GovEnergy
www.govenergy.gov

· August 15-18, 2010 · Dallas, Texas ·
· Dallas Convention Center ·

Energy Efficient Data Centers

Dale Sartor
Lawrence Berkeley National Laboratory

FEMP MISSION

FEMP Facilitates the Federal Government's implementation of sound, cost-effective energy management & investment practices to enhance the nation's energy security & environmental stewardship.

FEMP
Federal Energy Management Program

GovEnergy 2010
www.govenergy.gov

Federal Energy Legislation

Facilities

- *EISA 2007:* Agencies must ***reduce facility energy intensity*** by 30% by FY 2015
- *EPACT :* From 2010 – 2012, no less than 5% of electricity consumed by the Federal Government will come from ***renewable sources***, and after 2013, no less than 7.5%
- E.O. 13423: Agencies will ***reduce their water consumption*** intensity by 16% by the end of 2015, compared to a 2007 baseline.
- E.O. 13514: Agencies must implement "***best management practices***" in data center facilities.

Federal Energy Legislation

IT Energy Efficiency

- *EISA 2007*
  - Encourages agencies to minimize standby energy use
  - Requires Federal procurement to focus on Energy Star ® & FEMP-designated products
  - Calls for establishment of a voluntary data center information program to increase energy efficiency in data centers

- *EO 13423*
  - At least 95 % of electronic products acquired by an agency must meet be Electronic Product Environmental Assessment Tool (EPEAT) –registered products, unless there is no EPEAT standards for such product.

Federal Energy Legislation

Metering & Benchmarking

- *EPACT 2005* – All Federal buildings metered by Oct. 1, 2012
  - To the maximum extent practicable, agencies must install advanced meters that provide hourly electricity consumption at least daily.
  - Agencies must submit plans for meeting metering requirements to DOE.
- *EISA* 2007 – Agencies must identify "covered facilities"
  - Complete comprehensive energy & water evaluations of covered facilities at least once every 4 years.
  - Measure & verify energy & water savings
  - Track & certify compliance through use of a DOE Web application
  - Enter energy use data for each metered building into a benchmarking system.

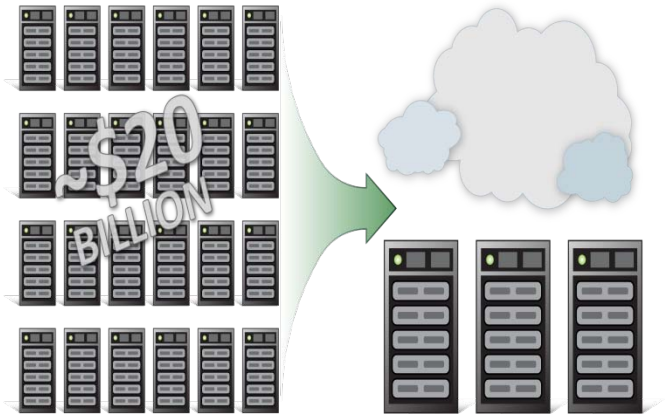
Federal Energy Legislation

Agency Strategic Sustainability Performance Plan

- *E.O. 13514* ***requires Federal agencies to create a Strategic Sustainability Performance Plan, to be updated each year.***
- ***Agencies must identify and achieve goals, schedules and milestones related to agency sustainability.***
- ***According to the latest SSPP template, agencies must work to achieve IT/Data Center goals including:***
  - ***Practice sound disposition practices***
  - ***Procure ENERGYSTAR or EPEAT-registered products***
  - ***Meter data centers***
  - ***Increase CPU utilization***
  - ***Increase rack space utilization***
  - ***Optimize data center use (virtualization, cloud computing, minimal # required)***

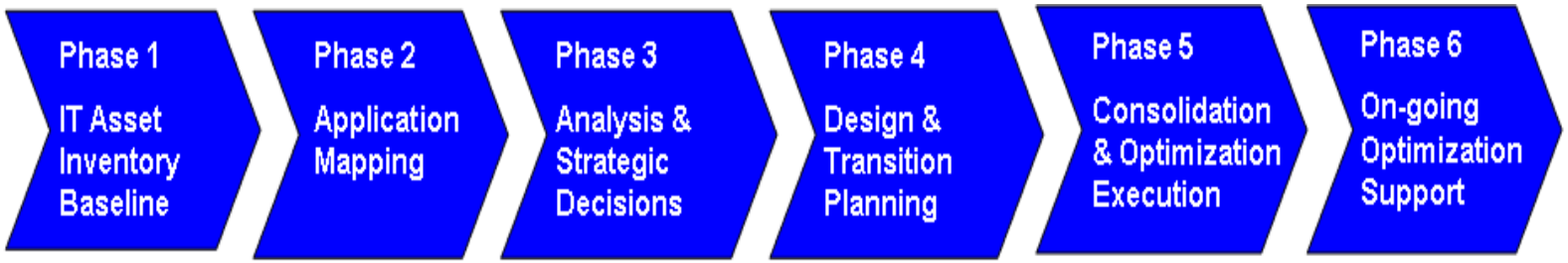
Federal Energy Legislation

OMB Data Center Consolidation Plan



Goal: **Define & monitor standard operational metrics across agencies (see Section 4.1), achieve efficiency gains & realize operational cost savings by improving:**

- **Server (CPU) Utilization (%)**
- **Rack Space Utilization (%)**
- **Rack Floor Utilization (%)**
- **Power Usage / Square Foot**
- **Power Usage Efficiency (PUE)**



Data Center Metrics: PUE

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

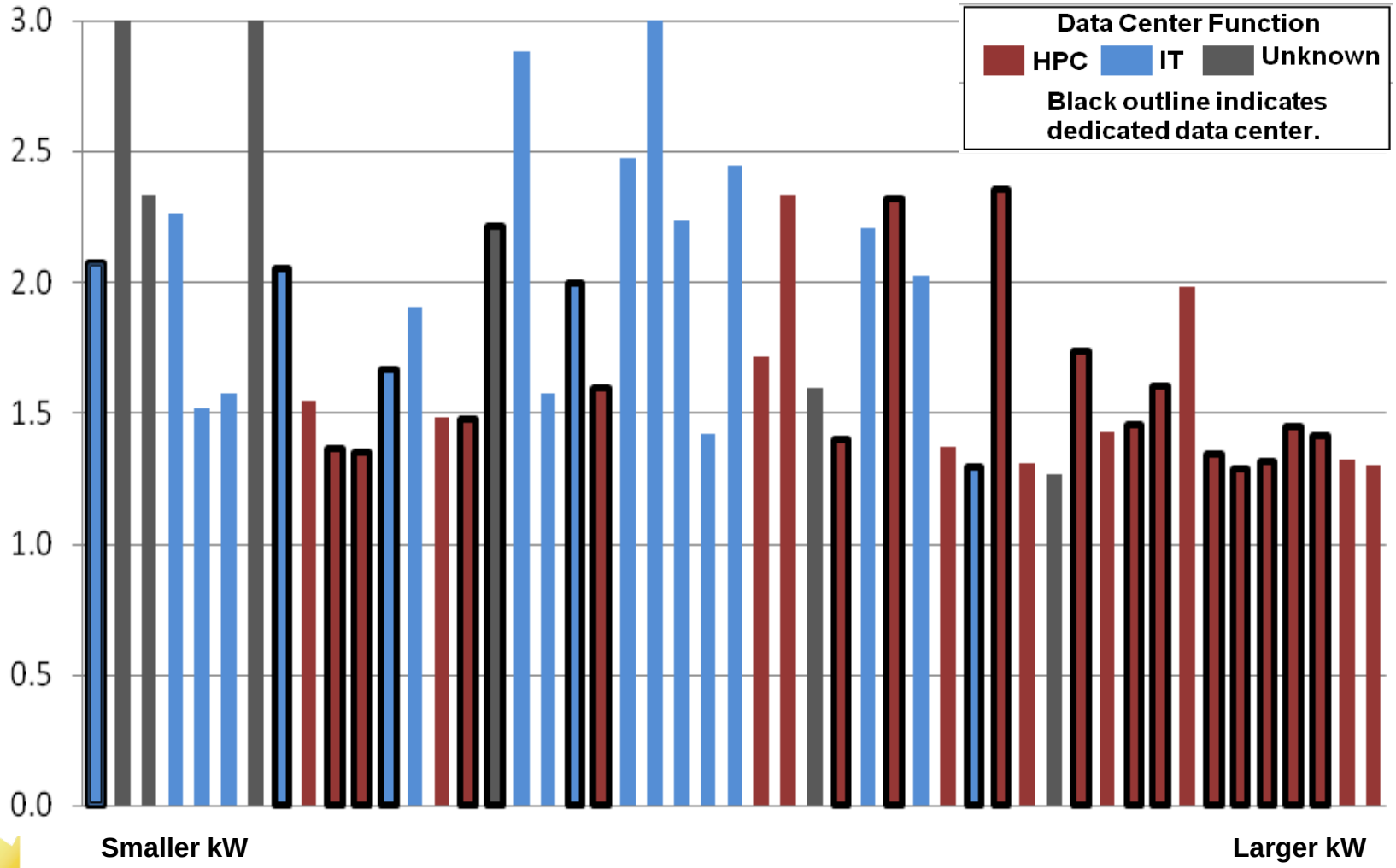
Standard	Good	Better
2.0	1.4	1.1

DOE Data Centers

$$\text{DOE Weighted Average PUE} = \frac{\text{Total DOE Data Center Power}}{\text{DOE Data Center IT Power}} = 1.44$$

GovEnergy 2010
www.govenergy.gov

PUE of DOE Data Centers



GovEnergy 2010
www.govenergy.gov

FEMP Data Center Services

If past consumption trends continue, data center electricity use will *double* over a period of five years!

Reversing the Trend

FEMP Will Help Agencies :

- *Get up to speed with best practices & technology case study publications*
- *Increase awareness of opportunities to increase efficiency & reliability through FEMP workshops*
- *Share best practices through forums and the Federal Partnership for Green Data Centers*
- *Benchmark & assess efficiency opportunities with technical assistance & using the DCPro tool suite*
- *Conduct energy audits to determine appropriate level of investment by providing access to technical experts*

Technical Assistance

FEMP provides technical assistance (TA) to data centers throughout the Federal Government

Types of TA

- **Training**
- **Technology demonstration**
- **Assessments**
- **Design reviews**
- **Metering plans**

FEMP offers data center assistance to….

DOE

DIA

DOD

GSA

…and more!

GovEnergy 2010
www.govenergy.gov

DOE Recovery Act Project

Title: **DOE Data Center Acceleration Campaign**
TA Recipient: **U.S. Department of Energy – Federal Energy Management Program**
Location: **Various**
Type: **Assessment & Training**
TA Provider: **LBNL & NewWest Technologies**

Project Scope:

- *Conduct* **web-based training, including DCPro & CADE metric**
- *Develop* **&** *maintain* **a database to track growth & efficiency improvements**
- *Perform* **two DOE data center assessments, including CADE & DCPro**
- *Recommend* **ways to better fit existing data center metrics the Federal sector, specifically DOE**
- *Set* **aggressive data center performance goals**
- *Create* **a final report with recommendations for implementing a diagnostic approach and develop a plan for distributing report.**

Benchmarking and Profiling Tools

Data Center Profiling Tool (DC-PRO)

- Designed for data center owners &operators
- Diagnoses how energy is used within a data centers
- Determines ways to save energy and money.

Inputs
- Utility bill data
- Systems information
- Facility description

Outputs
- End-use break out
- Energy reduction potential
- Areas for improvement

Energy Star® Portfolio Manager

- Tracks and assesses energy & water consumption across a building portfolio
- Operates in a secure online environment
- Contains the tools to:
  - Prioritize investment
  - Identify under-performing buildings
  - Verify efficiency improvements
  - Receive EPA recognition for superior energy performance

DOE Assessment Tool Suite

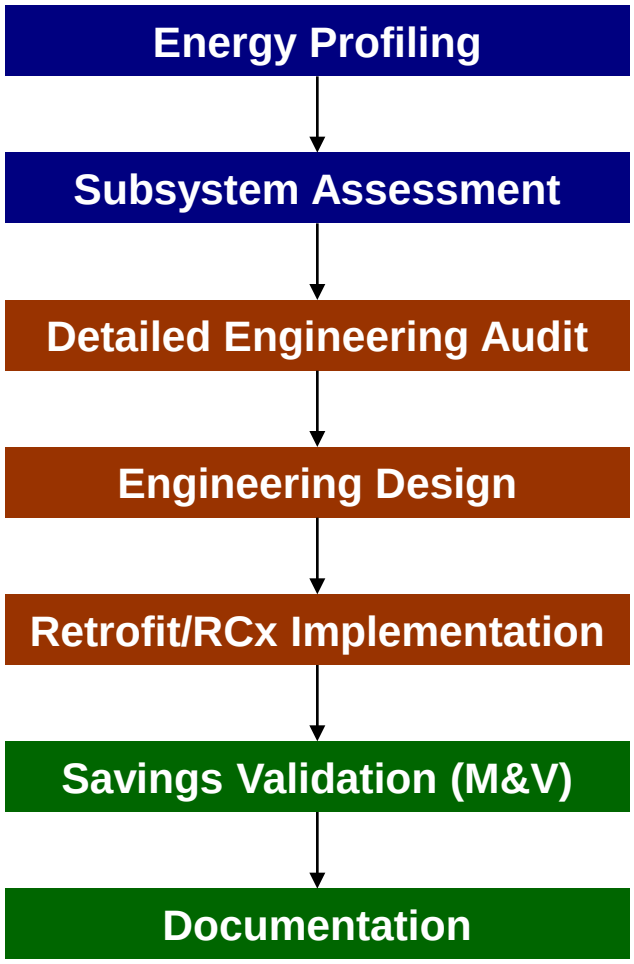
High-Level On-Line Profiling and Tracking Tool

- Overall efficiency (Power Usage Effectiveness [PUE])
- End-use breakout
- Potential areas for energy efficiency improvement
- Overall energy use reduction potential

In-Depth Assessment Tools → Savings

Air Management	Electrical Systems	IT-Equipment	Cooling
• Hot/cold separation • Environmental conditions • RCI and RTI	• UPS • PDU • Transformers • Lighting • Standby gen.	• Servers • Storage & networking • Software	• Air handlers/ conditioners • Chillers, pumps, fans • Free cooling

Steps to Saving Energy:



- Assessments conducted by owners and engineering firms using DOE tools
- Tools provide uniform metrics and approach

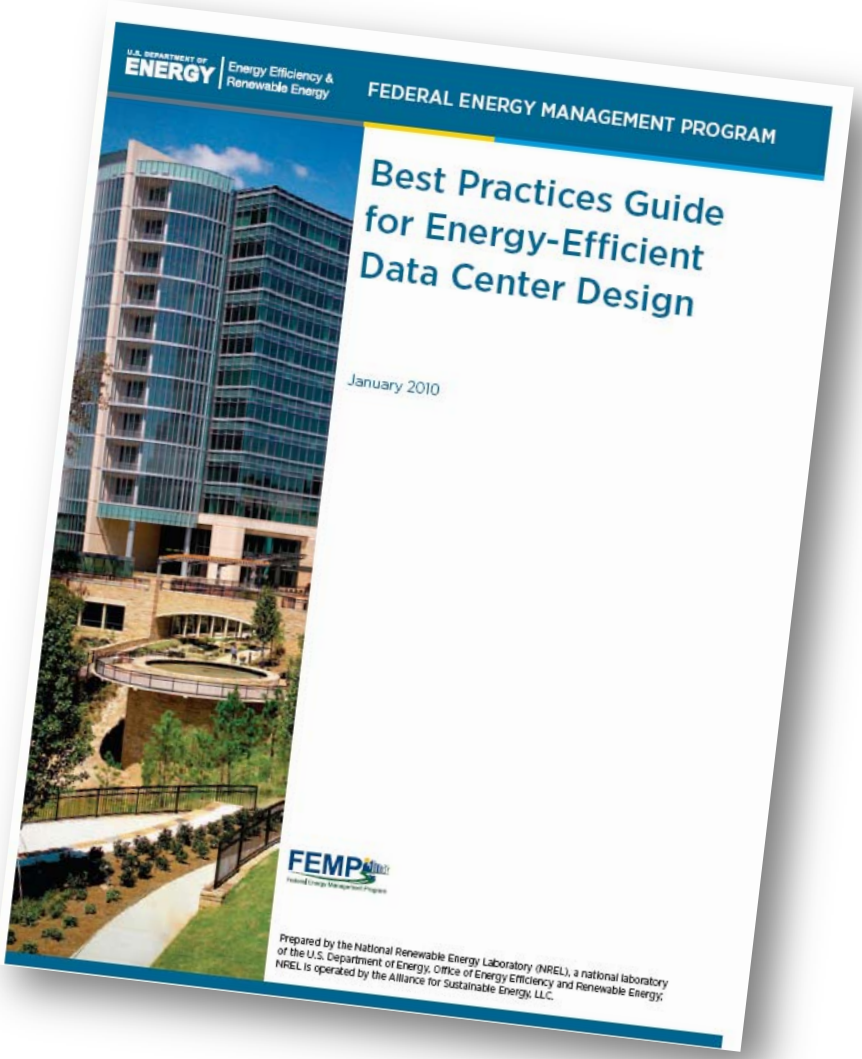
- Audits, design and implementation by engineering firms and contractors

- M&V by site personnel and eng firms
- DOE tools used to document results, track performance improvements, and disseminate best practices

GovEnergy 2010
www.govenergy.gov

Publications

- *Tool Manuals*
- *Best Practices Guide*
- *Technical Bulletins*
- *Process Manual*
- *Worksheets*
- *Master List of Actions*
- *Report Templates*
- *Procurement specs*
- *Case studies*



Training & Certification

DOE/ASHRAE Awareness Training

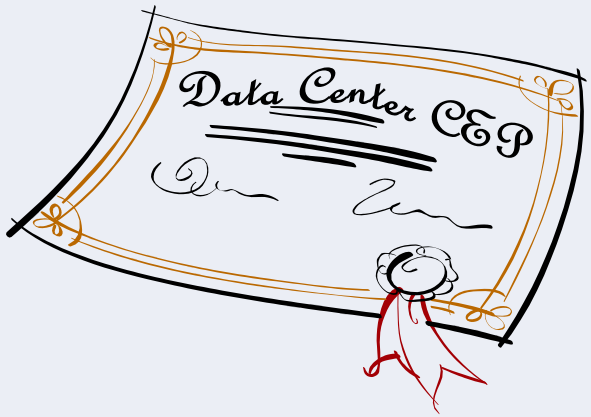
- *One-day training*
- *Target audience: data center operators*
- *No prequalifications*

DC Certified Energy Practitioner (DC-CEP) Generalist

- Three-day workshop with two options:
  - Training certificate track (no prequalifications, training only, training certificate)
  - Training & exam (training, CEP certificate)
- Target audience: DC personnel, consultants, & service providers.

DC-CEP Specialists

- Pre-qualifications: *Pass Generalist exam*
- Certifications tracks:
  - HVAC
  - Electrical & IT coming soon



Potential Benefits of Data Center Energy Efficiency

- ***20-40% savings typical***
- ***Aggressive strategies can yield 50+% savings***
- ***Extend life and capacity of infrastructures***

GovEnergy 2010
www.govenergy.gov

IT System Efficiency

Servers

- Choose *variable speed fans*
- Enable *power management capabilities*!
- Use EnergyStar® Servers

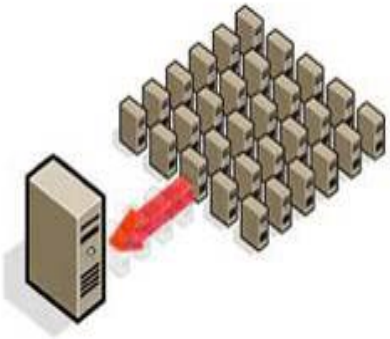
Power Supplies

- Optimal load level: 40-60%
- 80 PLUS Program offers certification of efficient power supplies

Storage Devices

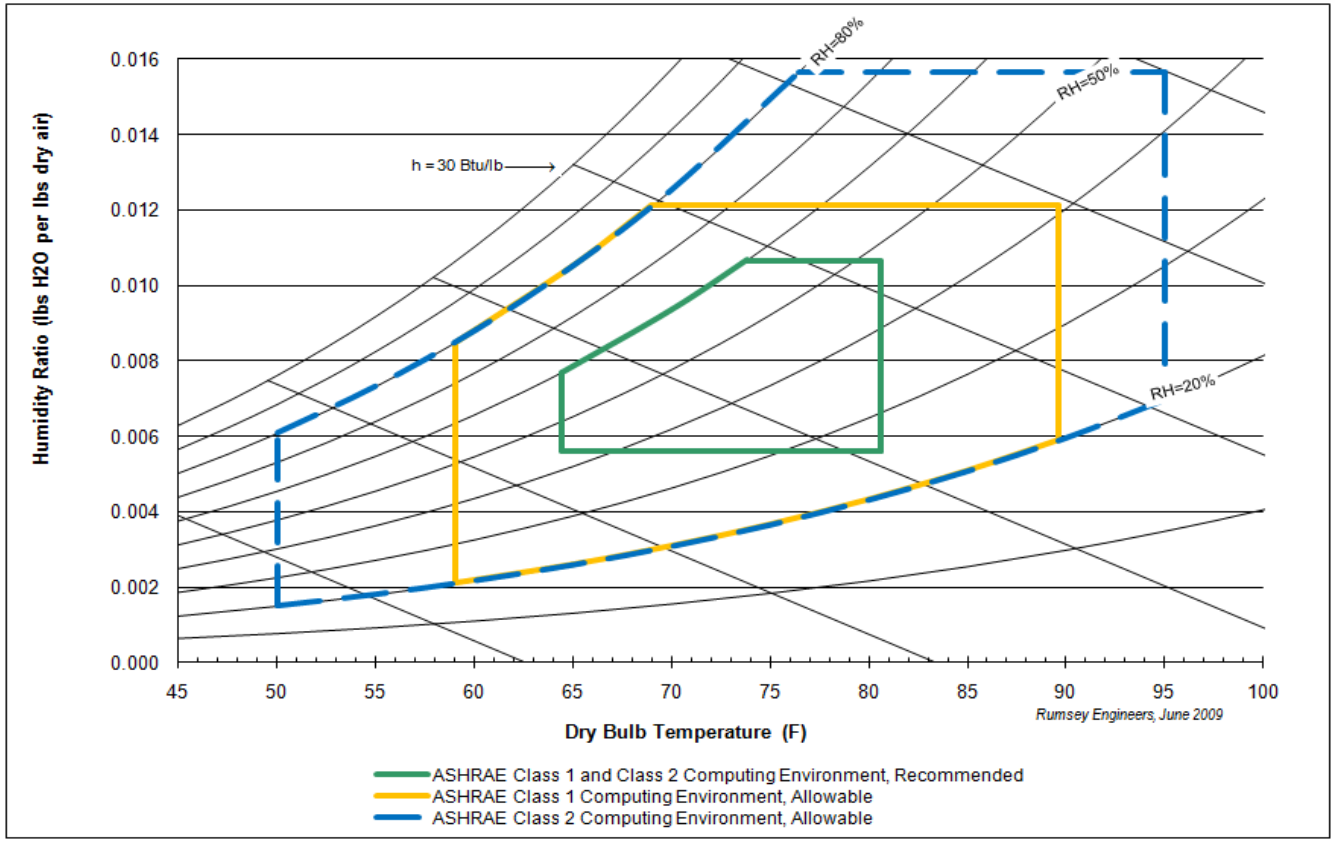
- Take superfluous data offline
- Use thin provisioning technology

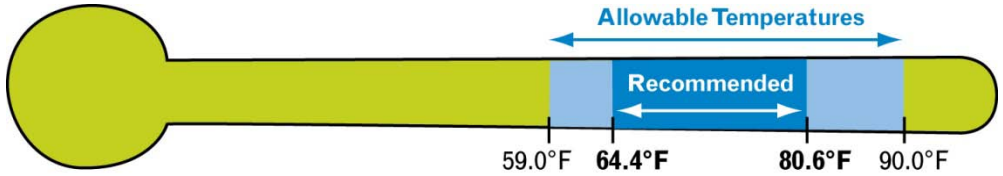
Consolidation



- Group hardware with similar heat load densities
- Practice virtualization

ASHRAE Temperature Guide

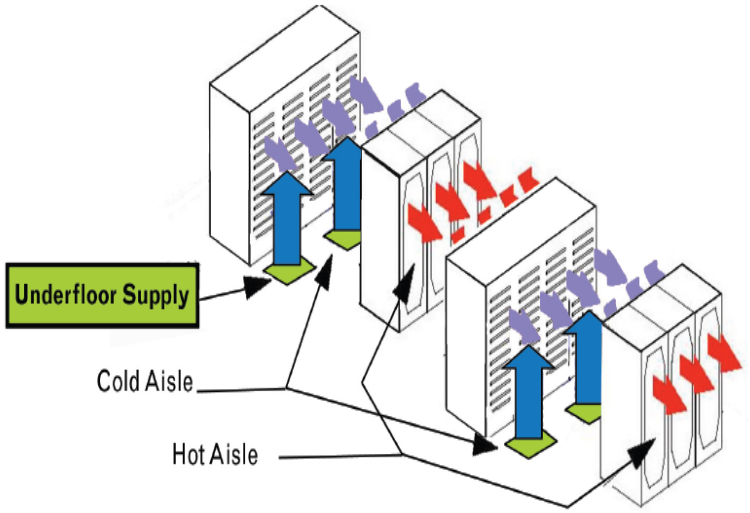




GovEnergy 2010
www.govenergy.gov

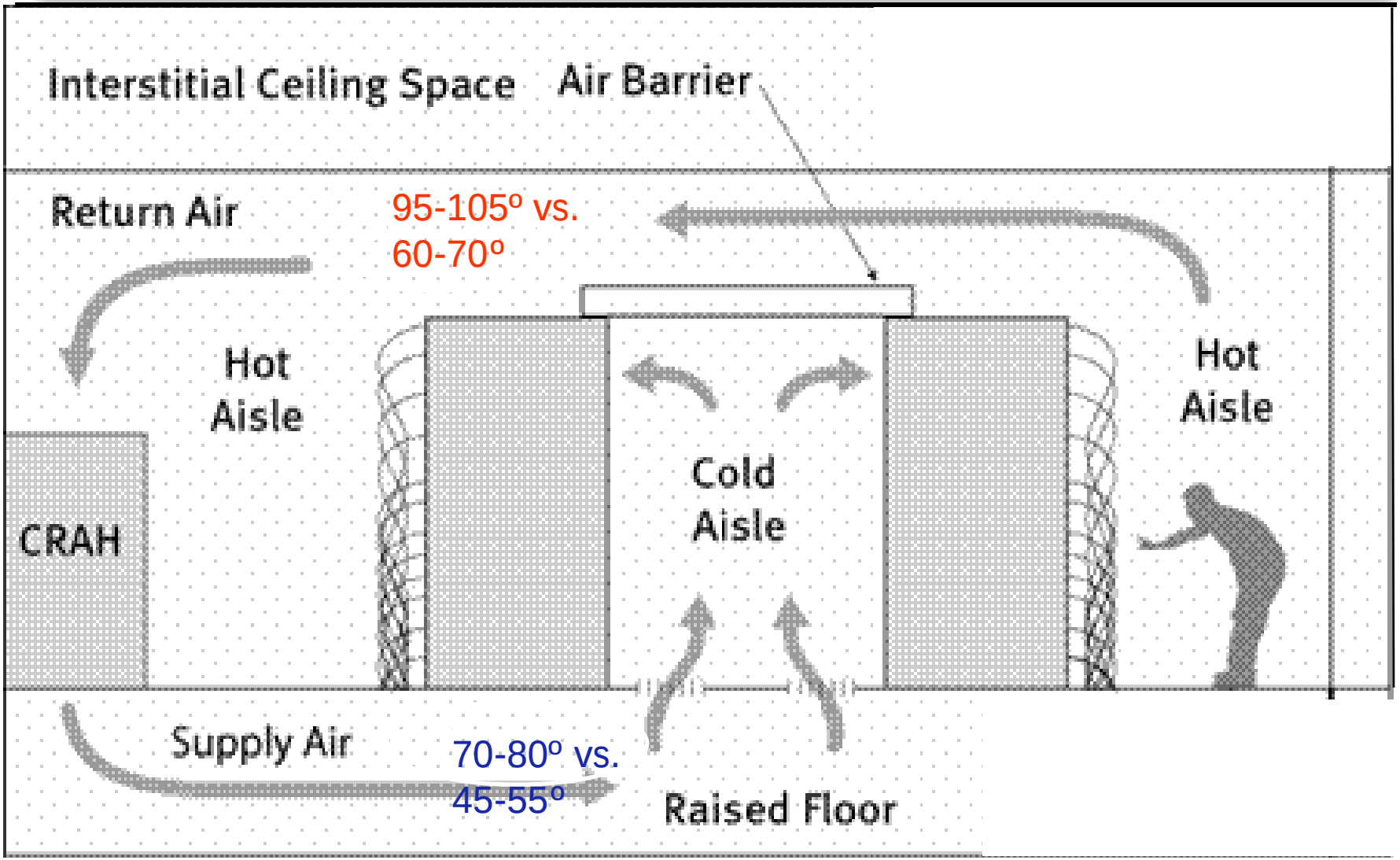
Air Management

- Typically, much more air is circulated through computer room air conditioners than is required
- Air mixing and short circuiting leads to:
  - Low supply temperature
  - Low Delta T
- Improve isolation of hot and cold “aisles”
  - Reduce fan energy
  - Improve air-conditioning efficiency
  - Increase cooling capacity



Hot aisle / cold aisle configuration decreases mixing of intake & exhaust air, promoting efficiency.

Best Practice – Isolate Cold and Hot Aisles



Use Free Cooling

- Water-side Economizers
  - In series with chiller
- Outside-Air Economizers
  - Can be very effective (24/7 load)
  - Must consider humidity
- Let's get rid of chillers in data centers

Liquid Cooling

- Transfer heat to a liquid at or near the server for best efficiency
- Cooled with tower only or chiller assisted
- Both options significantly better than CRAC units

Improve Humidity Control

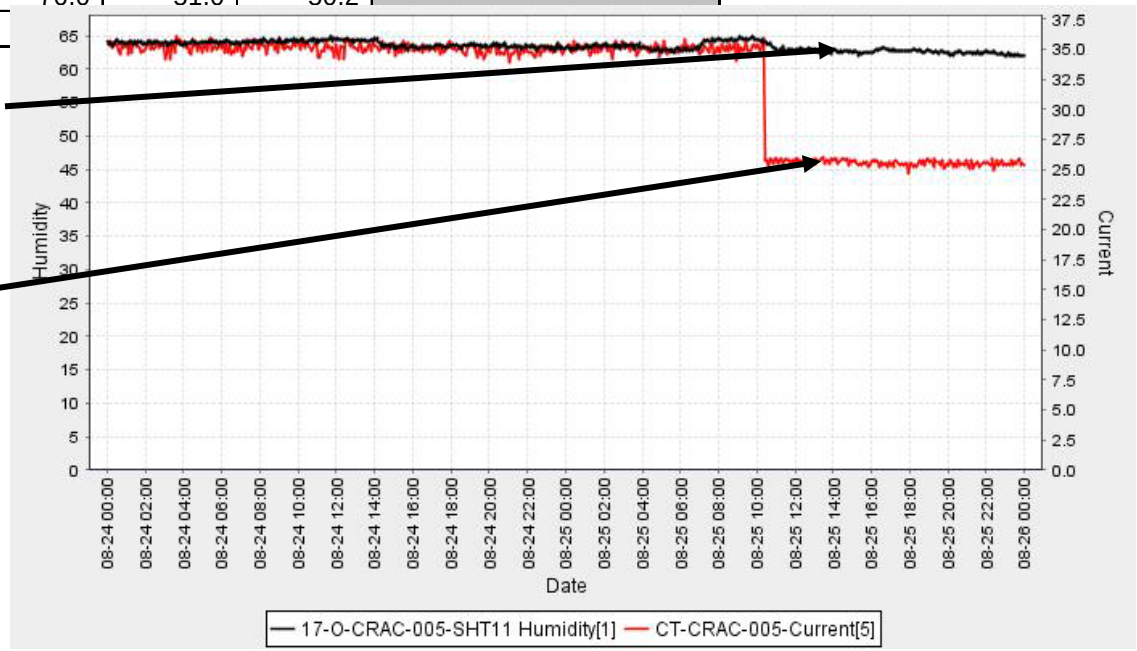
- Eliminate inadvertent dehumidification
  - Computer load is sensible only
- Use ASHRAE allowable RH and temperature
  - Many manufacturers allow even wider humidity range
- Eliminate equipment fighting
  - Coordinate controls

Improve Humidity Control

	Visalia Probe			CRAC Unit Panel			
	Temp	RH	Tdp	Temp	RH	Tdp	Mode
AC 005	84.0	27.5	47.0	76	32.0	44.1	Cooling
AC 006	81.8	28.5	46.1	55	51.0	37.2	Cooling & Dehumidification
AC 007	72.8	38.5	46.1	70	47.0	48.9	Cooling
AC 008	80.0	31.5	47.2	74	43.0	50.2	Cooling & Humidification
AC 010	77.5	32.8	46.1	68	45.0	45.9	Cooling
AC 011	78.9	31.4	46.1	70	43.0	46.6	Cooling & Humidification
Min	72.8	27.5	46.1	55.0	32.0	37.2	
Max	84.0	38.5	47.2	76.0	51.0	50.2	
Avg	79.2	31.7	46.4				

Humidity down 3%

CRAC power down 28%

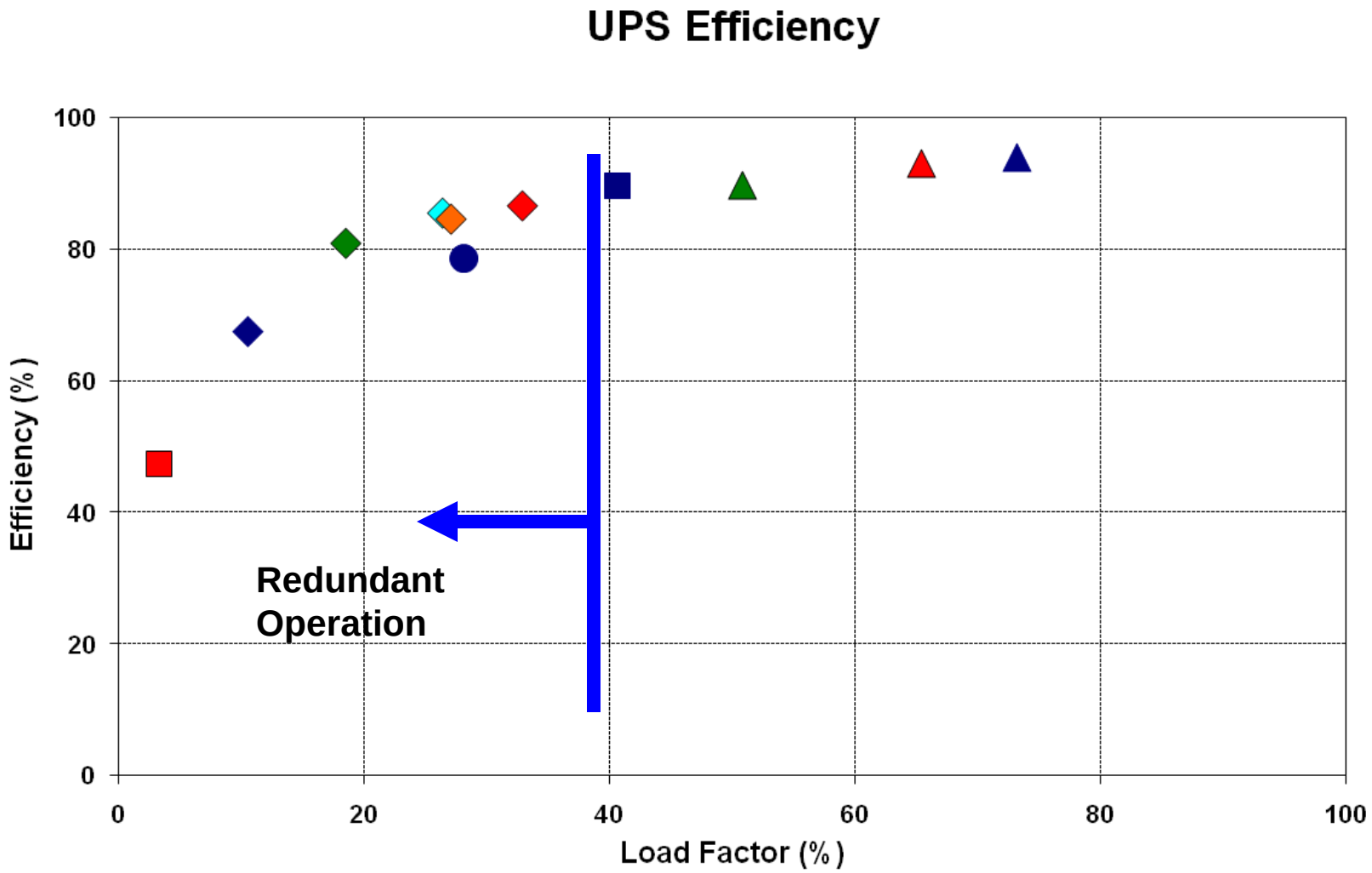


GovEnergy 2010
www.govenergy.gov

Improve The Power Chain

- Increase distribution voltage
- Improve equipment power supplies
  - Avoid redundancy unless needed
- Improve UPS
- Different redundancy strategies have different energy penalties
  - 2N vs. N+1
- Redundancy in electrical distribution puts you down the efficiency curve

Improve The Power Chain



GovEnergy 2010
www.govenergy.gov

Technical Assistance

For help with your data center, please contact your FEMP Customer Service Representative:

http://www1.eere.energy.gov/femp/about/contacts.html

Additional Resources

FEMP Federal Energy Management Program

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

BERKELEY LAB

ttp://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/

Contact Information

Dale Sartor

Lawrence Berkeley National Lab

dasartor@lbl.gov

GovEnergy 2010
www.govenergy.gov