Energy Efficiency Infrastructure Tool Kit

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Outline

EE HPC WG resources

Assessing your HPC center

- Data Center Energy Practitioner
- DC Pro Tools
- Assessment protocol

Center of Expertise

- Update projections
- Energy Challenge
- Measure and monitor

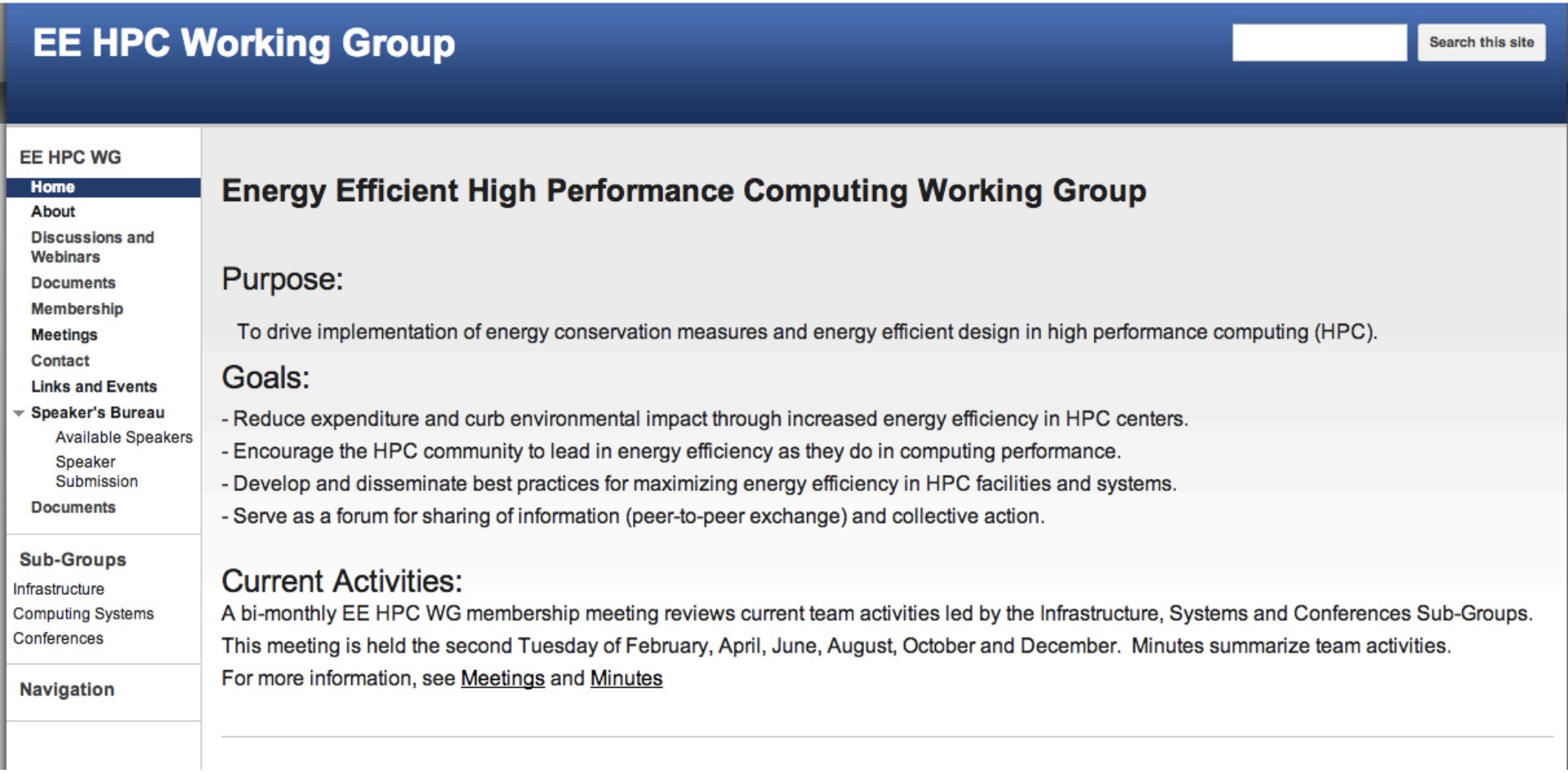
Other Resources

- LBNL (e.g. Case studies, Demonstrations, Wireless test kit)
- the Green Grid
- ASHRAE

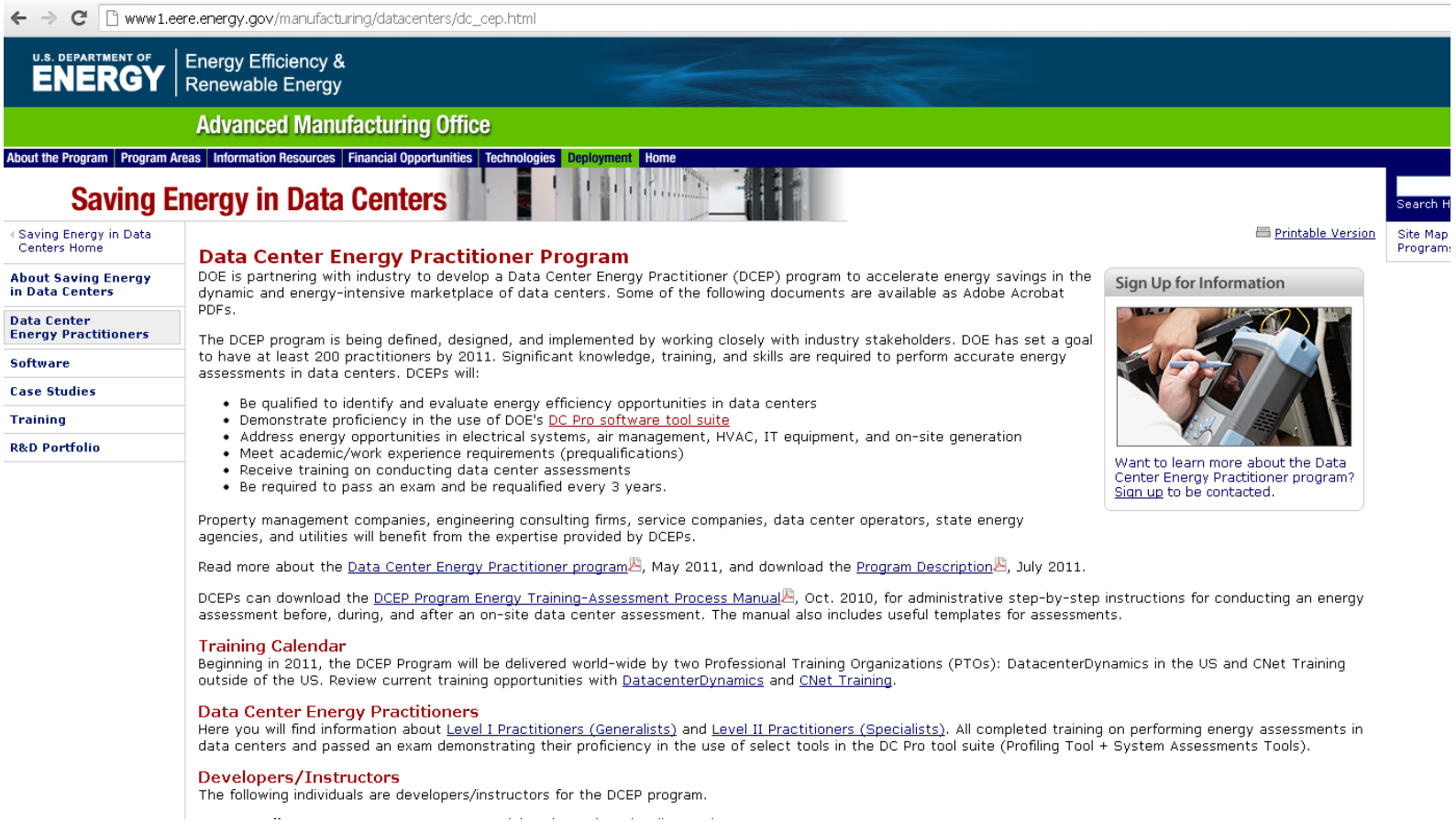
The EE HPC working group drives energy and computational performance improvement through collective actions

Members collaborate in areas such as performance metrics, thermal conditions, best practices, etc. as determined by the group. This large market influences manufacturers.

EE HPC WG Shares Information



The Data Center Energy Practitioner (DCEP) program qualifies individuals to perform data center assessments



Developed by DOE in collaboration with Industry

Objective: Raise standards, repeatability, reach large numbers

The DCEP program is administered by Professional Training Organizations – selected through a competitive process

http://www.cdcdp.com/dcep

http://www.datacenterdynamics.com/training/course-types/doe-certifed-energy-professional

PTOs license training and exam content from DOE, provide training, administer exams, and issue certificates

DOE's goal is to further privatize the program

Assessing energy performance of your HPC center

- DC Pro assessment tools
  - Energy Profiling Tool V3 release by end of 2013 (V2 retiring)
    - On line
    - Downloadable
    - Provides estimate of PUE and recommendations for improvements
    - Use to track performance
  - Air Management spreadsheet tool
  - Electrical distribution spreadsheet tool

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

Saving Energy in Data Centers

About Saving Energy in Data Centers
Data Center Energy Practitioners
Software
Case Studies
Training
R&D Portfolio

Tools and resources are available to help data center owners and operators benchmark data center energy use, identify savings opportunities, and adopt energy efficient practices. The R&D Portfolio includes projects funded by DOE's Industrial Technologies Program (ITP) that can dramatically improve the energy efficiency of the nation's information technology and telecommunications (ICT) industries. On this site you will find information on the following:

- R&D projects that advance new ICT technologies in equipment and software, power supply, and cooling.
- DC Pro Software Tool Suite includes three tools to measure energy use and identify opportunities for savings in data centers.
- Data Center Energy Practitioner program qualifies professionals to evaluate energy use and efficiency opportunities in data centers.
- Awareness training on energy efficiency is provided by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
- Case studies reveal steps companies are taking to reduce data center operating costs, increase energy efficiency, and regain cooling infrastructure capacity.
- Partnerships with the Federal Energy Management Program and other government and industry organizations work to improve data center efficiency and help meet ITP's goals. Contact us for more information.

Printable Version

Sybase Reduces Data Center Energy Use and Saves $262,000

Air-Management Tool Version 1.05 Available for Download

I Want to...

- Get tools to identify savings opportunities in my data center
- Learn about becoming qualified to perform data center assessments
- Find data center funding opportunities
- Receive e-mail updates

Search
Search Help | More Search Options

Site Map
EERE Information Center
Programs and Offices

NEWS

ITP's IMPACTS Report Released: Summary of Program Results for CY2008
August 20, 2010

New York State Commits $100 Million to Improve Data Center Energy Efficiency
March 18, 2010

Data Center Industry Leaders Reach Agreement on Guiding Principles for Energy Efficiency Metrics
February 1, 2010

More News

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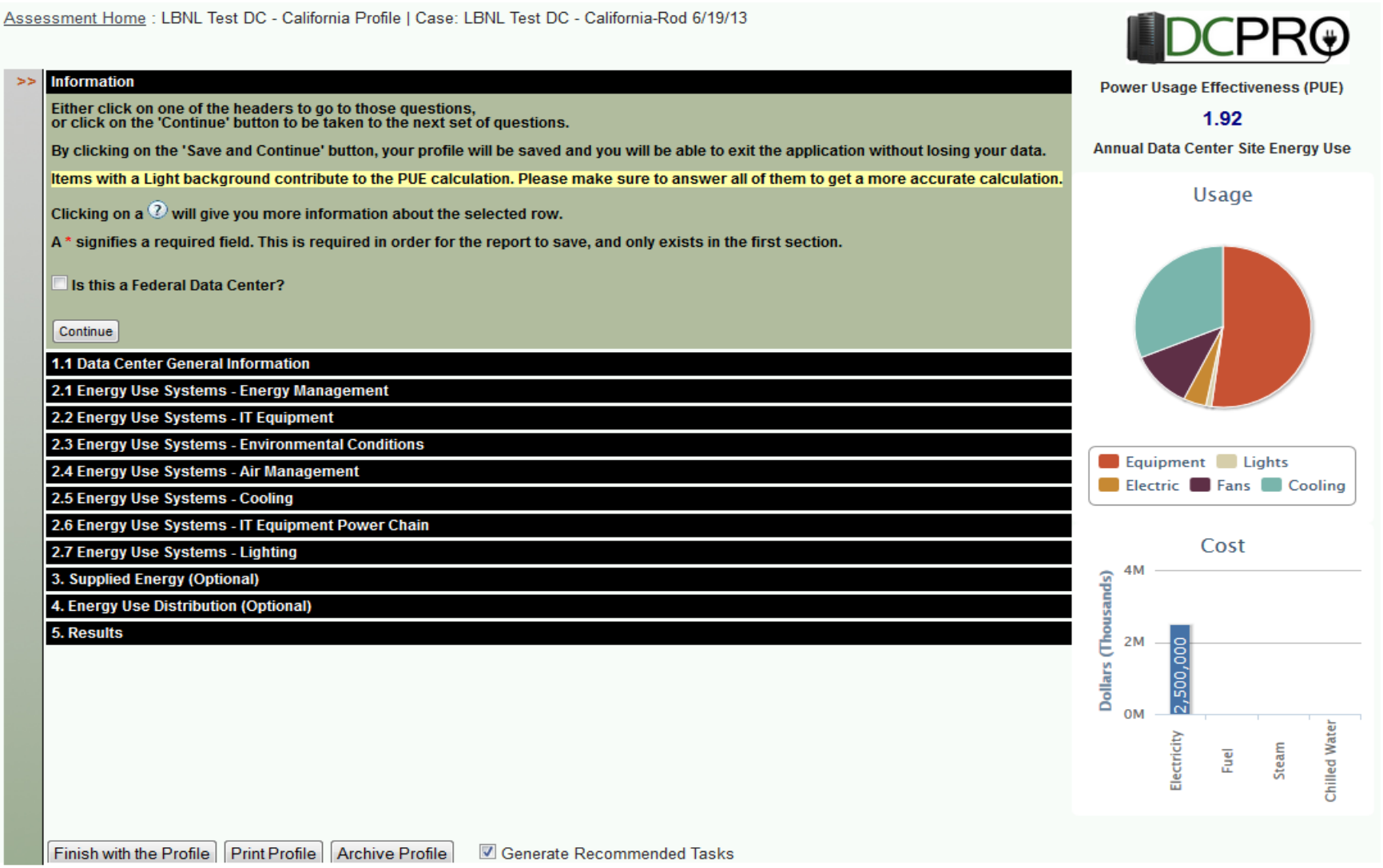
DC Pro Screen shots



General information

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Assessment Home : LBNL Test DC - California Profile | Case: LBNL Test DC - California-Rod 6/19/13

DCPRO

>> **Information**

1.1 Data Center General Information

* Profile Name:	LBNL Test DC - California-Rod 6/19/13	Give the current profile a unique name. Use the date to help organize multiple assessments in a datacenter (e.g., "Case #1, 2008-05-31").
* Department:	DOE	
* Organization:	Lawrence Berkeley National Laboratory	
Country:	United States of America	This tool currently only supports the USA.
* Address:	5 94720	
State/Region:	California	
County:	Alameda	
Climate Zone:	3C	
* Floor Area - Data Center Space:	4000 sq feet	
* Floor Area - Data Center Support Space:	500 sq feet	
* Floor Area - Non Data Center Space:	1000 sq feet	
Total Facility Space:	5500 sq feet	
Type of Data Center:	Government	
* Data Center Tier (Uptime Institute definition):	Tier II	
* Data Center Class:	A1	Class as per the ASHRAE Guidelines

Previous Section | Next Section

2.1 Energy Use Systems - Energy Management

2.2 Energy Use Systems - IT Equipment

2.3 Energy Use Systems - Environmental Conditions

2.4 Energy Use Systems - Air Management

2.5 Energy Use Systems - Cooling

Finish with the Profile | Print Profile | Archive Profile | ☑ Generate Recommended Tasks

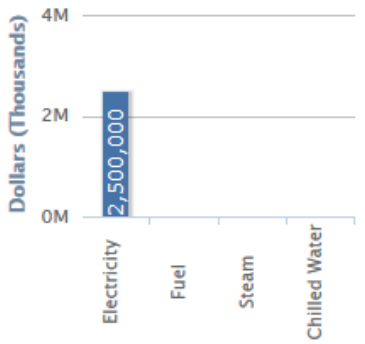
Power Usage Effectiveness (PUE)

1.92

Annual Data Center Site Energy Use

Usage

Cost



IT equipment questions

Assessment Home : LBNL Test DC - California Profile | Case: LBNL Test DC - California-Rod 6/19/13

>> Information

1.1 Data Center General Information

2.1 Energy Use Systems - Energy Management

2.2 Energy Use Systems - IT Equipment

Do you measure and track IT equipment(storage, server and network) utilization? ○ Yes ◉ No

Do you have a process for identifying abandoned/un-used servers and taking them offline? ○ Yes ◉ No

What is the average age at which you replace your servers? 4 Years

Are you using virtualization to consolidate your server workloads? ○ Yes ◉ No

How extensive is your storage consolidation? 1% to 50%

What storage tiers have you implemented? (mark all that apply)
- ☑ More than one production tier
- ☐ Archiving tier
- ☐ Near-line storage

Have you implemented storage optimization techniques such as thin provisioning, incremental snapshots, or de-duplication? ○ Yes ◉ No

Previous Section | Next Section

2.3 Energy Use Systems - Environmental Conditions

2.4 Energy Use Systems - Air Management

2.5 Energy Use Systems - Cooling

2.6 Energy Use Systems - IT Equipment Power Chain

2.7 Energy Use Systems - Lighting

3. Supplied Energy (Optional)

Finish with the Profile | Print Profile | Archive Profile | ☑ Generate Recommended Tasks

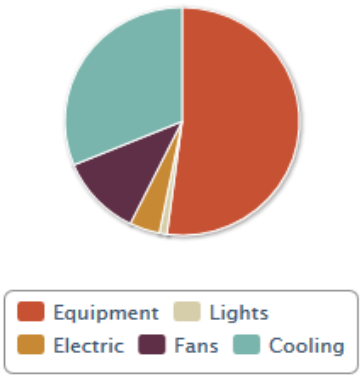
DCPRO

Power Usage Effectiveness (PUE)

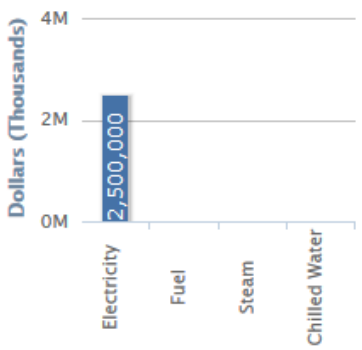
1.92

Annual Data Center Site Energy Use

Usage



Cost



Environmental conditions

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Assessment Home : LBNL Test DC - California Profile | Case: LBNL Test DC - California-Rod 6/19/13

DCPRO

What is a typical (average) air temperature leaving the cooling coils (supply)?	55F (13C)	?
What is a typical (average) air temperature entering the cooling coils (return)?	--Select One--	
What is the typical (average) IT equipment intake air temperature?	115F (46C)	?
What is the typical (average) IT equipment exhaust air temperature?	80F (27C)	?
Adopted IT Intake Air Temperature, Maximum:	70F (21C)	Per ASHRAE 2011.
Are the cooling system temperature sensors measuring air conditions that are representative of the IT equipment intake air conditions?	Yes / No	Also include humidity sensors, if any are present.
Does your air management scheme, your economizing system (if present), and your IT equipment allow your data center to operate near the ASHRAE max Recommended IT equipment intake temperature, and occasionally between the ASHRAE max Recommended and max Allowable intake temperature (per your data center Class) during 100% mechanical cooling?	Yes / No	
Do you have active, working humidification controls?	Yes / No	?
Do you have active, working dehumidification controls?	Yes / No	?
Are the current cooling system high and/or low humidity limit setpoints for the IT intake air tighter than the ASHRAE Recommended limits for your data center Class?	Yes / No	?
Do CRAC/H units have centralized (networked) or distributed controls?	Distributed	?
Are CRAC/Hs fighting each other (for example, simultaneously humidifying and dehumidifying)?	Yes / No	?
Do the cooling system controls allow you to apply correction factors (Slope and Offset) to the signals from the temperature and humidity sensors?	Yes / No	

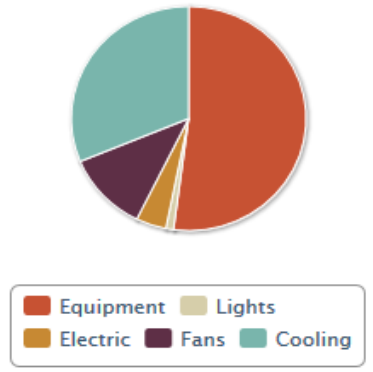
Finish with the Profile | Print Profile | Archive Profile | Generate Recommended Tasks

Power Usage Effectiveness (PUE)

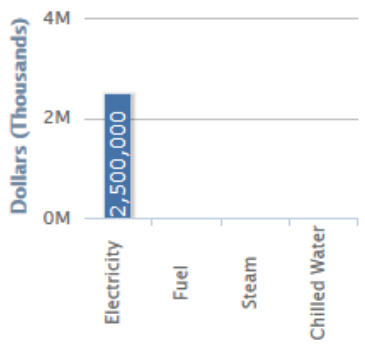
1.92

Annual Data Center Site Energy Use

Usage



Cost



Energy end use breakdown

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DCPRO

Power Usage Effectiveness (PUE)

1.92

Annual Data Center Site Energy Use

- Information
- 1.1 Data Center General Information
- 2.1 Energy Use Systems - Energy Management
- 2.2 Energy Use Systems - IT Equipment
- 2.3 Energy Use Systems - Environmental Conditions
- 2.4 Energy Use Systems - Air Management
- 2.5 Energy Use Systems - Cooling
- 2.6 Energy Use Systems - IT Equipment Power Chain
- 2.7 Energy Use Systems - Lighting
- 3. Supplied Energy (Optional)
- 4. Energy Use Distribution (Optional)

Use these screens to allocate the annual energy use for each meter identified in Step 3 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.

Once you have entered values for your breakouts, please click the Recalculate button to get your new Totals for each category.

Electricity | Fuel | Steam | Chilled Water

Meter ID	Total Annual Site Energy Use	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	%
1	8,300,000	4150000	50%	83000	1%	332000	4%	913000	11%	2490000	30%	7,968,000.00	96%	332,000	4%
Totals		4,150,000	50%	83,000	1%	332,000	4%	913,000	11%	2,490,000	30%	7,968,000	96%	332,000	4%

Previous Section | Next Section

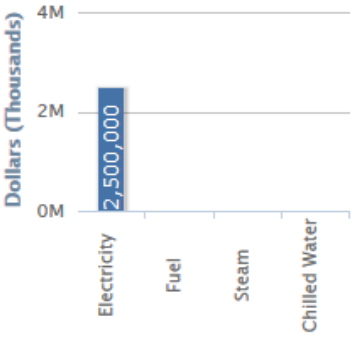
- 5. Results

Finish with the Profile | Print Profile | Archive Profile | Generate Recommended Tasks

Usage

Equipment | Lights | Electric | Fans | Cooling

Cost



Potential energy savings

Assessment Home : LBNL Test DC - California Profile | Case: LBNL Test DC - California-Rod 6/19/13

DCPRO

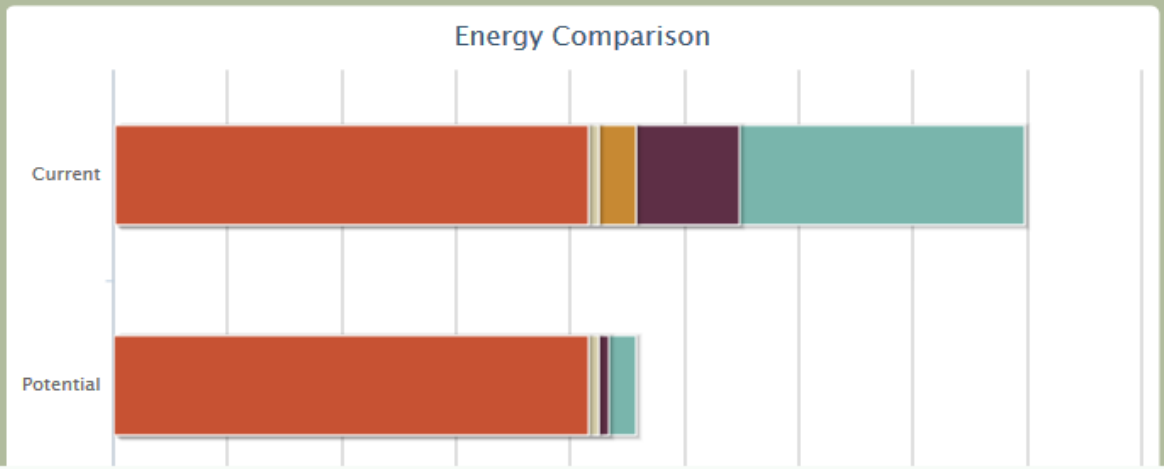
This is your customized DC Pro Summary Report.

Note: The 'Annual Energy Use' and 'Potential Annual Energy Savings' tables will only have data if you entered data into Sections 3 and 4 (Supplied Energy and Energy Use Distribution).

However you can still generate the recommended actions by clicking 'Finish with the Profile' button and making sure the checkbox is checked.

Annual Energy Use

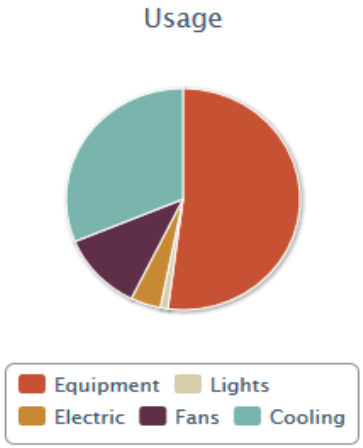
	Total Amount (in kWh/yr)	$/yr	$/kWh
Electricity	7968000	$2,500,000.00	$0.31
Fuel	0	$0.00	$0.00
Steam	0	$0.00	$0.00
Chilled Water	0	$0.00	$0.00
Totals	**7968000**	**$2,500,000.00**	**$0.31**

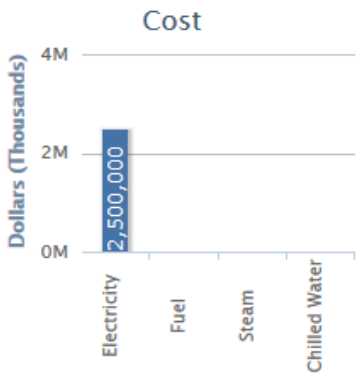


Power Usage Effectiveness (PUE)

1.92

Annual Data Center Site Energy Use





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Potential energy savings

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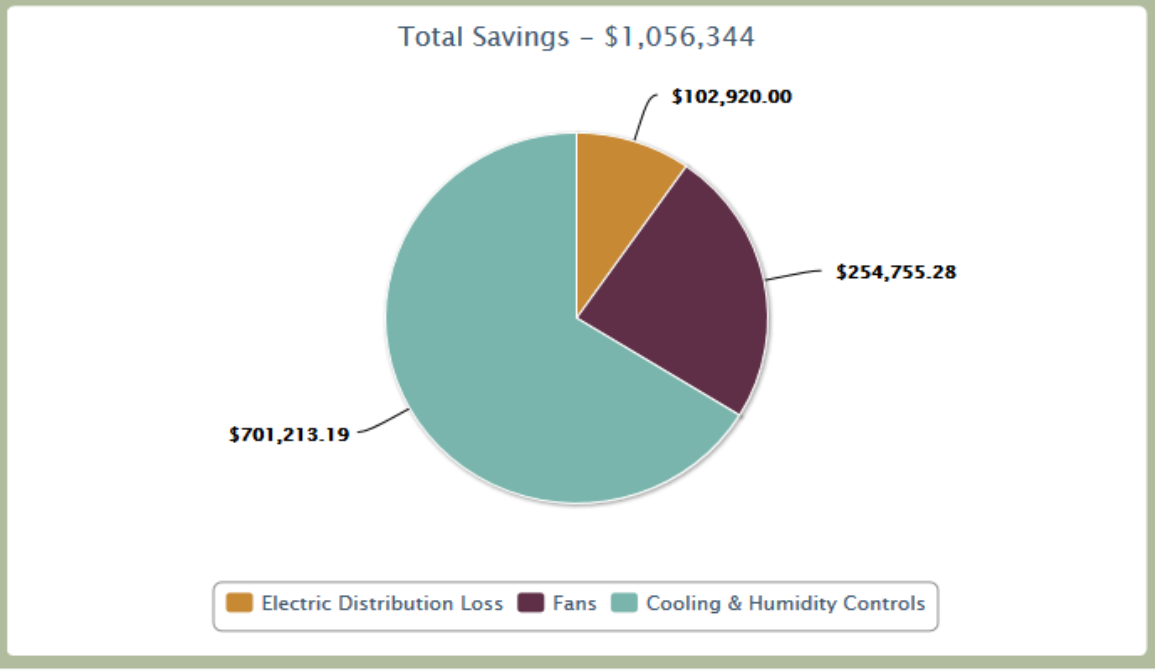
DCPRO

Potential Annual Energy Savings

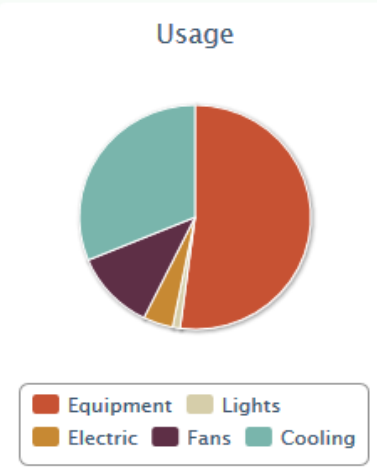
Breakout Category	Current Energy Use		Potential Energy Use		Potential Savings		
	kWh/yr	%	kWh/yr	%	kWh/yr	%	$
IT Equipment	4150000	52.1%	4150000	91.0%	0	0%	$0.00
Data Center Lights	83000	1%	91208.79	2.0%	-8208.79	-0.1%	($2,544.72)
Electric Distribution Losses	332000	4.2%	0	0.0%	332000	4.2%	$102,920.00
Fans	913000	11.5%	91208.79	2.0%	821791.21	10.3%	$254,755.28
Cooling	2490000	31.2%	228021.98	5.0%	2261978.02	28.4%	$701,213.19
Totals	**7968000**	**100%**	**4560439.56**	**100%**	**3407560.44**	**42.8%**	**$1,056,343.74**
PUE		**1.92**		**1.1**			

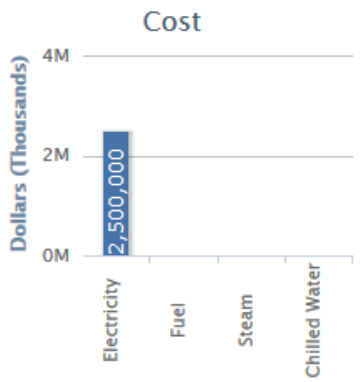


Power Usage Effectiveness (PUE)

1.92

Annual Data Center Site Energy Use





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Center of Expertise for Data Centers

Coming Soon

Center of Expertise – Energy Challenge

- **Federal and Private industry Energy Challenge being developed**
- **Goal – lead to continual improvement**
- **Possible elements:**
  - PUE – best, most improved
  - Utilization
  - Site generation
  - Benchmarking data base
- **Your ideas are welcomed**

Center of Expertise – Measure and Manage

Most Federal centers are not adequately metered

Many "enterprise" data centers are not adequately metered

Initiative will provide guidance and best practices in collaboration with industry groups

Your input is welcome

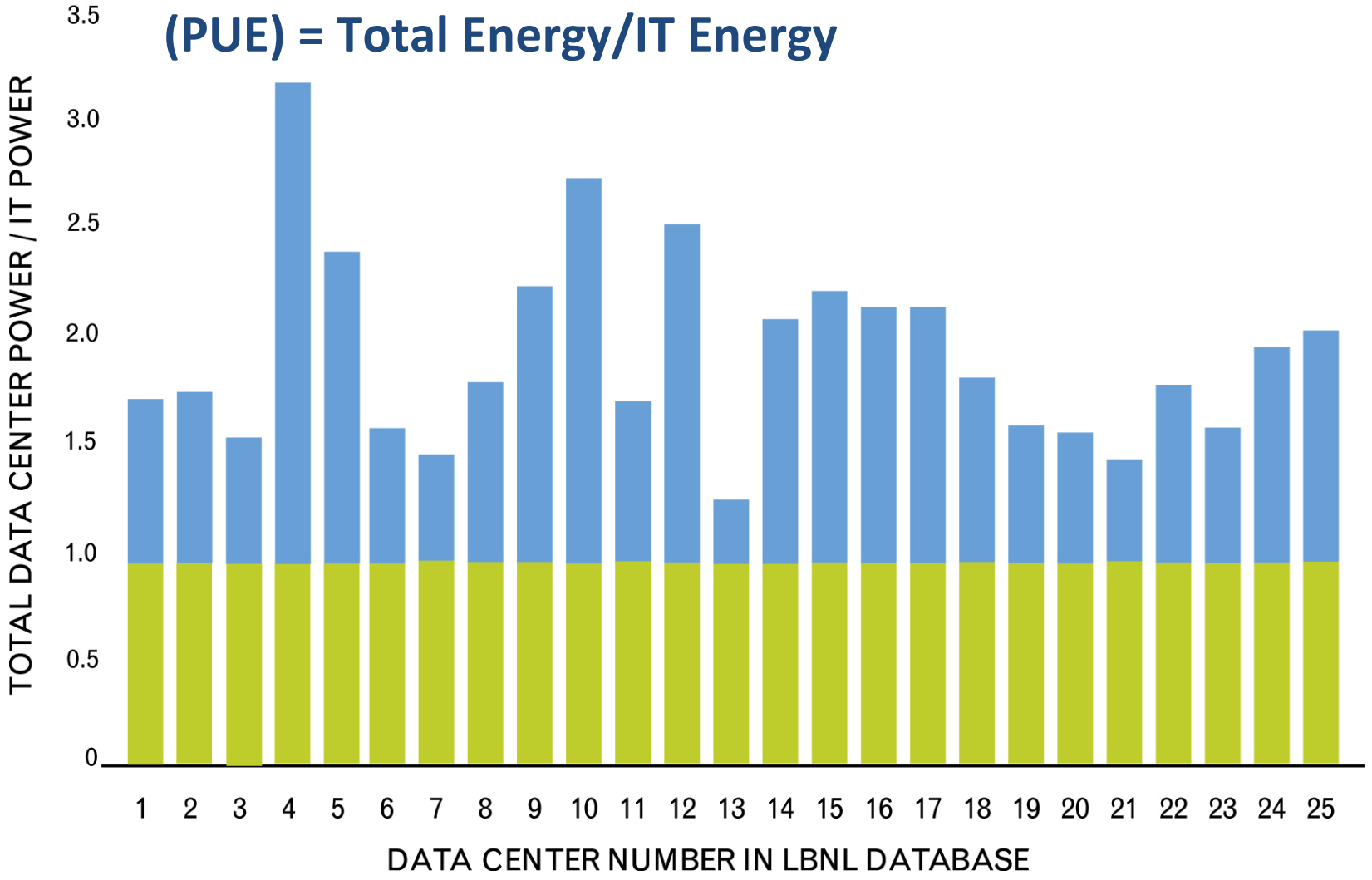
Center of Expertise

- Update data center projections originally presented in 2007 EPA report to Congress

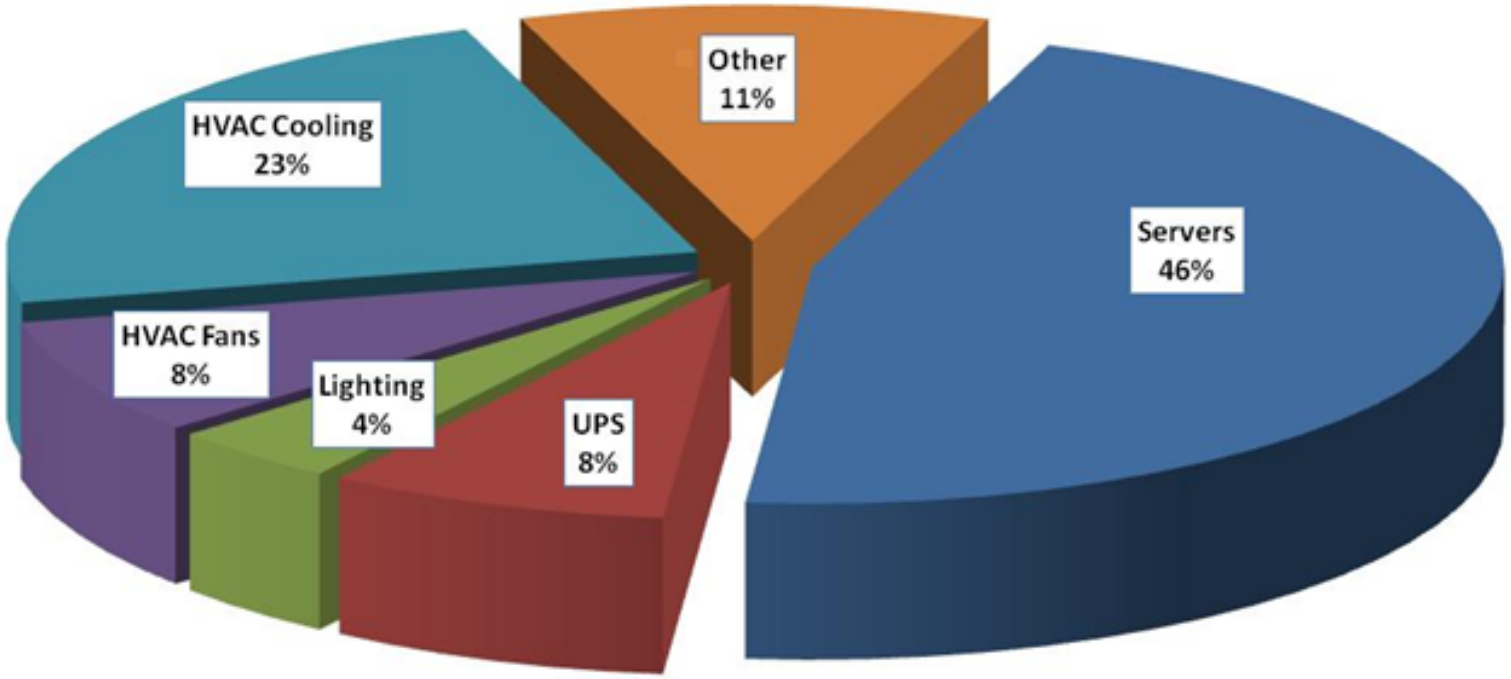
Energy benchmarking reveals wide variation

High Level Metric: Power Utilization Effectiveness

(PUE) = Total Energy/IT Energy



End use breakdowns can be instructional



Resources

Federal Programs

Federal Energy Management Program (FEMP)

- Assessment tools
- Data Center Energy Practitioner Program
- Data Center Challenge
- Industry Projections
- Measure and monitor
- Case studies

General Services Administration (GSA)

Environmental Protection Agency (EPA)

- Energy Star Buildings
- Energy Star Products

Federal Data Center Consolidation Initiative

Industry Organizations

The Green Grid

ASHRAE

7 X 24 Exchange

Uptime Institute

AFCOM

ITIC

Silicon Valley Leadership Group

Critical Facilities Roundtable

LBNL developed resources

Wireless Test Kit developed with goal of quickly capturing 75-80% of assessment data

GSA Green Proving Ground reported on the technology: http://www.gsa.gov/portal/content/140959

the Green Grid Maturity Model

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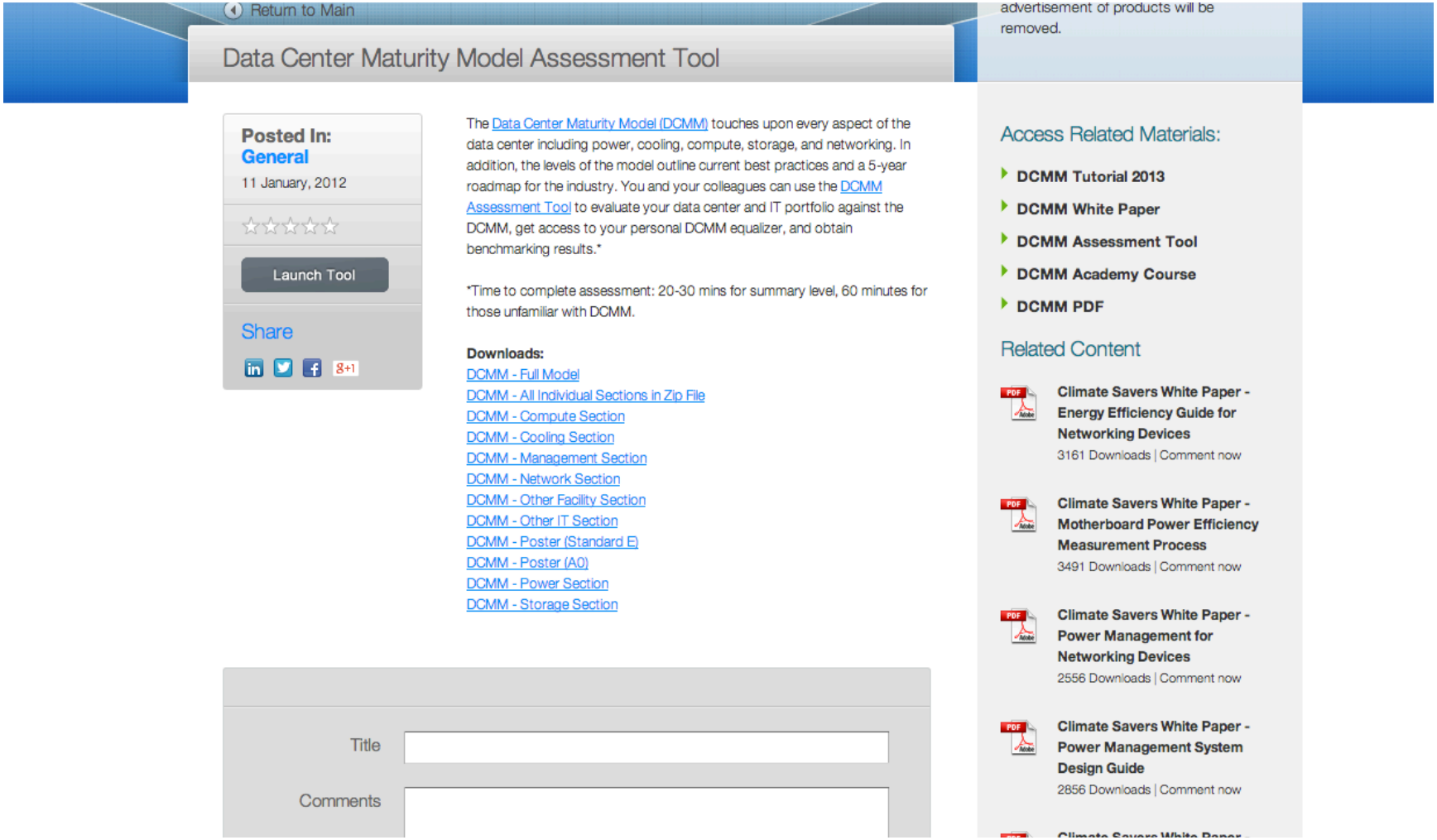

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advertisement of products will be removed.

Data Center Maturity Model Assessment Tool

Posted In:
General
11 January, 2012

Launch Tool

Share

The Data Center Maturity Model (DCMM) touches upon every aspect of the data center including power, cooling, compute, storage, and networking. In addition, the levels of the model outline current best practices and a 5-year roadmap for the industry. You and your colleagues can use the DCMM Assessment Tool to evaluate your data center and IT portfolio against the DCMM, get access to your personal DCMM equalizer, and obtain benchmarking results.*

*Time to complete assessment: 20-30 mins for summary level, 60 minutes for those unfamiliar with DCMM.

Downloads:
DCMM - Full Model
DCMM - All Individual Sections in Zip File
DCMM - Compute Section
DCMM - Cooling Section
DCMM - Management Section
DCMM - Network Section
DCMM - Other Facility Section
DCMM - Other IT Section
DCMM - Poster (Standard E)
DCMM - Poster (A0)
DCMM - Power Section
DCMM - Storage Section

Title

Comments

Access Related Materials:

- **DCMM Tutorial 2013**
- **DCMM White Paper**
- **DCMM Assessment Tool**
- **DCMM Academy Course**
- **DCMM PDF**

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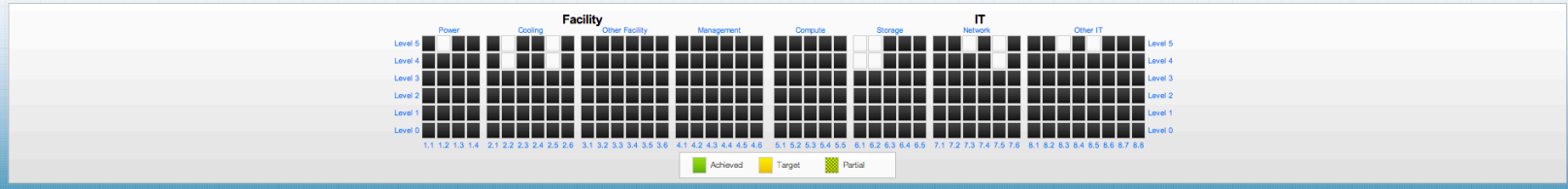
Maturity Model promotes continual improvement

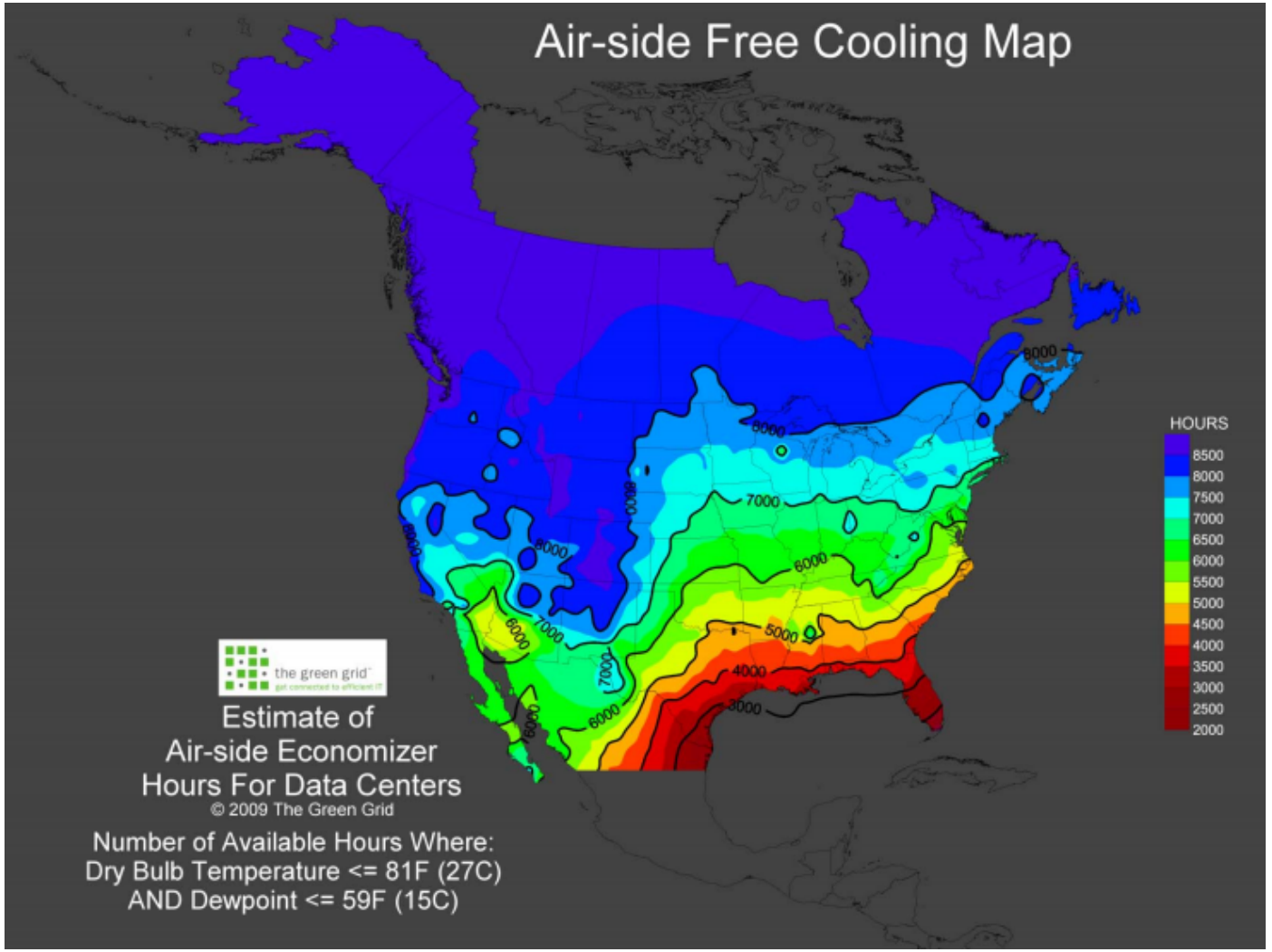
Data Center Maturity Model - Detailed Assessment (test 1)



Achieved
Target

	Level 0 Minimal/No Progress	Level 1 Part Best Practice	Level 2 Best Practice	Level 3	Level 4	Level 5 Visionary - 5 Years
Facility						
Power	**Assessment**	**Assessment**	**Assessment**	**Assessment**	**Assessment**	**Assessment**
1.1 Critical Power Path Efficiency - Building Entrance to IT load	• Mid to low efficiency <90% based on your typical utilization	• 90% efficiency based on your typical utilization	• 92% efficiency based on your typical utilization	• 94% efficiency based on your typical utilization	• 95% efficiency based on your typical utilization	• 96% efficiency base
1.2 Architecture	• Low efficiency power infrastructure and inefficient UPS use	• Eco Mode UPS if applicable to business type	• Consolidate transformers (use fewer series isolation transformers, consider autotransformers)	• Eco Mode UPS that works for all business types	• Move to higher IT load voltage, either AC or DC	
1.2 Architecture	• Greater redundancy than required	• Fewer and higher efficiency transformers (NEMA TP1 or equivalent)	• Select power (and backup) technologies based on TCO, Materials & Sustainability	• Scalable power infrastructure		
1.2 Architecture	• Numerous isolation transformers	• Verify the product's efficiency curve is highest for the load range used vs. highest overall		• Use products with flat, high efficiency at all loads		
1.2 Architecture				• Review and capture waste heat (for example, to augment generator block heaters)		

Green Grid Free Cooling Map



Map Courtesy of The Green Grid

http://cooling.thegreengrid.org/namerica/WEB_APP/calc_index.html

GSA Wireless Study

GSA U.S. General Services Administration

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- Green Proving Ground
- Overview
- What is GPG?
- FY 11 Technology Assessments
- FY 11 Technology Findings
- FY 12 Technology Assessments
  - Building Envelope
  - HVAC/Energy Management
    - Central Plant Optimization Strategy
    - Wireless Pneumatic Thermostat
    - Plug Load Control
    - Wireless Sensor Networks
  - Lighting
  - On-Site Power Generation
  - Water
- Request for Information

Wireless Sensor Networks

Findings, March 2012

"By most standards, this data center is an efficient facility. The fact that a wireless sensor network helped it significantly reduce its energy profile speaks volumes for the technology."

Ron Jones

Facility Manager, Office of the Chief Information Officer, USDA

Wireless Sensors Help Decrease Data Center Energy Consumption

Data centers consume roughly two percent of all energy used in the United States, and their carbon footprint is projected to exceed that of the airline industry by 2020(1). Nearly 50 percent

CONTACTS

Kevin Powell
(510) 919-9192
- kevin.powell@gsa.gov
- View Contact Details

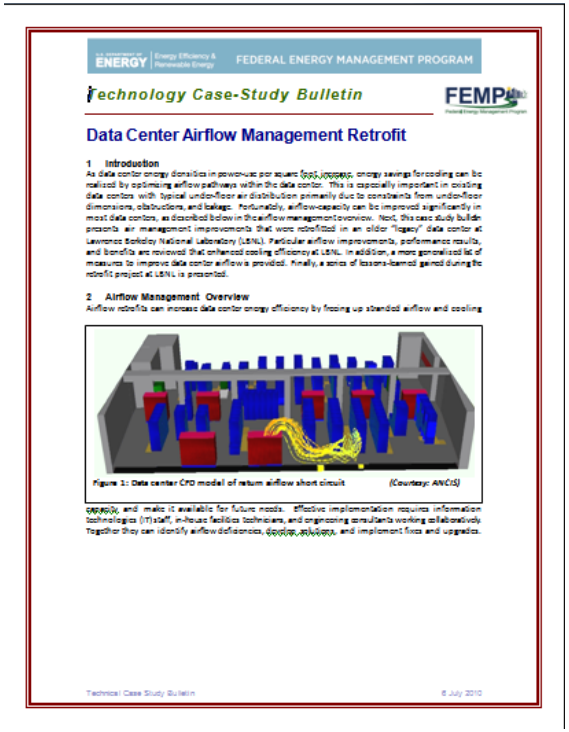
DOWNLOAD FINDINGS

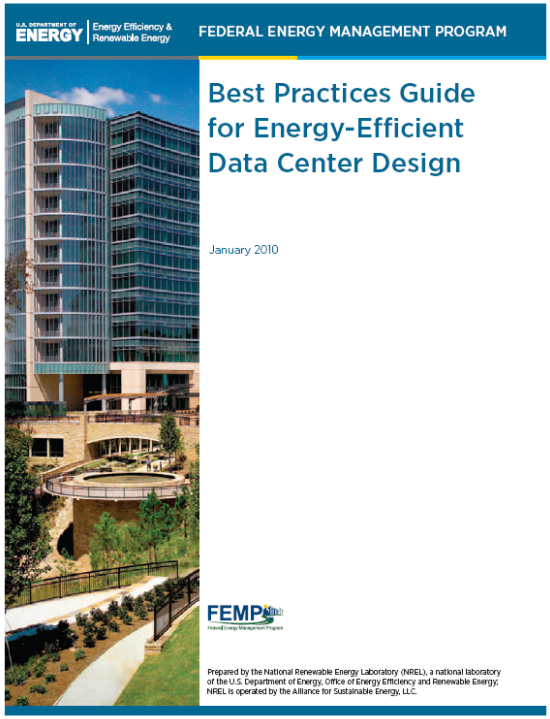
Findings: Wireless Sensor Networks >

DOWNLOAD FULL REPORT

Wireless Sensor Network for Improving the Energy Efficiency of Data Centers *Lawrence Berkeley National Laboratory* >

Federal Energy Management Program resources

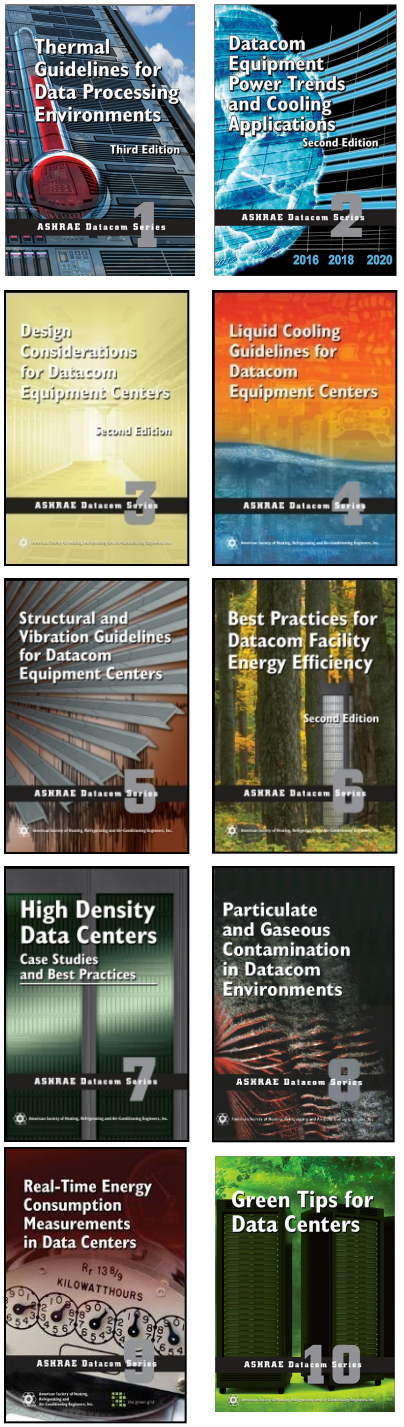




- Best Practices Guide
- Benchmarking Guide
- Data Center Programming Guide
- Technology Case Study Bulletins
- Process Manuals
- Procurement Specifications
- Report Templates
- Quick-Start Guide

ASHRAE data center book series

1. Thermal Guidelines for Data Processing Environments 3rd Edition (2011)
2. Power Trends & Cooling Applications 2nd Edition (2012)
3. Design Considerations for Datacom Equipment Centers (2009)
4. Liquid Cooling Guidelines for Datacom Equipment Centers (2006)
5. Structural & Vibration Guidelines for Datacom Equipment Centers (2008)
6. Best Practices for Datacom Facility Energy Efficiency 2nd Edition (2009)
7. High Density Data Centers – Case Studies & Best Practices (2008)
8. Particulate & Gaseous Contamination in Datacom Environments (2009)
9. Real-Time Energy Consumption Measurements in Data Centers (2010)
10. Green Tips for Data Centers (2010)

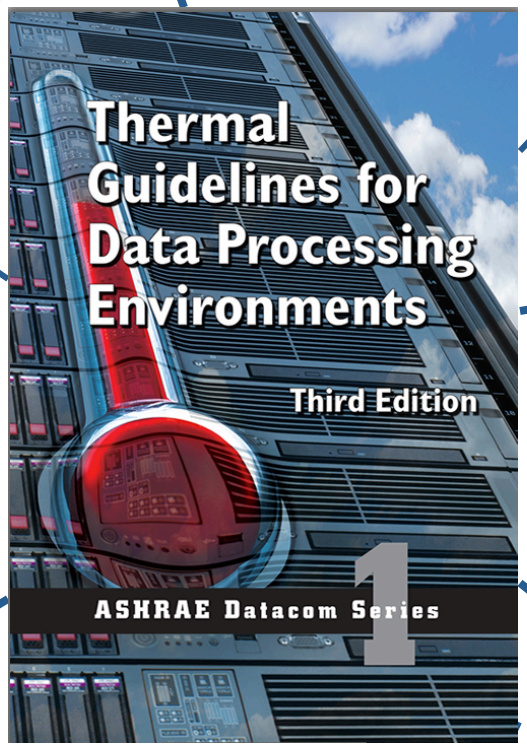


ASHRAE guidelines apply to HPC systems

Provides common understanding between IT and facility staff.

Recommends temperature range up to 80.6°F with “allowable” much higher.

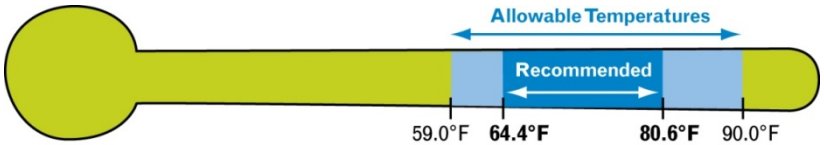
Developed with IT manufacturers



Six classes of equipment identified with wider allowable ranges to 45° C (113°F).

Provides more justification for operating above the recommended limits

Provides wider humidity ranges



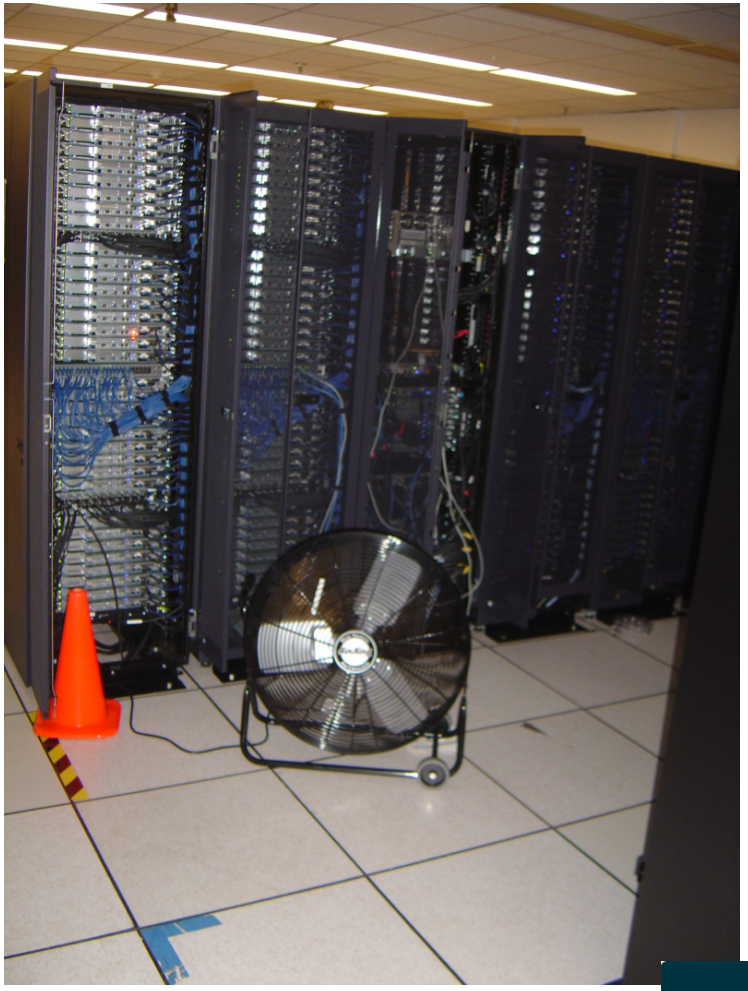
In summary, the infrastructure tool kit includes resources to help improve energy efficiency in HPC centers.

Assessment tools and resources are available

Keep your eye on FEMP's "Center of Expertise"

Existing guides and technical resources provide direction

There is always more that can be done



Questions?

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Break