Save Energy Now - Data Center Briefing October 1, 2008

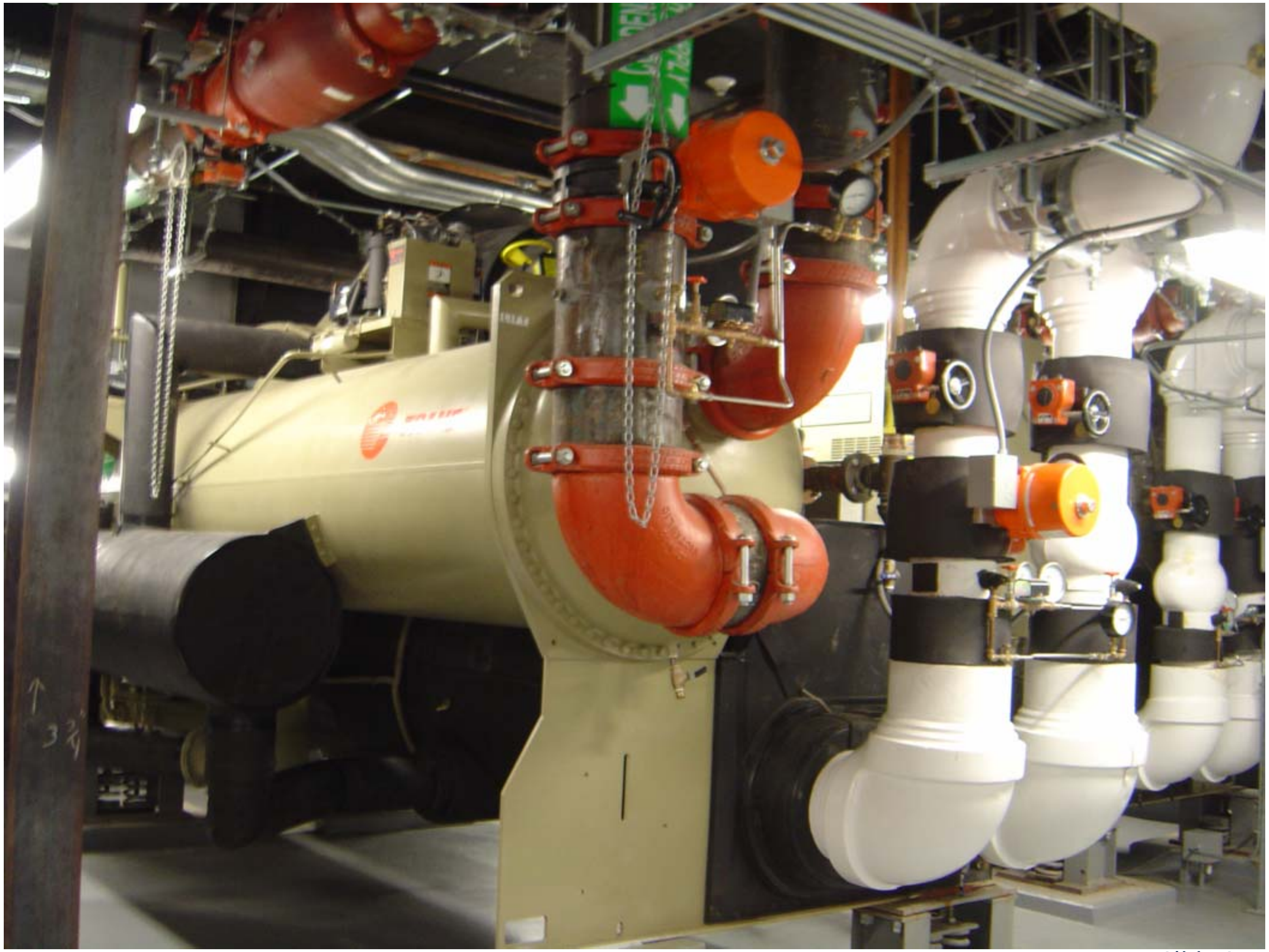
William Tschudi, PE
Lawrence Berkeley National Laboratory
WFTschudi@lbl.gov
510-495-2417

Data Centers are INFORMATION FACTORIES

- Data centers are energy intensive facilities
  - Server racks now designed for more than 25+ kW
  - Surging demand for data storage
  - Typical facility ~ 1MW, can be > 20 MW
  - Nationally 1.5% of US Electricity consumption in 2006
    - Projected to double in next 5 years
- Significant data center building boom
  - Power and cooling constraints in existing facilities

Resembling large industrial facilities

Lucas Films




CONDENSER WATER RETURN

Also with specialized equipment

The rising cost of ownership

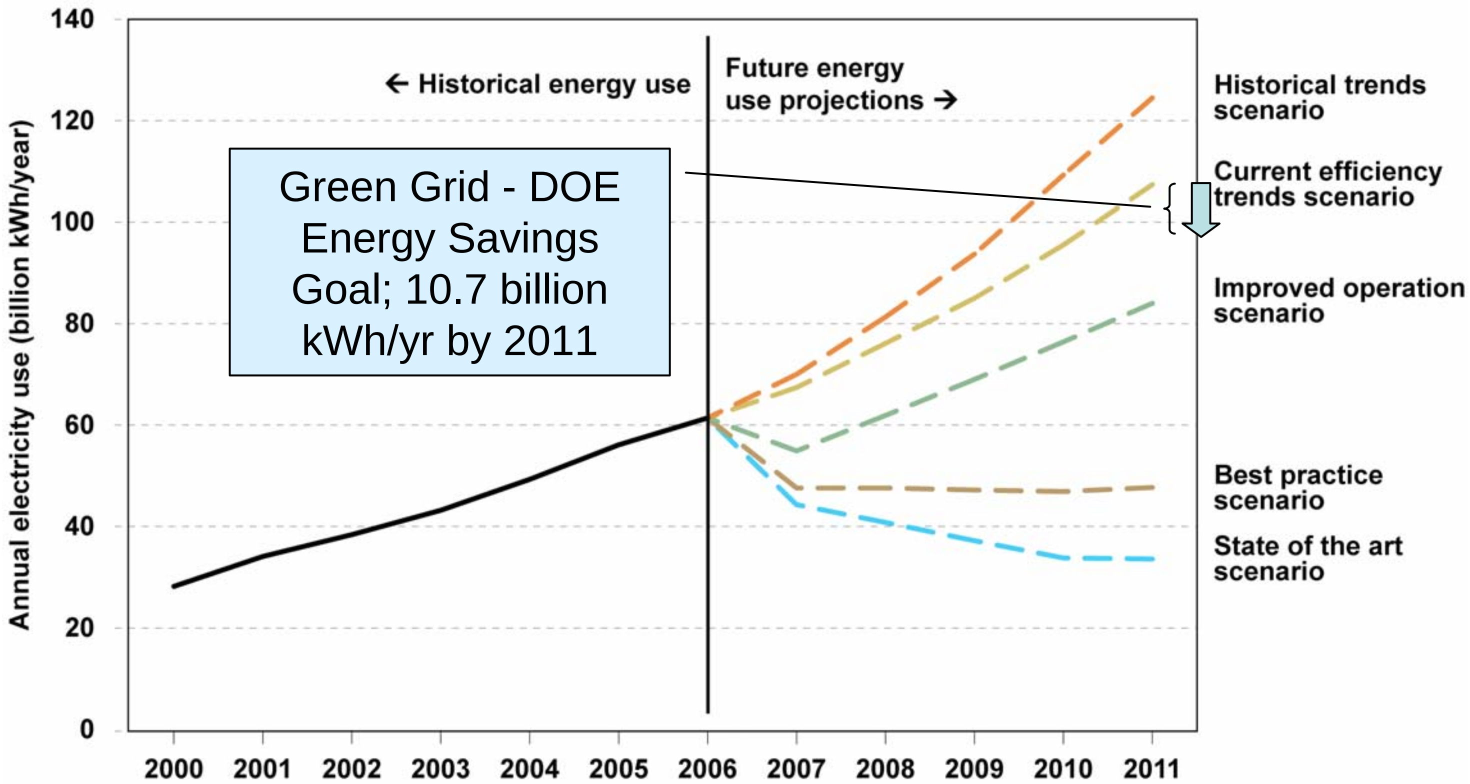
- Cost of electricity and supporting infrastructure now surpassing capital cost of IT equipment
- Perverse incentives -- IT and facilities costs separate

Source: The Uptime Institute, 2007

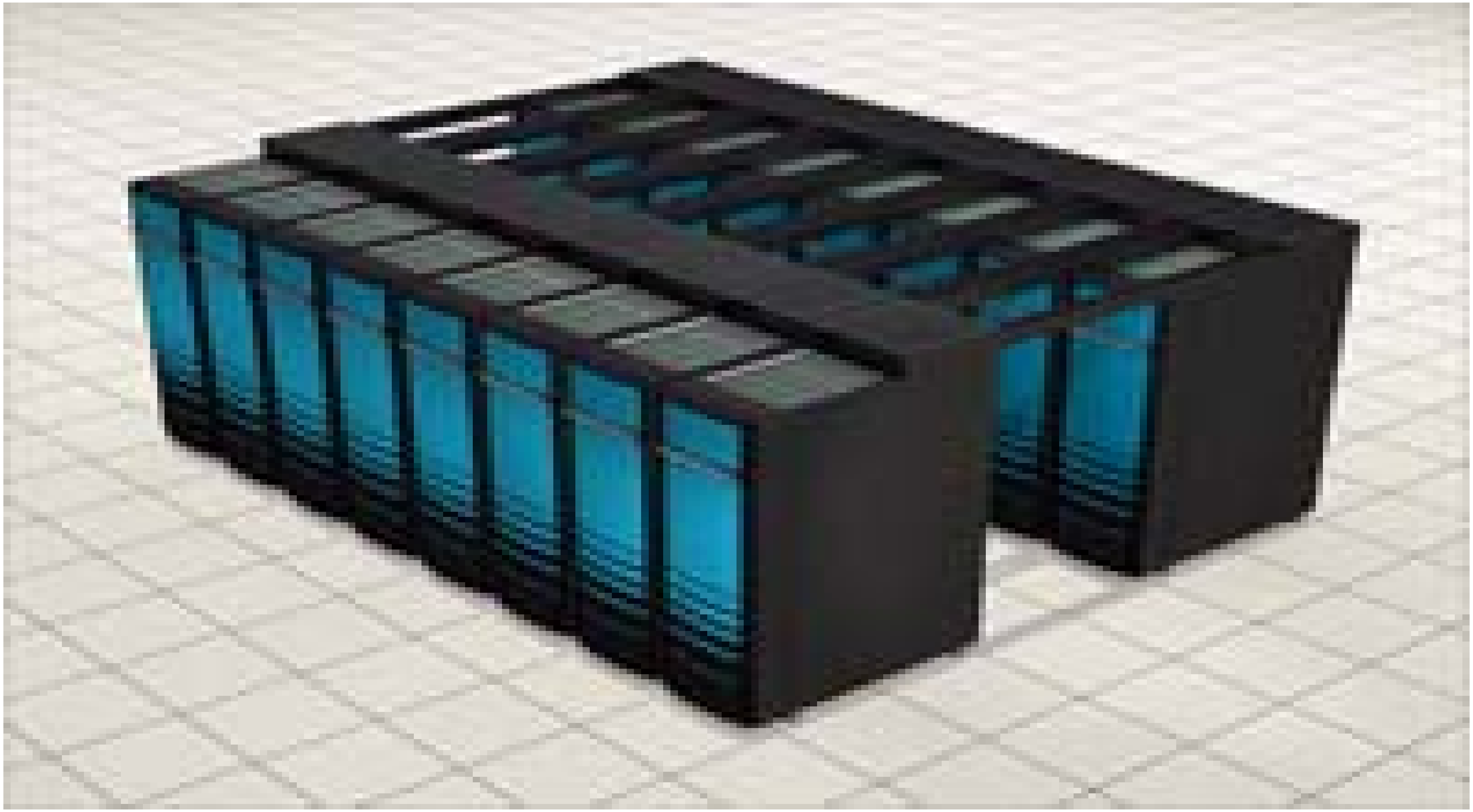
DOE-Green Grid partnership goals

2011 goal is 10% energy savings overall in U.S. data center

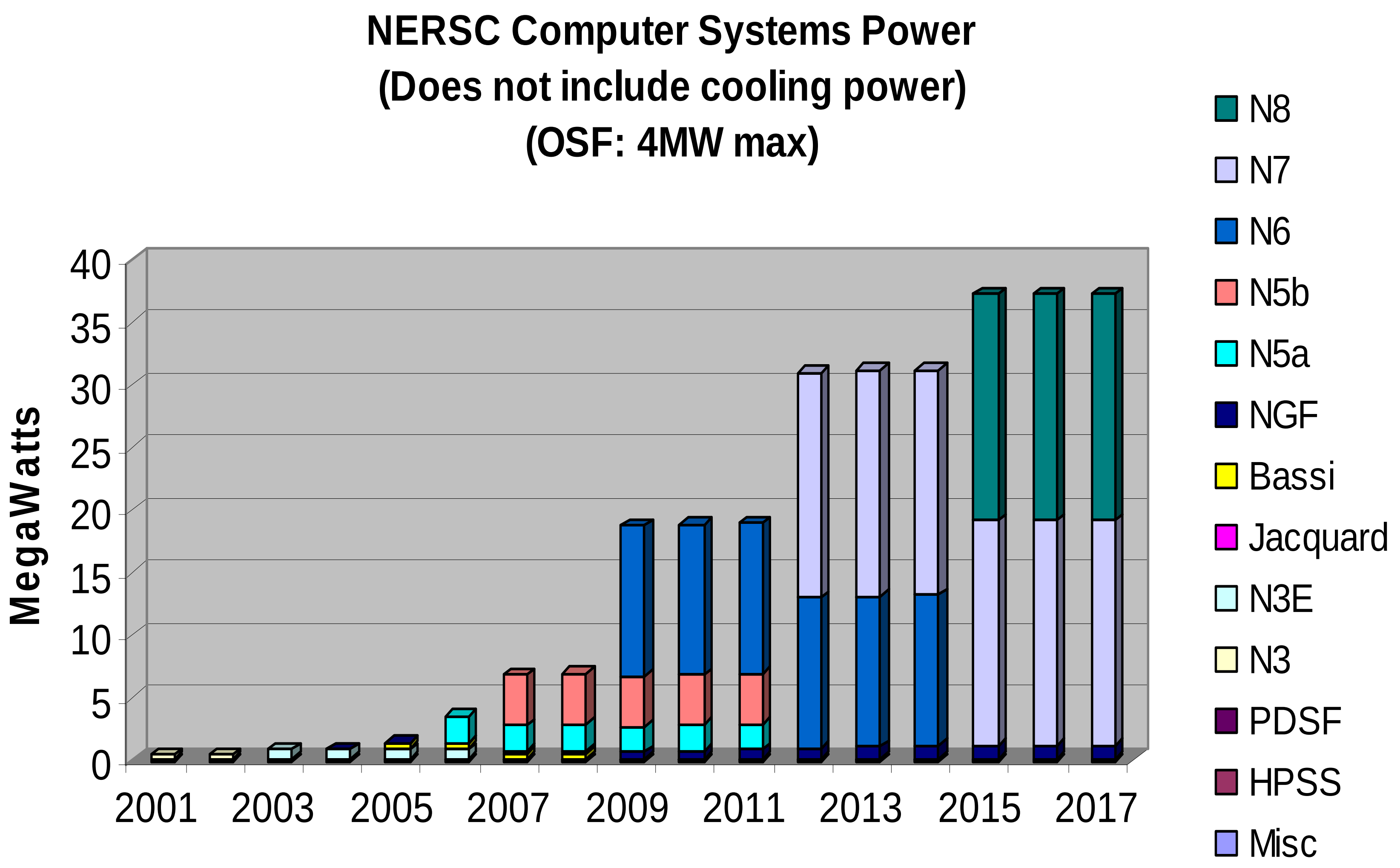
- 10.7 billion kWh
- Equivalent to electricity consumed by 1 million typical U.S. households
- Reduces greenhouse gas emissions by 6.5 million metrics tons of CO_2 per year



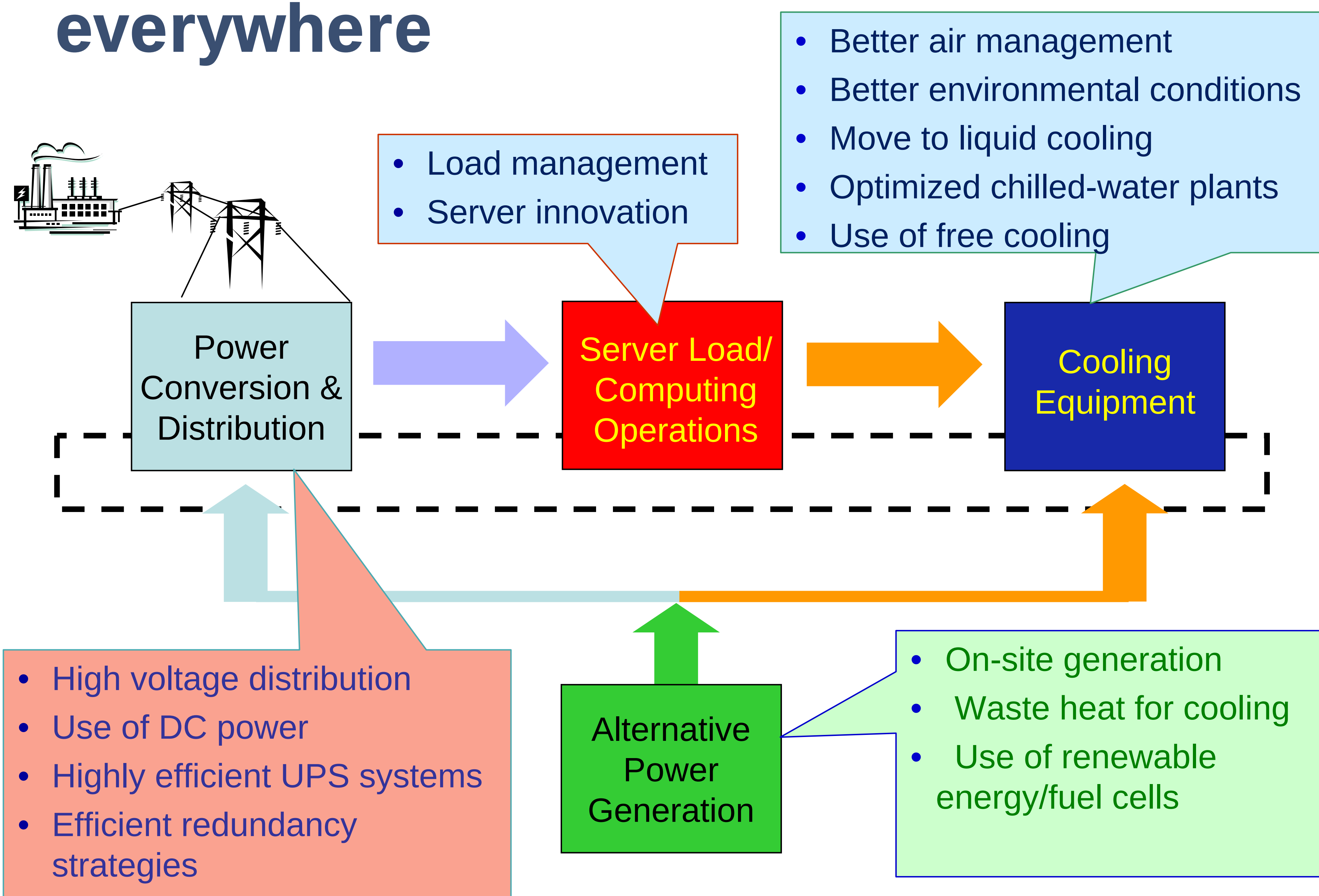
LBNL feels the energy cost pain!



LBNL super computer systems power:



Energy efficiency opportunities are everywhere



Data center efficiency opportunities

Benchmarking over 30 centers consistently lead to opportunities

No silver bullet

Lots of silver bb's

Many areas for improvement...

Cooling

- Air Management
- Free Cooling – air or water
- Environmental conditions
- Centralized Air Handlers
- Low Pressure Drop Systems
- Fan Efficiency
- Cooling Plant Optimization
- Direct Liquid Cooling
- Right sizing/redundancy
- Heat recovery
- Building envelope

Electrical

- UPS and transformer efficiency
- High voltage distribution
- Premium efficiency motors
- Use of DC power
- Standby generation
- Right sizing/redundancy
- Lighting – efficiency and controls
- On-site generation

IT

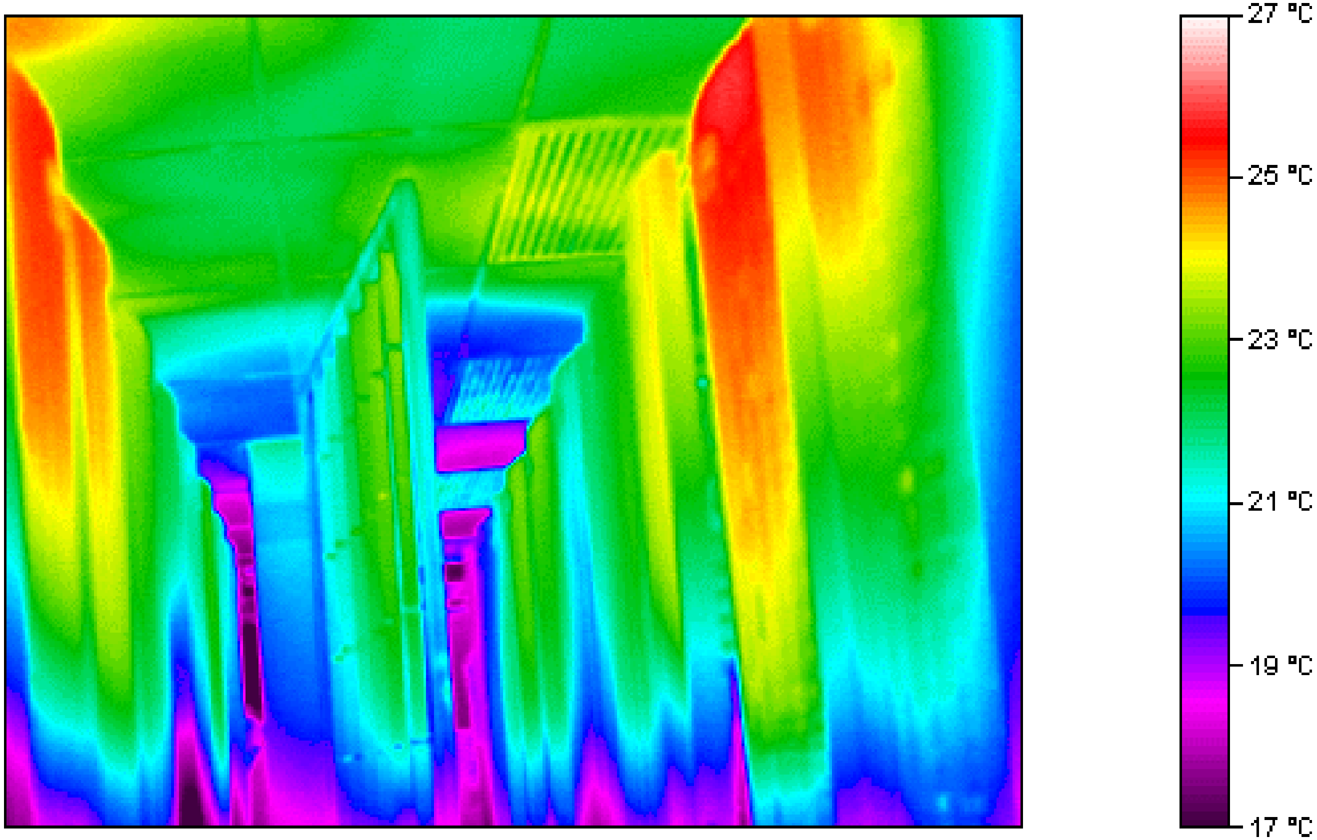
- Power supply efficiency
- Standby/sleep power modes
- IT equipment fans
- Virtualization
- Load shifting

Where to focus to improve efficiency?

- IT equipment – reduce the load at the source
- Environmental conditions – most centers are not optimal
- Free cooling – a majority of centers do not employ free cooling
- Power distribution – unnecessary power conversions
- Redundancy – understanding what redundancy costs and what it buys
- Cooling systems efficiency – evolution of data centers neglected best practices
- Research new solutions
  - optimize power delivery all the way to the chip
  - optimize cooling from the chip to atmosphere
  - Remove barriers
  - High tech moves quickly
- Benchmarking – the starting point

Visualize the problem

- Infrared thermography



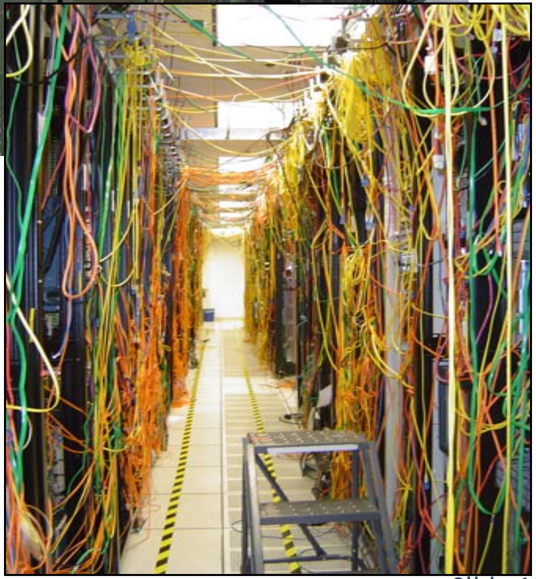
Potential savings

- 20-40% savings are typically possible
- Aggressive strategies – better than 50% savings
- Paybacks are short – 1 to 3 years are common
- Potential to extend life and capacity of existing data center infrastructure but this also could allow for more IT equip – raising total use
- Some opportunities need to be integrated with infrastructure upgrades
- Most don’t know if their center is good or bad

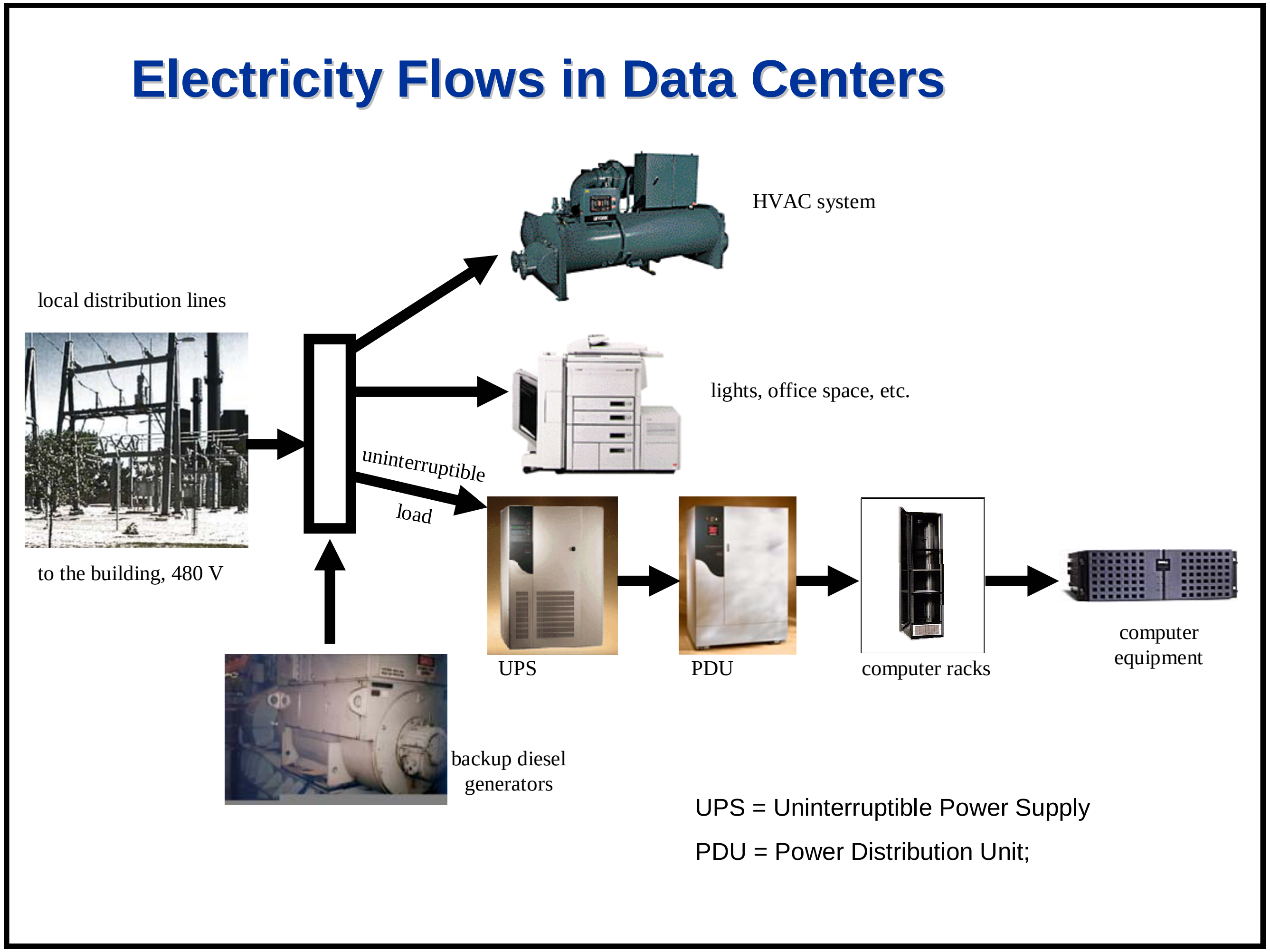
Benchmarking for energy performance improvement:

Energy benchmarking can be effective in helping to identify better performing designs and strategies.

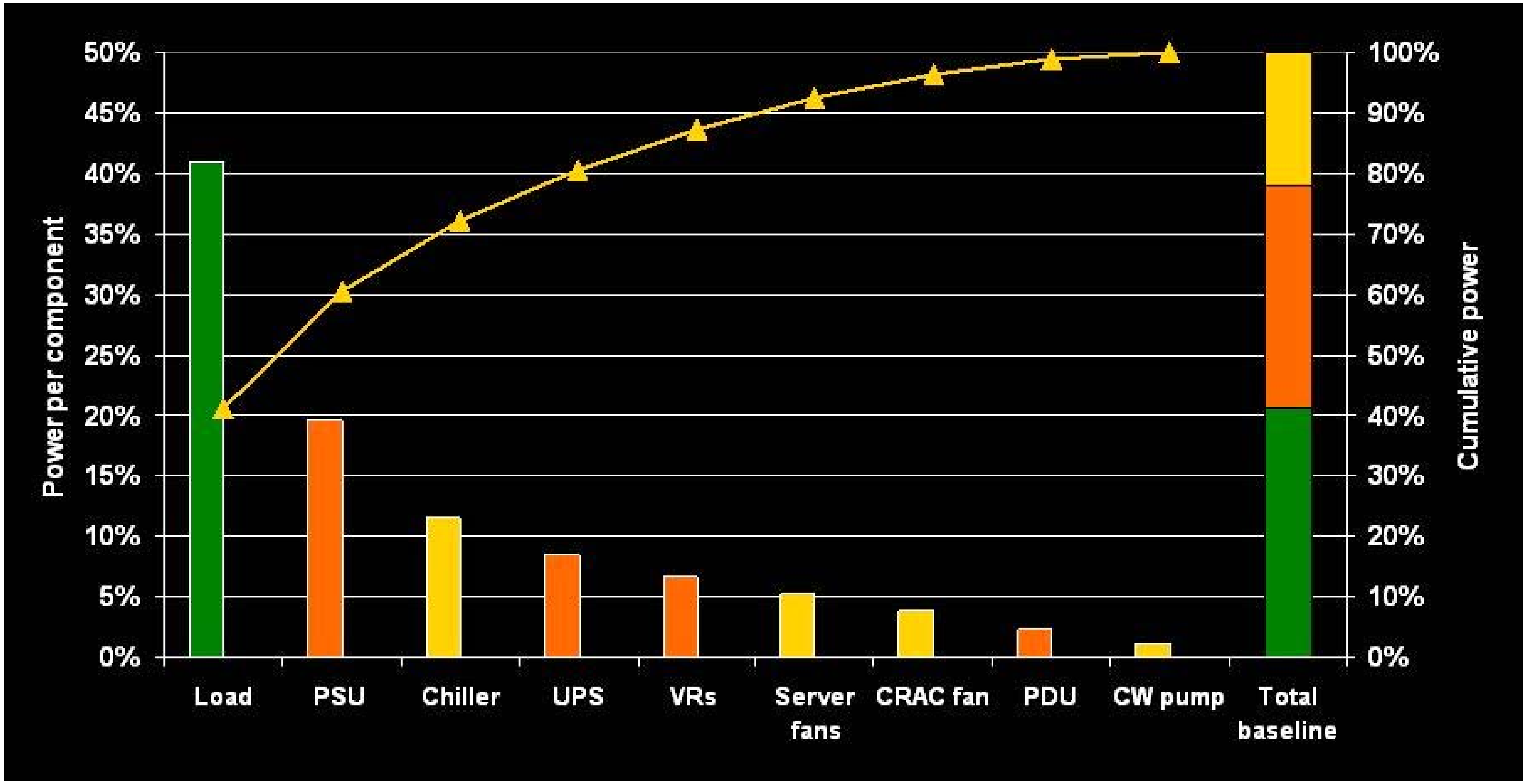
As new strategies are implemented (e.g. liquid cooling), energy benchmarking will enable comparison of performance.



Benchmarking energy end use



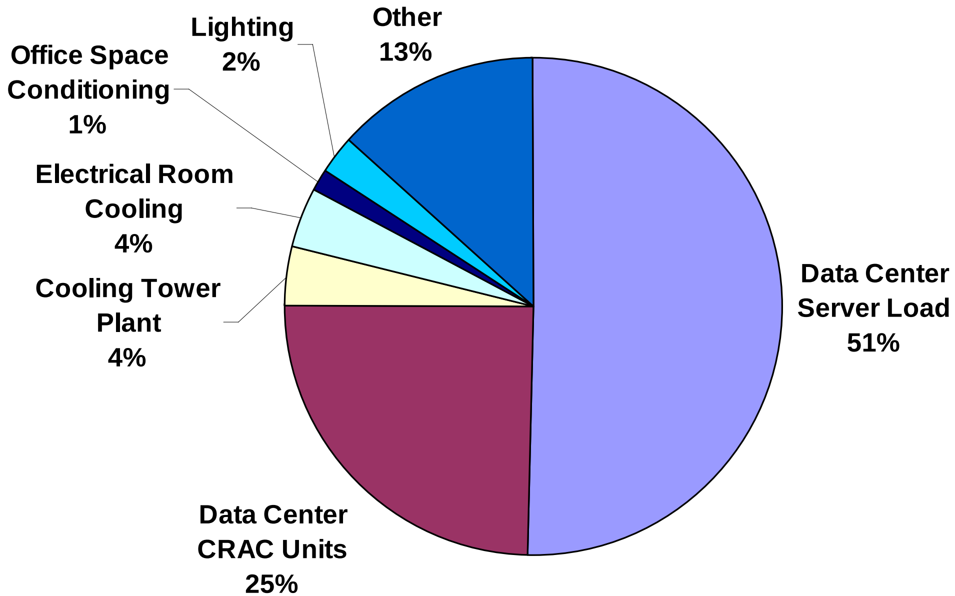
Electrical end use in one center

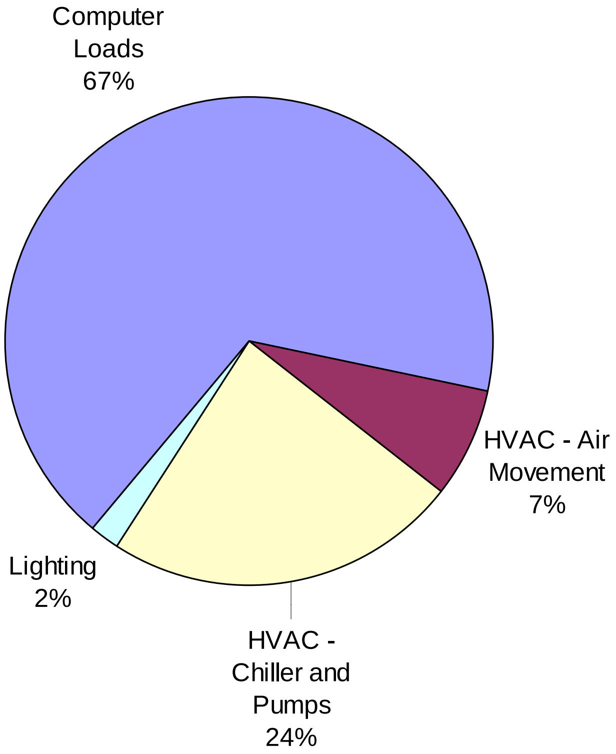


Courtesy of Michael Patterson, Intel Corporation

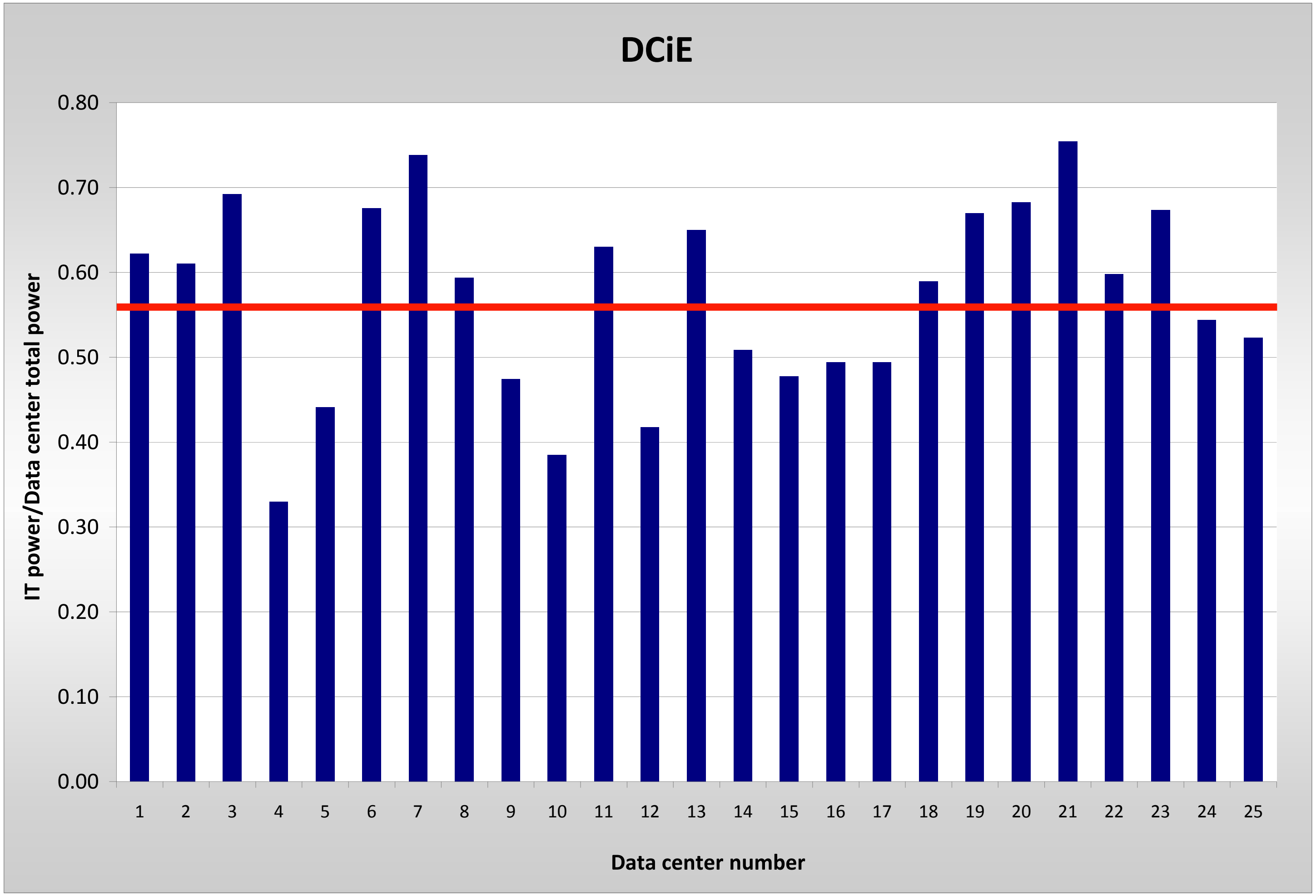
Your mileage will vary

The relative percentages of the energy doing computing varied considerably.





High level metric – IT/total



Average .57

Higher is better

Source: LBNL

Save Energy Now

- Data Center assessment tool suite – DC Pro
- Awareness training
- Qualified specialist program
- Certification – continuous improvement
- Collaboration with industry associations
  - Green Grid
  - ASHRAE
  - Uptime
  - Silicon Valley Leadership Group
  - others

Steps to saving energy:

1. Energy Profiling
2. Subsystem Assessment

- Assessments conducted by owners and engineering firms using DOE tools
- Tools provide uniform metrics and approach
- Raises awareness of opportunities

3. Detailed Engineering Audit
4. Engineering Design
5. Retrofit/RCx Implementation

- Audits, design and implementation by engineering firms and contractors

6. Savings Validation (M&V)
7. Documentation

- M&V by site personnel and eng firms
- DC Pro can document results, and track performance improvements
- Further best practices can be identified

DC Pro tools

High Level Profiling Tool

- Overall energy performance (baseline) of data center
- Performance of systems (infrastructure & IT) compared to benchmarks
- Prioritized list of energy efficiency actions and their savings, in terms of energy cost ($), source energy (Btu), and carbon emissions (Mtons)
- Points to more detailed system tools

IT Module

- Servers
- Storage & networking
- Software

Cooling

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

Air Management

- hot cold separation
- environmental conditions

Power Systems

- UPS
- Transformers
- Lighting
- Standby gen.

On-Site Gen

- Renewables
- use of waste heat

DC Pro tool suite

- Profiling Tool: profiling and tracking
  - Establish DCIE baseline and efficiency potential (~1-3 hours effort)
  - Document actions taken
  - Track progress in DCiE 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 visit)

Tool development status and outlook

Currently Available:

- **High level profiling tool** v 1.0
- **Electrical assessment tool** Beta

Future Assessment Tools:

- **Electrical module** (initial issue)
- **Air management module** (December 08)
- **Cooling module** (TBD depends upon utility funding)
- **IT module** (February 09 – Green Grid input
  June 09 Beta version)
- **On-site Generation** (TBD)

DC Pro profiling tool demonstration

www.eere.energy.gov/datacenters

ITP BestPractices: DC Pro - Home Page - Berkeley Lab

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http://dcpro.ppc.com/

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Data Center Energy Profiler

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Data Center Energy Profiler

Get Started Now!

Returning User

Username bsmith@abc.com
Password *****
Forgotten password
Login

First Time User

Click here to register

The Data Center Energy Profiler, or DC Pro, is an online software tool provided by the U.S. Department of Energy to help industries worldwide identify how energy is being purchased and consumed by their data center(s) and also identify potential energy and cost savings. DC Pro is designed so that the user can complete a data center profile in about an hour. When you complete a DC Pro case you are provided with a customized, printable report that shows the details of energy purchases for your data center, how energy is consumed by your data center, potential cost and energy savings, comparison of your data center energy utilization versus other data centers, and a list of next steps that you can follow to get you started saving energy.

This is the beta version of DC Pro. released 06/02/2008.

DC Pro Resources

- **Checklist** - The DC Pro checklist lists all of the information that you will need to collect to complete the DC Pro.

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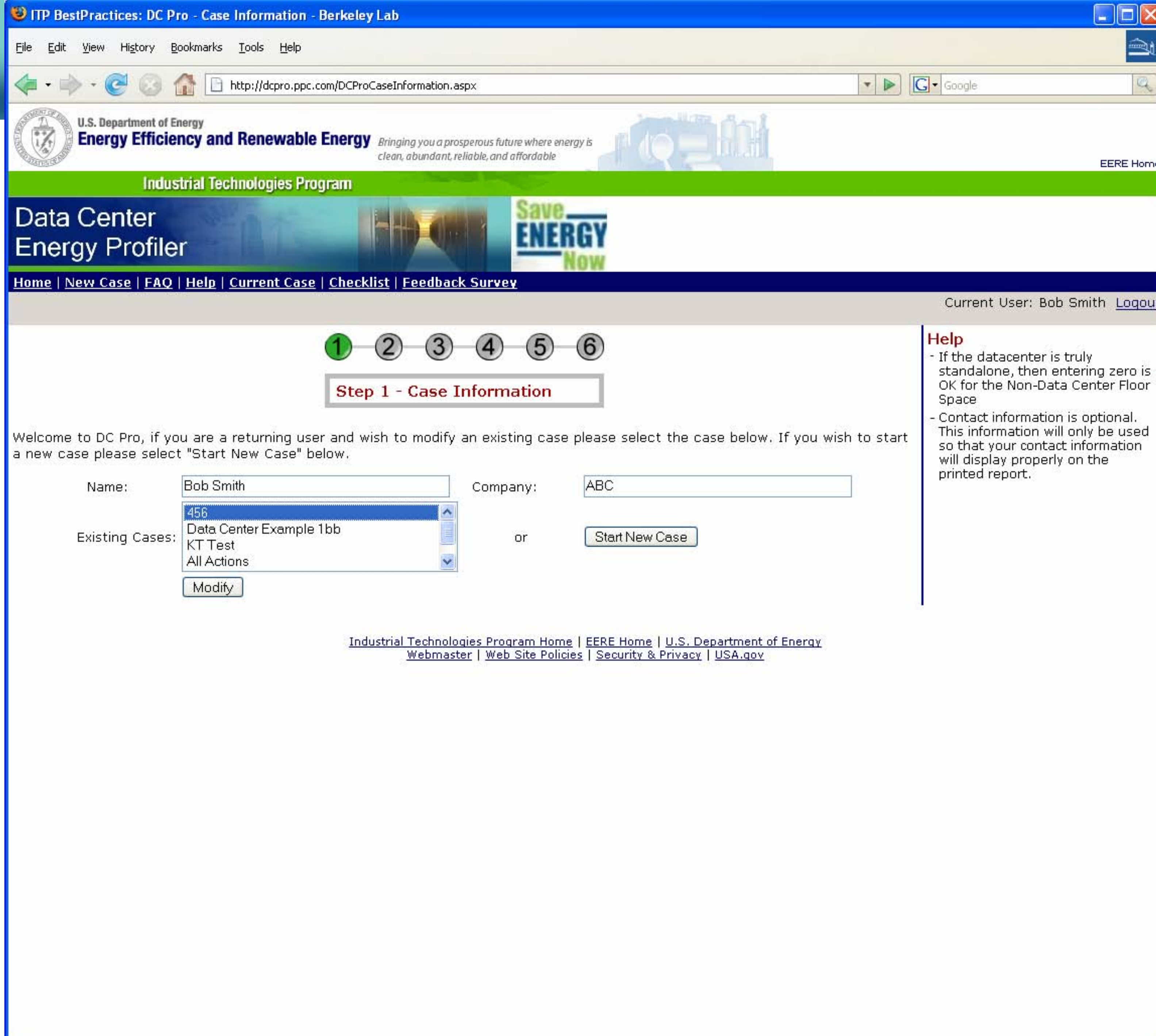
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1 2 3 4 5 6
Step 1 - Case Information
Welcome to DC Pro, if you are a returning user and wish to modify an existing case please select the case below. If you wish to start a new case please select "Start New Case" below.
Name: Bob Smith
Company: ABC
Existing Cases: 456
Data Center Example 1bb
KT Test
All Actions
or
Start New Case
Modify
Help
- If the datacenter is truly standalone, then entering zero is OK for the Non-Data Center Floor Space
- Contact information is optional. This information will only be used so that your contact information will display properly on the printed report.
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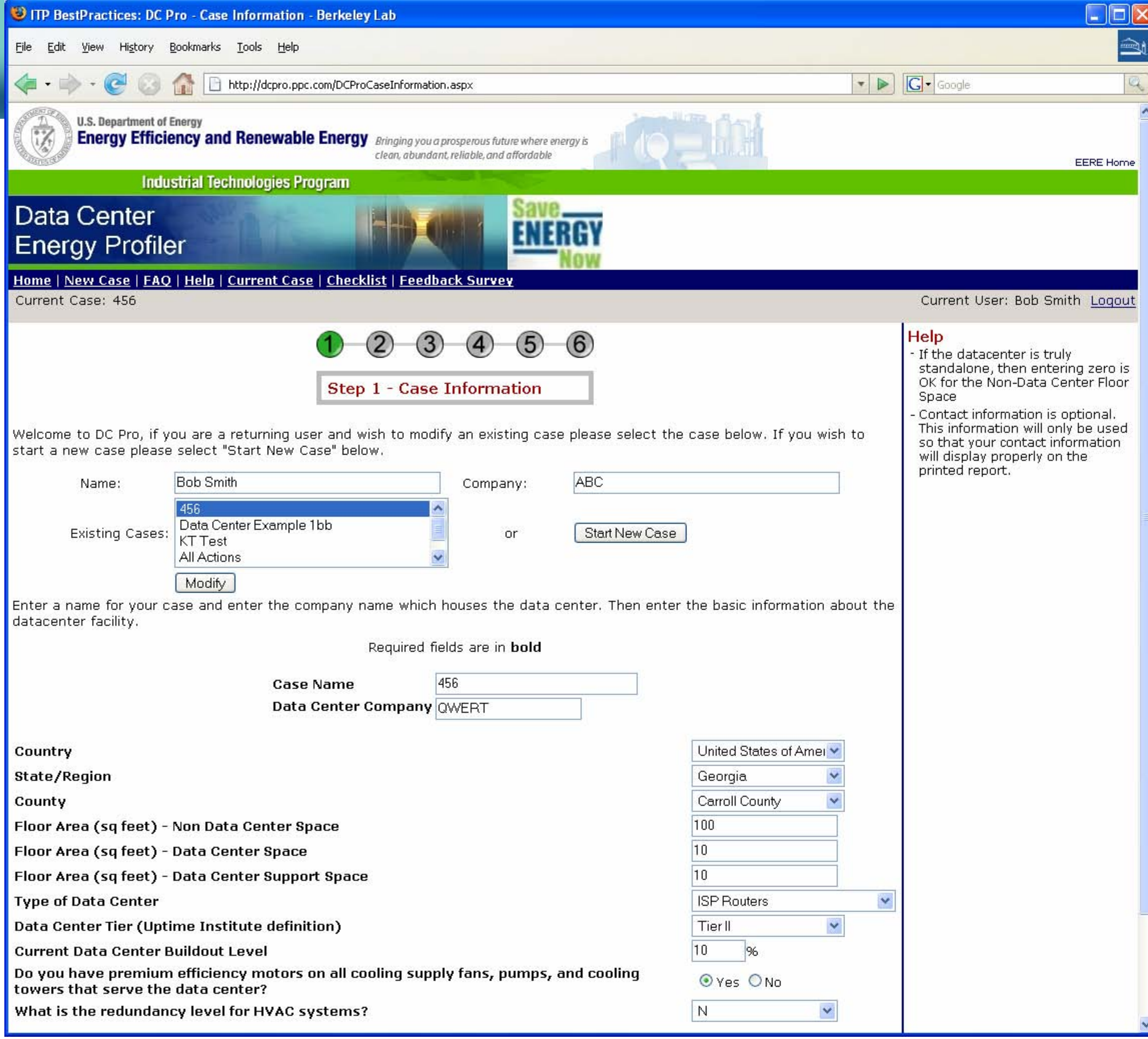
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Name: Bob Smith
Company: ABC
Existing Cases: 456 / Data Center Example 1bb / KT Test / All Actions
or
Start New Case
Modify
Enter a name for your case and enter the company name which houses the data center. Then enter the basic information about the datacenter facility.
Required fields are in bold
Case Name 456
Data Center Company QWERT
Country United States of Amei
State/Region Georgia
County Carroll County
Floor Area (sq feet) - Non Data Center Space 100
Floor Area (sq feet) - Data Center Space 10
Floor Area (sq feet) - Data Center Support Space 10
Type of Data Center ISP Routers
Data Center Tier (Uptime Institute definition) Tier II
Current Data Center Buildout Level 10 %
Do you have premium efficiency motors on all cooling supply fans, pumps, and cooling towers that serve the data center? Yes No
What is the redundancy level for HVAC systems? N
Help
- If the datacenter is truly standalone, then entering zero is OK for the Non-Data Center Floor Space
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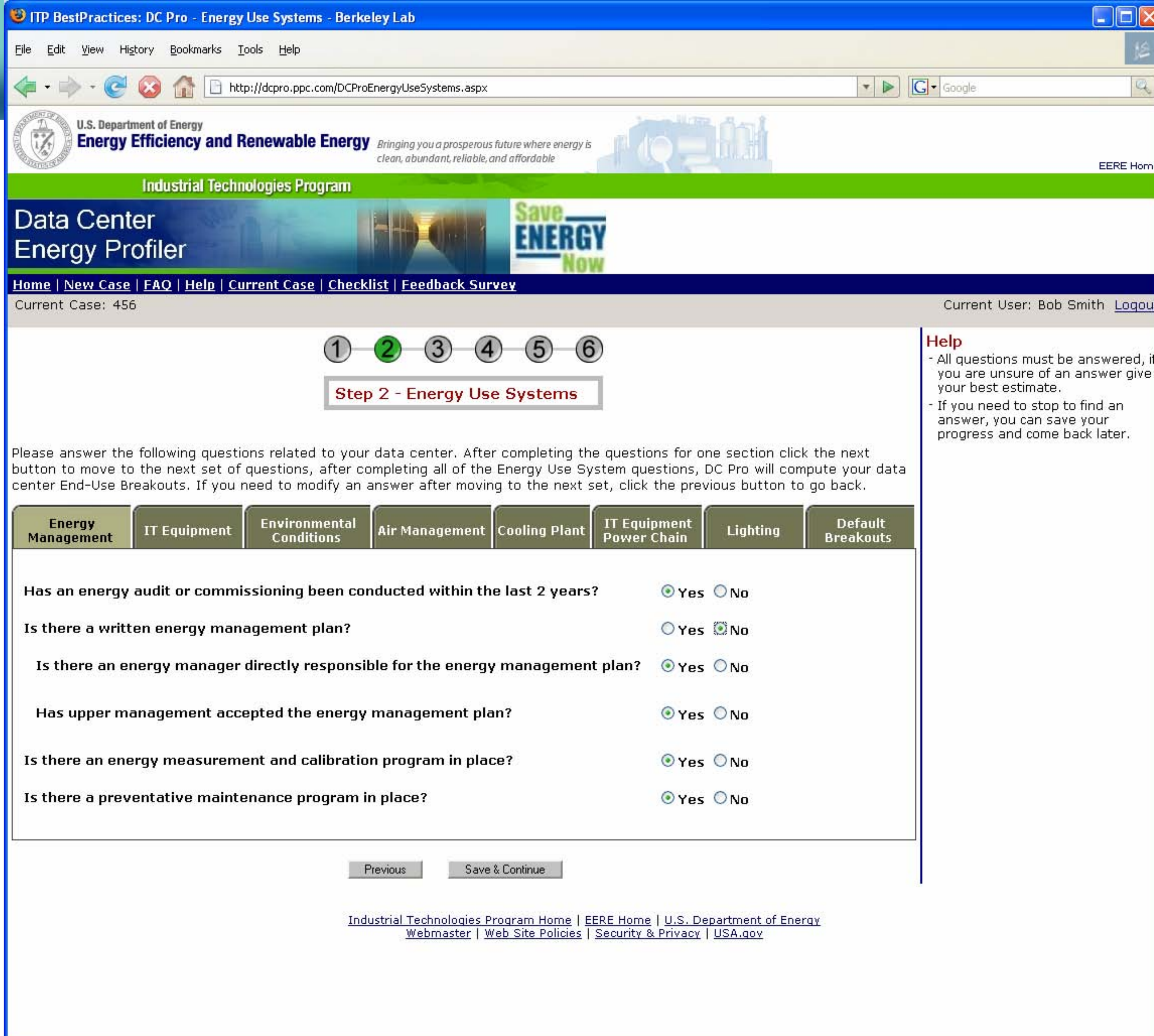
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Step 2 - Energy Use Systems

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.

Energy Management | IT Equipment | Environmental Conditions | Air Management | Cooling Plant | IT Equipment Power Chain | Lighting | Default Breakouts

Has an energy audit or commissioning been conducted within the last 2 years?	◉ Yes	○ No
Is there a written energy management plan?	○ Yes	◉ No
Is there an energy manager directly responsible for the energy management plan?	◉ Yes	○ No
Has upper management accepted the energy management plan?	◉ Yes	○ No
Is there an energy measurement and calibration program in place?	◉ Yes	○ No
Is there a preventative maintenance program in place?	◉ Yes	○ No

Previous | Save & Continue

Help

- All questions must be answered, if you are unsure of an answer give your best estimate.
- If you need to stop to find an answer, you can save your progress and come back later.

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Energy Management | IT Equipment | Environmental Conditions | **Air Management** | Cooling Plant | IT Equipment Power Chain | Lighting | Default Breakouts

How many CRAC/CRAH/AHUs are there that operate under normal conditions?	4
Is there any supplemental cooling?	In-Row
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?	11% to 89%
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?	Fair
Degree of current efforts to minimize recirculated air at the racks (for example, blanking panels)?	Fair
Degree of current efforts to minimize bypass air at the racks (for example, sealing cable penetrations in the floor)?	Fair

Help

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Energy Management | IT Equipment | Environmental Conditions | Air Management | Cooling Plant | IT Equipment Power Chain | Lighting | Default Breakouts

Is there an Uninterruptible Power Supply (UPS)?	(•) Yes ( ) No
UPS Technology Type	Double Conversion
What is the average load factor per active UPS module?	50% to 100%
UPS Redundancy Configuration	N+1
Is there a standby generator?	(•) Yes ( ) No
Standby Generator Power Configuration	N
Are there PDUs with built-in transformers?	(•) Yes ( ) No
What are the types of MV and LV transformer(s)?	Temp rise >80C
Average Load Factor per Active PDUs / Transformers	25% to 49%

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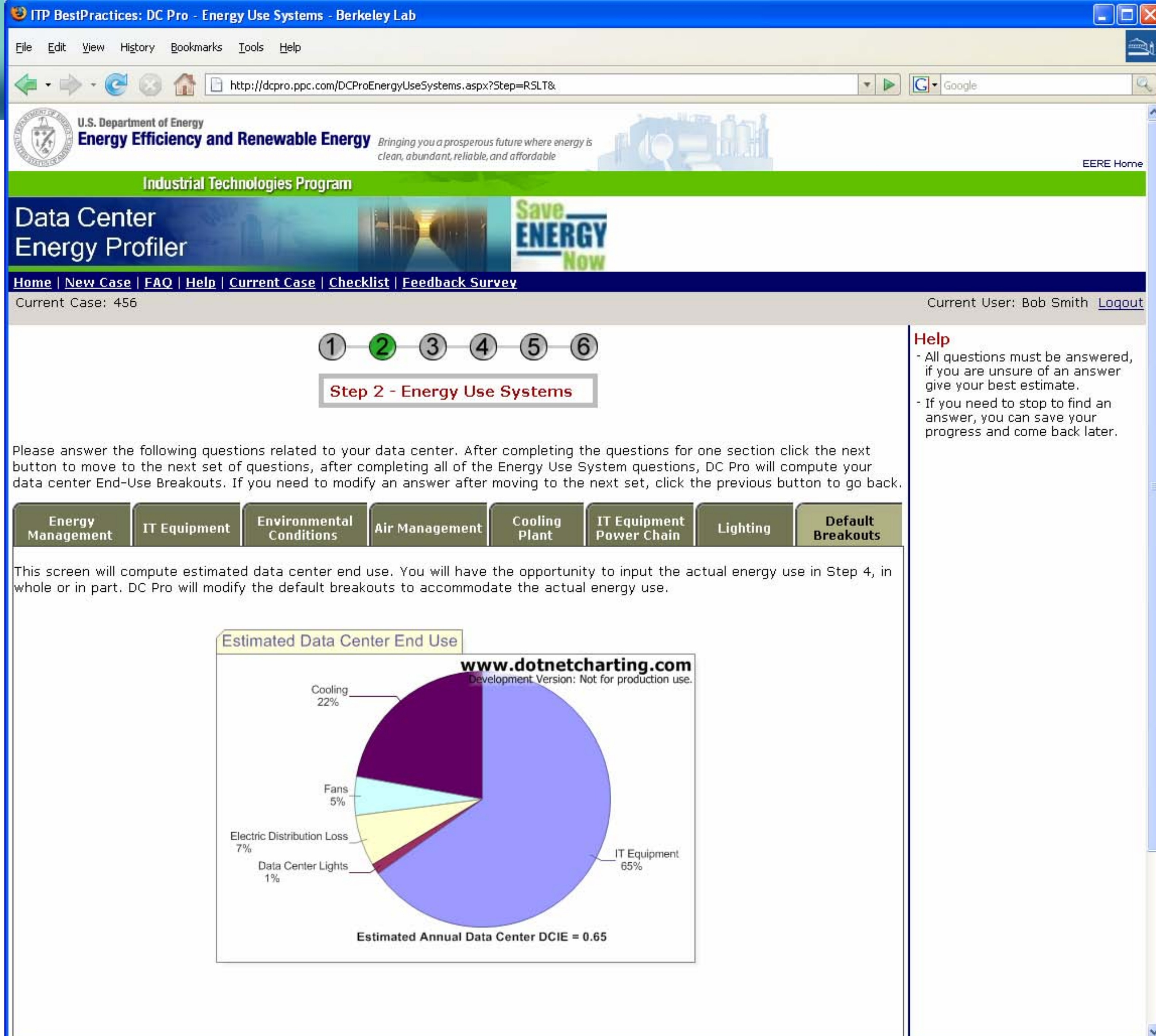
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Energy Management
IT Equipment
Environmental Conditions
Air Management
Cooling Plant
IT Equipment Power Chain
Lighting
Default Breakouts
This screen will compute estimated data center end use. You will have the opportunity to input the actual energy use in Step 4, in whole or in part. DC Pro will modify the default breakouts to accommodate the actual energy use.
Estimated Data Center End Use
www.dotnetcharting.com
Development Version: Not for production use.
Cooling 22%
Fans 5%
Electric Distribution Loss 7%
Data Center Lights 1%
IT Equipment 65%
Estimated Annual Data Center DCIE = 0.65
Help
- All questions must be answered, if you are unsure of an answer give your best estimate.
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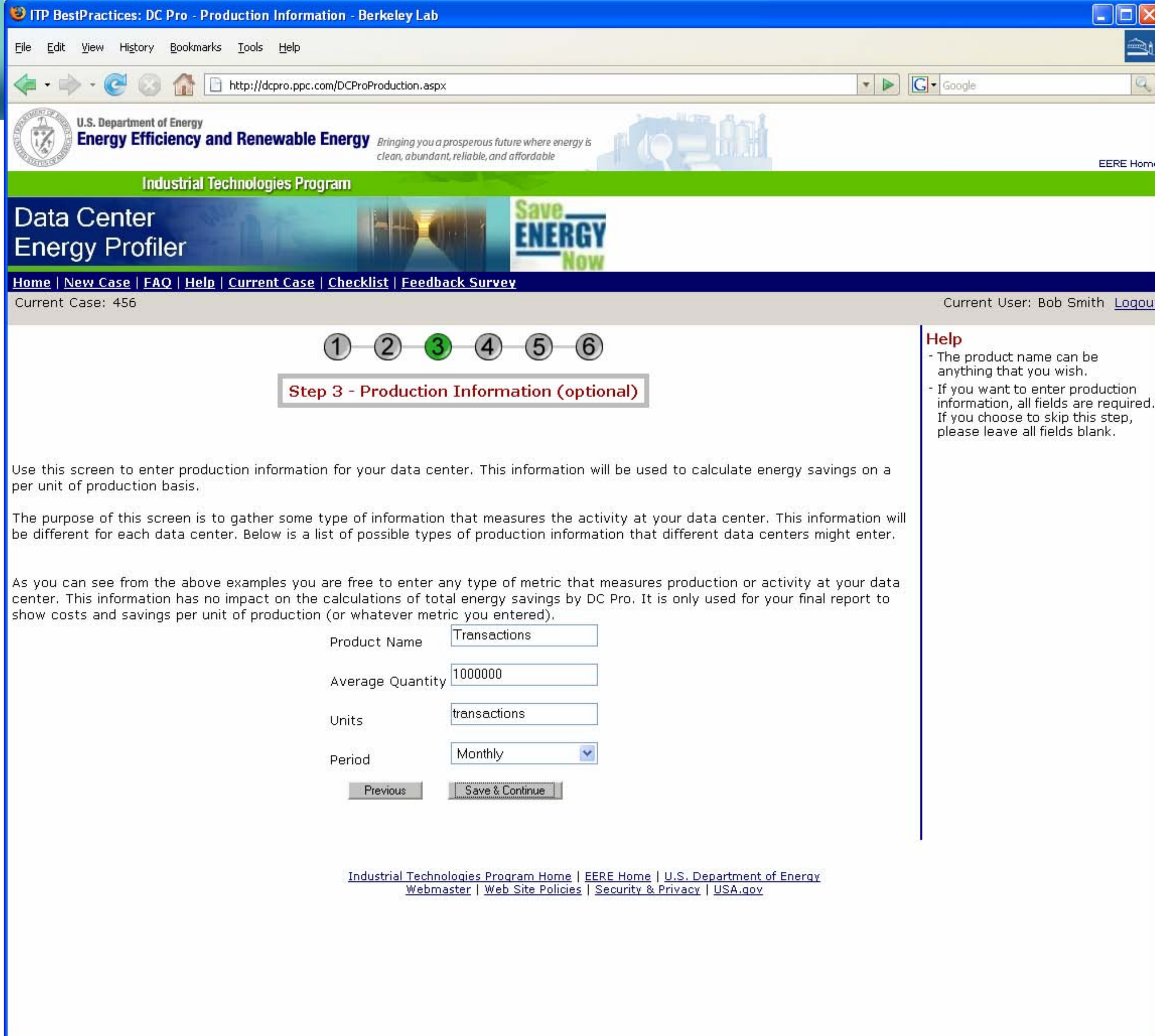
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Step 3 - Production Information (optional)
Help
- The product name can be anything that you wish.
- If you want to enter production information, all fields are required. If you choose to skip this step, please leave all fields blank.
Use this screen to enter production information for your data center. This information will be used to calculate energy savings on a per unit of production basis.
The purpose of this screen is to gather some type of information that measures the activity at your data center. This information will be different for each data center. Below is a list of possible types of production information that different data centers might enter.
As you can see from the above examples you are free to enter any type of metric that measures production or activity at your data center. This information has no impact on the calculations of total energy savings by DC Pro. It is only used for your final report to show costs and savings per unit of production (or whatever metric you entered).
Product Name
Transactions
Average Quantity
1000000
Units
transactions
Period
Monthly
Previous
Save & Continue
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Step 4 - Supplied Energy (optional)

Use the next four screens to enter data from utility bills and/or submeters recordings, entering this data is optional but doing so will help DC Pro more accurately profile your facility. If you do not, DC Pro will use the default energy end-use percentages from Step 2. Enter data only for those meters that support -- either partly or wholly -- the DC Load and/or the DC cooling system. You will be allowed to distribute any of the energy streams across the end-use breakout categories in the next step (Step 5) of the DC Pro process. If your facility does not use one or more of the energy stream simply leave that screen blank and click the Next button.

For each energy stream you will need to enter account information for each meter or sub-meter you have data on. For each account enter a Meter ID, select whether or not the meter is a sub-meter (and if so what meter it is a sub of), enter the average quantities and units purchased, and select the period for which this purchase reflects. 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.

Electricity | Fuel | Steam | Chilled Water

	Meter ID	On Site	Sub-Meter Of	Use per Period	Units	Period	Bills per Period	Annual Use	Units	Annual Bills
Edit Delete	001	No		250,000	kWh	Monthly	$1,110.00	3,000,000	kWh	$13,320.00
Edit Delete	002	No	001	50,000	kWh	Monthly	$250.00	600,000	kWh	$3,000.00
Edit Delete	213	No		25,555	kWh	Monthly	$12,345.00	306,660	kWh	$148,140.00
Save										

Previous | Save & Continue | Skip Step 4

Help

- You may enter as many meter accounts as you wish for each energy stream.
- If you do enter data for a particular stream, all fields are required.
- Remember to enter the average cost and quantity for the selected period.
- The cost that you enter should be the TOTAL cost of the energy stream for the selected period. This should include the cost of energy plus the total of all other charges including demand charges and any other recurring charges.
- Don't forget to enter energy that is generated on site at your plant. When entering on site generation just check the Generated On Site checkbox, but remember DO NOT ASSIGN ANY COST TO THIS.
- Click the information icons to display the tooltip popup. Tooltips help to better understand what the question is asking.

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Step 4 - Supplied Energy (optional)

Use the next four screens to enter data from utility bills and/or submeters recordings, entering this data is optional but doing so will help DC Pro more accurately profile your facility. If you do not, DC Pro will use the default energy end-use percentages from Step 2. Enter data only for those meters that support -- either partly or wholly -- the DC Load and/or the DC cooling system. You will be allowed to distribute any of the energy streams across the end-use breakout categories in the next step (Step 5) of the DC Pro process. If your facility does not use one or more of the energy stream simply leave that screen blank and click the Next button.

For each energy stream you will need to enter account information for each meter or sub-meter you have data on. For each account enter a Meter ID, select whether or not the meter is a sub-meter (and if so what meter it is a sub of), enter the average quantities and units purchased, and select the period for which this purchase reflects. 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.

Electricity | Fuel | Steam | Chilled Water

	Meter ID	Sub-Meter Of	Use per Period	Units	Bills per Period	Period	Annual Use	Units	Annual Bills
Edit Delete	1234		1,111	ton-hours	$111.00	Monthly	13,332	ton-hours	$1,332.00
Save									

Previous | Save & Continue | Skip Step 4

Help

- You may enter as many meter accounts as you wish for each energy stream.
- If you do enter data for a particular stream, all fields are required.
- Remember to enter the average cost and quantity for the selected period.
- The cost that you enter should be the TOTAL cost of the energy stream for the selected period. This should include the cost of energy plus the total of all other charges including demand charges and any other recurring charges.
- Don't forget to enter energy that is generated on site at your plant. When entering on site generation just check the Generated On Site checkbox, but remember DO NOT ASSIGN ANY COST TO THIS.
- Click the information icons to display the tooltip popup. Tooltips help to better understand what the question is asking.

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

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http://dcpro.ppc.com/DCProEnergyUseDistribution.aspx

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Data Center Energy Profiler

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Current Case: 456 Current User: Bob Smith Logout

1 2 3 4 5 6

Step 5 - Energy Use Distribution (optional)

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

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

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

Electricity | Fuel | Steam | Chilled Water | Summary

Site Energy End-Use Breakout Categories (Recalculate)

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

Previous | Save & Continue

Help

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

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http://dcpro.ppc.com/DCProReport.aspx?step=&screen=1

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Current Case: 456 Current User: Bob Smith Logout

1 2 3 4 5 6

Step 6 - Results

Open the Report in PDF

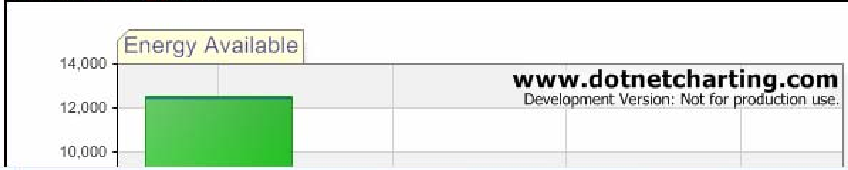
This is your customized DC Pro Summary Report. The report is broken into five basic sections. If you wish to go back and edit any of your values or add more dat page to navigate to the desired screen.

1. Case Information - your basic case information including energy consumption and savings on a per unit of production basis.
2. Annual Energy Use - a summary of your data center's annual energy purchases and consumption broken down by energy category.
3. Potential Annual Energy Savings - an estimation of potential annual energy savings for your data center's energy use systems displayed in MMBtu and dollar
4. Potential Annual CO2 Savings - an estimation of the potential annual reduction of CO2 emissions.
5. Suggested Next Steps - a customized list of suggested next steps for you to take to realize potential energy and cost savings.

Case Information

Case Name	456
Name	Bob Smith
Email	bsmith@abc.com
Company	ABC
Data Center Company	QWERT
County	Carroll County
State	Georgia

Annual Energy Use



	Total Amount Generated On Site	Total Amount	Unit
Electricity	0	12,535	MMBTU/yr
Fuel	0	4,980	MMBTU/yr

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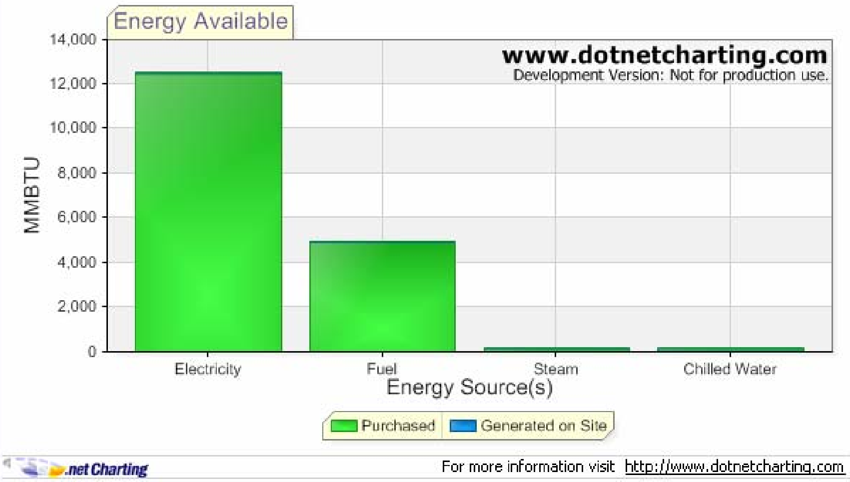
http://dcpro.ppc.com/DCProReport.aspx?step=&screen=1

Annual Energy Use



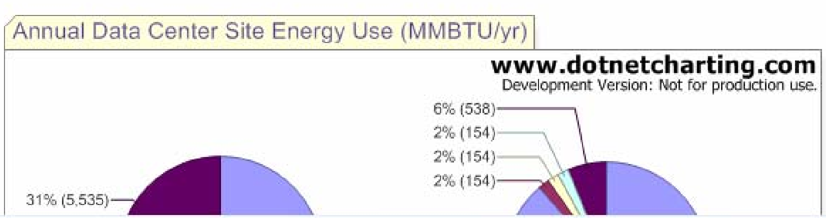
	Total Amount Generated On Site	Total Amount	Unit
Electricity	0	12,535	MMBTU/yr
Fuel	0	4,980	MMBTU/yr
Steam	0	176	MMBTU/yr
Chilled Water	0	160	MMBTU/yr
Total	0	17,851	MMBTU/yr

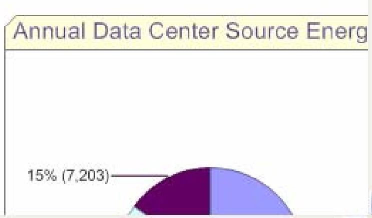
Potential Annual Energy Savings

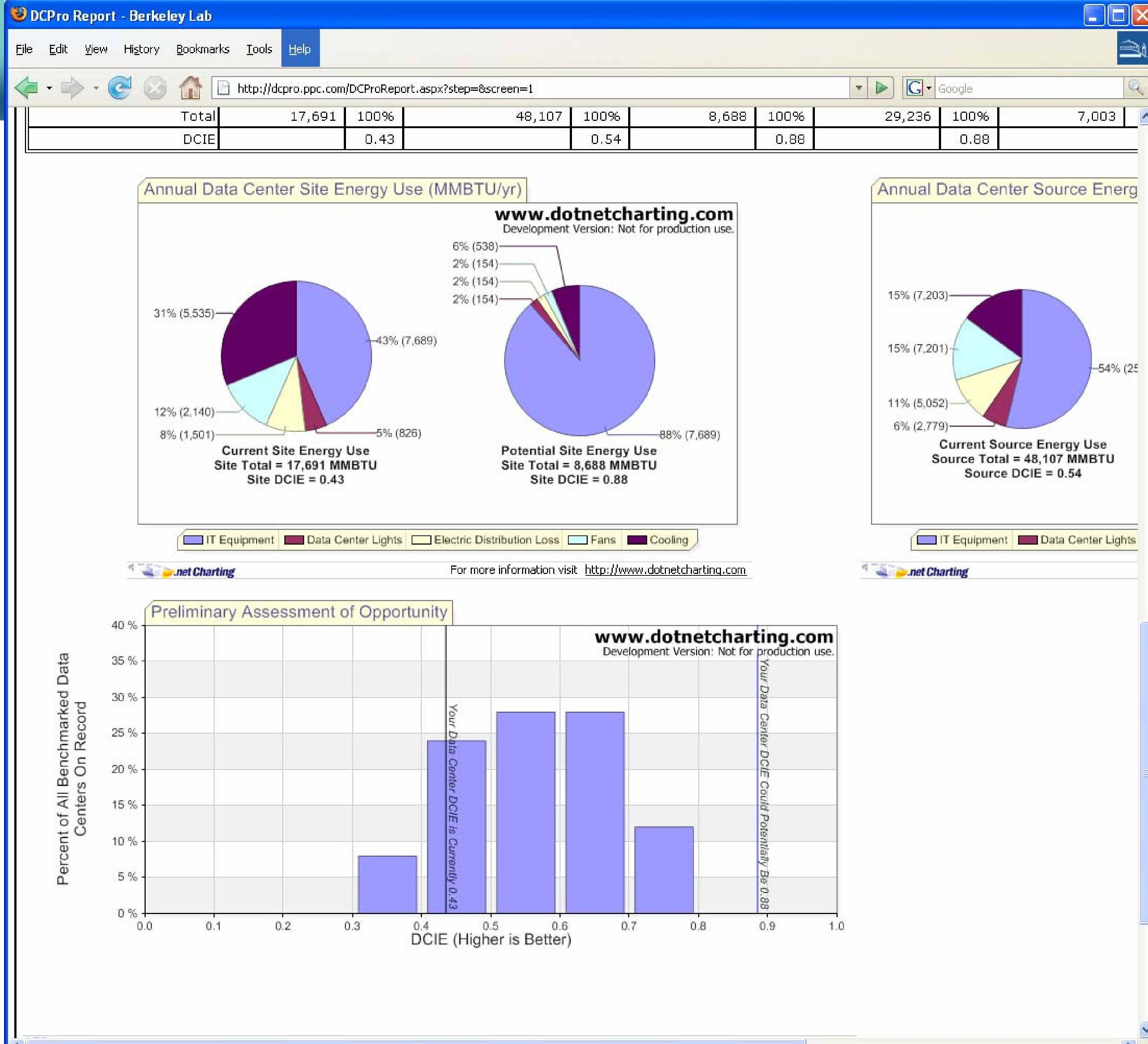
Suggested Next Steps

The following chart and data table summarize your data center's potential annual energy savings by breakout catergory.
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 su

Breakout Category	Current Energy Use				Potential Energy Use				Potential Sa
	Site Energy		Source Energy		Site Energy		Source Energy		
	MMBTU/yr	%	MMBTU/yr	%	MMBTU/yr	%	MMBTU/yr	%	MMBTU/yr
IT Equipment	7,689	43%	25,872	54%	7,689	88%	25,872	88%	0
Data Center Lights	826	5%	2,779	6%	154	2%	517	2%	672
Electric Distribution Losses	1,501	8%	5,052	11%	154	2%	517	2%	984
Fans	2,140	12%	7,201	15%	154	2%	517	2%	1,623
Cooling	5,535	31%	7,203	15%	538	6%	1,811	6%	3,724
Total	17,691	100%	48,107	100%	8,688	100%	29,236	100%	7,003
DCIE		0.43		0.54		0.88		0.88	



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http://dcpro.ppc.com/DCProReport.aspx?step=&screen=1
Total 17,691 100% 48,107 100% 8,688 100% 29,236 100% 7,003
DCIE 0.43 0.54 0.88 0.88
Annual Data Center Site Energy Use (MMBTU/yr)
www.dotnetcharting.com
Development Version: Not for production use.
31% (5,535)
43% (7,689)
12% (2,140)
8% (1,501)
5% (826)
Current Site Energy Use
Site Total = 17,691 MMBTU
Site DCIE = 0.43
6% (538)
2% (154)
2% (154)
2% (154)
88% (7,689)
Potential Site Energy Use
Site Total = 8,688 MMBTU
Site DCIE = 0.88
IT Equipment
Data Center Lights
Electric Distribution Loss
Fans
Cooling
.net Charting
For more information visit http://www.dotnetcharting.com
Annual Data Center Source Energ
15% (7,203)
15% (7,201)
11% (5,052)
6% (2,779)
54% (25
Current Source Energy Use
Source Total = 48,107 MMBTU
Source DCIE = 0.54
IT Equipment
Data Center Lights
.net Charting
Preliminary Assessment of Opportunity
www.dotnetcharting.com
Development Version: Not for production use.
Percent of All Benchmarked Data Centers On Record
40 %
35 %
30 %
25 %
20 %
15 %
10 %
5 %
0 %
Your Data Center DCIE is Currently 0.43
Your Data Center DCIE Could Potentially Be 0.88
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
DCIE (Higher is Better)

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http://dcpro.ppc.com/DCProReport.aspx?Step=ECOND&screen=2

[illegible]	[illegible]
County	Carroll County
State	Georgia

Suggested Next Steps **Potential Annual Savings**

Energy Management | IT Equipment | **Environmental Conditions** | Air Management | Cooling Plant | IT Equipment Power Chain | Lighting | Global Action

EC.A.1	Consider Air-Management measures	A low air temperature rise across the data center and/or IT equipment intake temperatures outside the recommended range suggest air management problems. A low return temperature is due to by-pass air and an elevated return temperature is due to recirculation air. Estimating the Return Temperature Index (RTI) and the Rack Cooling Index (RCI) will indicate if corrective, energy-saving actions are called for.
EC.A.2	Consider increasing the supply temperature	A low supply temperature makes the chiller system less efficient and limits the utilization of economizers. Enclosed architectures allow the highest supply temperatures (near the upper end of the recommended intake temperature range) since mixing of hot and cold air is minimized. In contrast, the supply temperature in open architectures is often dictated by the hottest intake temperature.
EC.A.4	Place temperature/humidity sensors so they mimic the IT equipment intake conditions	IT equipment manufacturers design their products to operate reliably within a given range of intake temperature and humidity. The temperature and humidity limits imposed on the cooling system that serves the data center are intended to match or exceed the IT equipment specifications. However, the temperature and humidity sensors are often integral to the cooling equipment and are not located at the IT equipment intakes. The condition of the air supplied by the cooling system is often significantly different by the time it reaches the IT equipment intakes. It is usually not practical to provide sensors at the intake of every piece of IT equipment, but a few representative locations can be selected. Adjusting the cooling system sensor location in order to provide the air condition that is needed at the IT equipment intake often results in more efficient operation.
EC.A.5	Recalibrate temperature and humidity sensors	Temperature sensors generally have good accuracy when they are properly calibrated (+/- a fraction of a degree), but they tend to drift out of adjustment over time. In contrast, even the best humidity sensors are instrinsically not very precise (+/- 5% RH is typically the best accuracy that can be achieved at reasonable cost). Humidity sensors also drift out of calibration. To ensure good cooling system performance, all temperature and humidity sensors used by the control system should be treated as maintenance items and calibrated at least once a year. Twice a year is better to begin with. After a regular calibration program has been in effect for a while, you can gauge how rapidly your sensors drift and how frequent the calibrations should be. Calibrations can be performed in-house with the proper equipment, or by a third-party service.
EC.A.6	Network the CRAC/CRAH controls	CRAC/CRAH units are typically self-contained, complete with an on-board control system and air temperature and humidity sensors. The sensors may not be calibrated to begin with, or they may drift out of adjustment over time. In a data center with many CRACs/CRAHs it is not unusual to find some units humidifying while others are simultaneously dehumidifying. There may also be significant differences in supply air temperatures. Both of these situations waste energy. Controlling all the CRACs/CRAHs from a common set of sensors avoids this.
EC.A.8	Consider disabling or eliminating humidification controls or reducing the humidification setpoint	Tightly controlled humidity can be very costly in data centers since humidification and dehumidification are involved. A wider humidity range allows significant utilization of free cooling in most climate zones by utilizing effective air-side economizers. In addition, open-water systems are high-maintenance items.
EC.A.9	Consider disabling or eliminating dehumidification controls or increasing the dehumidification setpoint	Most modern IT equipment is designed to operate reliably when the intake air humidity is between 20% and 80% RH. However, 55% RH is a typical upper humidity level in many existing data centers. Maintaining this relatively low upper limit comes at an energy cost. Raising the limit can save energy, particularly if the cooling system has an airside economizer. In some climates it is possible to maintain an acceptable upper limit without ever needed to actively dehumidify. In this case, consider disabling or removing the dehumidification controls entirely.
EC.A.10	Change the type of humidifier	Most humidifiers are heat based; ie, they supply steam to the air stream by boiling water. Electricity or natural gas are common fuel sources. The heat of the steam becomes an added load on the cooling system. An evaporative humidifier uses much less energy. Instead of boiling water, it introduces a very fine mist of water droplets to the air stream. When set up properly the droplets quickly evaporate, leaving no moisture on nearby surfaces. This has an added cooling benefit, as the droplets absorb heat from the air as they evaporate.

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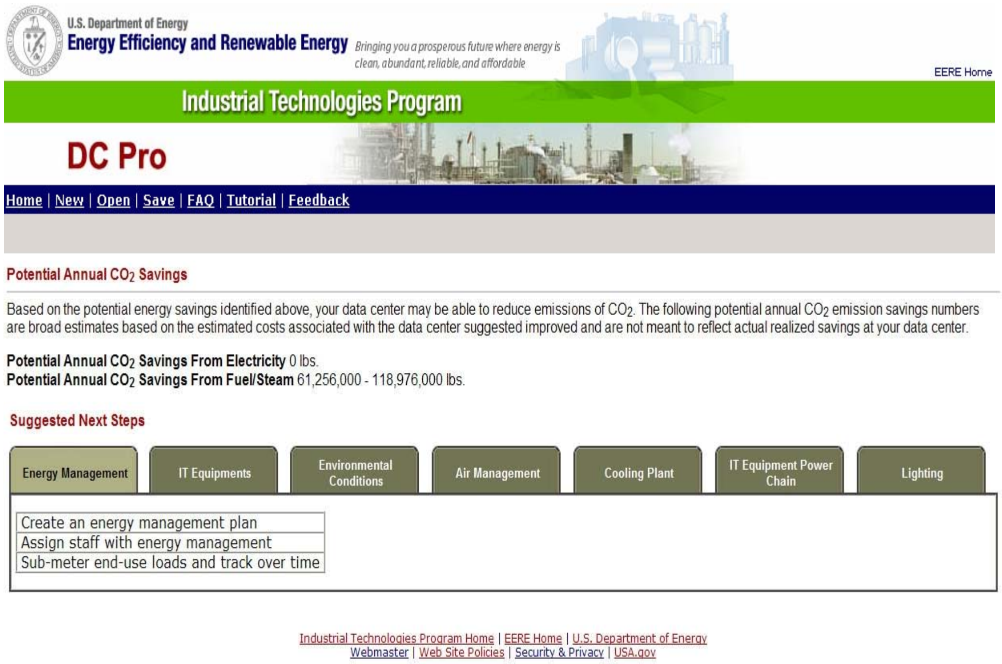
Example “DC Pro” recommendations

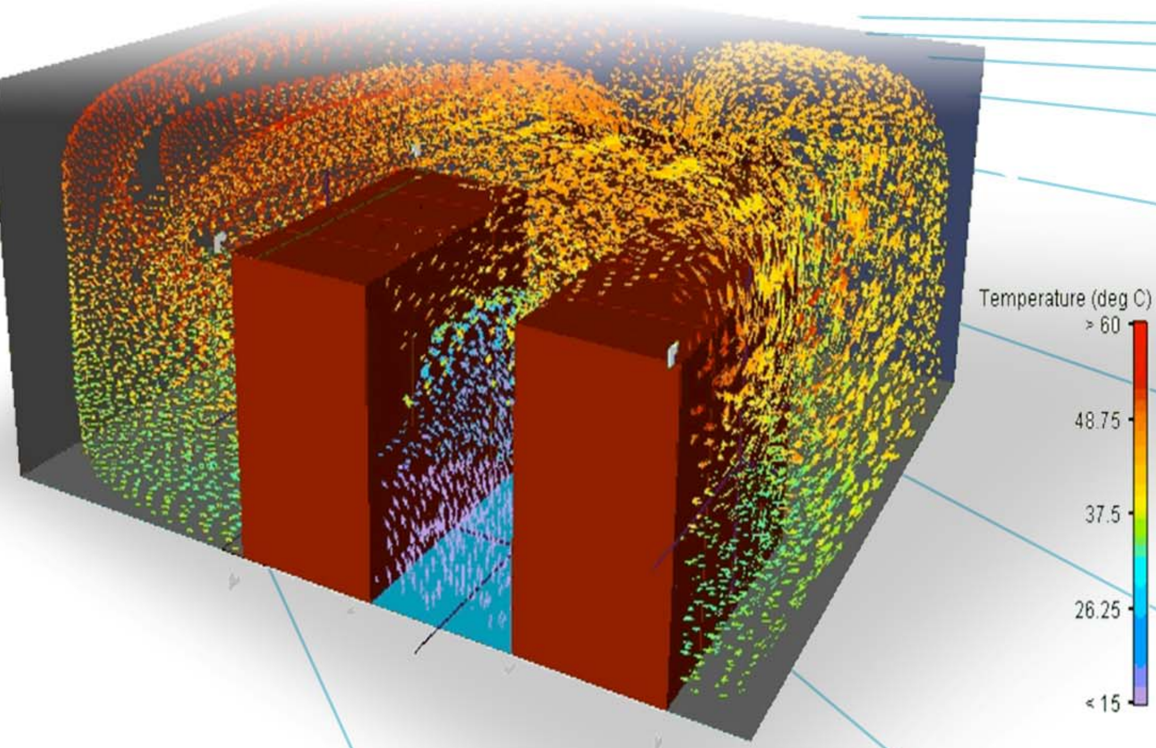
List of Actions (for Electric Distribution System)

- Avoid lightly loaded UPS systems
- Use high efficiency MV and LV transformers
- Reduce the number of transformers upstream and downstream of the UPS
- Locate transformers outside the data center
- Use 480 V instead of 208 V static switches (STS)
- Specify high-efficiency power supplies
- Eliminate redundant power supplies
- Supply DC voltage to IT rack



DOE activities are leveraged:

- Industry is taking action
  - IT manufacturers
  - Infrastructure equipment manufacturers
- Industry Associations are active:
  - ASHRAE
  - Green Grid
  - Uptime Institute
  - Afcom
  - Critical Facilities Roundtable
  - 7 X 24 Exchange
- Utilities and State governments programs



Questions / discussion

Links to get started

DOE Website: Sign up to stay up to date on new developments
www.eere.energy.gov/datacenters

Lawrence Berkeley National Laboratory (LBNL)
http://hightech.lbl.gov/datacenters/

LBNL Best Practices Guidelines (cooling, power, IT systems)
http://hightech.lbl.gov/datacenters-bpg/

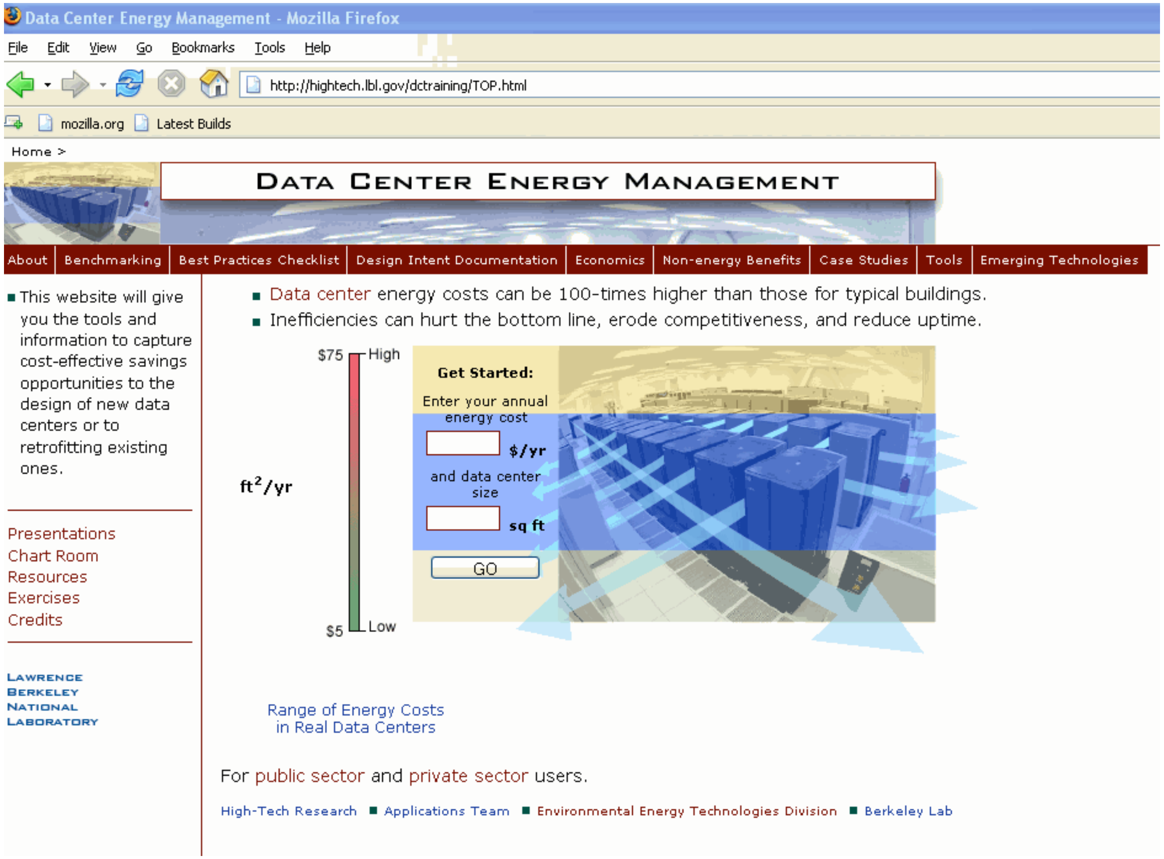
ASHRAE Data Center technical guidebooks
http://tc99.ashraetcs.org/

The Green Grid Association: White papers on metrics
http://www.thegreengrid.org/gg_content/

Energy Star® Program
http://www.energystar.gov/index.cfm?c=prod_development.server_efficiency

Uptime Institute white papers
www.uptimeinstitute.org

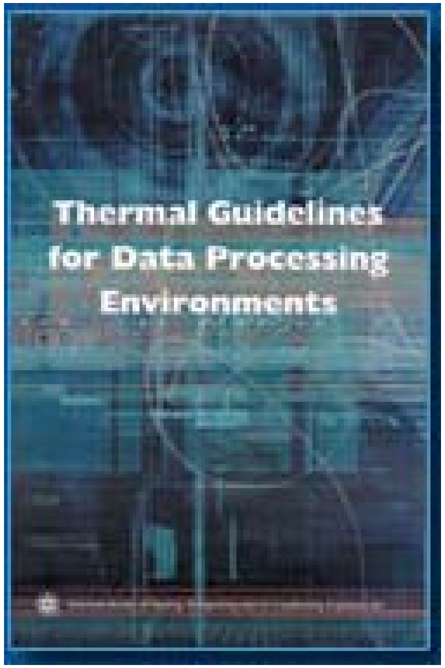
Web based training resource

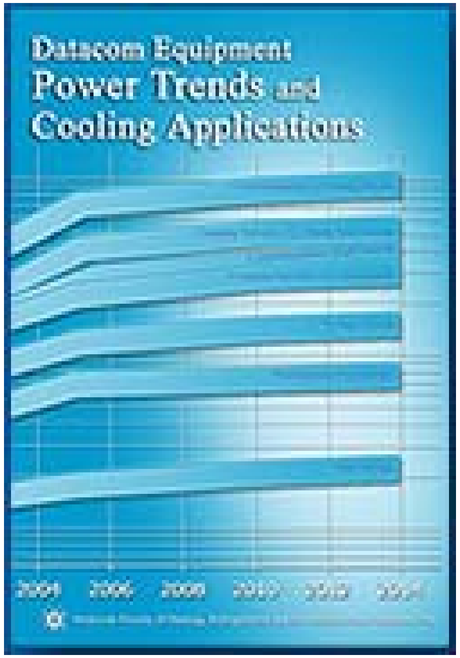


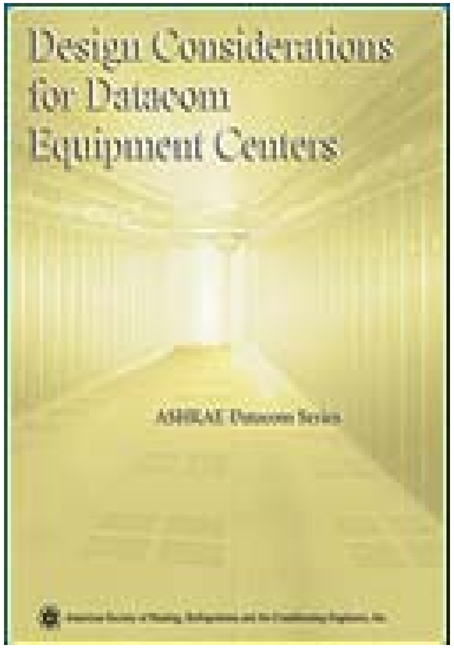
http://hightech.lbl.gov/dctraining/TOP.html

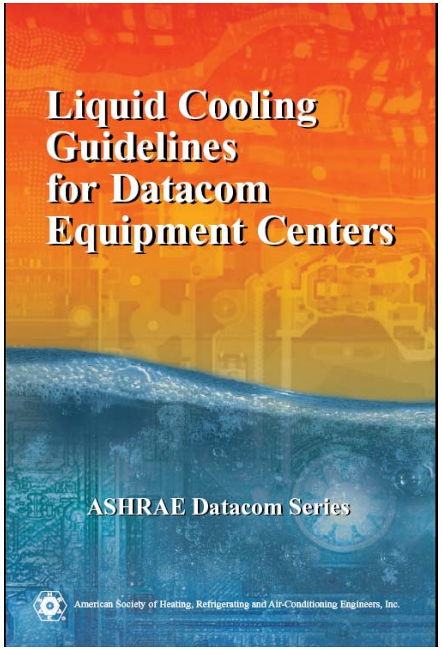
ASHRAE guidelines

six books published—more in preparation









ASHRAE, Thermal Guidelines for Data Processing Environments, 2004, Datacom Equipment Power Trends and Cooling Applications, 2005, Design Considerations for Datacom Equipment Centers, 2005, Liquid Cooling Guidelines for Datacom Equipment Centers, 2006, © American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., www.ashrae.org

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