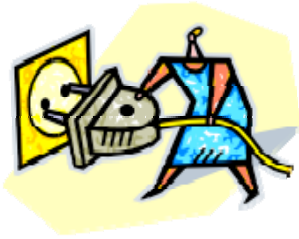


**DOE Best Practices Workshop
Power Management
San Francisco, Sept. 28-29, 2010**

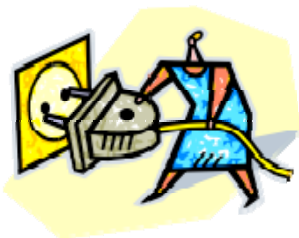
“Power-related facility and equipment standards,
ratings, and certifications”

Breakout Report



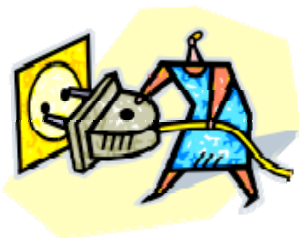
Breakout participants

- Bill Tschudi (Lead), Bob Schroeder (Co-Lead), Jim Crow (Note taker), Natalie Bates, Buddy Bland, Kathye Chavez, Chris DePrater, Alan Goodrum, Erich Strohmaier, Bryan Webb



Outline of Breakout Discussion

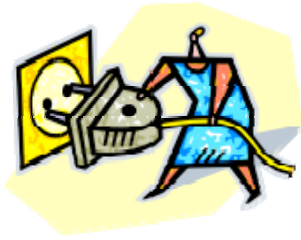
- Federal Requirements for Data Centers
- DOE Programs
 - Save Energy Now
 - Federal Energy Management Program
- EPA Energy Star
 - for products (servers, storage, UPS)
 - For buildings (data centers)
- California Energy Commission
- ASHRAE standards, training, and publications,
- The Green Grid
- LEED™ Certification for data centers
- Federal regulations for Carbon Measurement and carbon measurement tools
- General Discussion and Cross-cut questions



Best Practices in:

“Power-related facility and equipment standards, ratings, and certifications”

- Standards:
 - ASHRAE standards - 90.1, 127
 - California Title24 – possible candidate
- Ratings:
 - EPA Energy star
 - LEED™ Rating for data centers
- Certifications
 - DOE Data Center Energy Practitioner program
- Measure and verify, dashboard
 - Can't improve it if you can't measure it
 - Everything going into one location, whole picture

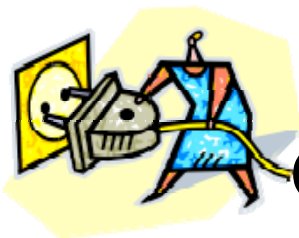


Experience

Novel / Interesting Approaches

“Power-related facility and equipment standards, ratings, and certifications”

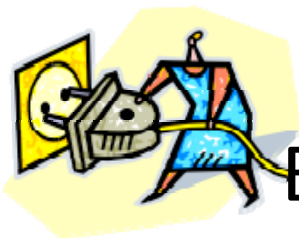
- LEED criteria (LBNL) for Data Centers proposed to USGBC
- Finding better ways to quantify other than PUE, something related to the computational output
- Energy Reuse metric
- ASHRAE training
- Rewarding excellence rather than punishing mediocrity
- DOE commitment to exceed minimum standards helps influence ASHRAE



Gaps Looking Forward to New Systems

“Power-related facility and equipment standards, ratings, and certifications”

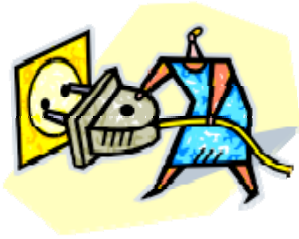
- Scientific instrument versus data center, should our standards or ratings be different from other commercial/more standard data centers?
 - The mission of the facility is very different
 - Uptime institute TIER levels, different focus
- We should think about an HPC “Tier Structure” to capture energy efficiency best practices *based on the mission*
- DOE to influence industry to have broader environmental conditions
 - Put it into the RFP and you’ll ultimately get there
 - Ask for it through ASHRAE
- We need to put energy efficiency metrics work on the R&D agenda
- Energy Star ratings for Servers do not apply to HPC equipment
 - Don’t require me to only buy Energy Star rated servers if it keeps me from meeting my mission



Evolve or start over for future systems?

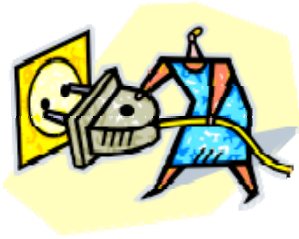
“Power-related facility and equipment standards, ratings, and certifications”

- There is a need for revising the ASHRAE recommendations to allow higher temperatures and wider humidity ranges for air cooled equipment
- Encourage the use of higher max temperature for liquid cooling; improve the delta T
 - Suggest ASHRAE develop at recommended and allowable ranges for liquid cooling



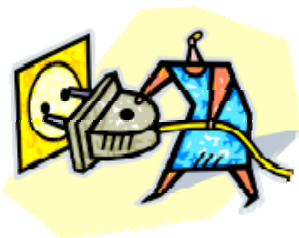
Issues shared with large commercial centers

- Federal regulations target federal facilities, open issue as to whether exec. orders etc. apply to GOCO labs.
- Adding new programs (computing capability) runs counter to energy reduction goals
- GreenGrid, ASHRAE, Silicon Valley Leadership Group are all able to collaborate
- Other standards, ratings, etc. apply to either



- Hardware/facility/system interfaces to influence

- A "standard" or template RFI is needed. If the vendors start seeing such a document or similar requirements from multiple customers, that will undoubtedly have a big impact. DOE could require this for HPC procurements.



Status of (de facto) standards

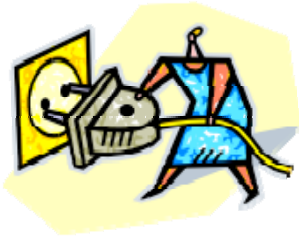
Metrics:

- PUE needs more, better deployment
- Computing metrics need to be established with community buy-in and deployment
- ASHRAE guidelines are becoming “standard”. Guidelines for liquid cooling could be developed



Other key findings

- Some ability to influence local utility (Oak Ridge)
- Standardizing on measurement requirements (not on specific methods)
- Recognition or rewards are better than minimum standards



Standards, Government Programs Influence on Future HPC

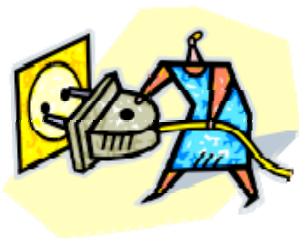
September 27-28, 2010



William Tschudi

wftschudi@lbl.gov

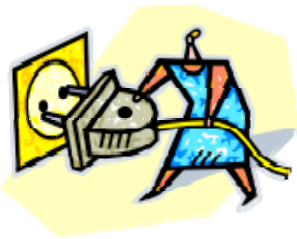
510-495-2417



Federal Requirements

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.



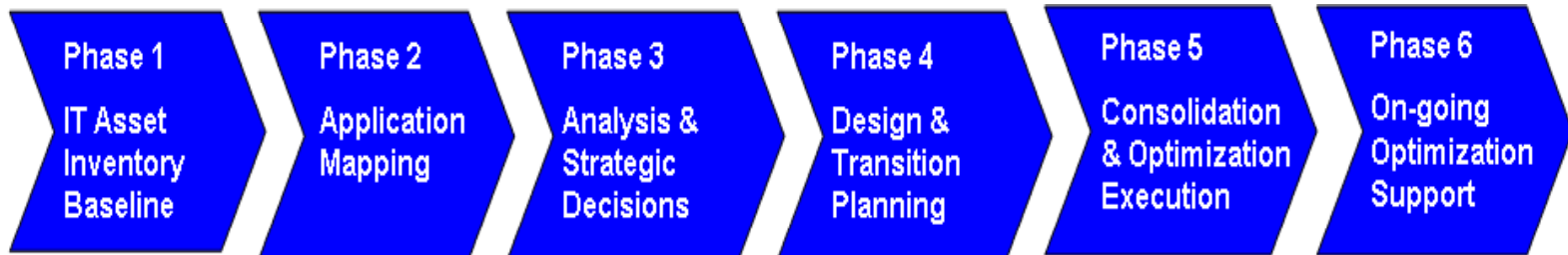
Federal Energy Legislation

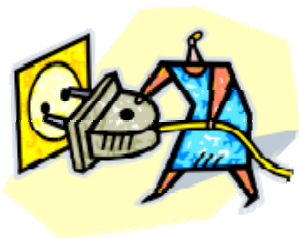
OMB Data Center Consolidation Plan



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)



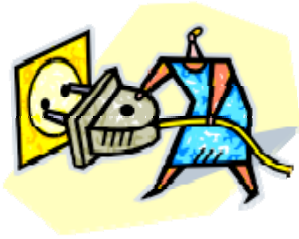


DOE (EERE) Industrial Technology Program

Data Center Activities (Save Energy Now Program)



- DC Pro assessment tools
- Best practices/Case studies
- Awareness training jointly developed with ASHRAE
- Data Center Energy Practitioner Program (DCEP)
- Industry and International collaboration
 - Green Grid, ASHRAE, Uptime, SVLG, etc.
 - International - European Code of Conduct, Japan, India, China
- Research and Demonstration projects



DOE DC Pro Software Tool Suite

High-Level On-Line Profiling (and Tracking) Tool

- Overall efficiency (PUE)
- End-use breakout
- Potential areas for energy efficiency improvement
- Overall energy use reduction potential

In-Depth Assessment Tools

Air Management

- Hot/cold separation
- Environmental conditions

Electrical Systems

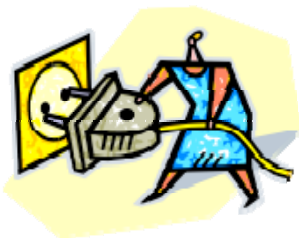
- UPS
- PDU
- Transformers
- Lighting
- Standby gen.

Cooling

- Air handlers/conditioners
- Chillers, pumps, fans
- Free cooling.

IT-Equipment

- Servers
- Storage & networking
- Network
- Software.



DC Pro Profiling Tool



ITP BestPractices: DC Pro - Energy Use Distribution - Berkeley Lab

U.S. Department of Energy
Energy Efficiency and Renewable Energy
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

Industrial Technologies Program

Data Center Energy Profiler

Home | New Case | FAQ | Help | Current Case | Checklist | Feedback Survey

Current Case: 456 Current User: Bob Smith [Logout](#)

1 2 3 4 5 6

Step 5 - Energy Use Distribution (optional)

Use these screens to allocate the annual energy use for each meter identified in Step 4 across the Energy End-Use Breakout Categories.

If you do not know what the allocations are for a given meter, it is OK to skip this screen or enter estimates. All of the energy use for a given meter does not have to be allocated to the breakout categories. If the meter serves more than just the data center, it is OK to leave a portion of the energy in the Remainder column.

NOTE: DC Pro provides default percentages for you based on the information entered in Step 2. You may use these default percentages if you are unsure of the actual percentages that each energy use system uses. However, for more accurate results you should estimate your actual percentages and enter them in the boxes below.

Meter ID	Electricity		Fuel		Steam		Chilled Water				Summary				
	Site Energy End-Use Breakout Categories Recalculate														
	IT Load		Lights		Electric Distribution Losses		Fans		Cooling & Humidity Controls		Site Energy Use Related to Data Center		Remainder (Non-Data Center Use)		
	kWh/yr	kWh/yr	%	kWh/yr	%	kWh/yr	%	kWh/yr	%	kWh/yr	%	kWh/yr	%	kWh/yr	%
001	3,000,000	1700000	57%	90000	3%	350000	12%	600000	20%	90000	3%	2,830,000.0	94%	170,000	6%
002	600,000	400000	67%	60000	10%	90000	15%	18000	3%	12000	2%	580,000.0	97%	20,000	3%
213	306,660	153330	50%	91998	30%	0	0%	9199.8	3%	9199.8	3%	263,727.6	86%	42,932.4	14%
Totals	2,253,330	58%	241,998	6%	440,000	11%	627,199.8	16%	111,199.8	3%	3,673,727.6	94%	232,932.4	6%	
Is this all the electricity associated with the breakout categories being used by the data center?		Yes <input type="button" value="v"/>		Yes <input type="button" value="v"/>		Yes <input type="button" value="v"/>		Yes <input type="button" value="v"/>		Yes <input type="button" value="v"/>					

Help

- Please enter a value for each meter or sub-meter. If the meter or sub-meter does not use any energy from a given category, enter zero.
- The total annual energy use for each meter are the values calculated in Step 4. If you notice a problem with a meter or need to modify one, go back to Step 4 by clicking the circle on the top of this page.
- The percentages in the "Energy Use Related to Data Center" and "Remainder" column for a given meter MUST equal 100%. DC Pro will not let you move onto the next page if they do not.
- You must select "Yes" or "No" in the final row before proceeding to the next energy type. Select "Yes" if there is no additional energy being used by the data center for a given breakout category. Select "No" if there is.

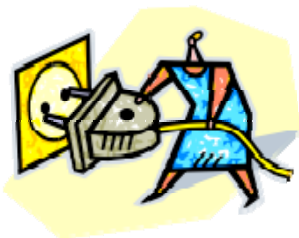


Data Center Energy Practitioner Program (DCEP)

The Data Center Industry and DOE have partnered to develop a certificate process to qualify energy practitioners to evaluate energy efficiency opportunities in Data Centers.

Key objectives:

Raise the standards of those involved in energy assessments to accelerate energy savings in Data Centers; provide repeatability and credibility of recommendations.



DCEP Training Disciplines/Levels

Level 1:

“Generalist”

Training/Exam on All
Disciplines
+ Assessment Process
+ DC Pro Profiling Tool

Level 2:

“Specialist”

Training/Exam on Select
Disciplines
+ Assessment Process
+ DC Pro System
Assessment Tools

**IT-Equipment, Air-Management, Cooling
Systems, and Electrical Systems**

**Cooling
Systems**

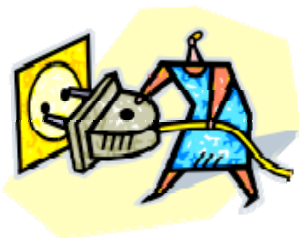
**Air
Management**

**Electrical
Systems**

**IT
Equipment**

**HVAC
(2010)**

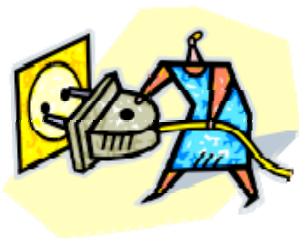
**Save
ENERGY
Now**



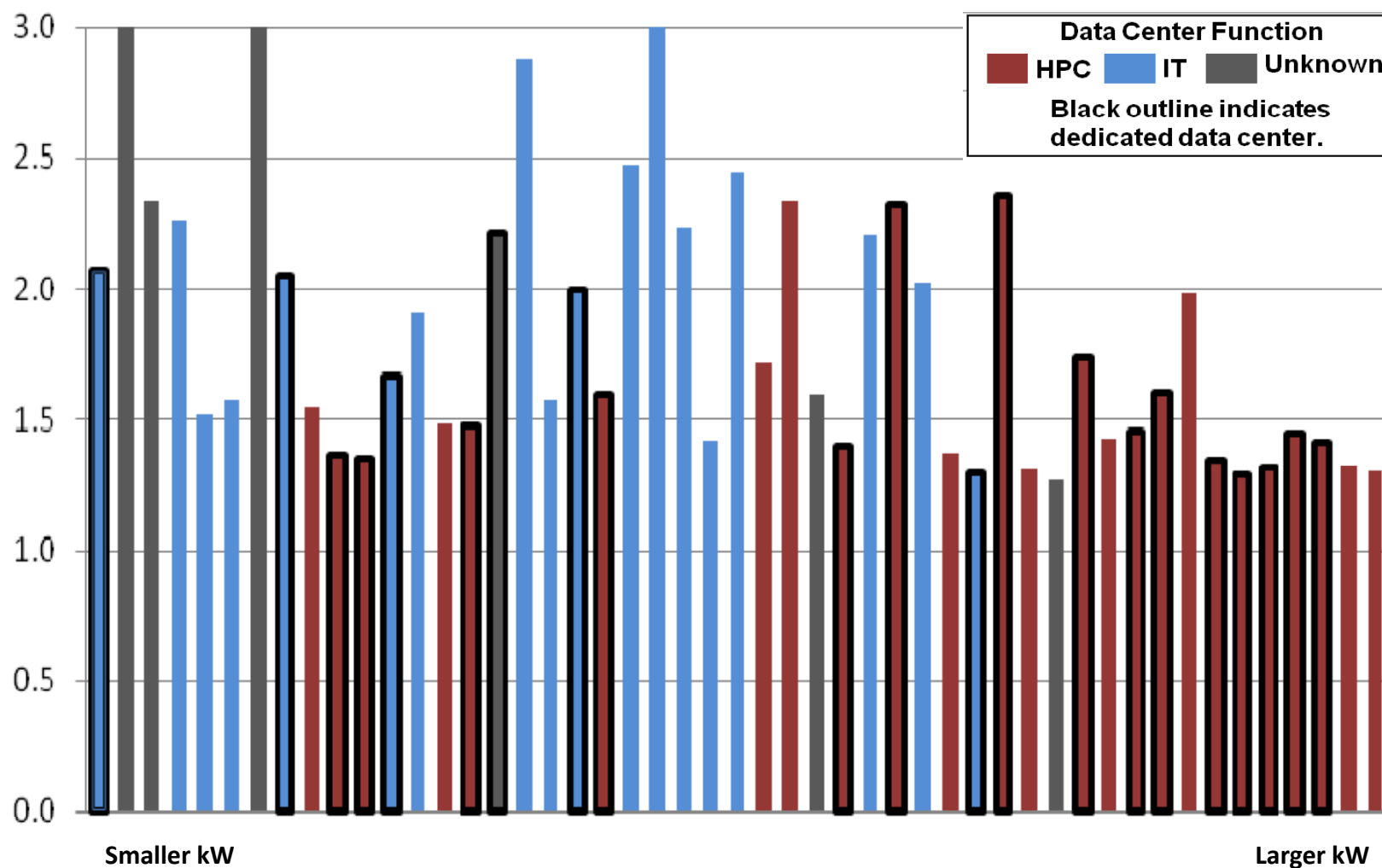
DOE Federal Energy Management Program



- Survey and benchmarking of DOE Data Centers
- Assistance to DOE and other Federal Agencies
 - Training for use of DC Pro tools
 - Alternative financing - ESPC contracts
 - Technical assistance including assessments
- Guidelines and case studies
- Pilot adoption of technologies
- Federal procurement specifications



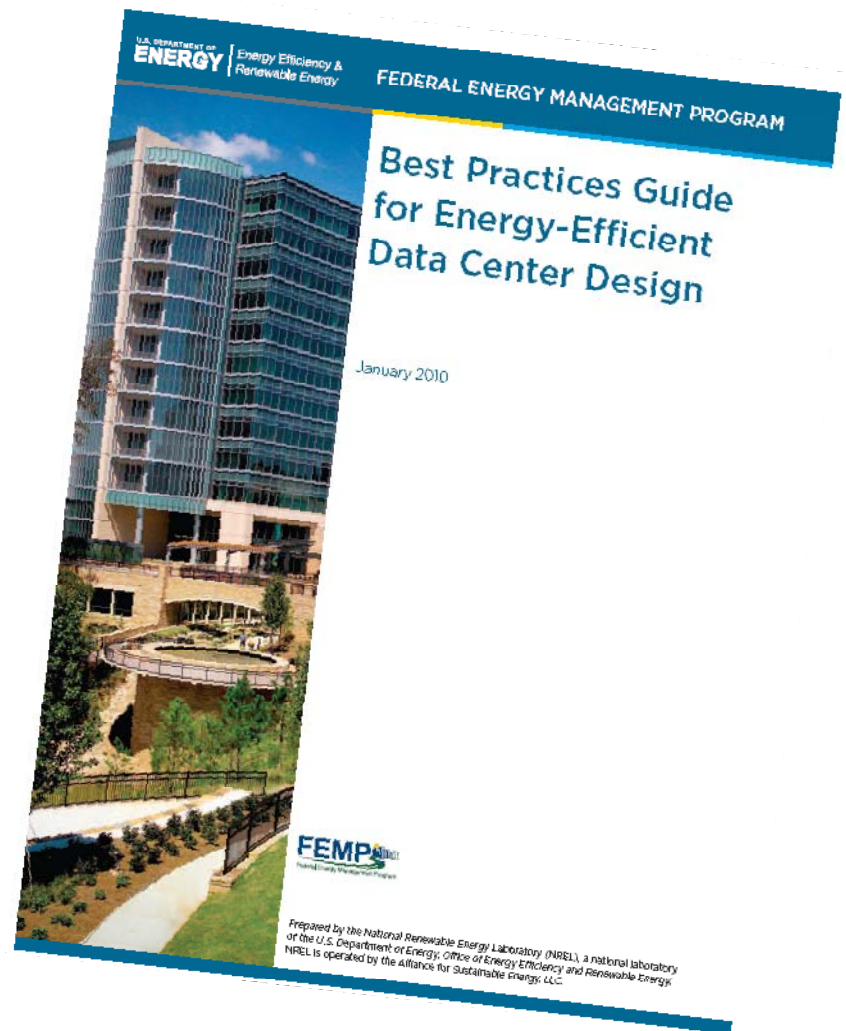
PUE of DOE Data Centers

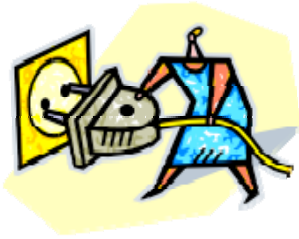




FEMP Data Center Publications

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

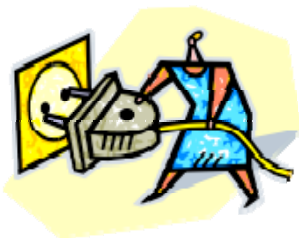




ENERGY STAR Initiatives



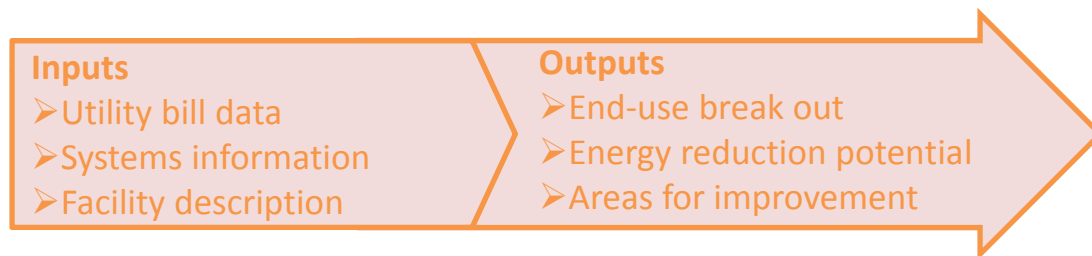
- Identifying energy efficient products
 - Servers
 - Storage
 - UPS
- Data Center building rating
- Reward top quartile
- Supporting Federal agencies in implementing EO 13514 and data center consolidation



Benchmarking and Profiling Tools

Data Center Profiling Tool (DC-PRO)

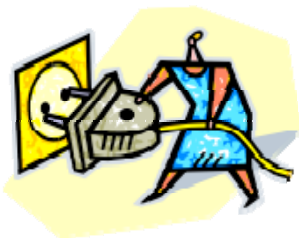
- Designed for data center owners & operators
- Diagnoses how energy is used within a data centers
- Determines ways to save energy and money.



Energy Star® Portfolio Manager

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





California Energy Commission

- Public Interest Energy Research (PIER) program funds research and demonstration projects with goal to improve efficiency of data centers
- CEC - PIER has sponsored LBNL for a number of years in RD&D projects for high tech buildings
- LBNL partners with the Silicon Valley Leadership Group to showcase demonstration projects

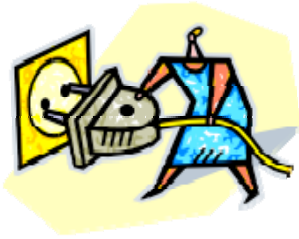


9/29/10

Best Practices Power Management



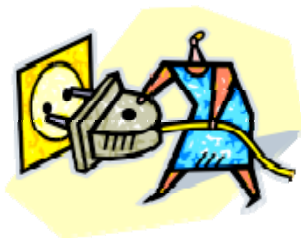
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ASHRAE

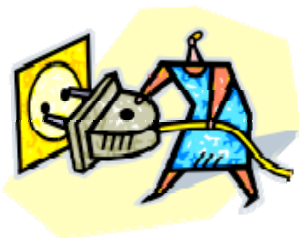
American Society of Heating Refrigeration and Air
Conditioning Engineers

- Technical Committee: TC 9.9
- Standards
 - ASHRAE Standard 90.1 (buildings - DOE's goal is to be 30% better than this standard)
 - ASHRAE Standard 127 (Computer room air conditioners)
 - Standards set *minimum* energy requirements
- Training
 - Jointly developed with DOE, offers a one day training workshop
- Publications
 - 8 books available on line
 - ASHRAE Journal articles available



The Green Grid

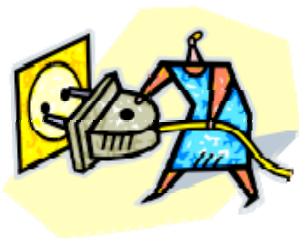
- Metrics
 - PUE (Power Utilization Effectiveness)
 - ERE (Energy Reuse Effectiveness)
 - Proxies for computing metric
- White papers
- Tools
 - Free cooling tool
 - PUE calculator



US Green Building Council (USGBC)

LEED™ Rating Criteria

- A points based rating system for sustainability with various levels (e.g. Silver, Gold, Platinum)
- LEED™ criteria for commercial buildings misses key attributes for data centers
- Sponsored by the California Energy Commission, LBNL collaborated with all major US data center organizations to draft proposed criteria for *new* data centers and submitted it to the USGBC for consideration
- USGBC evaluation of criteria is almost complete
- Draft criteria for *existing* data centers in progress by same team that developed the criteria for new centers. Draft should be available in January 2011.



Additional Resources



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



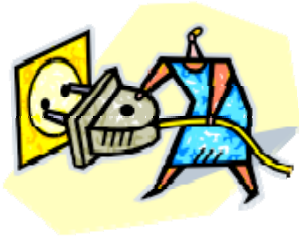
<http://hightech.lbl.gov/datacenters.html>



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

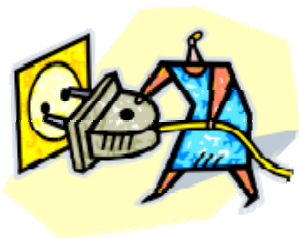


<http://www1.eere.energy.gov/industry/datacenters/>



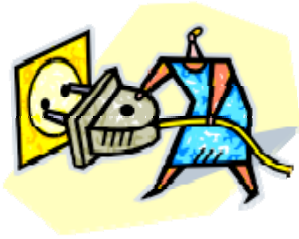
Discussion

Reporting Out



Ideas for Discussion

- How will DOE meet energy goals given that HPC is rapidly growing?
- Should Energy Star address HPC?
- What standards should DOE adopt?
 - Lead by example
 - Improvement over ASHRAE minimum
 - Minimum PUE levels
 - Computing performance metrics
- How can DOE influence industry to raise energy performance?
- Could DOE develop minimum energy standards



Back-up Slides



Industrial Technologies Program

- Tool suite & metrics for baselining
- Training
- Qualified specialists
- Case studies
- Recognition of high energy savers
- R&D - technology development



Federal Energy Management Program

- Workshops
- Federal case studies
- Federal policy guidance
- Information exchange & outreach
- Access to financing opportunities
- Technical assistance



GSA

- Workshops
- Quick Start Efficiency Guide
- Technical Assistance



EPA

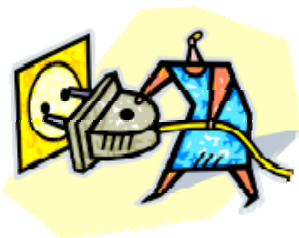
- Metrics
- Server performance rating & ENERGY STAR label
- Data center benchmarking



Industry

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





Contacts/Links

Paul Scheihing, DOE

Paul.Scheihing@ee.doe.gov

Magnus K. Herrlin, ANCIS Incorporated (Lead DCEP)

mherrlin@ancis.us

Dale Sartor, LBNL

DASartor@lbl.gov

Bill Tschudi, LBNL

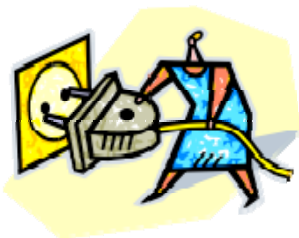
wftschudi@lbl.gov

DOE Website:

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

Lawrence Berkeley National Laboratory (LBNL)

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



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)*