



Save Energy Now in Federal Data Centers

An LBNL Case Study

Dale Sartor, PE
Lawrence Berkeley National Laboratory
(LBNL)

June 4, 2009
CEE Program Meeting
Boston, Massachusetts

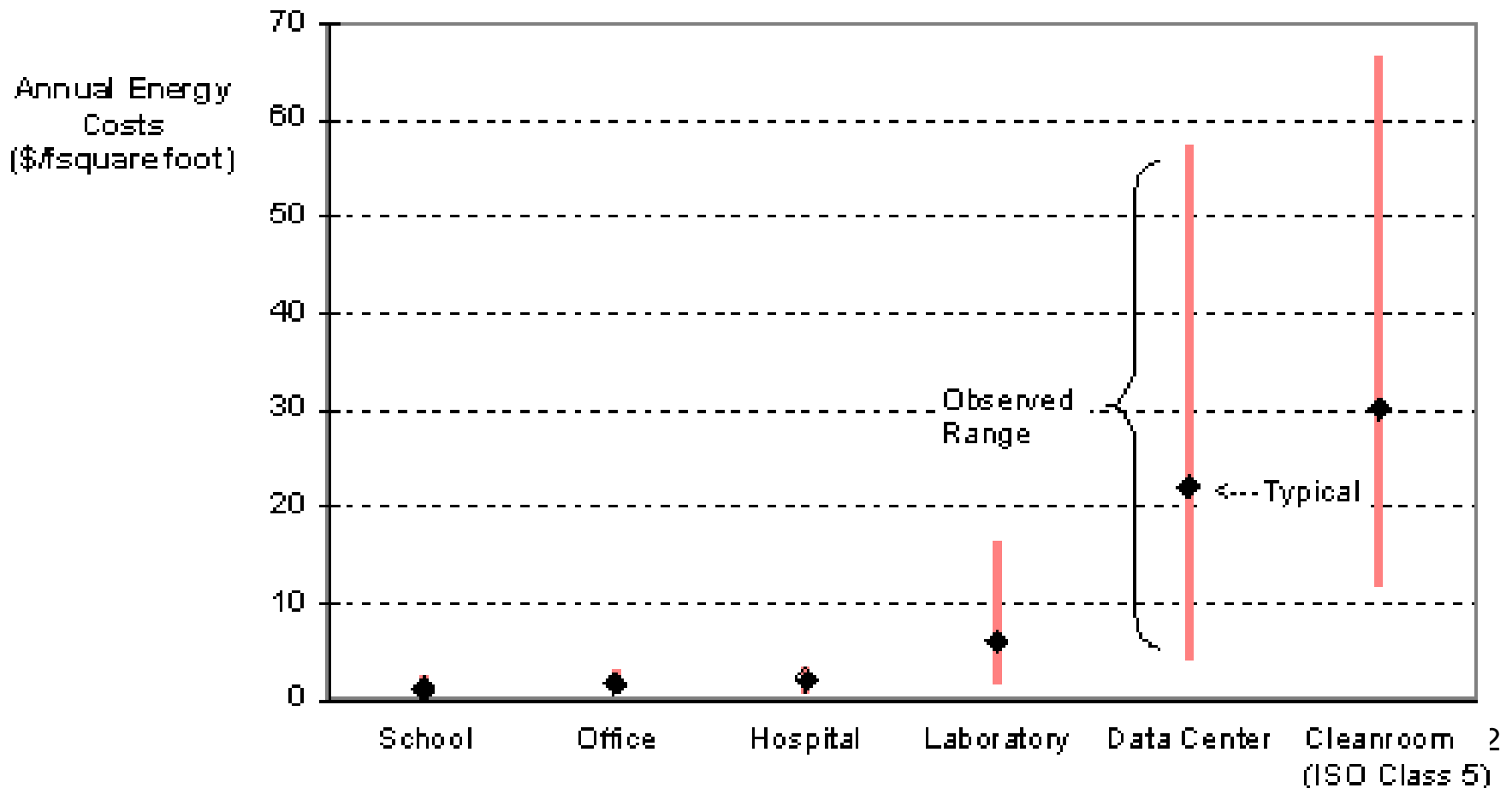




High Tech Buildings are Energy Hogs:

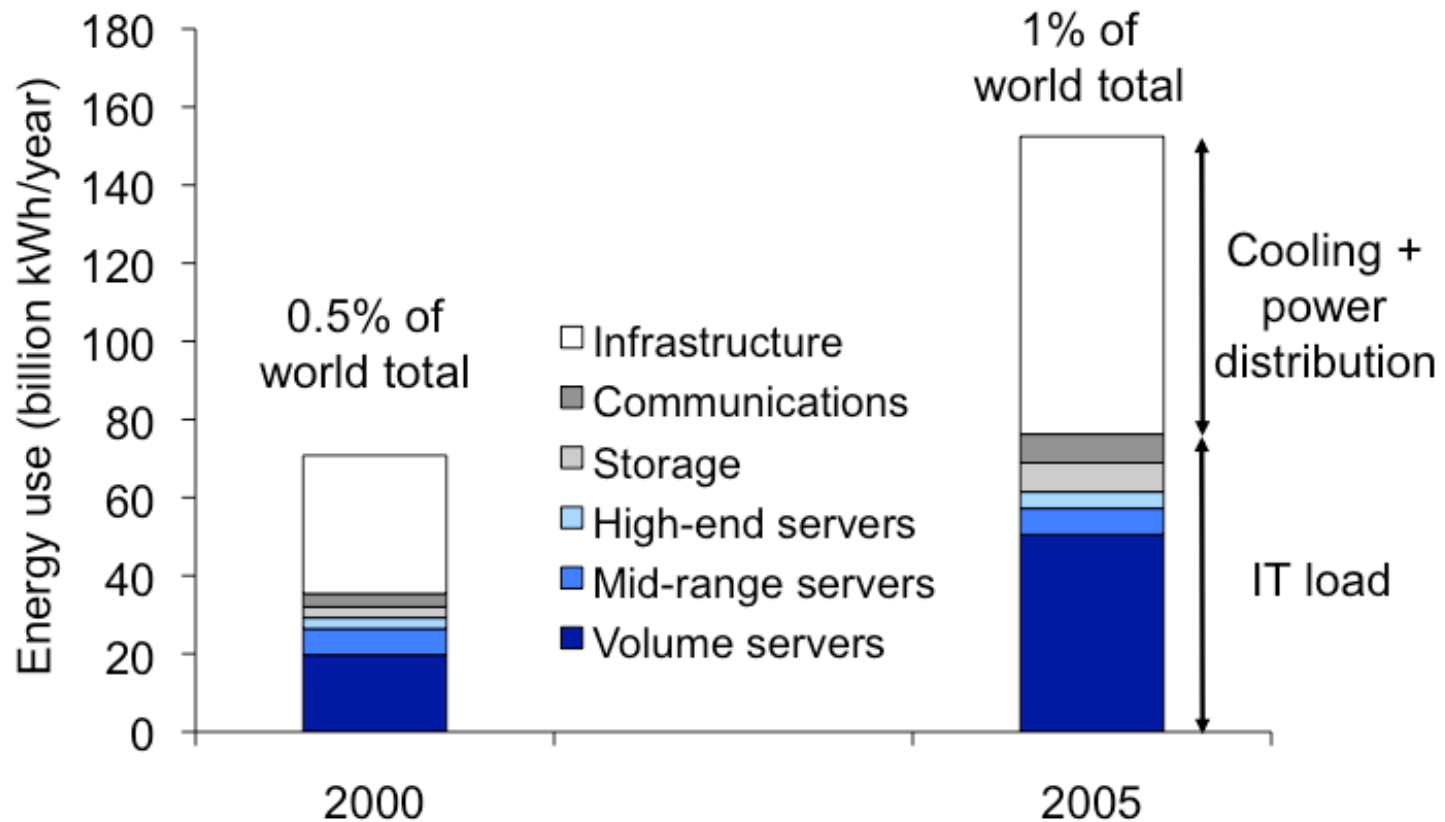
Comparative Energy Costs

High-Tech Facilities vs. Standard Buildings



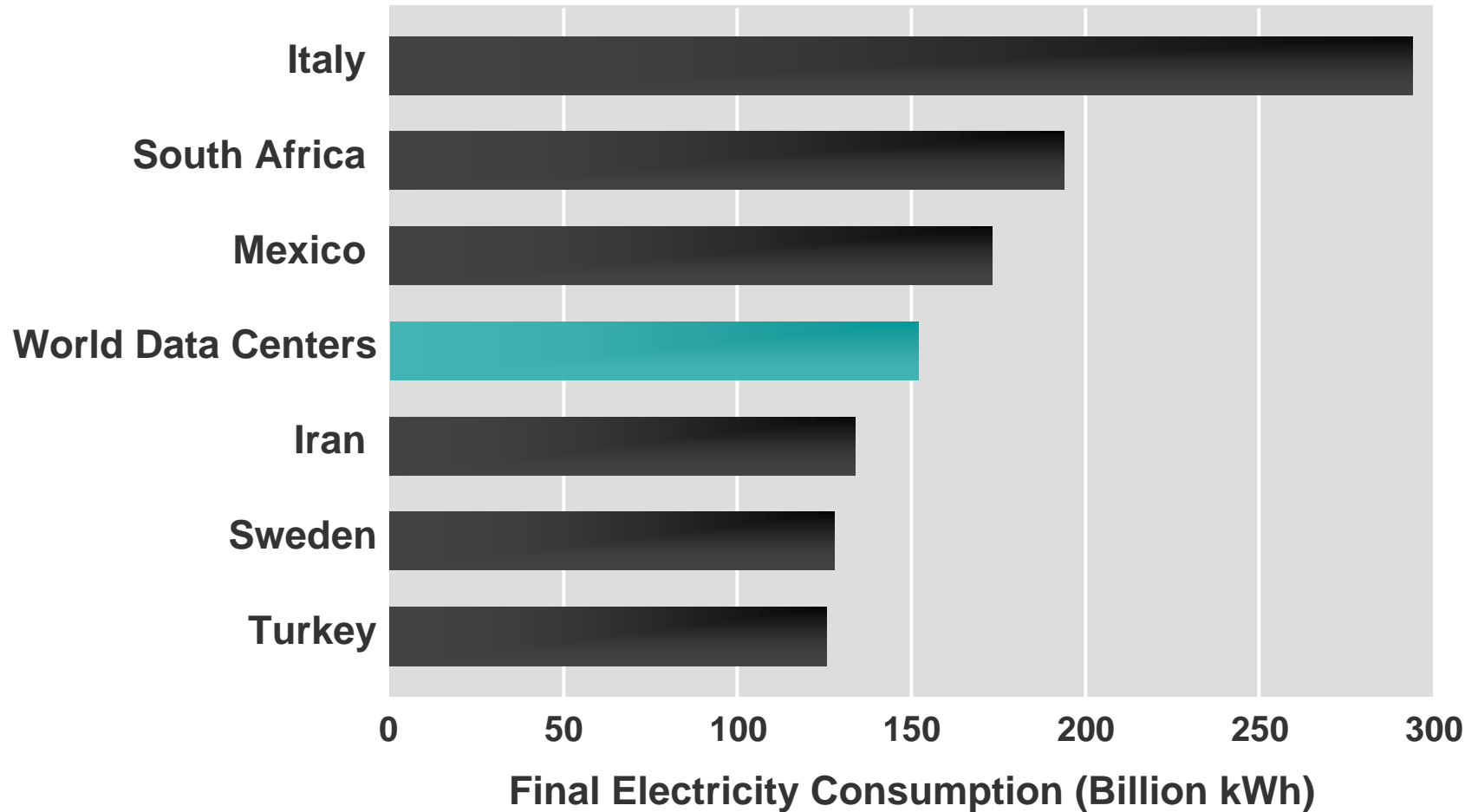


World data center electricity use, 2000 and 2005



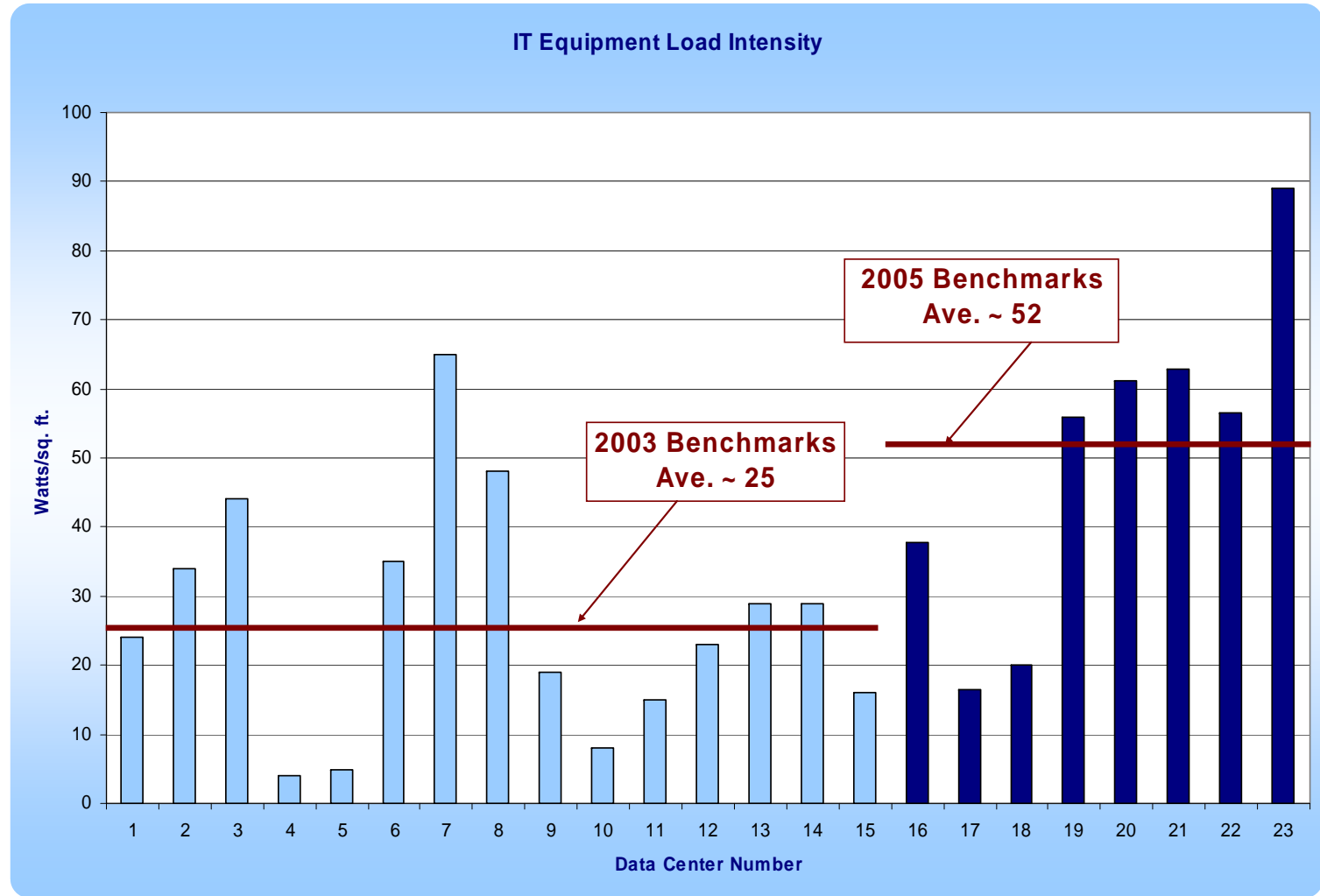
Source: Koomey 2008

How much is 152B kWh?



Source for country data in 2005: International Energy Agency, *World Energy Balances* (2007 edition)

IT equipment load density



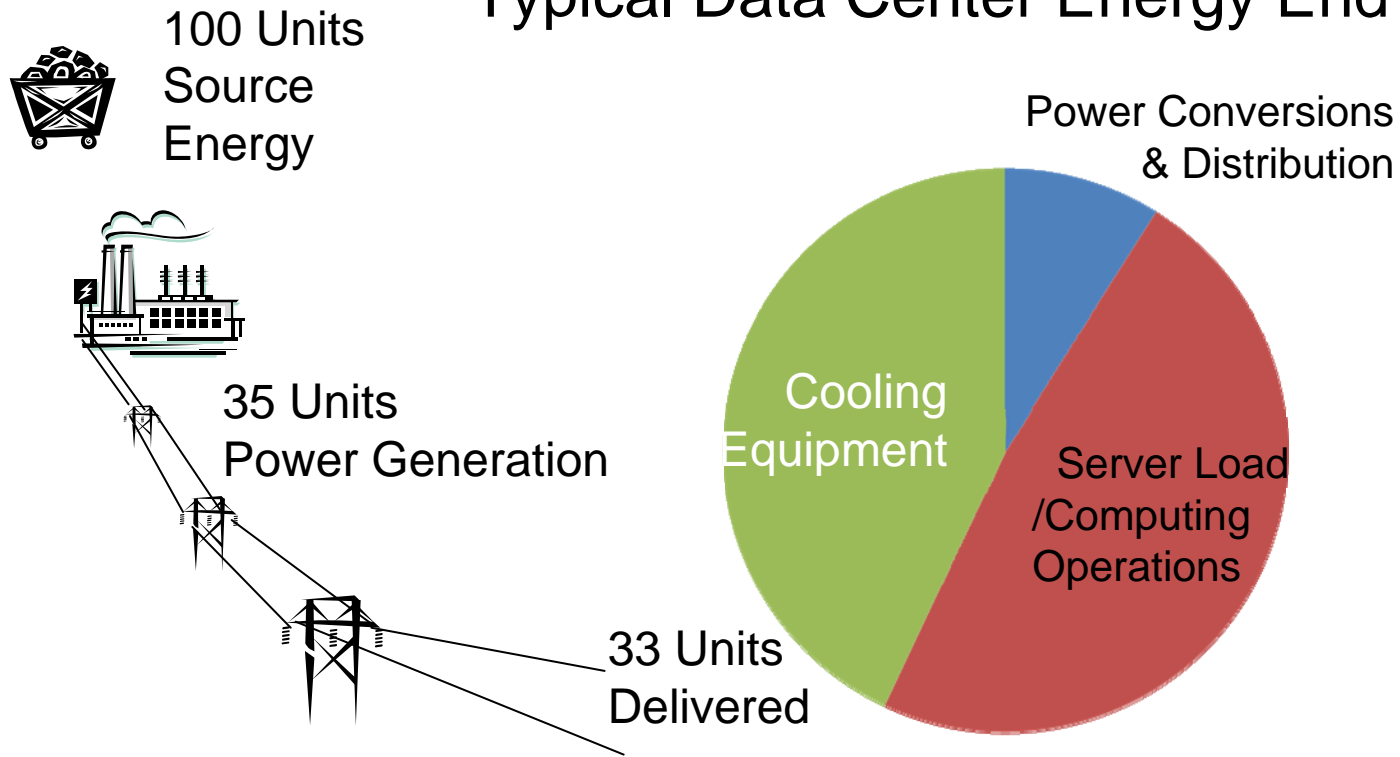
LBNL Feels the Pain!



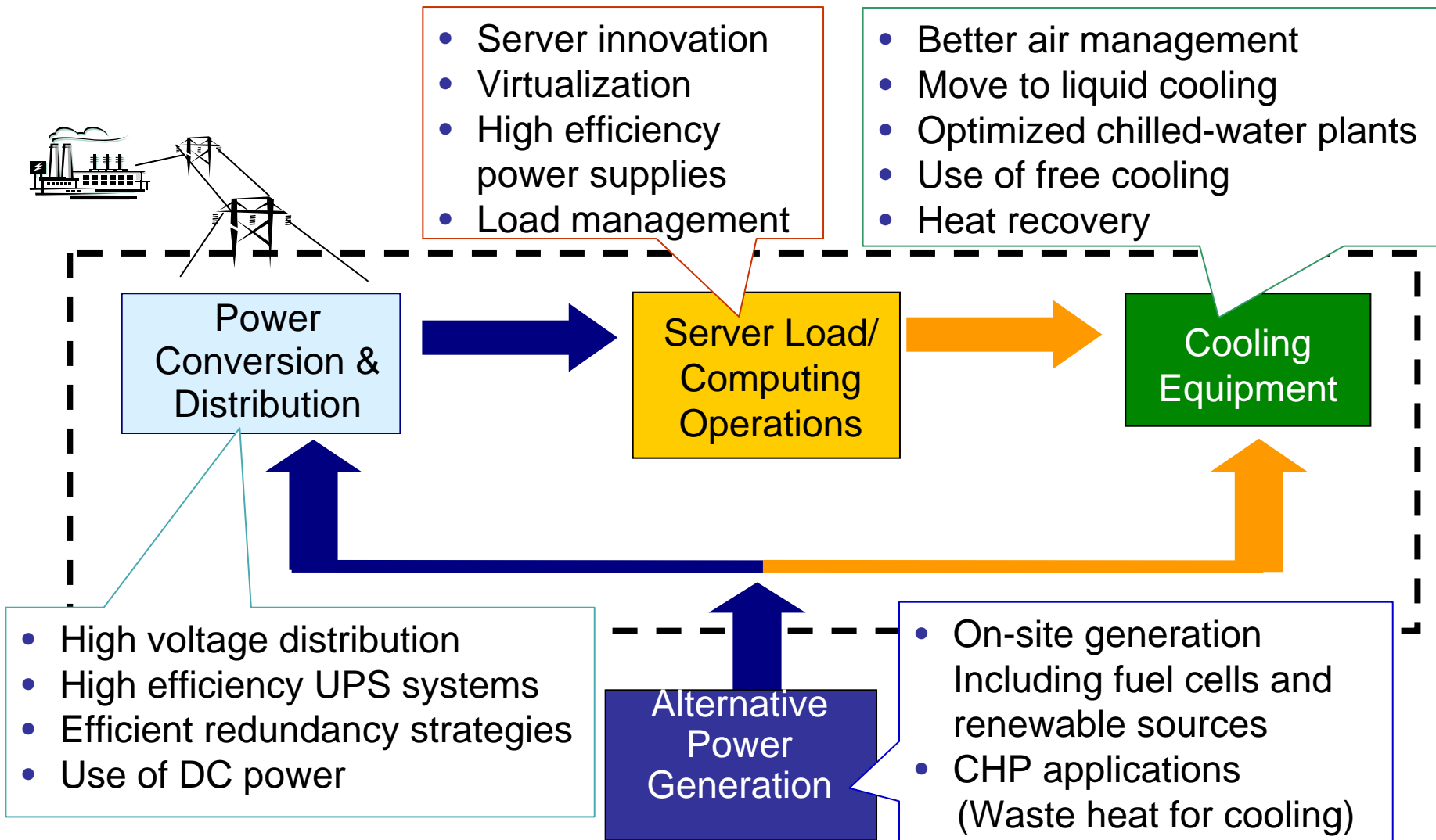
Data Center Energy Efficiency = 15% (or less)

(Energy Efficiency = Useful computation / Total Source Energy)

Typical Data Center Energy End Use

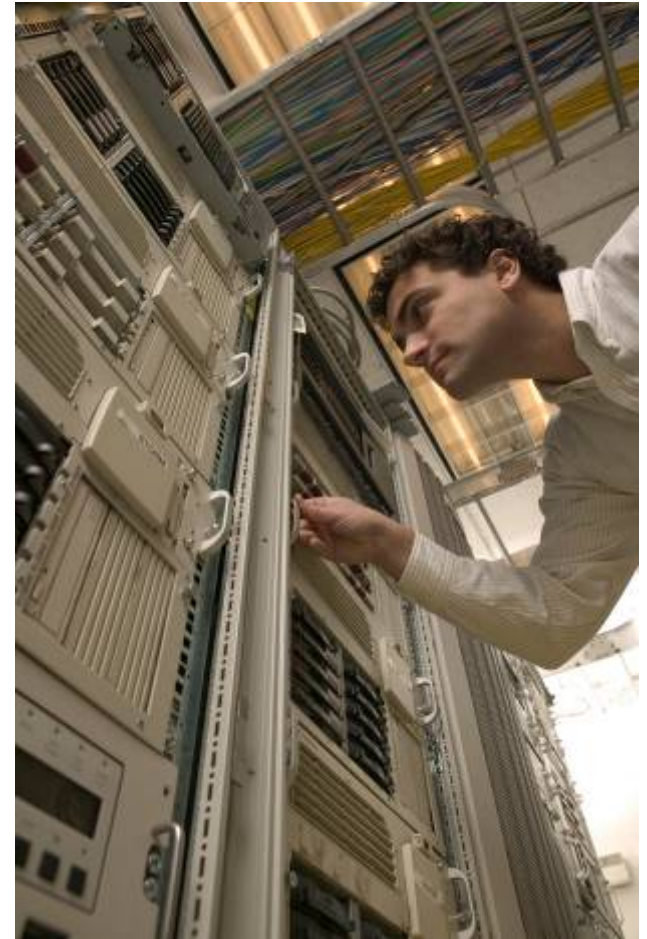


Energy Efficiency Opportunities



Potential Benefits of Data Center Energy Efficiency:

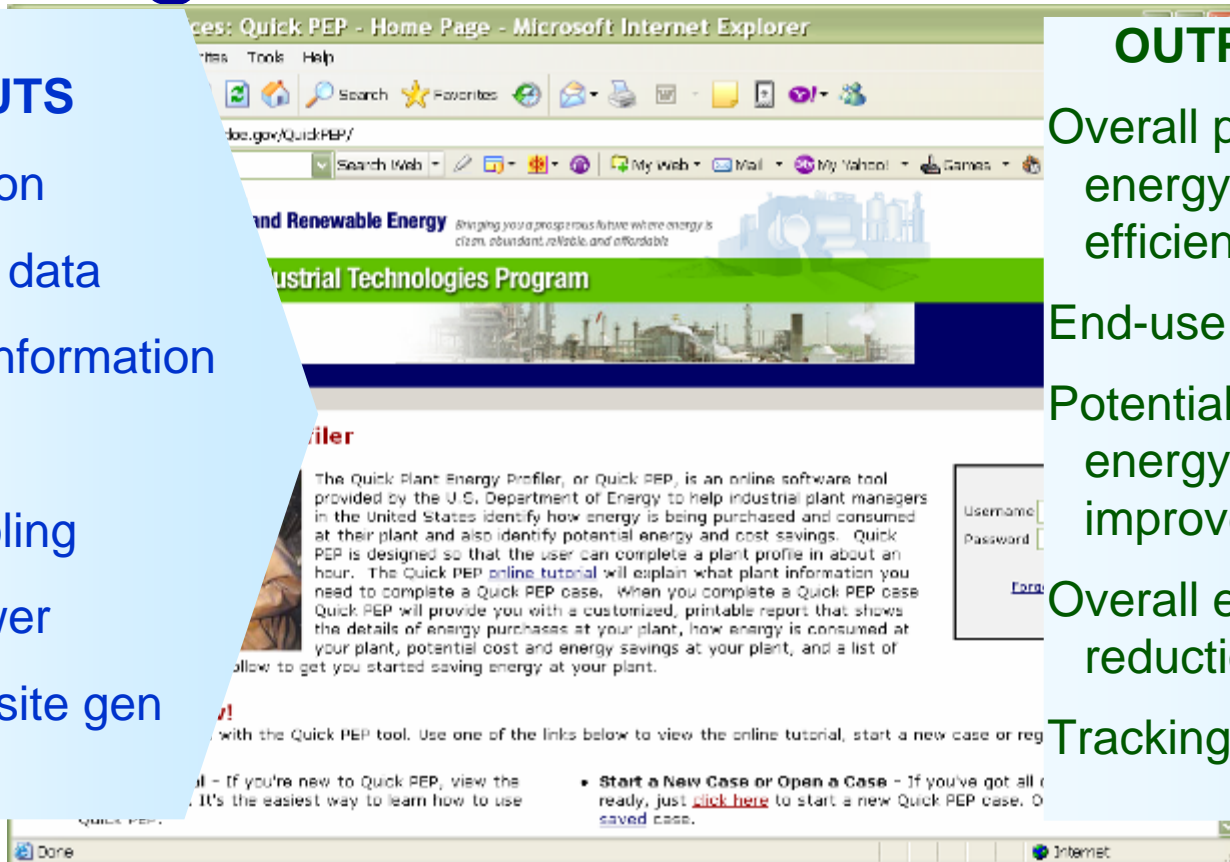
- 20-40% savings typically possible
- Aggressive strategies can yield better than 50% savings
- Extend life and capacity of existing data center infrastructures
- But is my center good or bad?



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
- Tracking capability

Benchmarking for Energy Performance Improvement:

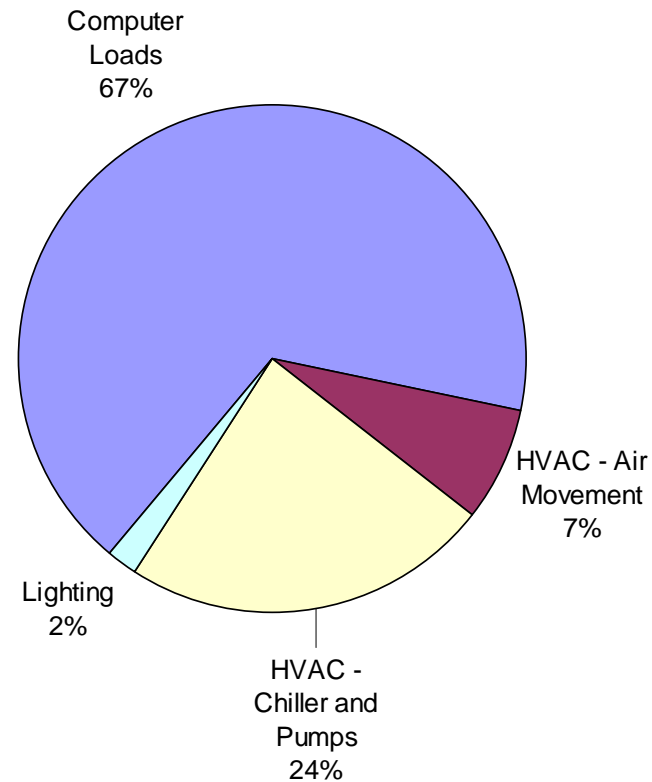
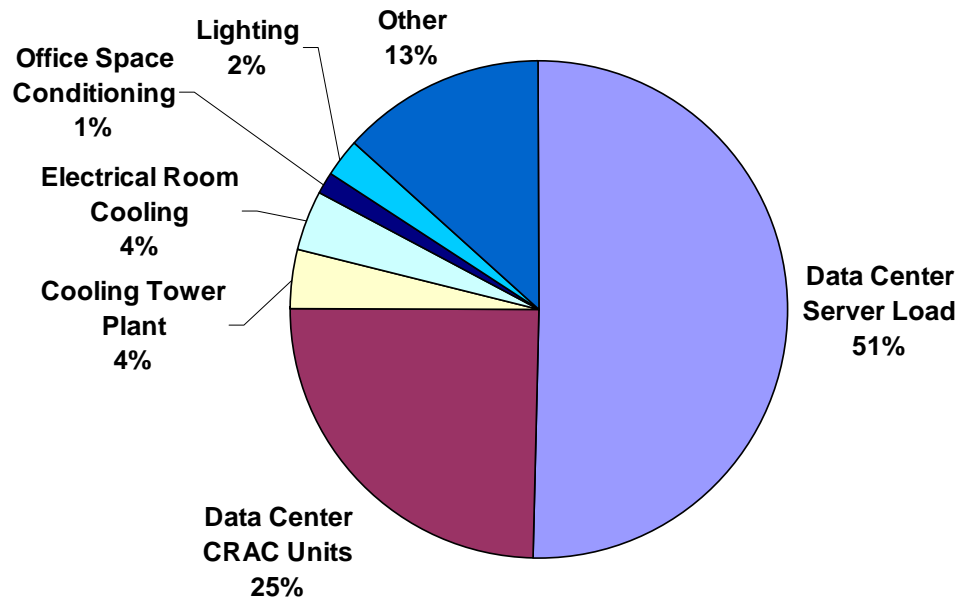
- Energy benchmarking can allow comparison to peers and help identify best practices
- LBNL conducted studies of over 30 data centers:
 - Found wide variation in performance
 - Identified best practices





Your Mileage Will Vary

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





Data Center Performance Varies in Cooling and Power Conversion

DCiE

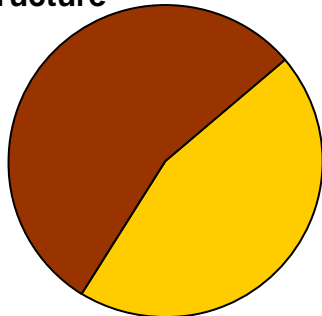
Data Center Infrastructure Efficiency

$$\text{DCiE} = \frac{\text{Energy for IT Equipment}}{\text{Total Energy for Data Center}}$$

Typical DCiE (Data Center Infrastructure Efficiency) < 0.5

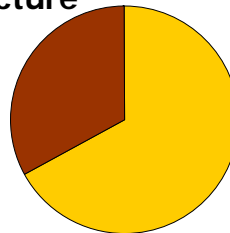
- Power and cooling systems are not optimized
- Less than half of the power is for the servers

Infrastructure



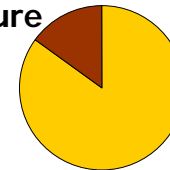
Typical Practice
DCiE < 0.5

Infrastructure



Better Practice
DCiE = 0.7

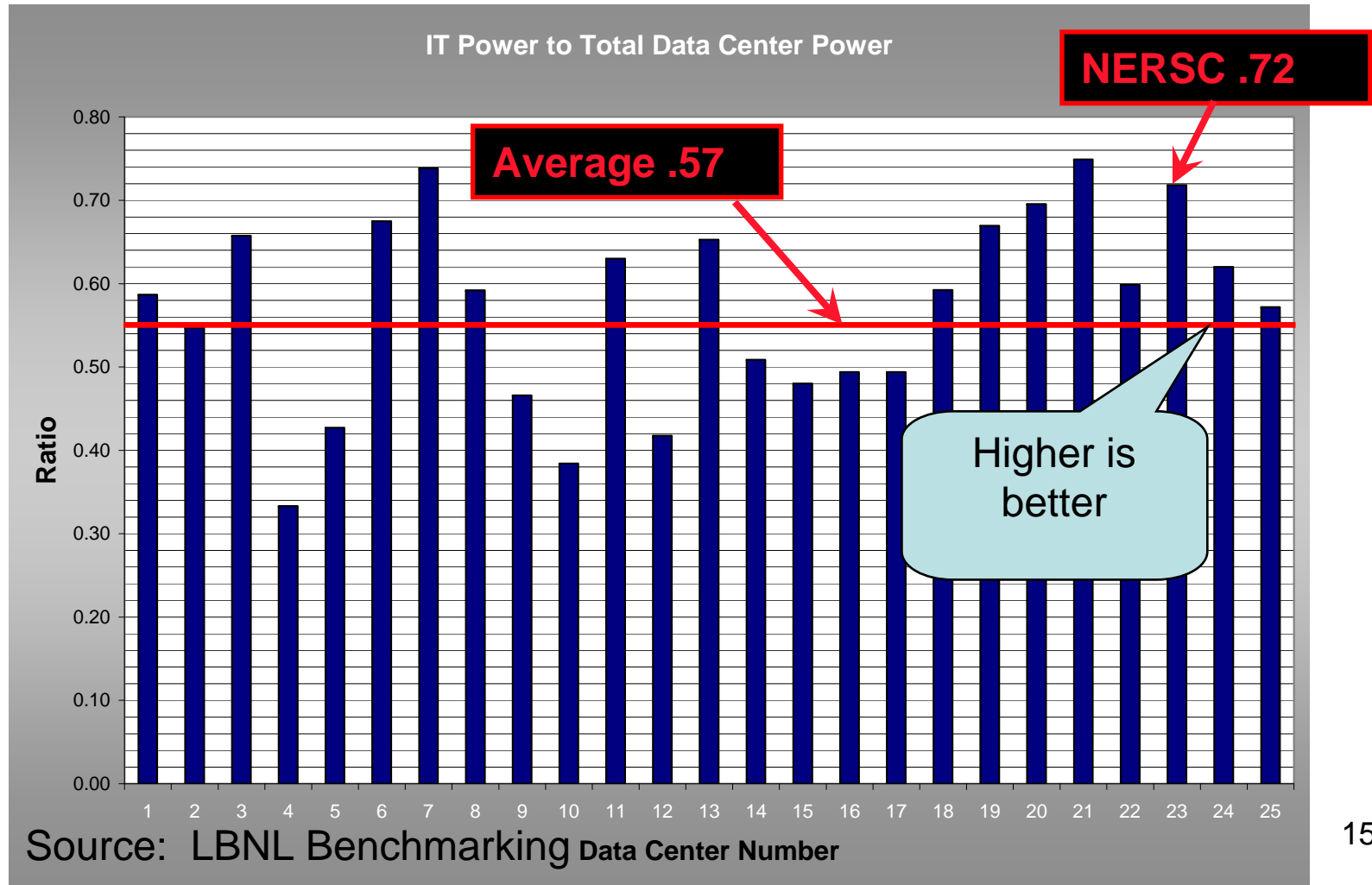
Infrastructure



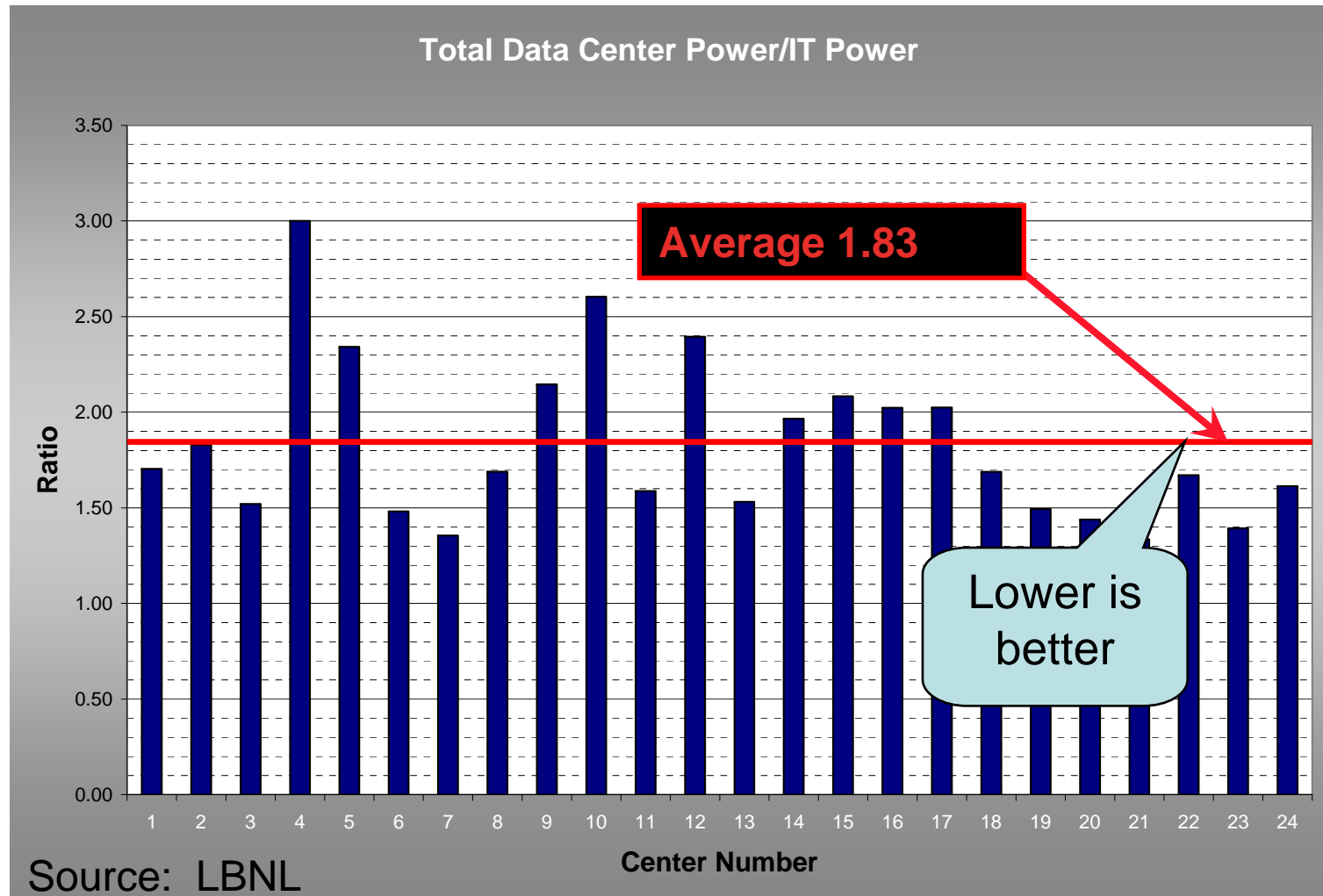
Best Practice
DCiE = 0.85

IT Energy

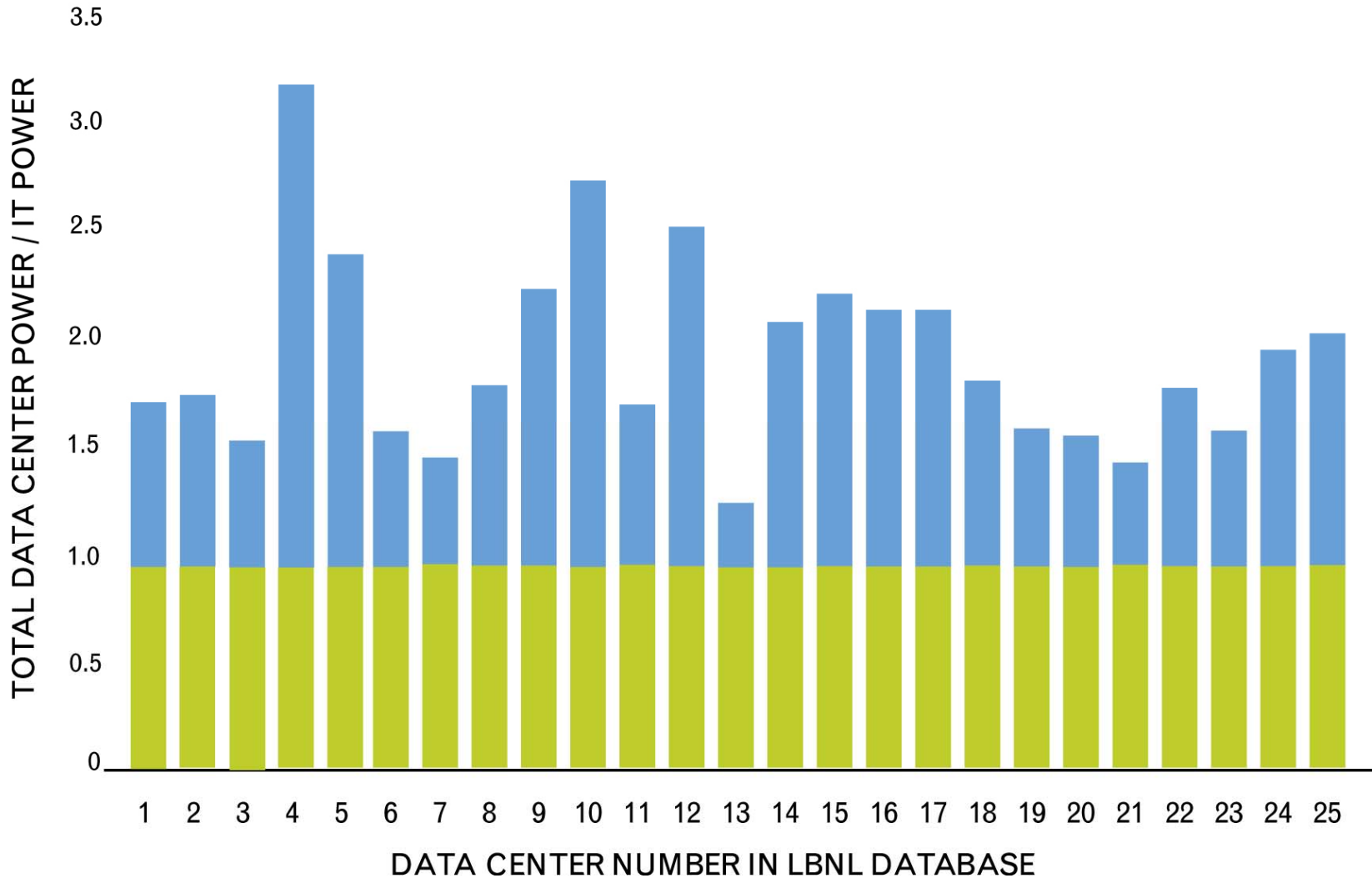
High Level Metric— Data Center Infrastructure Efficiency (DCiE) Ratio of Electricity Delivered to IT Equipment to Total



Inverse metric — Total/IT (PUE)

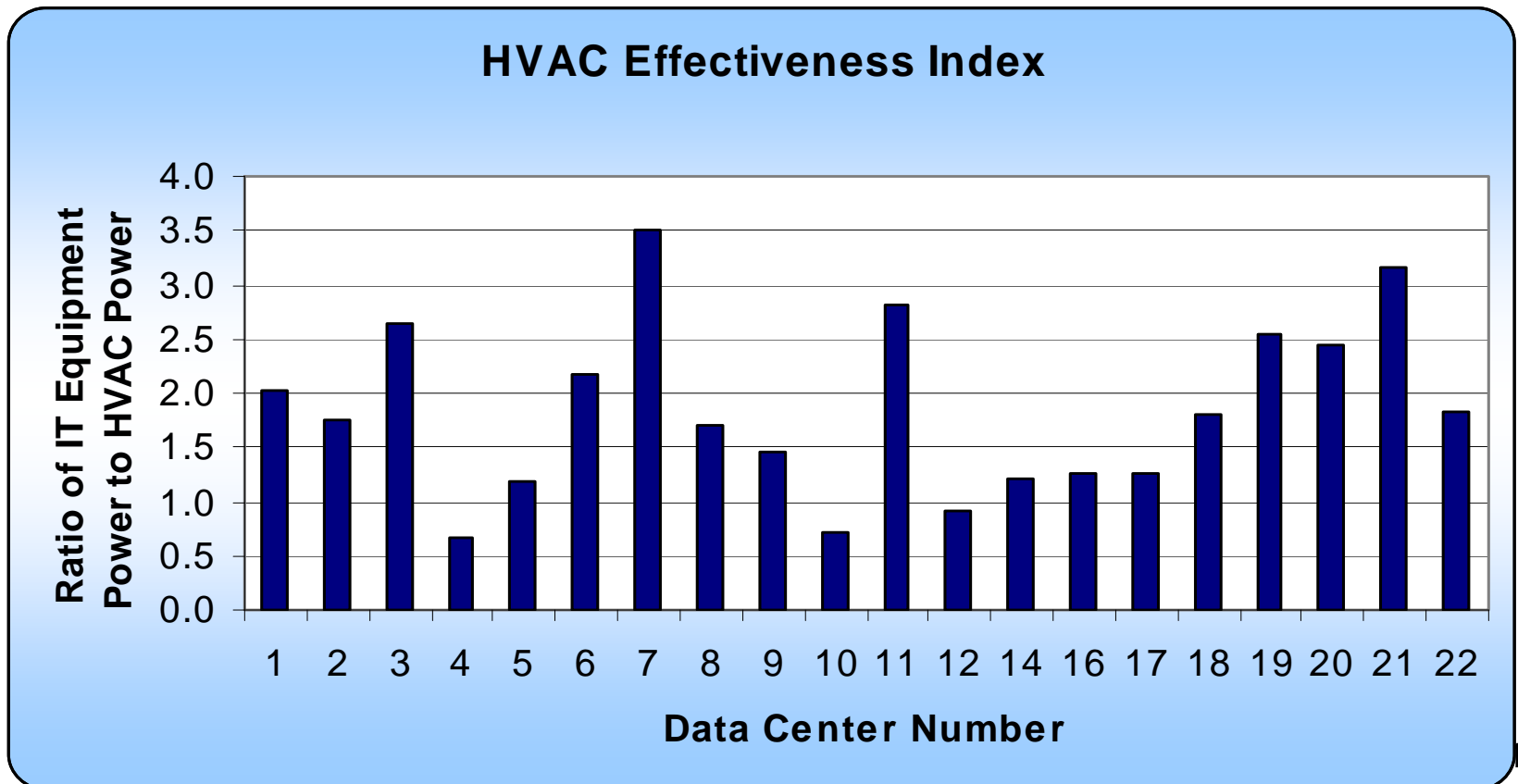


Inverse metric — Total/IT (PUE)



HVAC system effectiveness

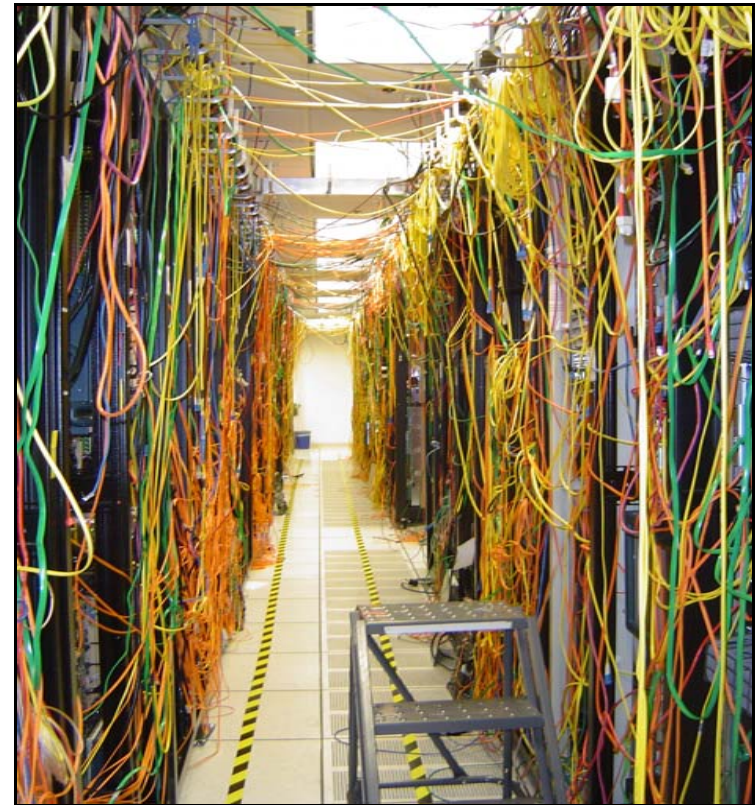
We observed a wide variation in HVAC performance





Best practices based on 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**





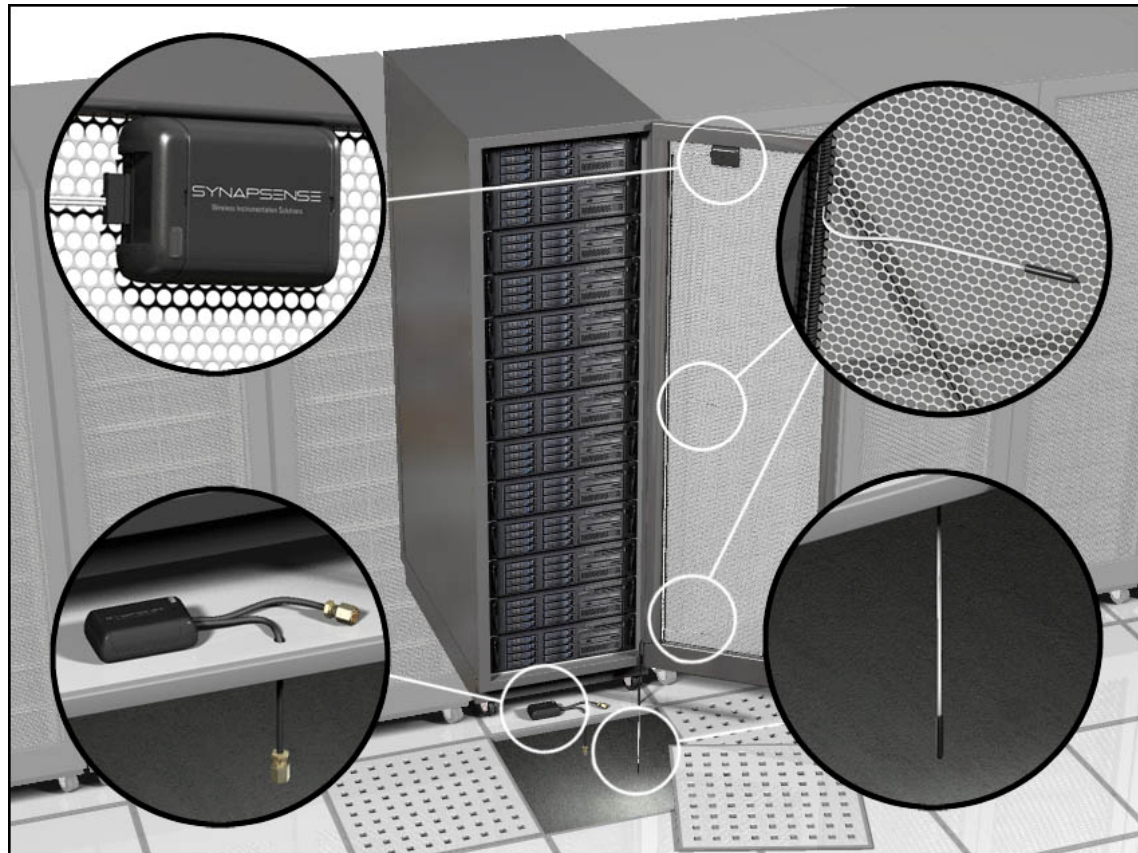
Use IT to Save Energy in IT:

- Most operators lack visibility into their data center environment
- We can't manage what we don't measure
- Provide the same level of monitoring and visualization of the physical space as we have for the IT environment
- Measure and track performance metrics
- Spot problems before they result in high energy cost or down time



LBNL Wireless Monitoring System:

- 700 point SynapSense wireless monitoring
 - Temperature, humidity, under-floor pressure, current
 - Fast installation, easy redeployment



source: SynapSense



Wireless Monitoring:

- Now we have a detailed and quantified understanding of environmental conditions
 - Real-time and historical data
 - Remote console(s) and alert notification
 - Quick reports and graphs from underlying database
 - Modules can also measure liquid flow, liquid presence, particle count, and other conditions
- Air management and other tasks now based on empirical data, not intuition



Next Steps with SynapSense

- Integration of monitoring system with controls (Automatic staging of CRACs and Demand based resets of pressure and temperature)
- ‘Live Imaging’ heat-map animations
- Real time DCiE (data center infrastructure efficiency) calculation
- Retrofit VAV

Industrial Technologies Program

- DC Pro tool suite & training
- Metrics & energy baselining
- Qualified specialists
- Case studies
- Certification of continual improvement
- Recognition of high energy savers
- Best practice information & training
- Best-in-Class guidelines
- R&D - technology development



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

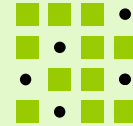
EPA

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



Industry

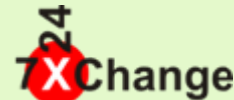
- Tools
- Metrics
- Training
- Best practice information
- Best-in-Class guidelines
- IT work productivity standard



Information Technology Industry Council
Leading Policy for the Innovation Economy



Uptime
Institute





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

Contact Information:

Dale Sartor, P.E.

Lawrence Berkeley National Laboratory

Applications Team

MS 90-3111

University of California

Berkeley, CA 94720

DA_Sartor@LBL.gov

(510) 486-5988

<http://Ateam.LBL.gov>

