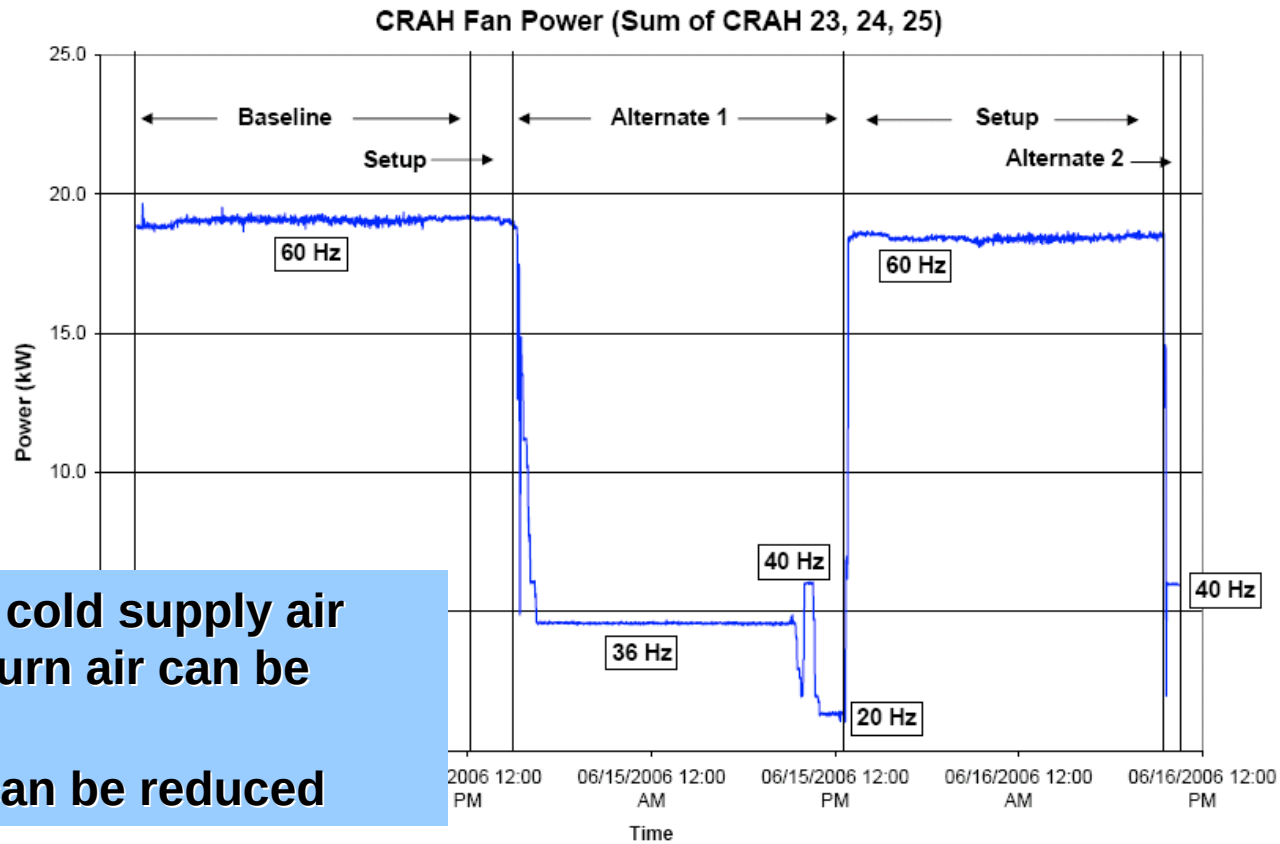
Best Scenario— Isolate Cold and Hot



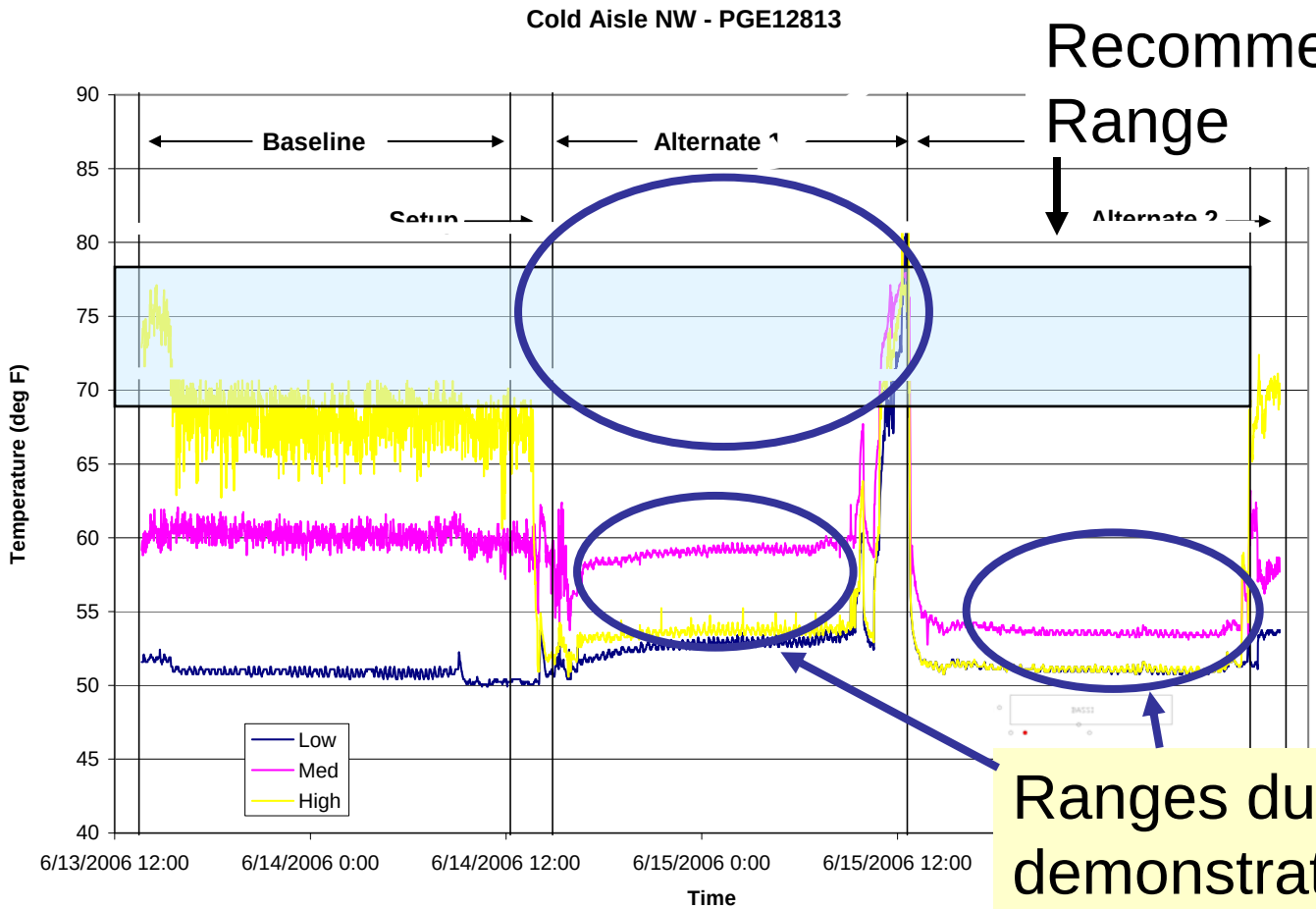
Fan Energy Savings – 75%



If mixing of cold supply air with hot return air can be eliminated-
fan speed can be reduced

Better Temperature Control Can Allow Raising the Temperature in The Entire Center

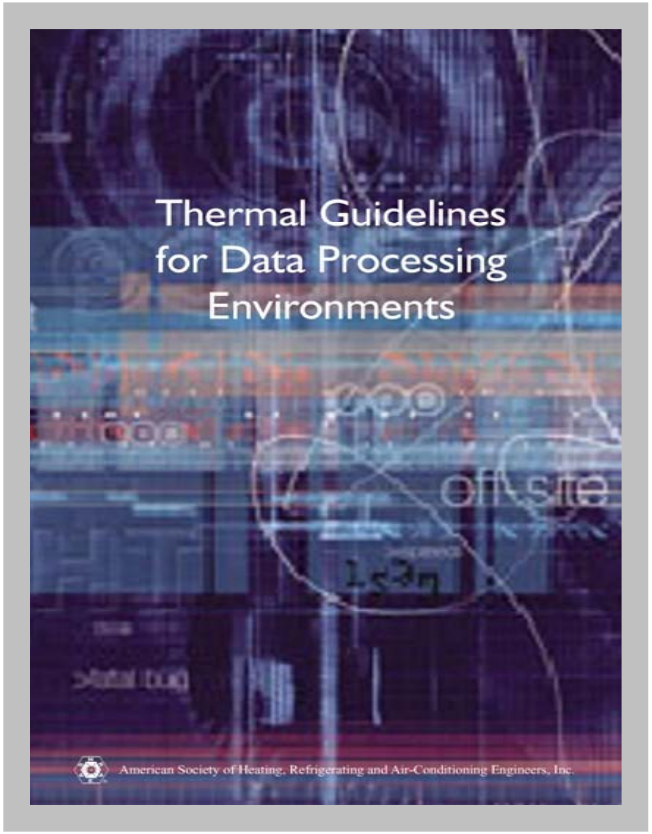
ASHRAE Recommended Range



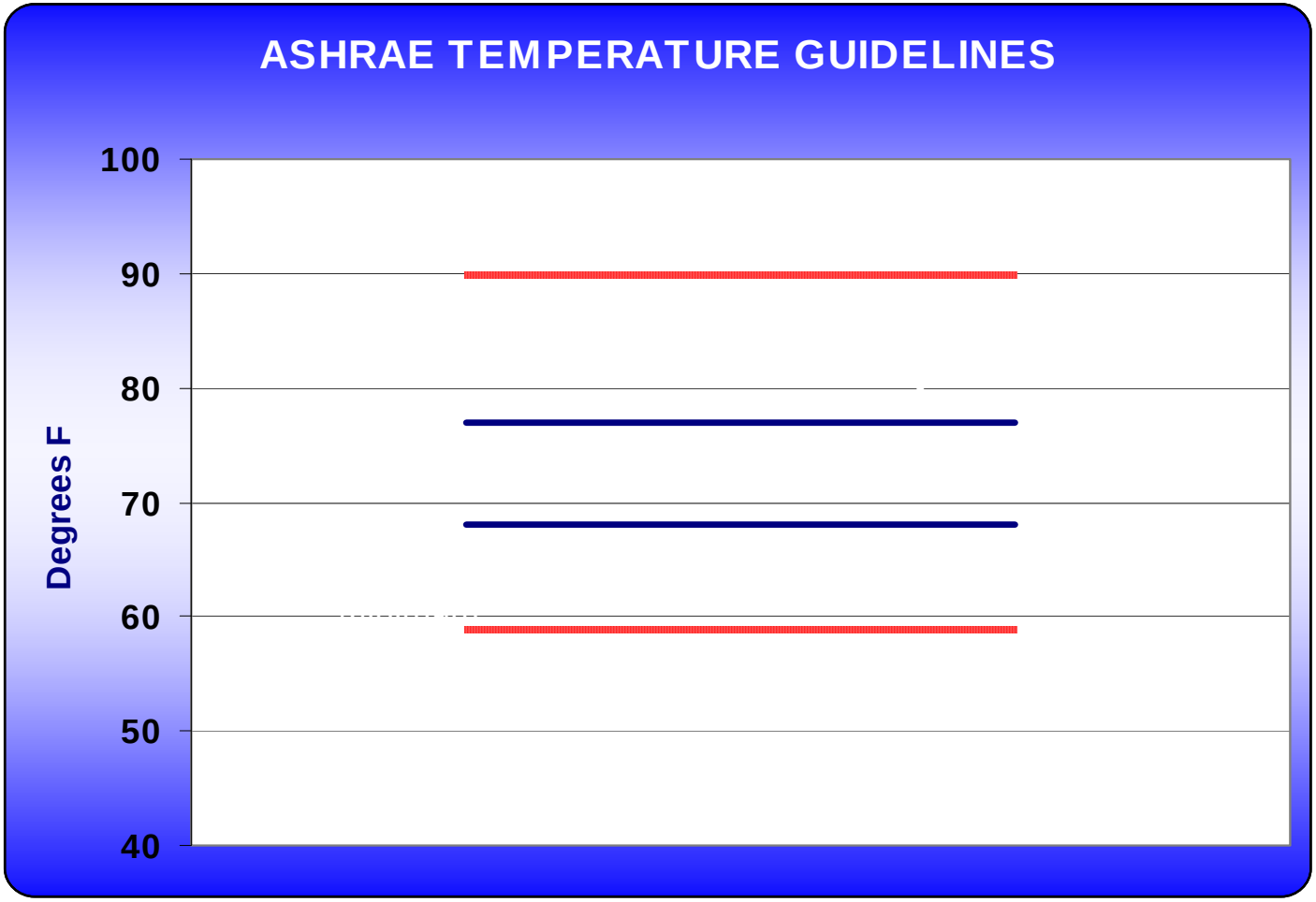
Ranges during demonstration

Environmental Conditions

- Use ASHRAE Recommended and Allowable ranges of temperature and humidity



Temperature Guidelines – *at The Inlet* to IT Equipment



Best air management practices:

- Arrange racks in hot aisle/cold aisle configuration
- Match server airflow by aisle
- Get variable speed or two speed servers fans
- Provide variable airflow fans for AC units
- Consider overhead supply
- Plug floor leaks and provide blank off plates in racks
- Draw return from as high as possible
- Provide isolation of hot and cold spaces
- Use CFD to inform design and operation

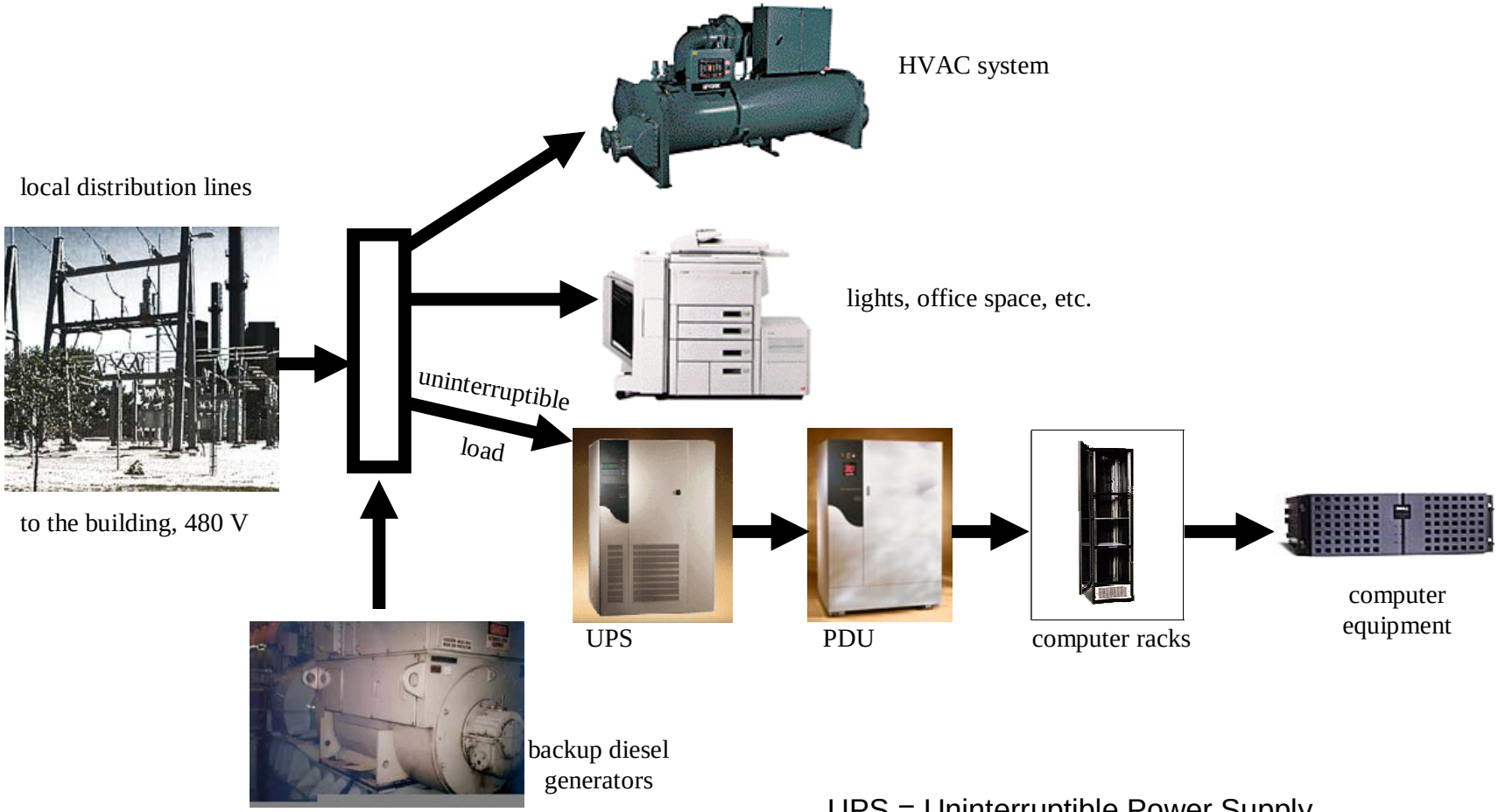
Use Free Cooling:

- Outside-Air Economizers
  - Can be very effective (24/7 load)
  - Controversial re: contamination
  - Must consider humidity
- Water-side Economizers
  - No contamination question
  - Can be in series with chiller

Improve Humidity Control:

- Eliminate inadvertent dehumidification
  - Computer load is sensible only
  - Medium-temperature chilled water
  - Humidity control at make-up air handler only
- Use ASHRAE allowable RH and temperature
- Eliminate equipment fighting
  - Coordinated controls on distributed AHUs

Electricity Flows in Data Centers



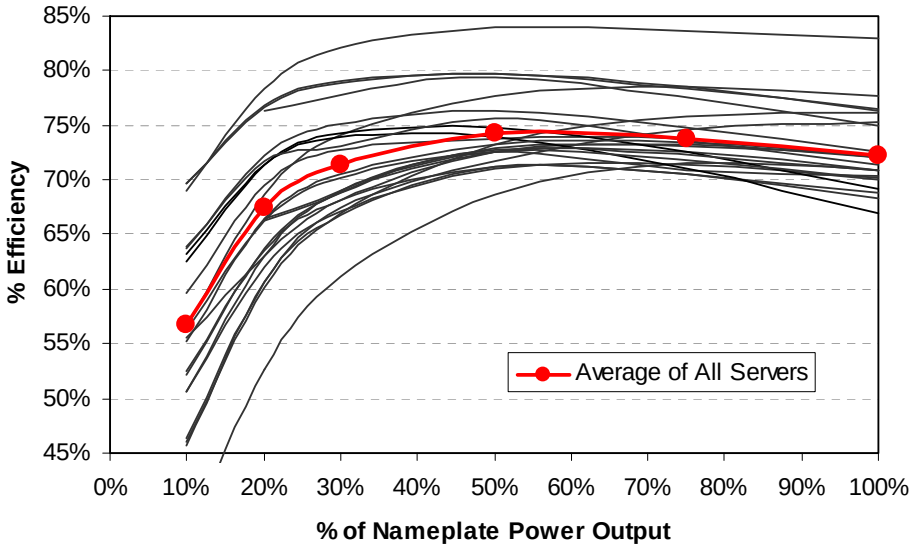
UPS = Uninterruptible Power Supply

PDU = Power Distribution Unit;

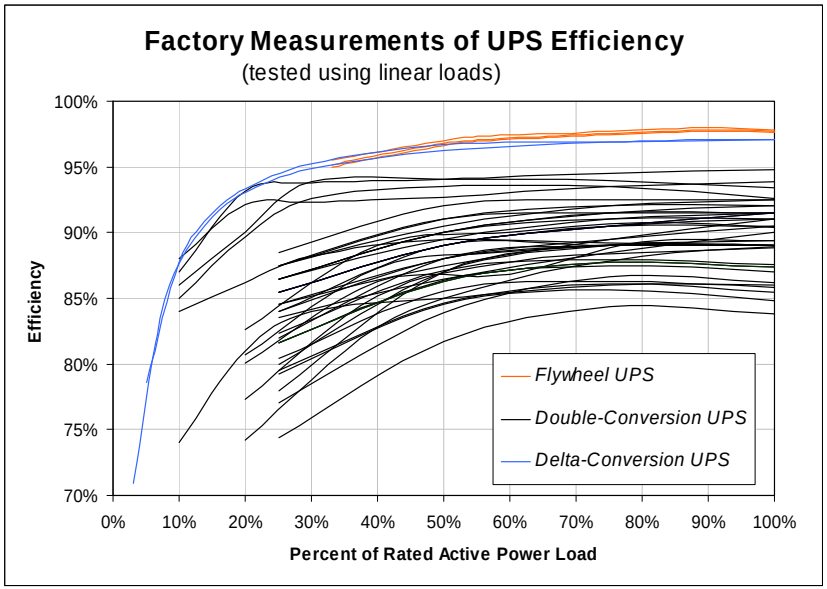
Improving the Power Chain:

- Increase distribution voltage
- DC distribution
- Improve equipment power supplies
- Improve UPS

Specify Efficient Power Supplies and UPSs



Power supplies in IT equipment generate much of the heat. Highly efficient supplies can reduce IT equipment load by 15% or more.

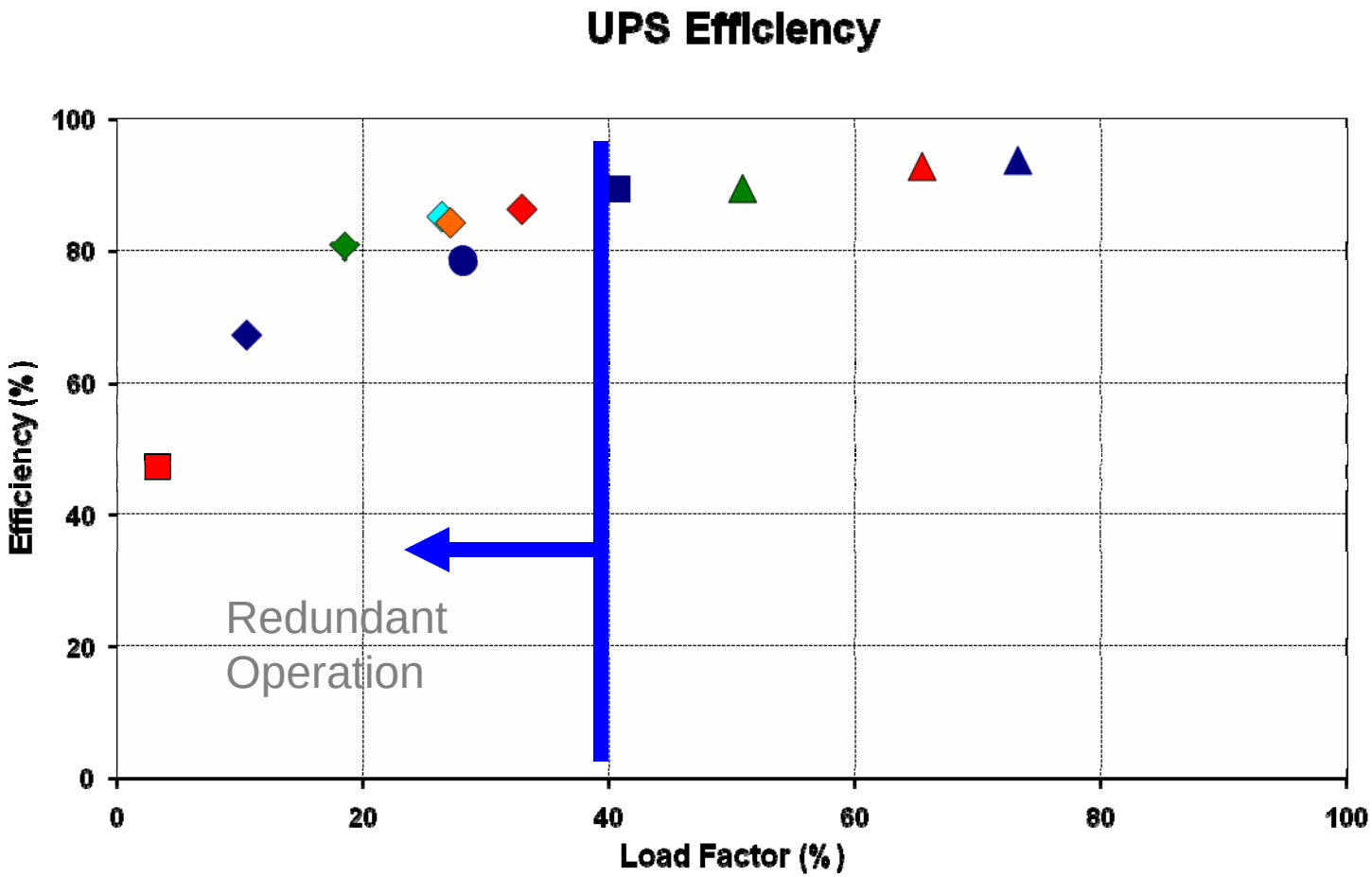


UPS efficiency also varies a lot.

Redundancy

- Understand what redundancy costs – is it worth it?
- Different strategies have different energy penalties (e.g. 2N vs. N+1)
- Redundancy in electrical distribution puts you down the efficiency curve

Measured UPS Efficiency



Improve Design and Operations Processes:

- Get IT and Facilities people to work together
- Use life-cycle total cost of ownership analysis
- Document design intent
- Benchmark existing facilities
- Re-commission as a regular part of maintenance

Top best practices identified through benchmarking

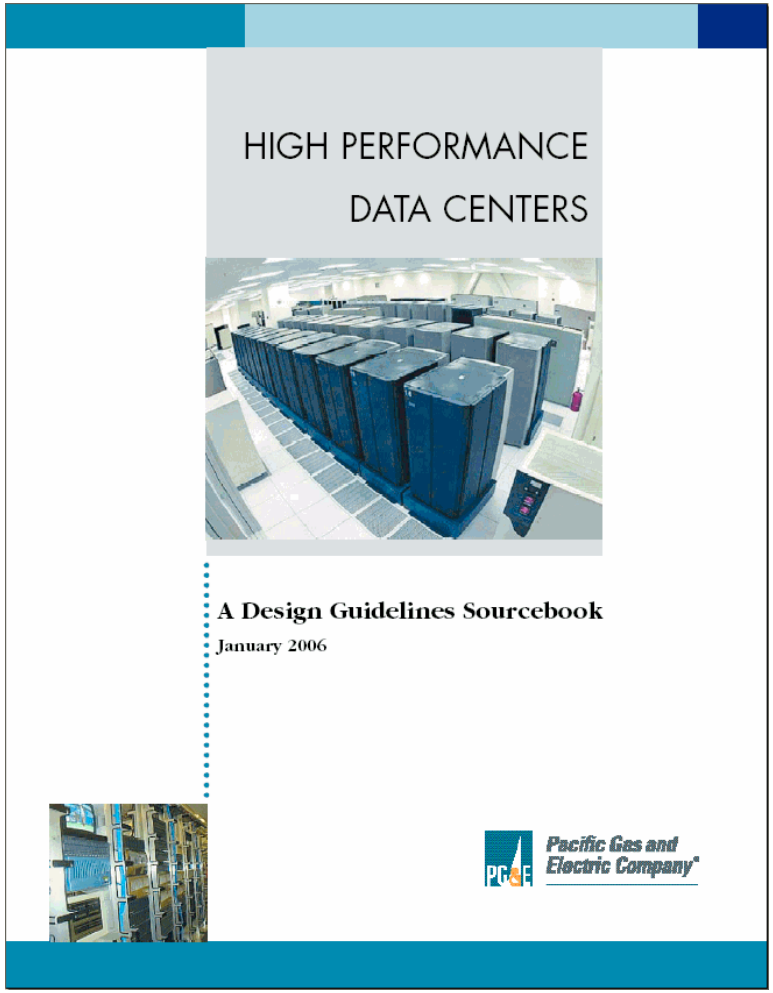
HVAC – Air Delivery – Water Systems		Facility Electrical Systems	IT Equipment	Cross-cutting / misc. issues
Air management	Cooling plant optimization	UPS systems	Power Supply efficiency	Motor efficiency
Air economizers	Free cooling	Self generation	Sleep/standby loads	Right sizing
Humidification controls alternatives	Variable speed pumping	AC-DC Distribution	IT equip fans	Variable speed drives
Centralized air handlers	Variable speed Chillers	Standby generation		Lighting
Direct liquid cooling				Maintenance
Low pressure drop air distribution				Commissioning/continuous benchmarking
Fan efficiency				Heat recovery
				Redundancies
				Method of charging for space and power
				Building envelope

Completed

Design Guidelines Are Available

- **Design Guides were developed based upon the observed best practices**
- **Guides are available through PG&E and LBNL websites**
- **Self benchmarking protocol also available**

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



Industrial Technologies Program

- Tool suite & metrics
- Energy baselining
- Training
- Qualified specialists
- Case studies
- Certification of continual improvement
- Recognition of high energy savers
- Best practice information
- Best-in-Class guidelines

Federal Energy Management Program

- Best practices showcased at Federal data centers
- Pilot adoption of Best-in-Class guidelines at Federal data centers
- Adoption of to-be-developed industry standard for Best-in-Class at newly constructed Federal data centers

EPA

- Metrics
- Server performance rating & ENERGY STAR label
- Data center performance benchmarking

Industry

- Tools
- Metrics
- Training
- Best practice information
- Best-in-Class guidelines
- IT work productivity standard

Links to Get Started

DOE Website: Sign up to stay up to date on new developments
www.eere.energy.gov/datacenters

Lawrence Berkeley National Laboratory (LBNL)
http://hightech.lbl.gov/datacenters.html

LBNL Best Practices Guidelines (cooling, power, IT systems)
http://hightech.lbl.gov/datacenters-bpg.html

ASHRAE Data Center technical guidebooks
http://tc99.ashraetcs.org/

The Green Grid Association – White papers on metrics
http://www.thegreengrid.org/gg_content/

Energy Star® Program
http://www.energystar.gov/index.cfm?c=prod_development.server_efficiency

Uptime Institute white papers
www.uptimeinstitute.org

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