

Energy Efficiency Infrastructure Tool Kit



Bill Tschudi

Lawrence Berkeley National Laboratory

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wftschudi@lbl.gov



Outline

U.S. DEPARTMENT OF
ENERGY



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 Working Group

 Search this site

EE HPC WG

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Discussions and Webinars

Documents

Membership

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Links and Events

▼ Speaker's Bureau

Available Speakers

Speaker

Submission

Documents

Sub-Groups

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Computing Systems

Conferences

Navigation

Energy Efficient High Performance Computing Working Group

Purpose:

To drive implementation of energy conservation measures and energy efficient design in high performance computing (HPC).

Goals:

- Reduce expenditure and curb environmental impact through increased energy efficiency in HPC centers.
- Encourage the HPC community to lead in energy efficiency as they do in computing performance.
- Develop and disseminate best practices for maximizing energy efficiency in HPC facilities and systems.
- Serve as a forum for sharing of information (peer-to-peer exchange) and collective action.

Current Activities:

A bi-monthly EE HPC WG membership meeting reviews current team activities led by the Infrastructure, Systems and Conferences Sub-Groups.

This meeting is held the second Tuesday of February, April, June, August, October and December. Minutes summarize team activities.

For more information, see [Meetings](#) and [Minutes](#)

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

← → ↻ www1.eere.energy.gov/manufacturing/datacenters/dc_cep.html

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

Advanced Manufacturing Office

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Saving Energy in Data Centers

← Saving Energy in Data Centers Home

About Saving Energy in Data Centers

Data Center Energy Practitioners

Software

Case Studies

Training

R&D Portfolio

Data Center Energy Practitioner Program

DOE is partnering with industry to develop a Data Center Energy Practitioner (DCEP) program to accelerate energy savings in the dynamic and energy-intensive marketplace of data centers. Some of the following documents are available as Adobe Acrobat PDFs.

The DCEP program is being defined, designed, and implemented by working closely with industry stakeholders. DOE has set a goal to have at least 200 practitioners by 2011. Significant knowledge, training, and skills are required to perform accurate energy assessments in data centers. DCEPs will:

- Be qualified to identify and evaluate energy efficiency opportunities in data centers
- Demonstrate proficiency in the use of DOE's [DC Pro software tool suite](#)
- Address energy opportunities in electrical systems, air management, HVAC, IT equipment, and on-site generation
- Meet academic/work experience requirements (prequalifications)
- Receive training on conducting data center assessments
- Be required to pass an exam and be requalified every 3 years.

Property management companies, engineering consulting firms, service companies, data center operators, state energy agencies, and utilities will benefit from the expertise provided by DCEPs.

Read more about the [Data Center Energy Practitioner program](#), May 2011, and download the [Program Description](#), July 2011.

DCEPs can download the [DCEP Program Energy Training-Assessment Process Manual](#), Oct. 2010, for administrative step-by-step instructions for conducting an energy assessment before, during, and after an on-site data center assessment. The manual also includes useful templates for assessments.

Training Calendar

Beginning in 2011, the DCEP Program will be delivered world-wide by two Professional Training Organizations (PTOs): DatacenterDynamics in the US and CNet Training outside of the US. Review current training opportunities with [DatacenterDynamics](#) and [CNet Training](#).

Data Center Energy Practitioners

Here you will find information about [Level I Practitioners \(Generalists\)](#) and [Level II Practitioners \(Specialists\)](#). All completed training on performing energy assessments in data centers and passed an exam demonstrating their proficiency in the use of select tools in the DC Pro tool suite (Profiling Tool + System Assessments Tools).


Developers/Instructors

The following individuals are developers/instructors for the DCEP program.

[Printable Version](#)

Search H
Site Map
Program:

Sign Up for Information



Want to learn more about the Data Center Energy Practitioner program? [Sign up](#) to be contacted.

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



DC Professional Development



<http://www.cdcdp.com/dcep>

<http://www.datacenterdynamics.com/training/course-types/doe-certified-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**

Industrial Technologies Program

[About the Program](#) | [Program Areas](#) | [Information Resources](#) | [Financial Opportunities](#) | [Technologies](#) | [Deployment](#) | [Home](#)

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](#)
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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

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DC Pro Screen shots

[Assessment Home](#) : LBNL Test DC - California Profile | Case: LBNL Test DC - California-Rod 6/19/13

>>

Information

Either click on one of the headers to go to those questions, or click on the 'Continue' button to be taken to the next set of questions.

By clicking on the 'Save and Continue' button, your profile will be saved and you will be able to exit the application without losing your data.

Items with a Light background contribute to the PUE calculation. Please make sure to answer all of them to get a more accurate calculation.

Clicking on a ? will give you more information about the selected row.

A * signifies a required field. This is required in order for the report to save, and only exists in the first section.

☐ Is this a Federal Data Center?

Continue

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)

5. Results

Finish with the Profile

Print Profile

Archive Profile

☒ Generate Recommended Tasks

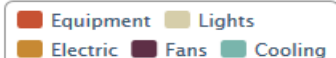
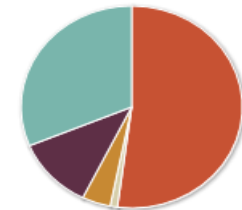


Power Usage Effectiveness (PUE)

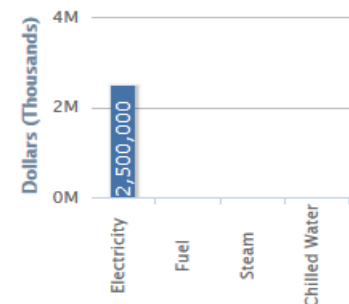
1.92

Annual Data Center Site Energy Use

Usage



Cost



General information

[Assessment Home](#) : LBNL Test DC - California Profile | Case: LBNL Test DC - California-Rod 6/19/13

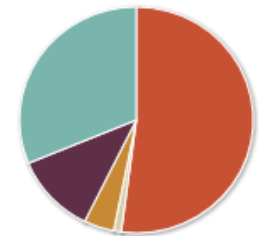


Power Usage Effectiveness (PUE)

1.92

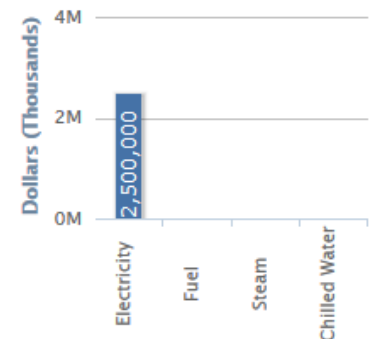
Annual Data Center Site Energy Use

Usage



Equipment Electric Fans Cooling Lights

Cost



>> Information

1.1 Data Center General Information

* Profile Name: 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:

* Organization:

Country: This tool currently only supports the USA.

* Address:

State/Region:

County:

Climate Zone:

* Floor Area - Data Center Space: sq feet ?

* Floor Area - Data Center Support Space: sq feet ?

* Floor Area - Non Data Center Space: sq feet ?

Total Facility Space: sq feet

Type of Data Center: ?

* Data Center Tier (Uptime Institute definition): ?

* Data Center Class: Class as per the ASHRAE Guidelines

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

☒ Generate Recommended Tasks

IT equipment questions

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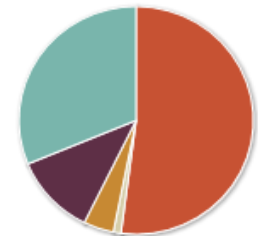


Power Usage Effectiveness (PUE)

1.92

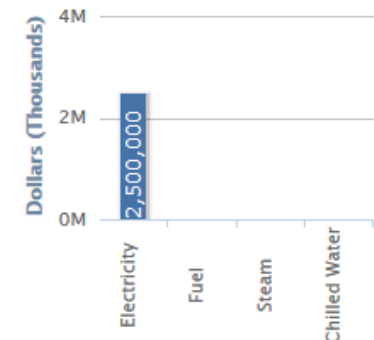
Annual Data Center Site Energy Use

Usage



Equipment Lights
Electric Fans Cooling

Cost



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

Environmental conditions

[Assessment Home](#) : LBNL Test DC - California Profile | Case: LBNL Test DC - California-Rod 6/19/13

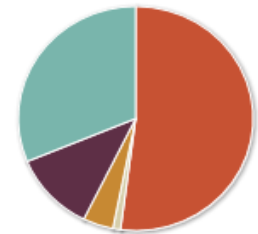


Power Usage Effectiveness (PUE)

1.92

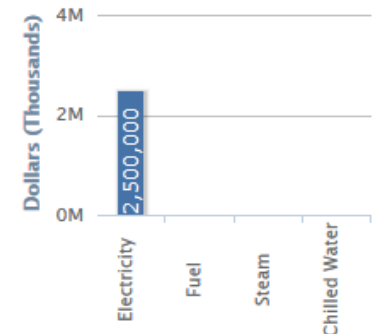
Annual Data Center Site Energy Use

Usage



Equipment Lights
Electric Fans Cooling

Cost



>>

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?	<input type="radio"/> Yes <input checked="" type="radio"/> 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?	<input type="radio"/> Yes <input checked="" type="radio"/> No	
Do you have active, working humidification controls?	<input type="radio"/> Yes <input checked="" type="radio"/> No	?
Do you have active, working dehumidification controls?	<input type="radio"/> Yes <input checked="" type="radio"/> 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?	<input type="radio"/> Yes <input checked="" type="radio"/> No	?
Do CRAC/H units have centralized (networked) or distributed controls?	Distributed	?
Are CRAC/Hs fighting each other (for example, simultaneously humidifying and dehumidifying)?	<input type="radio"/> Yes <input checked="" type="radio"/> No	?
Do the cooling system controls allow you to apply correction factors (Slope and Offset) to the signals from the temperature and humidity sensors?	<input type="radio"/> Yes <input checked="" type="radio"/> No	

Finish with the Profile

Print Profile

Archive Profile

☒ Generate Recommended Tasks

Energy end use breakdown

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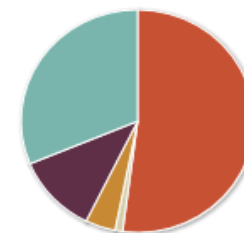


Power Usage Effectiveness (PUE)

1.92

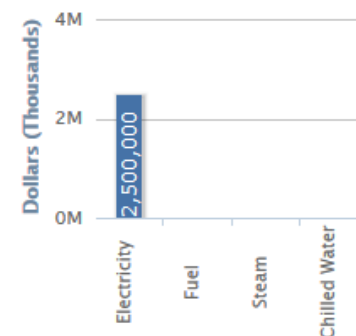
Annual Data Center Site Energy Use

Usage



Equipment Lights
Electric Fans Cooling

Cost



Information

1.1 Data Center General Information

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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											Remainder (Non-Data Center Use)		
		IT Load		Lights		Electric Distribution Losses		Fans		Cooling & Humidity Controls		Site Energy Use Related to Data Center			
		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

Potential energy savings

[Assessment Home](#) : LBNL Test DC - California Profile | Case: LBNL Test DC - California-Rod 6/19/13



Power Usage Effectiveness (PUE)

1.92

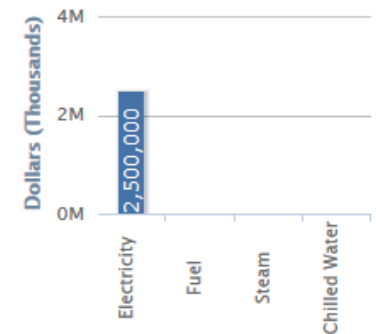
Annual Data Center Site Energy Use

Usage



Equipment Lights
Electric Fans Cooling

Cost



This is your customized DC Pro Summary Report.

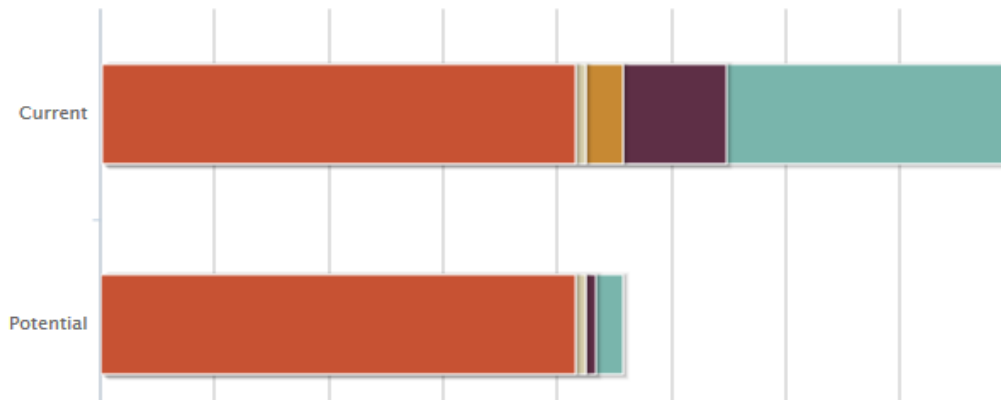
Note: The 'Annual Energy Use' and 'Potential Annual Energy Savings' tables will only have data if you entered data into Sections 3 and 4 (Supplied Energy and Energy Use Distribution).

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

Energy Comparison



[Finish with the Profile](#) [Print Profile](#) [Archive Profile](#) ☒ Generate Recommended Tasks

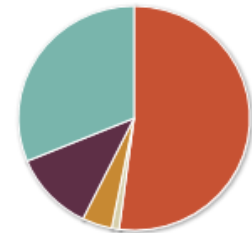
Potential energy savings

[Assessment Home](#) : LBNL Test DC - California Profile | Case: LBNL Test DC - California-Rod 6/19/13

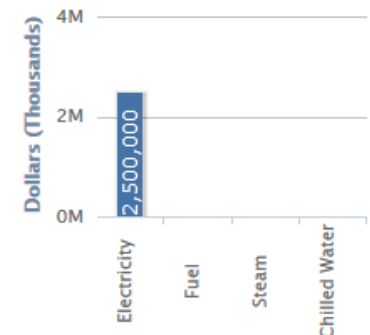


Power Usage Effectiveness (PUE)
1.92
Annual Data Center Site Energy Use

Usage



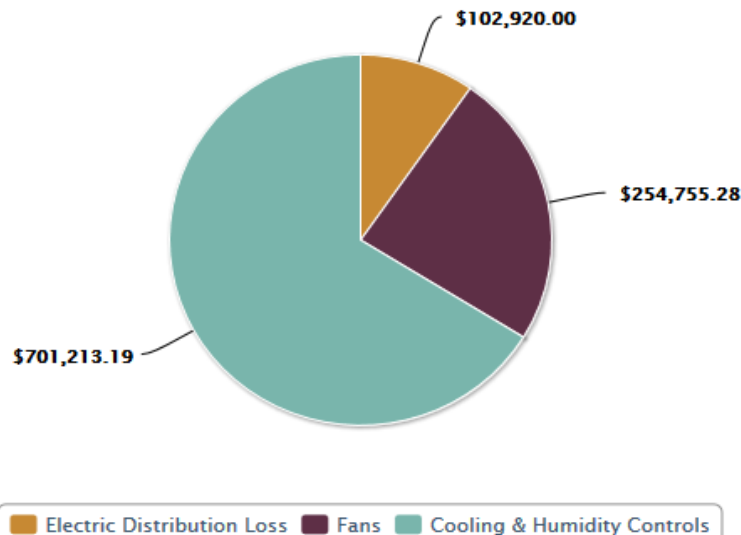
Cost



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			

Total Savings – \$1,056,344



Center of Expertise for Data Centers



CENTER OF
EXPERTISE
FOR ENERGY EFFICIENCY IN DATA CENTERS

SEARCH



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"While information technology (IT) is improving the efficiency of government, energy use in data centers is growing at a significantly faster rate than any other building segment..."



A new Department of Energy-led CENTER of EXPERTISE will demonstrate national leadership in decreasing the energy use of data centers. The Center will partner with key influential public and private stakeholders. It will supply know-how, tools, best practices, analyses, and the introduction of technologies to assist Federal agencies with implementing policies and developing data center energy efficiency projects.



Initiatives

The Data Center Energy Challenge will require participating Federal agencies and other data center owners to establish an efficiency goal for their data centers...

[MORE DETAILS](#)



Resources

The Center's activities will include establishing metrics, providing technical assistance to agencies piloting innovative measurement and management approaches...

[MORE DETAILS](#)

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**

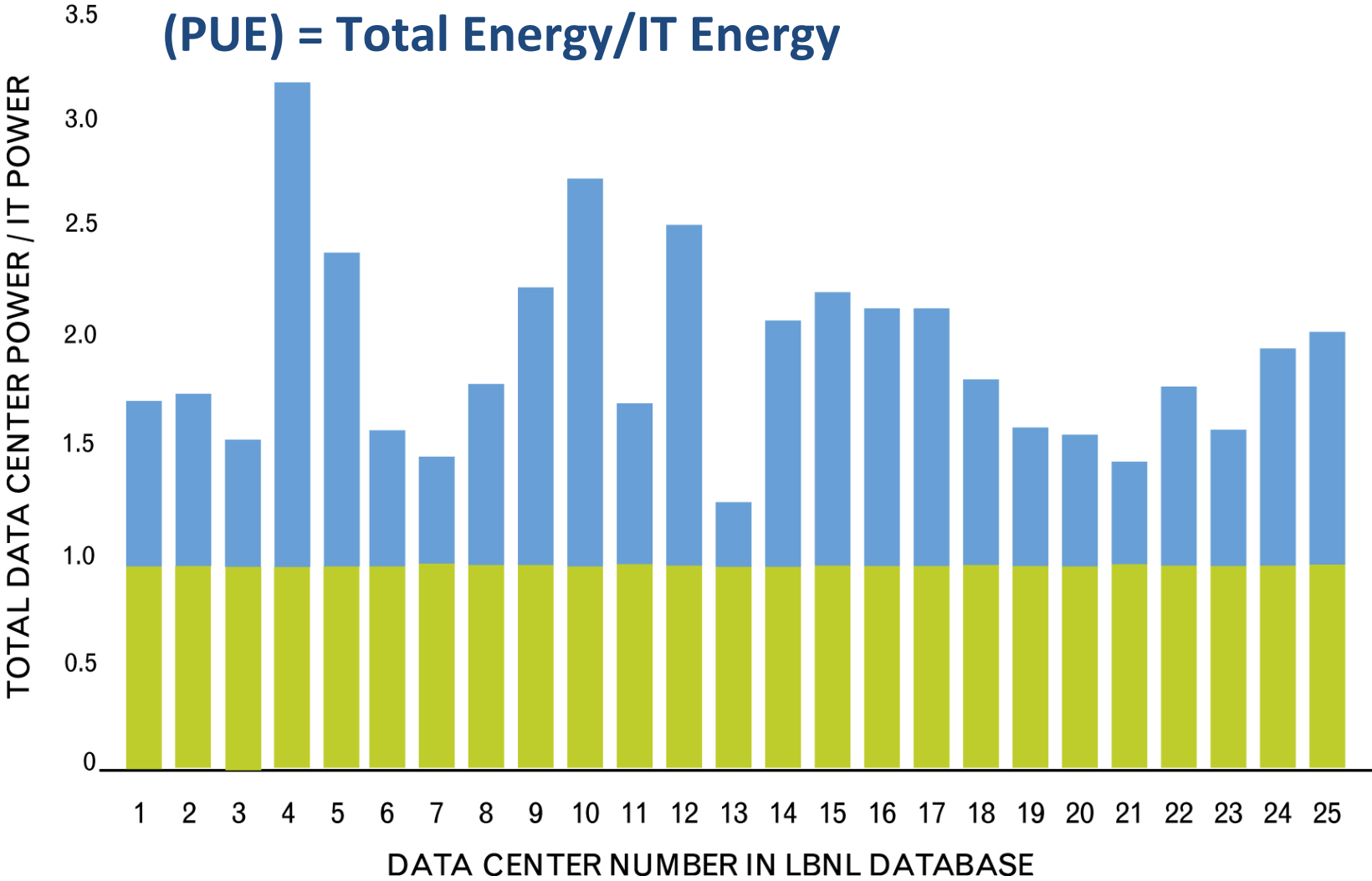
**Initiative will provide guidance and
best practices in collaboration with
industry groups**

Your input is welcome

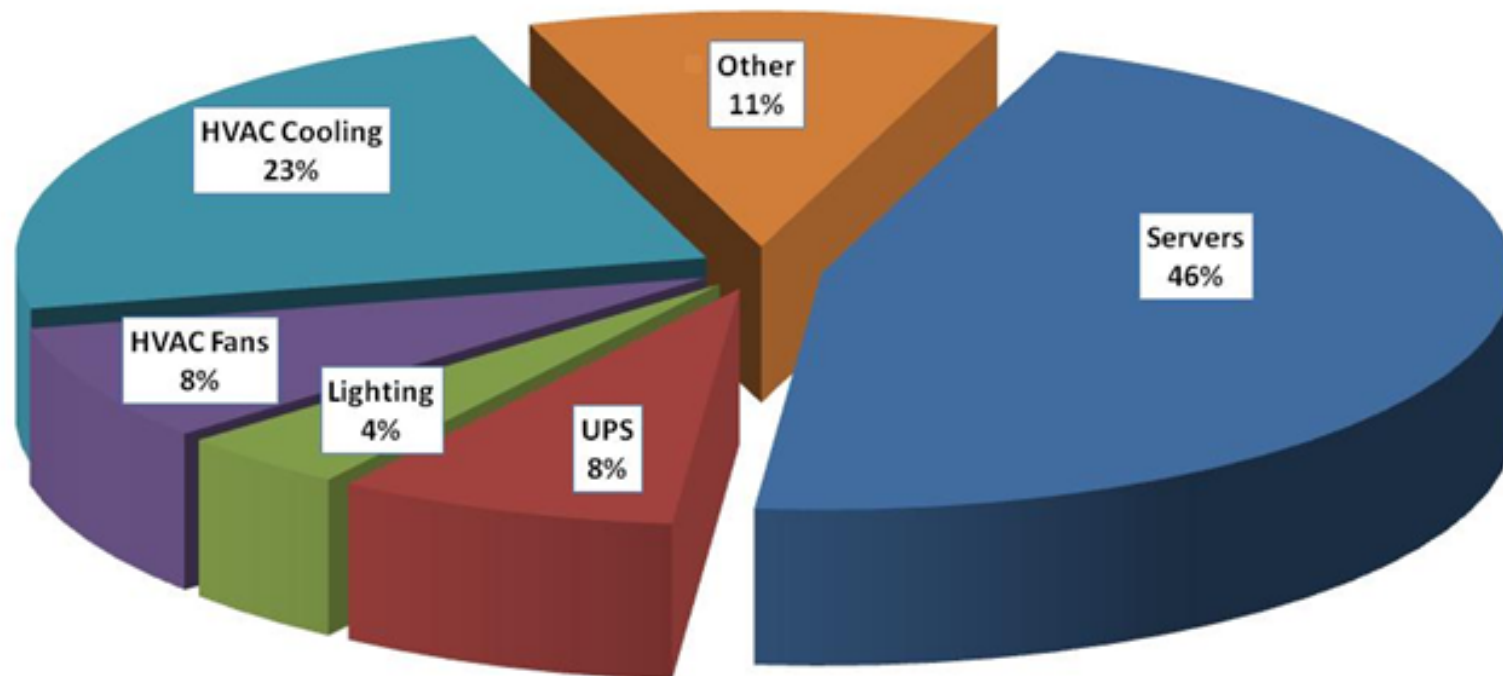
- Update data center projections originally presented in 2007 EPA report to Congress

Energy benchmarking reveals wide variation

High Level Metric: Power Utilization Effectiveness



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

[Return to Main](#)

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

advertisement of products will be removed.

Access Related Materials:

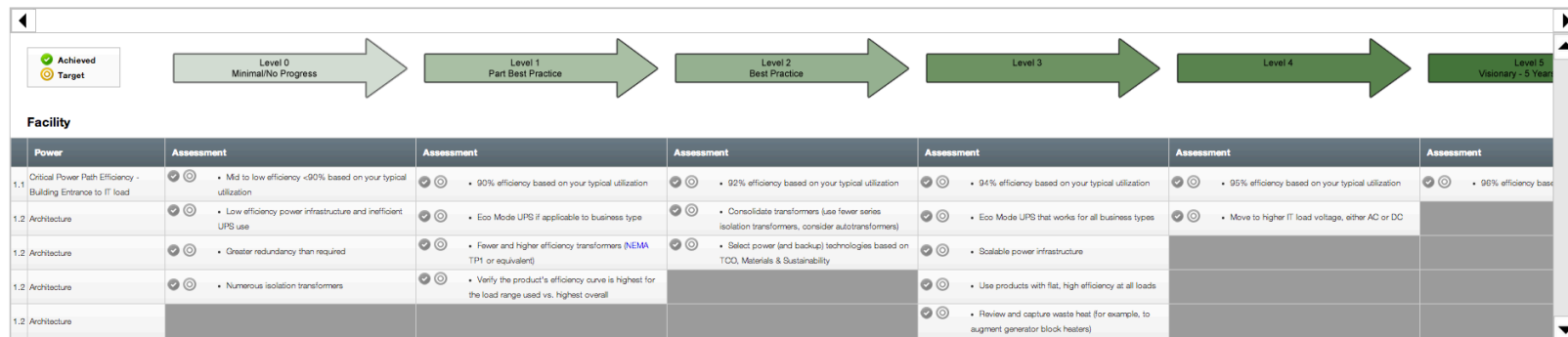
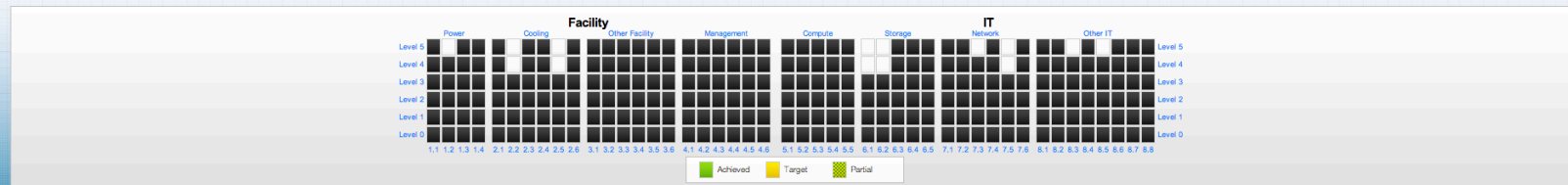
- ▶ **DCMM Tutorial 2013**
- ▶ **DCMM White Paper**
- ▶ **DCMM Assessment Tool**
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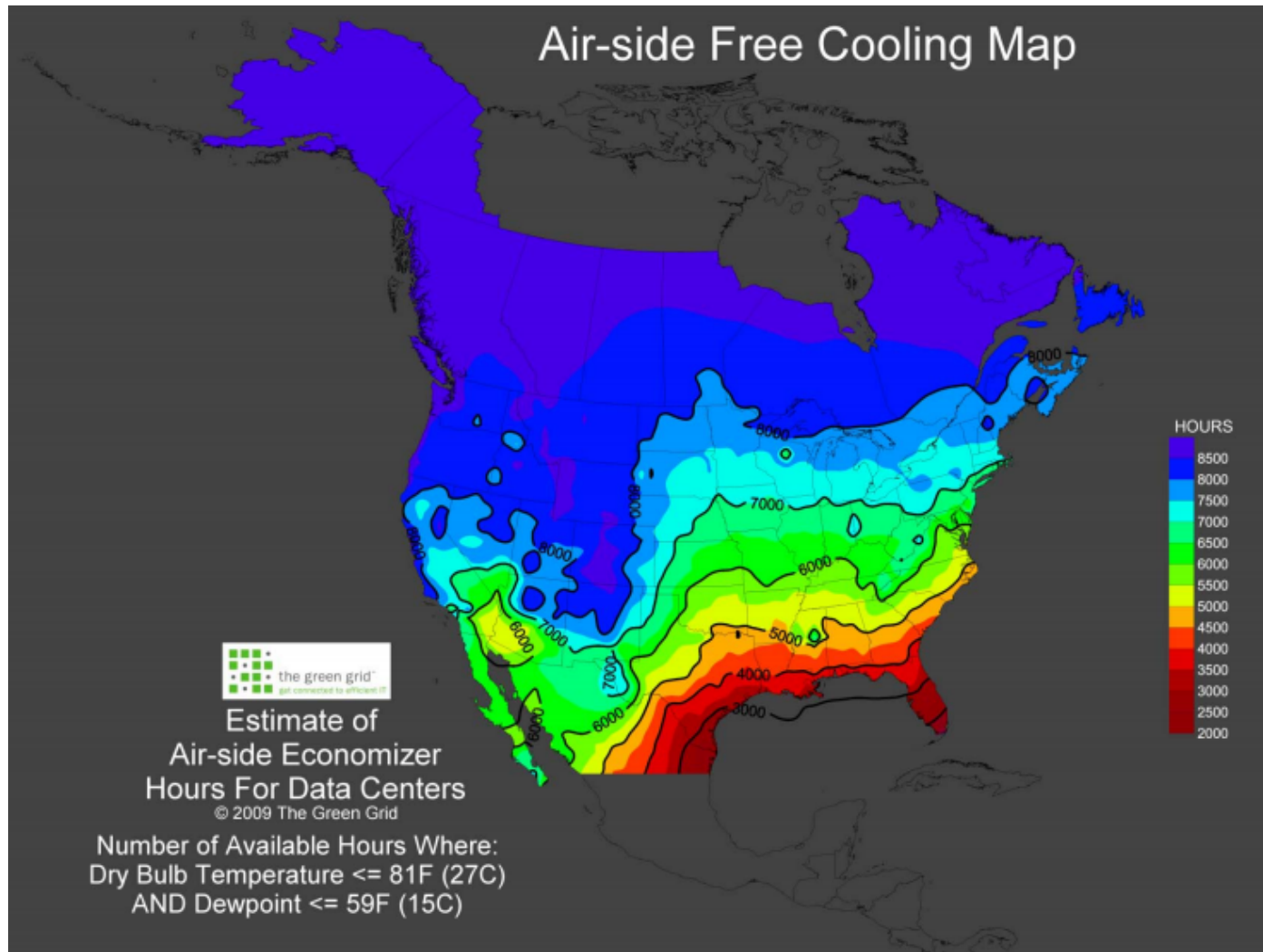
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-  **Climate Savers White Paper - Power Management for Networking Devices**
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-  **Climate Savers White Paper - Power Management System Design Guide**
2856 Downloads | [Comment now](#)
-  **Climate Savers White Paper -**

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

Data Center Maturity Model - Detailed Assessment (test 1)



Green Grid Free Cooling Map



Map Courtesy of The Green Grid

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

GSA Wireless Study



U.S. General Services Administration

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Green Proving Ground

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• 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](#)

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[Findings: Wireless Sensor Networks >](#)

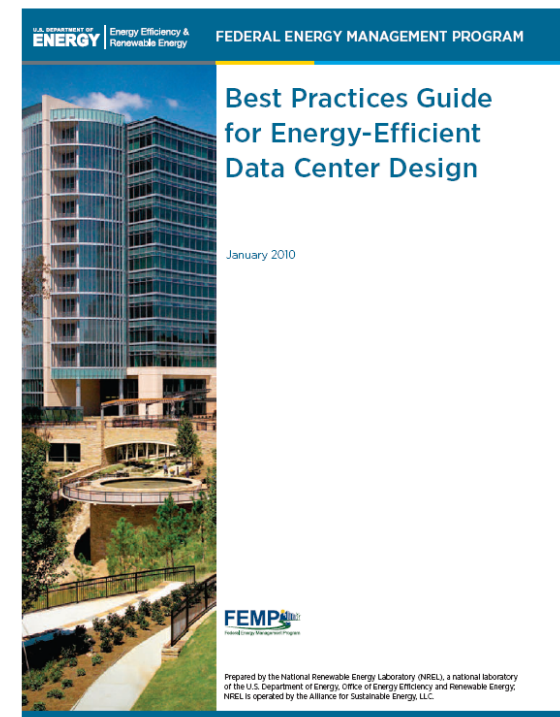
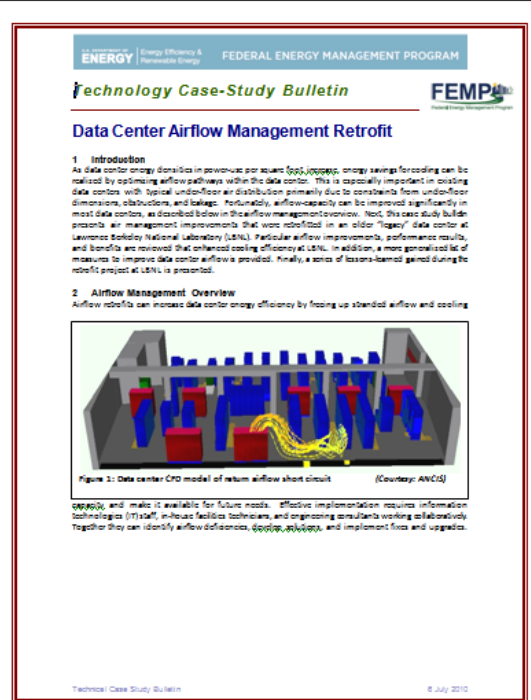


DOWNLOAD FULL REPORT

[Wireless Sensor Network for Improving the Energy Efficiency of Data Centers](#)
Lawrence Berkeley National Laboratory >



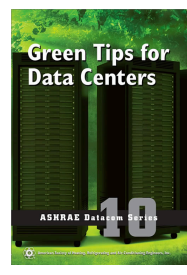
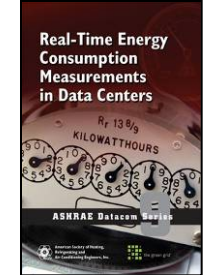
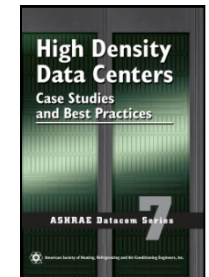
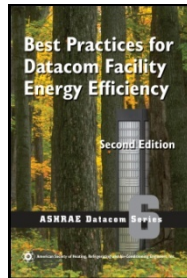
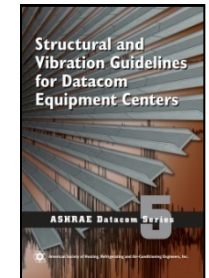
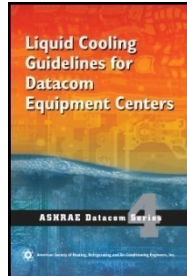
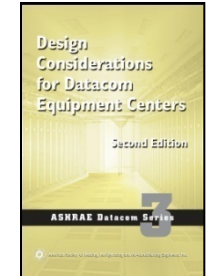
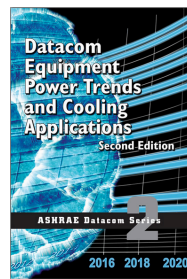
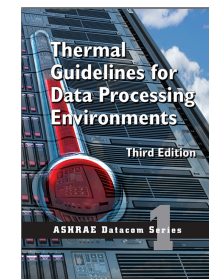
Federal Energy Management Program resources



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

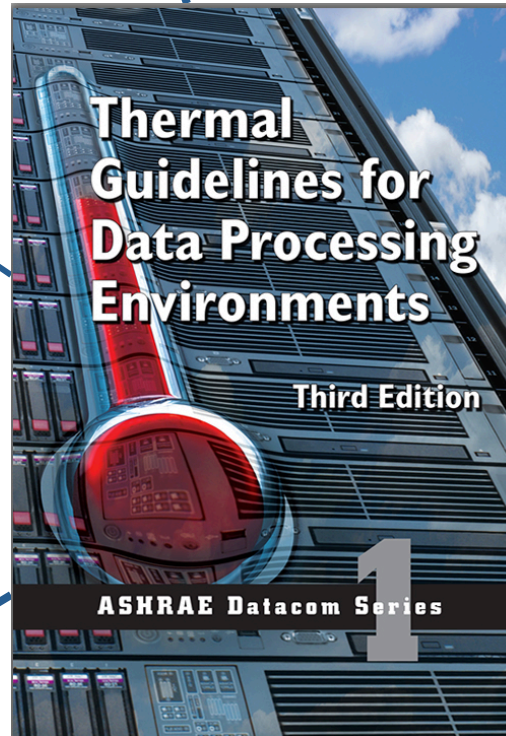


ASHRAE guidelines apply to HPC systems

Provides common understanding between IT and facility staff.

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

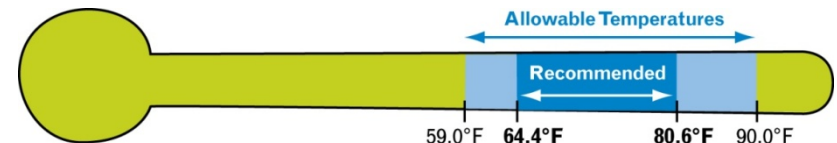
Developed with IT manufacturers



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

Provides wider humidity ranges

Provides more justification for operating above the recommended limits



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?

Break

