

# Energy Efficiency Infrastructure Tool Kit



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# 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

#### Home

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#### Speaker's Bureau

[Available Speakers](#)[Speaker](#)[Submission](#)[Documents](#)

#### Sub-Groups

[Infrastructure](#)[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

The screenshot shows a web browser window with the URL [www1.eere.energy.gov/manufacturing/datacenters/dc\\_cep.html](http://www1.eere.energy.gov/manufacturing/datacenters/dc_cep.html). The page header includes the U.S. Department of Energy logo and the text "Energy Efficiency & Renewable Energy" and "Advanced Manufacturing Office". A navigation bar contains links for "About the Program", "Program Areas", "Information Resources", "Financial Opportunities", "Technologies", "Deployment", and "Home". The main heading is "Saving Energy in Data Centers". A sidebar on the left lists categories: "Saving Energy in Data Centers Home", "About Saving Energy in Data Centers", "Data Center Energy Practitioners", "Software", "Case Studies", "Training", and "R&D Portfolio". The main content area features the "Data Center Energy Practitioner Program" section, which describes the program's goal to accelerate energy savings in data centers by 2011. It lists five requirements for practitioners: 1) Be qualified to identify and evaluate energy efficiency opportunities in data centers; 2) Demonstrate proficiency in the use of DOE's DC Pro software tool suite; 3) Address energy opportunities in electrical systems, air management, HVAC, IT equipment, and on-site generation; 4) Meet academic/work experience requirements (prequalifications); 5) Receive training on conducting data center assessments. A "Sign Up for Information" box on the right contains an image of a person using a handheld device and text asking if the user wants to learn more about the program. Below the main text, there are sections for "Property management companies...", "Read more about the Data Center Energy Practitioner program...", "DCEPs can download the DCEP Program Energy Training-Assessment Process Manual...", "Training Calendar", "Data Center Energy Practitioners", and "Developers/Instructors".

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-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](#)
- ▶ Receive [e-mail updates](#)

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[EERE Information Center](#)  
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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?

- 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

Generate Recommended Tasks

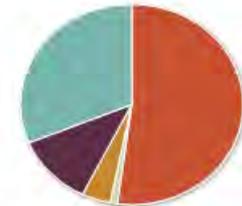


Power Usage Effectiveness (PUE)

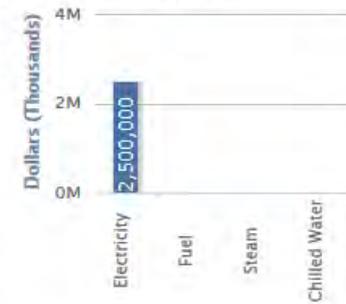
1.92

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

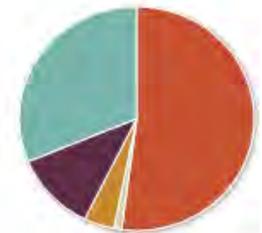


Power Usage Effectiveness (PUE)

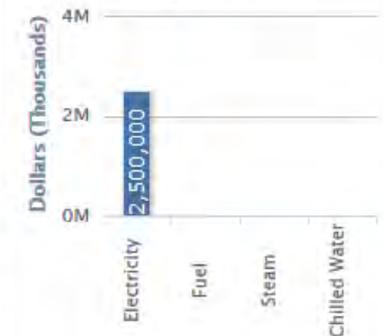
**1.92**

Annual Data Center Site Energy Use

Usage



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: 3C

\* 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

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

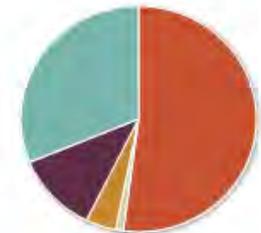


Power Usage Effectiveness (PUE)

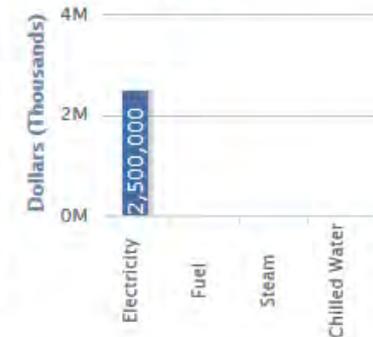
**1.92**

Annual Data Center Site Energy Use

Usage



Cost



>> **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?

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

How extensive is your storage consolidation?

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

**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)**

Generate Recommended Tasks

# Environmental conditions

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

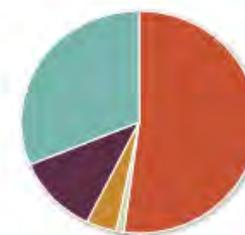


Power Usage Effectiveness (PUE)

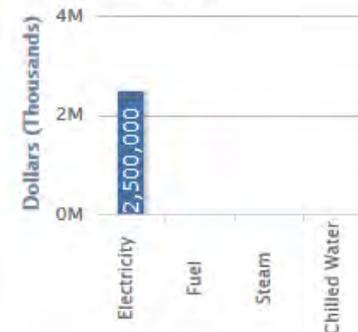
**1.92**

Annual Data Center Site Energy Use

Usage



Cost



What is a typical (average) air temperature leaving the cooling coils (supply)?	55F (13C) <input style="float:right" type="button" value="?"/>
What is a typical (average) air temperature entering the cooling coils (return)?	--Select One-- <input style="float:right" type="button" value="?"/>
What is the typical (average) IT equipment intake air temperature?	115F (46C) <input style="float:right" type="button" value="?"/>
What is the typical (average) IT equipment exhaust air temperature?	80F (27C) <input style="float:right" type="button" value="?"/>
Adopted IT Intake Air Temperature, Maximum:	70F (21C) <input style="float:right" type="button" value="?"/> 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 <input style="float:right" type="button" value="?"/> 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 <input style="float:right" type="button" value="?"/>
Do you have active, working humidification controls?	<input type="radio"/> Yes <input checked="" type="radio"/> No <input style="float:right" type="button" value="?"/>
Do you have active, working dehumidification controls?	<input type="radio"/> Yes <input checked="" type="radio"/> No <input style="float:right" type="button" value="?"/>
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 <input style="float:right" type="button" value="?"/>
Do CRAC/H units have centralized (networked) or distributed controls?	Distributed <input style="float:right" type="button" value="?"/>
Are CRAC/Hs fighting each other (for example, simultaneously humidifying and dehumidifying)?	<input type="radio"/> Yes <input checked="" type="radio"/> No <input style="float:right" type="button" value="?"/>
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 <input style="float:right" type="button" value="?"/>

# Energy end use breakdown

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

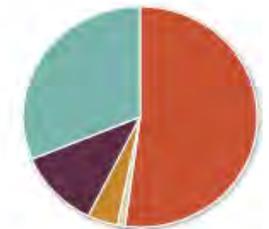


Power Usage Effectiveness (PUE)

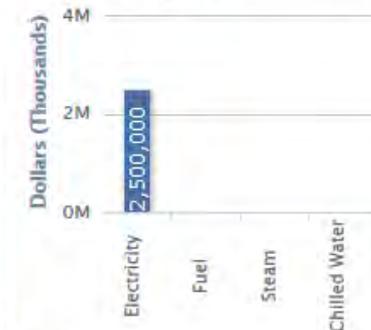
**1.92**

Annual Data Center Site Energy Use

Usage



Cost



- Information
- 1.1 Data Center General Information
- 2.1 Energy Use Systems - Energy Management
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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	
		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	%
1	8,300,000	4,150,000	50%	83,000	1%	332,000	4%	913,000	11%	2,490,000	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

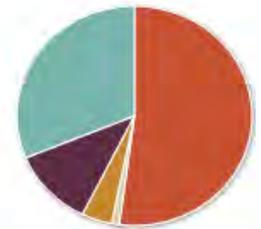


Power Usage Effectiveness (PUE)

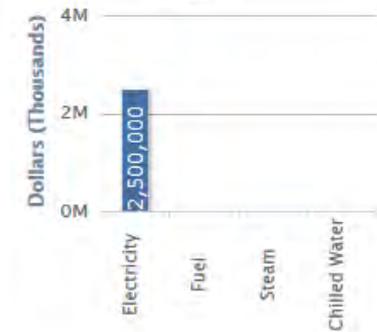
**1.92**

Annual Data Center Site Energy Use

Usage



Cost



## This is your customized DC Pro Summary Report.

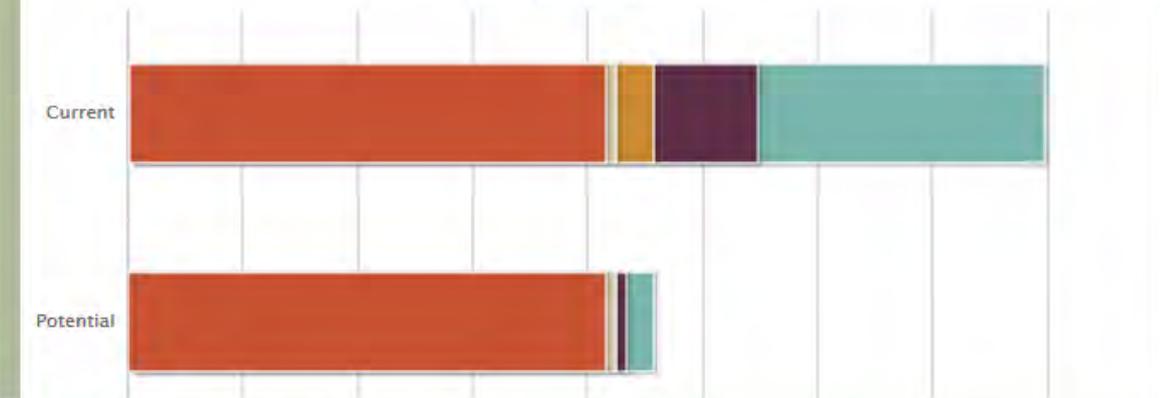
Note: The 'Annual Energy Use' and 'Potential Annual Energy Savings' tables will only have data if you entered data into Sections 3 and 4 (Supplied Energy and Energy Use Distribution).

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
<b>Totals</b>	<b>7968000</b>	<b>\$2,500,000.00</b>	<b>\$0.31</b>

### Energy Comparison



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

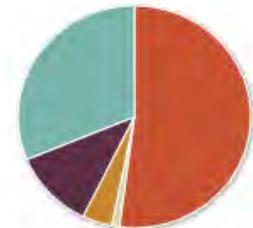
# Potential energy savings

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

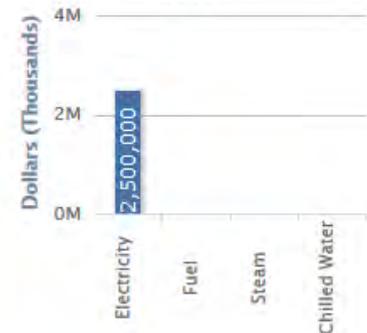


Power Usage Effectiveness (PUE)  
**1.92**  
Annual Data Center Site Energy Use

Usage



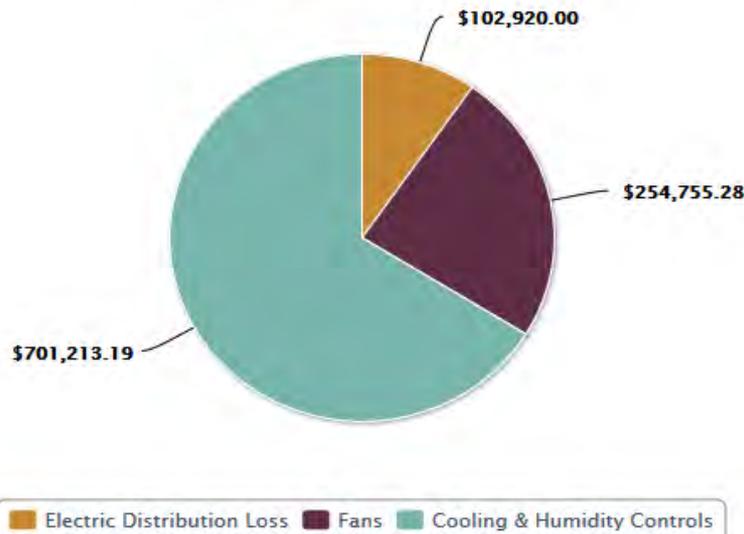
Cost



## Potential Annual Energy Savings

Breakout Category	Current Energy Use		Potential Energy Use <sup>?</sup>		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
<b>Totals</b>	<b>7968000</b>	<b>100%</b>	<b>4560439.56</b>	<b>100%</b>	<b>3407560.44</b>	<b>42.8%</b>	<b>\$1,056,343.74</b>
PUE		<b>1.92</b>		<b>1.1</b>			

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**

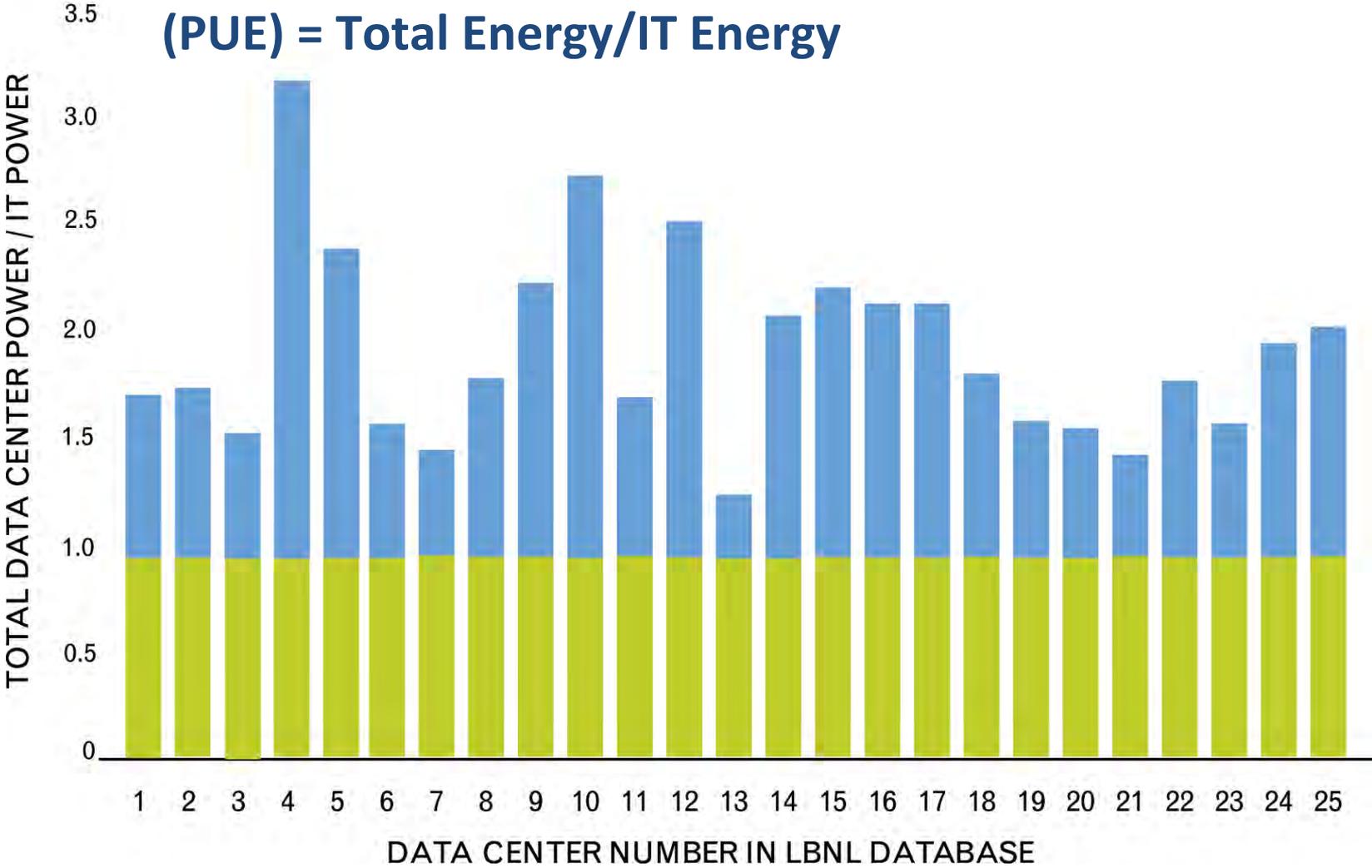
# Center of Expertise

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

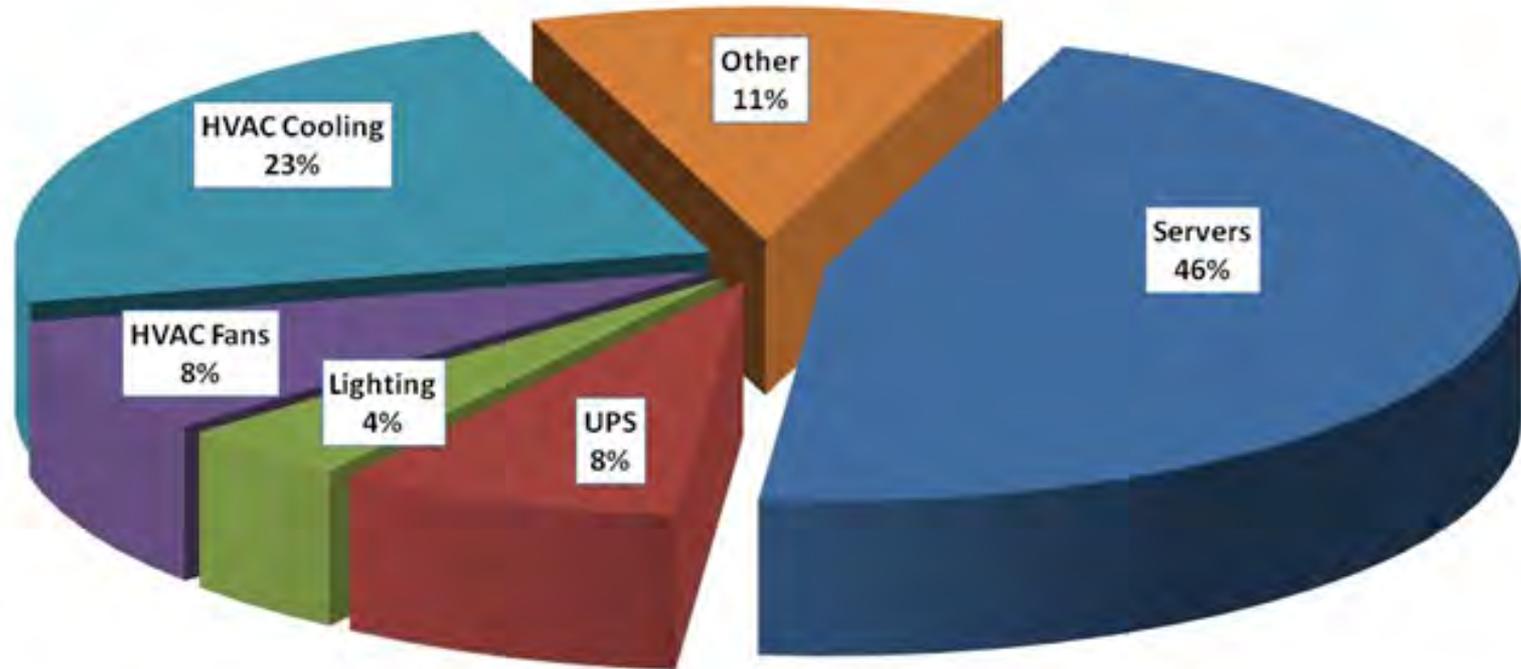
# Energy benchmarking reveals wide variation

## 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

[Return to Main](#)

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](#)

### Access Related Materials:

- ▶ [DCMM Tutorial 2013](#)
- ▶ [DCMM White Paper](#)
- ▶ [DCMM Assessment Tool](#)
- ▶ [DCMM Academy Course](#)
- ▶ [DCMM PDF](#)

### Related Content

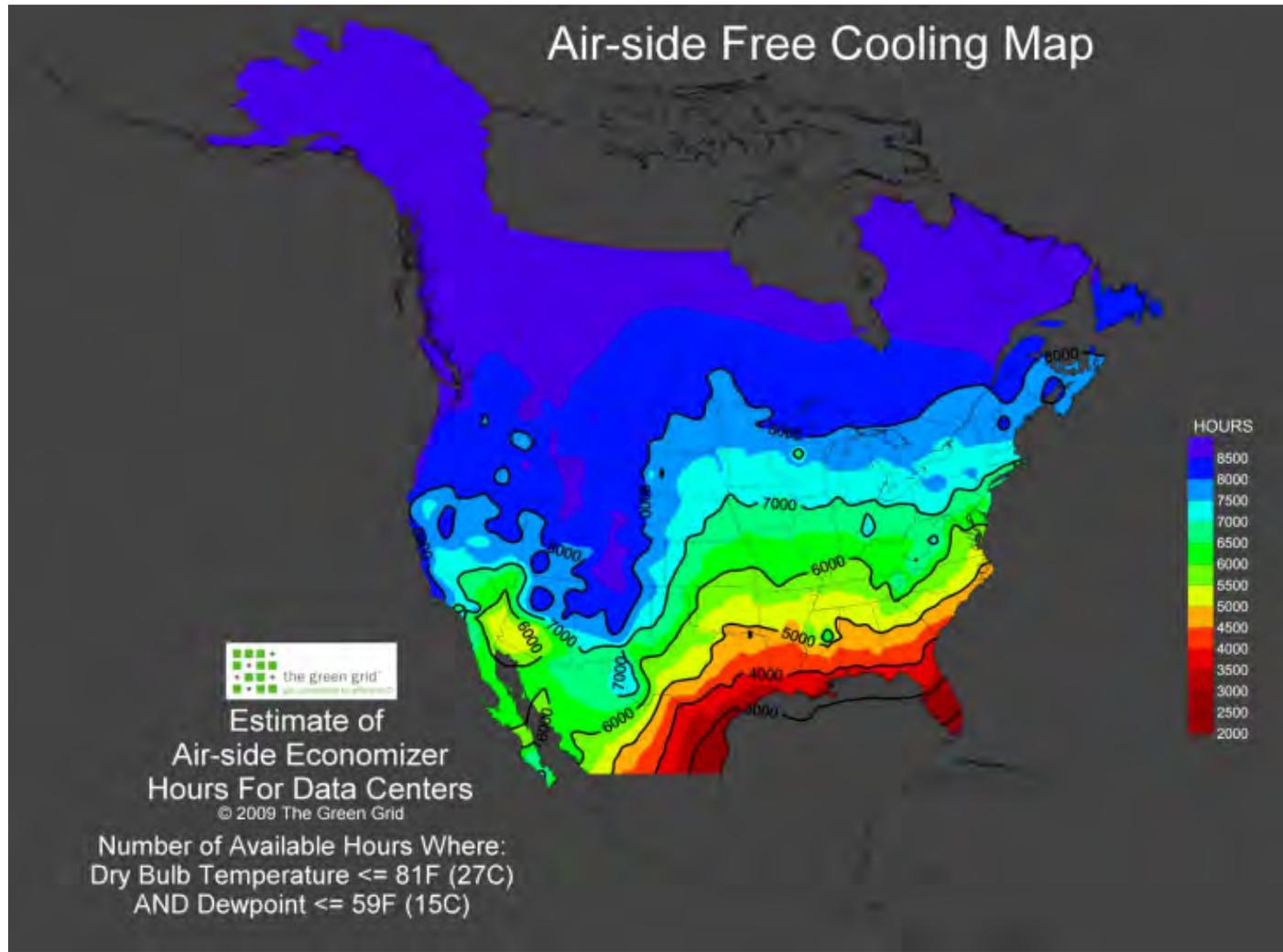
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Title

Comments



# Green Grid Free Cooling Map



Map Courtesy of The Green Grid

[http://cooling.thegreengrid.org/namerica/WEB\\_APP/calc\\_index.html](http://cooling.thegreengrid.org/namerica/WEB_APP/calc_index.html)

# GSA Wireless Study

WHAT GSA OFFERS

DOING BUSINESS WITH GSA

LEARN MORE

BLOG

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## Green Proving Ground

[Overview](#)

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## 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<sup>(1)</sup>. Nearly 50 percent

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



# Federal Energy Management Program resources

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy | FEDERAL ENERGY MANAGEMENT PROGRAM

## Data Center Rack Cooling with Rear-door Heat Exchanger

Technology Case-Study Bulletin



Figure 1: Passive Rear Door Heat Exchanger device at LBNL.

As data center energy densities in power-use per square foot increase, energy savings for cooling can be realized by incorporating liquid-cooling devices instead of increasing airflow volumes. This is especially important in a data center with a typical under-floor cooling system. An airflow-capacity limit will eventually be reached that is constrained, in part, by under-floor limitations and obstructions.

### 4 Introduction

Liquid-cooling devices were installed on server racks in a data center at Lawrence Berkeley National Laboratory (LBNL) in Figure 1. The passive-technology device removes heat generated by the servers from the airflow leaving the server rack. This heat is readily transferred to cooling water circulated from a central chiller plant. However at LBNL, the devices are connected to a treated water system that rejects the heat directly to a cooling tower, thereby eliminating chiller energy use to cool the associated servers. In addition to cooling with passive heat exchangers, similar results can be achieved with fan-assisted rear-door heat exchangers and refrigerant-cooled rear-door exchangers.

### 2 Technology Overview

The rear door heat exchanger (RDHX) devices reviewed in this case study are referred to as passive devices because they have no moving parts, however, they do require cooling water flow. A passive RDHX contributes to optimizing energy efficiency in a data center facility in several ways. First, since the device is installed, it does not directly require infrastructure electrical energy to operate. Second, RDHX devices can use less chiller energy since they perform well at warmer (higher) chilled water set-points. Third, depending on climate and piping arrangements, RDHX devices can eliminate chiller energy because they can use treated water from a plate-and-frame heat exchanger connected to a cooling tower. These inherent features of a RDHX help reduce energy use while minimizing maintenance costs.

### 21 Basic operation

The RDHX device, which resembles an automobile radiator, is placed in the airflow outlet of a server rack. During operation, hot server-rack airflow is forced through the RDHX device by the server fans. Heat is exchanged from the hot air to circulating water from a chiller or cooling tower. Thus, server-rack outlet air temperature is reduced before it is discharged into the data center.

### 22 Technology Benefits

RDHX cooling devices can save energy and increase operational reliability in data centers because of straightforward installation, simple operation, and low maintenance. These features, combined with compactness, indirect evaporative cooling, make RDHX a viable technology in both new and retrofit data center designs. It may also help eliminate the complexity and cost of under-floor air distribution systems.

### Reduce Maintenance

Because passive RDHX devices have no moving parts, they require less maintenance compared to computer room air conditioning (CRAC) units. RDHX devices will require occasional cleaning of dust and lint from the air-side of the coils. RDHX performance also depends on proper water-side maintenance.

### Reduce or Eliminate Chiller Operation

RDHX devices present an opportunity to save energy by either reducing or

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## Technology Case-Study Bulletin

### Data Center Airflow Management Retrofit

FEMP

### 1 Introduction

As data center energy densities in power-use per square foot (p/sqft), energy savings for cooling can be realized by optimizing airflow pathways within the data center. This is especially important in cooling data centers with typical under-floor air distribution primarily due to constraints from under-floor dimensions, obstructions, and leakage. Fortunately, airflow-capacity can be improved significantly in most data centers, as described below in the airflow management overview. Next, this case study bulletin presents air management improvements that were retrofitted in an older "legacy" data center at Lawrence Berkeley National Laboratory (LBNL). Particular airflow improvements, performance results, and benefits are reviewed that enhanced cooling efficiency at LBNL. In addition, a more general list of measures to improve data center airflow is provided. Finally, a series of lessons-learned generalizing the retrofit project at LBNL is presented.

### 2 Airflow Management Overview

Airflow retrofits can increase data center energy efficiency by forcing up standard airflow and cooling

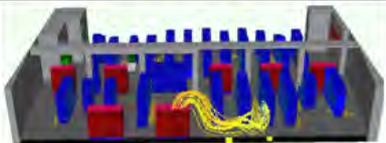


Figure 1: Data center CAD model of return airflow short circuit (Courtesy: AVECS)

applying, and make it available for future needs. Effective implementation requires information technologies (IT staff, software facilities technicians, and engineering consultants) working collaboratively together to can identify airflow deficiencies, develop solutions, and implement fixes and upgrades.

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## Best Practices Guide for Energy-Efficient Data Center Design

January 2010



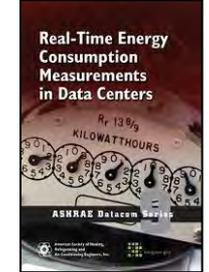
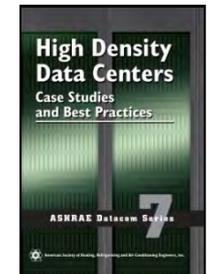
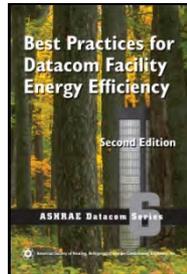
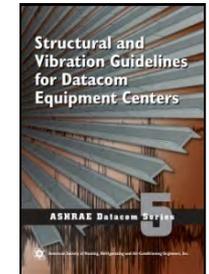
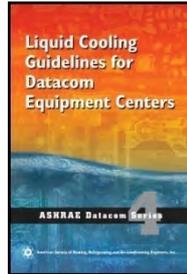
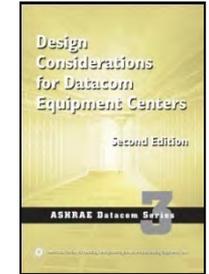
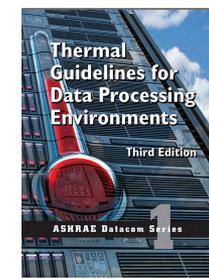
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Prepared by the National Renewable Energy Laboratory (NREL), a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. NREL is operated by the Alliance for Sustainable Energy, LLC.

- 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 3<sup>rd</sup> Edition (2011)
2. Power Trends & Cooling Applications 2<sup>nd</sup> 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 2<sup>nd</sup> Edition (2009)
7. High Density Data Centers – Case Studies & Best Practices (2008)
8. Particulate & Gaseous Contamination in Datacom Environments (2009)
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10. Green Tips for Data Centers (2010)

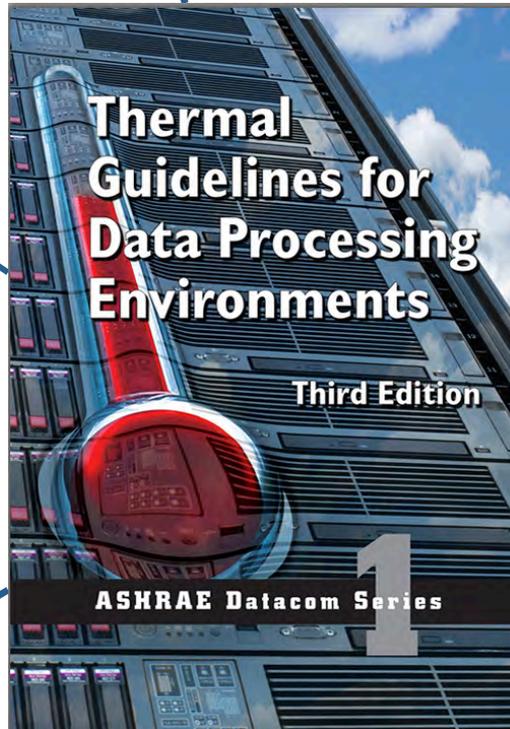


# ASHRAE guidelines apply to HPC systems

Provides common understanding between IT and facility staff.

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

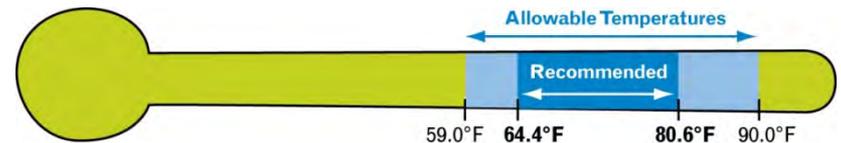
Developed with IT manufacturers



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

