Tools and Resources

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William Tschudi, PE
Lawrence Berkeley National Laboratory
WFTschudi@lbl.gov
510-495-2417

DOE Save Energy Now – data center program

Major Program Elements:

- "DC Pro" Assessment tools
- Create consensus metrics
- Create and publicize Save Energy Now case studies
- Awareness training - developed in conjunction with ASHRAE
- Data Center Energy Practitioner (DCEP) program to qualify data center assessors
- Collaborative research program with industry
- Provide demonstrations of new technologies or best practices

Assessments of Computing Centers

- LBNL is developing tools to assist in performing energy assessments in data centers and HPC centers. These tools are available for public use.
- the Green Grid organization is collaborating and providing content for the IT portions of the tools.
- The assessment tools are collectively called DC Pro.
- An assessment process is described along with a suggested report format.

DOE tool suite: Collectively called DC Pro

- Energy Profiling Tool V2: profiling and tracking
  - Establish PUE baseline and efficiency potential (few hours effort once data is available)
  - Document actions taken
  - Track progress in PUE over time
- Assessment tools: more in-depth site assessments
  - Suite of tools to address major sub-systems
  - Provides savings for efficiency actions
  - ~2 week effort (including site work)

DC Pro - Profiling Tool

On-Line or downloadable Profiling Tool:

Profiling and tracking

- Establish PUE baseline and efficiency potential (few hours effort)
- Document actions taken
- Track progress in PUE over time
- DOE centers are now required to utilize DC Pro

DOE DC Pro tools

High-Level, On-Line Profiling and Tracking Tool

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

In-Depth Excel Assessment Tools

Air Management
- Hot/cold separation
- Environmental conditions
- RCI and RTI

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

IT-Equipment
- Servers
- Storage & networking
- Software

Cooling
- Simulation
- Air handlers/ conditioners
- Chillers, pumps, fans
- Free cooling

IT Assessment tool

- The Green Grid is developing content for IT Assessment tool
- Assessment tool will consider asset inventory, utilization, virtualization potential, power management, and storage and network issues
- Commercially available tools may automate data collection
- Considerable interest in Data Center Integrated Management tools (DCIM)
- LBNL researching available tools

Cooling Assessment tool

- CA public utilities funding development of a simulation tool
- Beta Equest tool is available
- Enables simulation of cooling energy use with yearly weather data
- Tool available in 2012

DC Pro Tools: quick walkthrough

http://www1.eere.energy.gov/industry/datacenters/#

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

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

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Saving Energy in Data Centers

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

Printable Version

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.

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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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
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Saving Energy in Data Centers

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Data Center Profiler Software Tool Suite

Companies can use the Data Center Profiler (DC Pro) Software Tool Suite to identify and evaluate energy efficiency opportunities in data centers. The suite features a Profiling Tool and a set of System Assessment Tools to perform energy assessments on specific areas of a data center. Some of the following documents are available as Adobe Acrobat PDFs. Download Adobe Reader.

Intended Users

The DC Pro Tool Suite is designed for data center owners and operators who want to diagnose how energy is being used by their data centers and determine ways to save energy and money.

System Requirements

Online version of DCPro Profiling Tool

The Profiling Tool is a web-based application and can be accessed from any computer using a browser with internet connectivity. The Profiling Tool is best viewed using:

- Windows Internet Explorer 6.x (32-bit)
- Windows Internet Explorer 7.x (32-bit)
- Windows Internet Explorer 8.x (32-bit) (includes running in compatibility mode)

The tool is hosted by the Energy Management Portal which is based on Microsoft SharePoint Server 2007 technology. Please refer to Microsoft's resource center for more information about client support for SharePoint 2007.

Downloadable version of DCPro Profiling Tool

This version of the Profiling Tool can be downloaded to a local computer and installed on the computer to run the tool. System Requirements for the tool are:

- OS Microsoft Windows 7
- Microsoft IE 7 or higher
- 32-bit Operating system
- .NET framework 2.0 or higher
- Administrative privileges on the local computer

DC Pro Profiling Tool

Use the Profiling Tool as a first step to identify potential savings and to reduce environmental emissions associated with data center energy use. Once you acquire your input data, you can complete a profile in a few hours.

Go to the Profiling Tool now!
Version: 2.0
Release Date: September 15, 2011
FAQs

Inputs

To use the Profiling Tool, users will need to input the following information:

- Description
- Utility bill data
- System information for IT, HVAC, electrical, and on-site generation

Outputs

Based on input, the Profiling Tool will provide:

- Overall picture of energy use and efficiency
- End-use breakout—site or source energy
- Potential areas for energy efficiency improvement

System Assessment Tools

Air-Management Tool

Air management in data centers is important both for energy and thermal management. The Air-Management Tool is intended mainly for raised-floor cooling with hot/cold equipment aisles.

Download the Air-Management Tool now!
Version: 1.16
Release Date: May 10, 2011
User's Manual
Engineering Reference—*provides detailed information on the tool calculations, equations, metrics, and limitations.*
Data Collection Guide—*provides information on collecting the tool input data.*

Inputs

To use the Air-Management Tool, users will need to fill in data and answer questions on four input sheets:

- Air-handler unit data for calculating Return Temperature Index (RTI) (energy metric)
- IT-equipment data for calculating the RTI metric
- IT-equipment intake temperatures for calculating Rack Cooling Index (RCI) (equipment cooling metric)
- Main input with questions for determining energy savings and recommendations

Outputs

Based on input, the Air-Management Tool will:

- Provide air-management recommendations
- Estimate the potential for reducing supply airflow rate and increasing supply air temperature
- Estimate the percentage of energy reduction for fans and chillers

Electrical Systems Tool

This tool is designed to help assess the potential savings from efficiency actions in the electrical power chain of a data center, including lighting.

Download the Electrical Systems Tool now!
Version:1.0
Release Date: January 25, 2010

Inputs

To use the Electrical Systems Tool, users will need to input:

- Basic configuration and efficiency information on electrical system components such as transformers, generators, uninterruptible power supply (UPS), power distribution unit (PDU) devices, and lighting
- Energy use of electrical systems

Outputs

Based on input, the Electrical Systems Tool will:

- Estimate potential savings for various electrical system efficiency actions.

Brochure and Fact Sheet

- DC Pro Tool Suite Brochure, Dec. 2010
- DC Pro Tool Suite Fact Sheet, Aug. 2010

Additional Resources

These resources can help you conduct your own data center energy use assessment:

- Data Center Energy Assessment Process — use this document as a step-by-step guideline for performing an assessment and see which DOE tools are available to help you with each step
- Master List of Actions for DC Pro, Jun. 2008 — this master list contains many of the energy efficiency actions addressed by the DC Pro Tool Suite that you can copy and paste into your data center assessment report
- Standard Report Template for Conducting a Data Center Energy Efficiency Assessment — this fillable document provides a template for your own data center assessment report, including the type of data that should be included.

- Energy Management Tools
- Buildings and Facilities
- Compressed Air Systems
- Data Centers
- Fans
- Motors
- Process Heating Systems
- Pumps
- Solar Power
- Steam Systems
- Waste Heat Reduction and Recovery
- ePEP

Data Centers

The DC Pro Profiling Tool is a Web-based program that uses basic information about a data center - such as the utility costs and description of the facility - to profile its energy use. The tool generates a customized, printable report that provides an overview of the plant's energy purchases, energy-use breakdowns, and suggested next steps, as well as a comparative analysis with other data centers

Save Cases

If you would like to be able to save cases for future reference, you must first register for a username and password on the DOE EnMS portal. You can register for a username and password using the following link. Once registered, login to the portal using the sign in link in the upper right corner of the screen.

Register for an EnMS Portal Username and Password

Release Information

A new version of DCPro (2.0) was released on September 15th, 2011. The updated version includes an improved user interface, streamlined data entry process, and cleaner report page. The same username and password from the DCPro 1.1 can be used to login into DCPro 2.0. Old cases from DCPro 1.1 can be imported into DCPro 2.0 using the import legacy case link on step 1.

Downloadable version of DCPro

This version of the tool can be downloaded to a local computer and installed on the computer to run the tool. System requirements to use the tool include:

- OS Microsoft Windows 7
- Microsoft IE 7 or higher
- 32-bit Operating system
- .NET framework 2.0 or higher
- Administrative privileges on the local computer

Enter a name for your case and enter the company name which houses the data center. Then enter the basic information about the datacenter facility.

* All of the following fields are required.

Case Name	Tschudi-1	
Data Center Company	LBNL	
State/Region	California	
County*	Alameda County	
Floor Area - Data Center Space	50000	meters squared
Floor Area - Non Data Center Space	5000	meters squared
Floor Area - Data Center Support Space	200	meters squared
Type of Data Center	Government	
Data Center Tier (Uptime Institution Definition)	Tier I	
Current Data Center Buildout Level	55	%

Save Current Case to File Save & Continue

Step 2 - Energy Use Systems

1 2 3 4 5

Please answer the following questions related to your data center. After completing the questions for one section click the next button to move to the next set of questions, after completing all of the Energy Use System questions, DC Pro will compute your data center End-Use Breakouts. If you need to modify an answer after moving to the next set, click the previous button to go back.

Current Case: Tschudi-1

* *indicates answer required.*

- Energy Management
- IT Equipment
- Environmental Condition
- Air Management
- Cooling
- IT Equipment Power Chain
- Lighting
- Default Breakouts

Environmental Condition

What is a typical difference between supply and return air temperatures?	5 F (3 C)
Has the temperature setpoint of the cooling system been optimized for the load?	○ Yes ◉ No
What is a typical (average) supply temperature?	65 F (18 C)
What is a typical (average) IT equipment intake temperature?	70 F (21 C)
Do you have active, working humidification controls?	○ Yes ○ No
Do you have active, working dehumidification controls?	○ Yes ◉ No
Where are air temperature and humidity sensors located?	Air Return
Do CRAC/H units have centralized (networked) or distributed controls?	Distributed
Are there procedures and personnel/cable grounding equipment to prevent ESD?	○ Yes ◉ No
Are CRACs/CRAHs fighting each other (for example, simultaneously humidifying and dehumidifying)?	○ Yes ◉ No
Does system have capability of taking slope and offset for sensor recalibration?	○ Yes ○ No

Air Management

How many CRAC/CRAH/AHUs are there that operate under normal conditions?	8
Is there any supplemental cooling?	Rear-Door
Does the CRAC/CRAH/AHU have a free cooling coil (water side economizer)? *	(•) Yes ( ) No
Is there air-side free cooling? *	( ) Yes (•) No
Air Supply Path	Underfloor Plenum
Is there a floor-tightness (sealing leaks) program in place?	( ) Yes ( ) No
Are the cable penetrations sealed?	90% to 100%
Is the cable build-up in the floor plenum or the over-head plenum more than 1/3 of the plenum height?	( ) Yes (•) No
Is there a cable-mining (allow proper pressure distribution) program in place?	(•) Yes ( ) No
IT equipment in rows?	(•) Yes ( ) No
Is there a rack/lineup-tightness (using blanking panels) program in place?	( ) Yes ( ) No
Degree of current implementation of alternating hot and cold aisles? *	Good
Degree of current efforts to minimize recirculated air at the racks (for example, blanking panels)? *	Good
Degree of current efforts to minimize bypass air at the racks (for example, sealing cable	Good

Is there a cable-mining (allow proper pressure distribution) program in place?	(•) Yes ( ) No
IT equipment in rows?	(•) Yes ( ) No
Is there a rack/lineup-tightness (using blanking panels) program in place?	( ) Yes ( ) No
Degree of current implementation of alternating hot and cold aisles? *	Good
Degree of current efforts to minimize recirculated air at the racks (for example, blanking panels)? *	Good
Degree of current efforts to minimize bypass air at the racks (for example, sealing cable penetrations in the floor)? *	Good
Supply Air: Where are the overhead diffusers or perforated floor tiles placed?	Cold Aisles Only
Is there a diffuser/tile-location (to conserve hot and cold aisles) program in place?	( ) Yes ( ) No
Degree to which hot and cold aisles are currently fully enclosed? *	Fair
Supply fans	Constant Speed
Do some areas of the data center have load densities that are more than 4 times the average load density?	(•) Yes ( ) No
Is the air-delivery system balanced to ensure correct airflow rates?	(•) Yes ( ) No
Is there an air-balancing (allow proper airflow distribution) program in place?	(•) Yes ( ) No

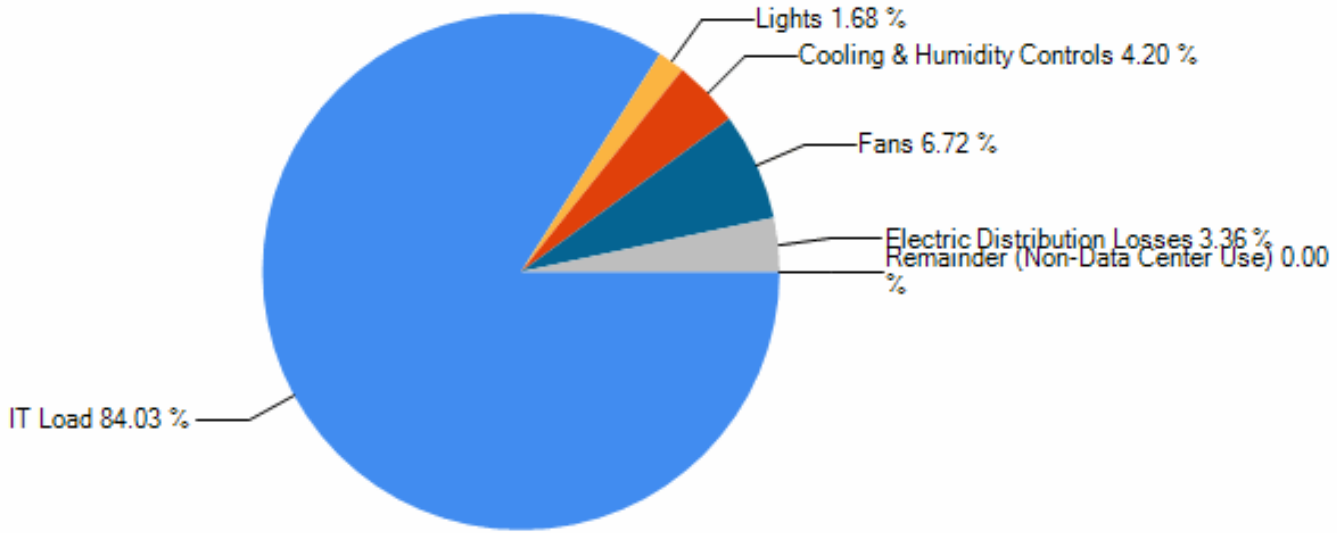
IT Equipment Power Chain

Is there an Uninterruptible Power Supply (UPS)? *	(•) Yes ( ) No
UPS Technology Type *	Double Conversion
What is the average load factor per active UPS module? *	25% to 49%
UPS Redundancy Configuration	N
Is there a standby generator?	( ) Yes (•) No
Are there PDUs with built-in transformers?	(•) Yes ( ) No
What are the types of MV and LV transformer(s)?	
Average Load Factor per Active PDUs / Transformers	50% to 100%
What is the load balance between the phases?	>20%

Lighting

Default Breakouts

This screen will compute estimated data center end use. You will have the opportunity to input the actual energy use in Step 4, in whole or in part. DC Pro will modify the default breakouts to accommodate the actual energy use.



Step 3 - Supplied Energy

1 2 3 4 5

Use this screen to enter data from utility bills or meters. Enter data only for those meters that support - either partly or wholly - the DC Load and/or the DC cooling system, and make sure that you enter all the energy streams that serve the data center.

Important: The chilled water and steam sections should be used only for imported chilled water or steam (e.g. from a district system or campus utility). If you produce chilled water or steam on site, the energy used by the chillers and boilers should be entered in the electricity and fuel sections respectively.

Entering different period intervals for different energy streams is acceptable, as DC Pro will calculate the annual data, but do not enter more than 1 year of data.

If you need additional information on individual columns, please click here.

Current Case: Tschudi-1

Supplied Electricity

Supplied Fuel

Imported Steam

Chilled Water

Previous | Save Current Case to File | Save & Continue

Step 3 - Supplied Energy

1 2 **3** 4 5

Use this screen to enter data from utility bills or meters. Enter data only for those meters that support - either partly or wholly - the DC Load and/or the DC cooling system, and make sure that you enter all the energy streams that serve the data center.

Important: The chilled water and steam sections should be used only for imported chilled water or steam (e.g. from a district system or campus utility). If you produce chilled water or steam on site, the energy used by the chillers and boilers should be entered in the electricity and fuel sections respectively.

Entering different period intervals for different energy streams is acceptable, as DC Pro will calculate the annual data, but do not enter more than 1 year of data.

If you need additional information on individual columns, please click here.

Current Case: Tschudi-1

Supplied Electricity

Meter ID	Use Per Period	Period	Bills per Period	Source Energy Factors	
1	1,000,000.00 kWh	Annual	$1,000,000.00	3.37	Edit Delete
2	450,000.00 kWh	Annual	$450,000.00	3.37	Edit Delete
3	35,000.00 kWh	Annual	$25,000.00	3.37	Edit Delete
	kWh	Annual		3.365	**Add**

Case Results

1 2 3 4 5

This is your customized DCPro Summary Report. The report is broken into five basic sections. If you wish to go back and edit any of your values or add more data click the previous button at the bottom of the page to navigate to the desired screen. If you need additional information on this step

Case Information

Case Name	Tschudi-1
Name	
Email	
Company	LBNL
County	Alameda County
State	California

Annual Energy Use

	Site Usage	Unit	Site Cost	Unit Cost
Electricity	5067.03087	MMBTU	$1,475,000.00	$291.10
TOTAL	5067.03087		$1,475,000.00	$291.10

Potential Annual Energy Savings

The following chart and data table summarize your data center's potential annual energy savings by breakout category.
NOTE:The energy and money savings listed below are only estimates based on the data you entered and the estimated costs associated with the data center suggested improved. Your actual savings will vary.

	Current Energy Use				Potential Energy Use				Potential Savings (Site Energy)		
	Site Energy		Source Energy		Site Energy		Source Energy				
Breakout Category	**MMBTU/yr**	**%**	**MMBTU/yr**	**%**	**MMBTU/yr**	**%**	**MMBTU/yr**	**%**	**MMBTU/yr**	**%**	**$**
IT Load	2047	4.8%	2019	3.2%	2047	9.3%	6889	9.3%	0	0%	-0.2
Lights	2730	6.5%	2692	4.2%	40.9	0.2%	138	0.2%	2689	6%	88400
Electric Distribution Losses	3412	8.1%	3365	5.3%	40.9	0.2%	138	0.2%	3371	8%	110800
Fans	4095	9.7%	4038	6.3%	164	0.7%	551	0.7%	3931	9%	129200
Cooling & Humidity Controls	10400	24.6%	11900	18.7%	225	1%	758	1%	10200	24%	334700
Remainder (Non-Data Center Use)	19500	46.3%	39700	62.3%	19500	88.6%	65800	88.6%	0	0%	1.4
TOTAL	42200	100%	63700	100%	22100	100%	74300	100%	20200	48%	663200

Potential Annual CO_2 Savings

Based on the potential energy savings identified above, your data center may be able to reduce emissions of CO_2. The following potential annual CO_2 emission savings number is a broad estimate based on the estimated costs associated witht he data center suggested improved and is not meant to reflect actual realized savings at your data center.

Potential Annual CO_2 Savings

Suggested Next Steps

Category		
Global	Consider upgrading all cooling supply fan, pump, and cooling tower fan motors to premium efficiency.	Premium efficiency motors are generally a few percent more efficient than their baseline counterparts. The efficiency gains are modest, but the incremental first cost tends to be low as well, especially when replacing existing motors that have reached the end of their service life. Specifying a premium efficiency motor is almost always cost effective for applications with long or continuous runtimes.
Air Management	Remove abandoned cable and other obstructions from underfloor and over-head.	Under-floor and over-head obstructions often interfere with the distribution of cooling air. Such interferences can significantly reduce the air handlers' airflow as well as negatively affect the air distribution. The cooling capacity of a raised floor depends on its effective height, which can be increased by removing obstructions that are not in use.
Air	Implement a cable-mining program	Cable congestion in raised-floor plenums can sharply reduce the total airflow as well as degrade the airflow distribution through the perforated floor tiles. Both effects promote the development of hot

Contact Information for the DC Pro Tool Suite

Paul Mathew, Ph.D.
Lawrence Berkeley National Laboratory
510-486-5116
pamathew@lbl.gov

DC Pro Support
dcprotechsupport@ppc.com

Data Center Energy Practitioner Program

Data Center Energy Practitioner (DCEP) Program

DOE partnered with industry

- Developed qualification process to qualify data center assessors
- Handed off to private industry for implementation

Program Objectives

- Raise the standards of those involved in energy assessments
- Provide consistent, comprehensive approach
- Accelerate adoption of efficiency measures

Data center Energy Practitioner (DCEP) program

Prerequsite: Educational background and experience
Training and qualifying exam
Use of DC Pro tool suite
Standard assessment process and reporting
Refresher training

Target groups

- **all DOE data centers will be required to have a DCEP**
- **data center personnel – general industry and Federal**
- **consulting professionals**
- **design firms**
- **energy assessment firms**

http://www1.eere.energy.gov/industry/datacenters/dc_cep.html

http://www1.eere.energy.gov/industry/datacenters/software.html

DCEP Program Overview

The Practitioner:

- **Consistent qualifications and approach**
- **Trained to conduct system-level energy assessments**
- **Knowledge of design, operation, diagnostics experience, measurement equipment techniques**

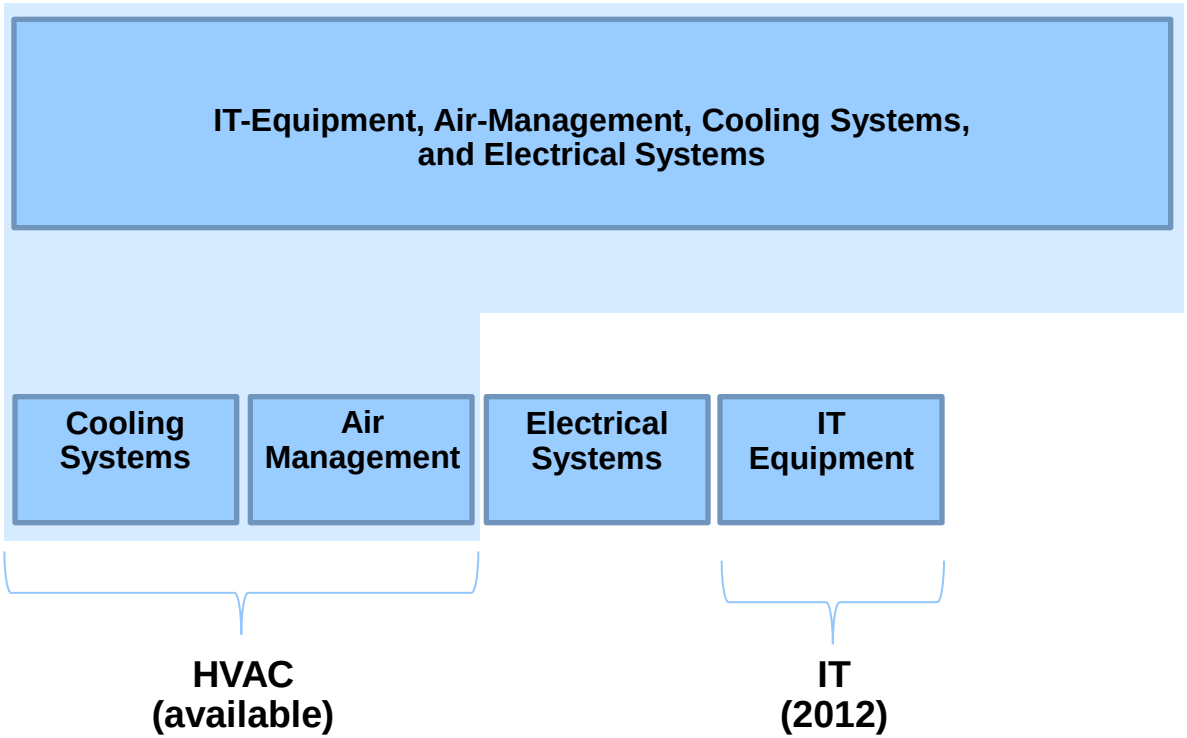
Training & Exam:

- **Documented training, knowledge, and skills**
- **Passing exam(s), including proficiency in the use of the DC Pro software tool suite**
- **Target groups include in-house operating groups, consulting professionals (for-fee consulting), or IT service vendors**

Training & Certificate Disciplines/Levels/Tracks

Level 1:
Generalist Training/Exam
on All Disciplines
+ Assessment Process
+ DC Pro Profiling Tool

Level 2:
Specialist Training/Exam
on Select Disciplines
+ Assessment Process
+ DC Pro System
Assessment Tools



Two Tracks:
- Certificate track (training + exam)
- Training track (training only)

Tools & Information

Training

Certificates

DOE/LBNL

Examples:

- DC Pro Software
  - Profiler
  - HVAC (2011)
  - Air Management
  - Electrical
  - IT (2012)
- Tool Manuals
- Process Manual
- Worksheets
- Master List of Actions
- Report Template

DOE/ASHRAE Awareness Training

One-Day Training Without Certificates.

Data Center Energy Practitioner (DCEP)

One-Three Day Training with Training Certificate.

Pre-qualifications: Yes.

Disciplines:

- Generalist
- Specialists in HVAC, Electrical (>2012), and/or IT (2012)

Data Center Energy Practitioner (DCEP)

Pre-qualification: Pass Generalist exam before taking Specialist exam.

Certifications:

- Generalist
- Specialists in HVAC, Electrical (>2012), and/or IT (2012)

Pre-qualifications

Generalist **High-level knowledge in HVAC, Electrical, and IT-Equipment**	**One of the following:** 4-year tech degree with 3 years verifiable DC design/operation experience 2-year tech degree with 6 years verifiable DC design/operation experience 10 years verifiable DC design/operation experience
HVAC Specialist **In-depth knowledge in HVAC**	**All of the following:** Passing score on the Generalist exam 4-year tech degree with 3 years verifiable DC design/operation experience **or** 4-year non-tech degree with 5 years verifiable DC design/operation experience Mech. PE, CEM by AEE, CDCDP by CNet

Professional Training Organizations

Beginning in 2011, the DCEP program is administered by Professional Training Organizations (PTOs) that were competitively selected (Datacenter Dynamics in the US and CNet internationally).

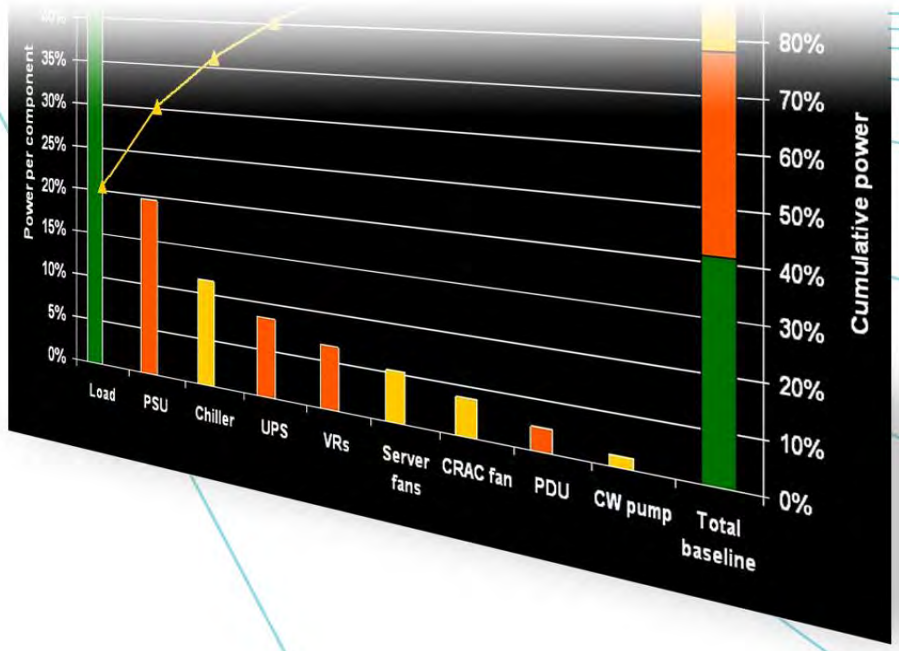
CNet Training

DCProfessionalDevelopment

DatacenterDynamics Knowledge & Networking

The PTO(s):

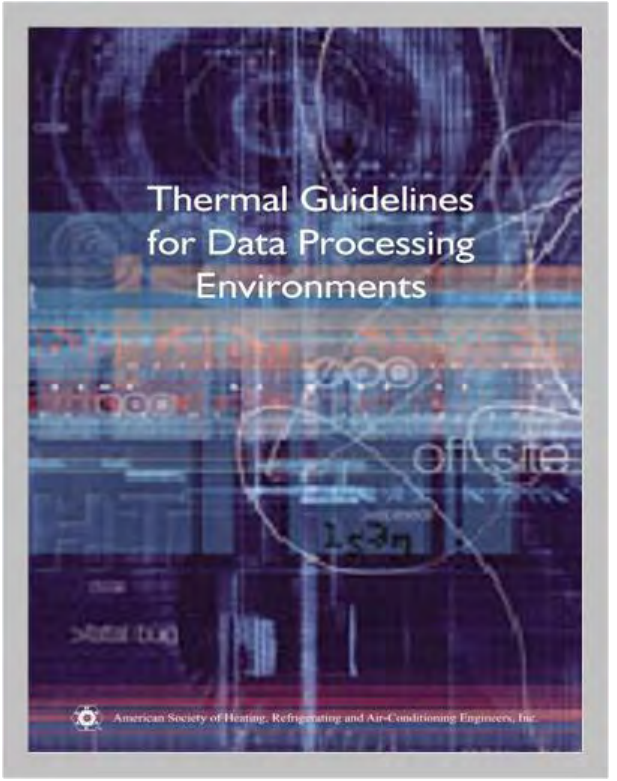
- **license training and exam content from DOE**
- **Administer the program**
  - **provide training/exams**
  - **issue certificates to successful candidates**
  - **provide refresher training**



Latest ASHRAE Environmental Conditions Guidelines

Environmental Conditions

- Most computing centers are over-cooled and have humidity control issues
- ASHRAE and IT equipment manufacturers established recommended and allowable conditions for air delivered to the intake of the computing equipment
- There is a lot of misunderstanding about cooling requirements for IT equipment
- The IT equipment manufacturers develop the guidelines and **recently agreed to even broader ranges of temperature and humidity**

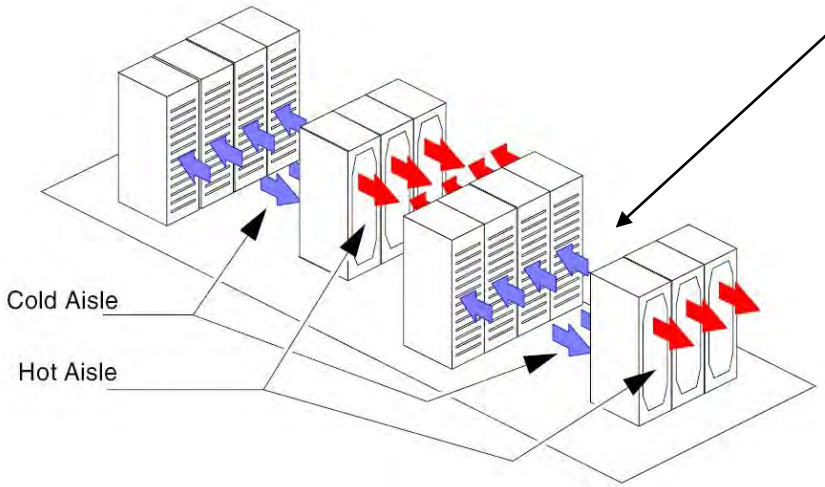


Environmental Conditions

- Prior to ASHRAE's Thermal Guidelines, there were no published temperature and humidity guidelines. The guidelines provide a common understanding for IT and facility staff.
- ASHRAE's Thermal Guidelines have a recommended temperature range of 18˚C to 27˚C (80.6 F) and allowable ranges much higher.
- All of the HPC manufacturers endorse this recommendation and using the upper end of the range enables large energy savings - especially when using economizers.
- **ASHRAE recently issued a white paper broadening the allowable ranges and providing more justification to allow operation above the recommended limits. Six classes of equipment are now identified with wider allowable ranges from 32 C to 45 C (113 F)**

Equipment environmental specification

<u>Air inlet</u> temperature to IT Equipment is the important specification to meet



Outlet temperature is not important to IT Equipment

2011 ASHRAE Thermal Guidelines

Classes (a)	Equipment Environmental Specifications							
	Product Operations (b)(c)					Product Power Off (c) (d)		
	Dry-Bulb Temperature (˚C) (e) (g)	Humidity Range, non-Condensing (h) (i)	Maximum Dew Point (˚C)	Maximum Elevation (m)	Maximum Rate of Change(˚C/hr) (f)	Dry-Bulb Temperature (˚C)	Relative Humidity (%)	Maximum Dew Point (˚C)
Recommended (Applies to all A classes; individual data centers can choose to expand this range based upon the analysis described in this document)								
A1 to A4	18 to 27	5.5ºC DP to 60% RH and 15ºC DP						
Allowable								
A1	15 to 32	20% to 80% RH	17	3050	5/20	5 to 45	8 to 80	27
A2	10 to 35	20% to 80% RH	21	3050	5/20	5 to 45	8 to 80	27
A3	5 to 40	-12˚C DP & 8% RH to 85% RH	24	3050	5/20	5 to 45	8 to 85	27
A4	5 to 45	-12˚C DP & 8% RH to 90% RH	24	3050	5/20	5 to 45	8 to 90	27
B	5 to 35	8% RH to 80% RH	28	3050	NA	5 to 45	8 to 80	29
C	5 to 40	8% RH to 80% RH	28	3050	NA	5 to 45	8 to 80	29

2011 Thermal Guidelines for Data Processing Environments – Expanded Data Center Classes and Usage Guidance. White paper prepared by ASHRAE Technical Committee TC 9.9

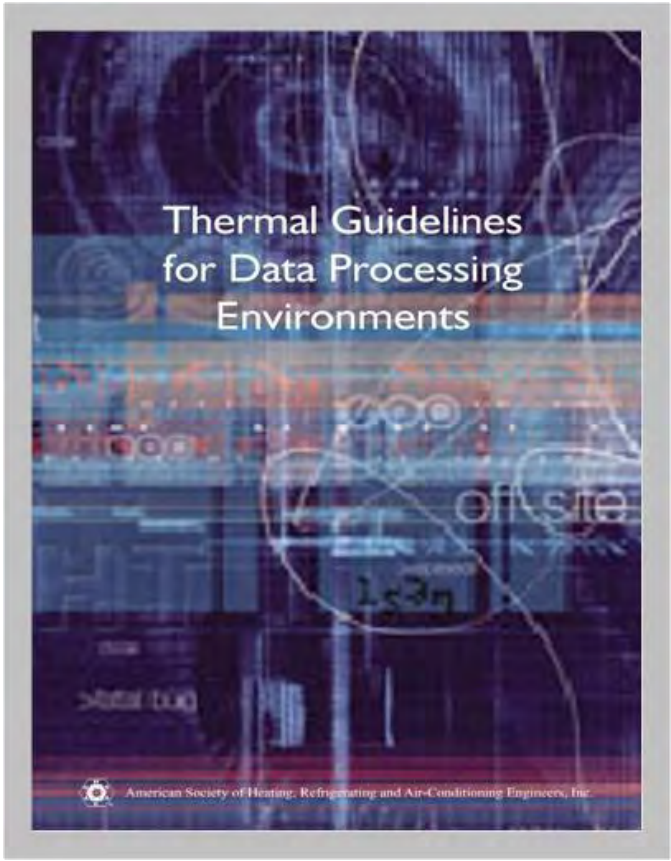
Temperature Rate-of-Change Specifications

(@ Equipment Intake)	Maximum
Computing Centers ASHRAE	20°C/hr
Telecom Centers NEBS	96.1°C/hr

Very large differences in temperature rate-of-change. The NEBS specification was developed by estimating the potential gradients in case of cooling outages.

ASHRAE Reference: ASHRAE (2011); NEBS References: Telcordia (2001, 2002, and 2006)

- Some manufacturers design for even harsher conditions.
- Facilities should be designed for computational equipment "comfort" – not people comfort. If the center is cold there is an efficiency opportunity.
- Most data center computer room air conditioners are controlling the temperature returning to the unit – this needs to change.
- Perceptions lead many to operate much cooler than necessary; often less than 68˚F at the inlet to computing equipment.



Example server specification

Environmental

Temperature:

- Operating: 10° to 35°C (50° to 95°F)
- Storage: -40° to 65°C (-40° to 149°F)

Relative humidity

- Operating: 20% to 80% (non-condensing)
- Storage: 5% to 95% (non-condensing)

Altitude

- Operating: -15 to 3048 m (-50 to 10,000 ft)
- Storage: -15 to 10,668 m (-50 to 35,000 ft)

Humidity Control

- **Design Conditions**
  - Maintain inlet conditions to the electronic equipment to the recommended ASHRAE Thermal Guideline or manufacturer's requirements.
  - Use dew-point control, NOT %RH.
  - The need for any humidity control needs more study.
- **Eliminate dehumidification, if possible**
  - High humidity is usually limited by cooling coil dew-point temperature.
- **Use more efficient means of dehumidification**
  - Control make-up air humidity and turn off CRAC humidification control

High Humidity Limit Issues

Hygroscopic Salts Failures

- Some contaminants (hydroscopic salts) in combination with high humidity can deposit and bridge across circuits over time causing current leakage or shorts
- Operating with high humidity (>60%) in an environment with high concentrations of particulates should be avoided
- Normal building filtration is effective in removing these particulates

Gaseous Contamination

- Operating with high humidity (>60%) in areas with gaseous contamination could cause additional failures. More study is needed in this area.

Low Humidity Limit Issues

Electrostatic discharge

- Industry practices
  - Telecom has no lower limit (personnel grounding)
  - Electrostatic Discharge Association removed humidity control as an ESD control measure in ESD/ANSI S20.20
  - IT equipment is qualified to withstand ESD and it is grounded
  - Many centers eliminate humidification with no adverse effects
- Recommended procedures
  - Personnel grounding
  - Cable grounding
  - Widen humidity ranges or eliminate humidity control

Questions? - Discussion

Thank you for attending

Contact information:

Bill Tschudi, P.E.
Lawrence Berkeley National Laboratory
MS 90R-3011
Berkeley, CA 94720

WFTschudi@LBL.gov
(510) 495-2417
http://hightech.LBL.gov

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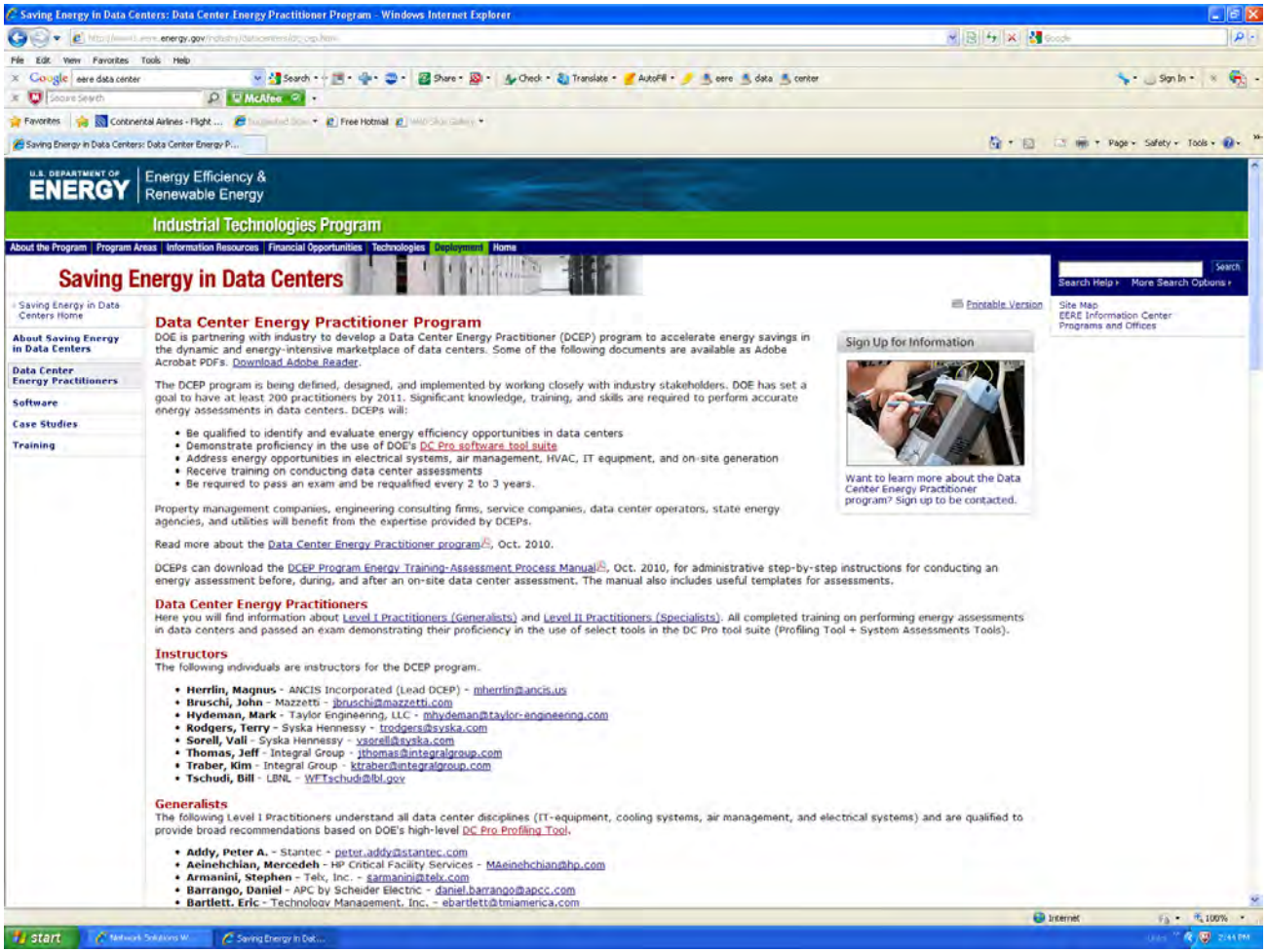

http://www1.eere.energy.gov/industry/datacenters/dc_cep.html