The webinar will start momentarily....

September 20, 2023
Webinar Logistics

- This webinar is being recorded. The Q&A section will not be made publically available.
- Your phone will be muted throughout the webinar.
- Enter any questions in the Question Box throughout the webinar.
- Instructions to take the quiz will be provided at the end of webinar.
- Slides will be sent out afterwards to those who attend the entire webinar.
Today’s Speakers

Rick Mears, CEM
Data Centers Program Lead
Federal Energy Management Program
Rick.Mears@hq.doe.gov
240-278-5857

Magnus Herrlin, Ph.D.
Center of Expertise for Energy Efficiency in Data Centers
Lawrence Berkeley National Laboratory
mkherrlin@lbl.gov
510-206-9739

Jeff Murrell, P.E.
Energy-Intensive Project Manager
Federal Energy Management Program
Jefferey.Murrell@hq.doe.gov
202-394-2240
Berkeley Lab’s Center of Expertise (CoE)

Use CoE’s Energy Efficiency Toolkit, including simulation tools.

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Filter CoE’s many resources by type and topic.

Search resources by topics of interest.

We offer tools, technologies and analysis to enhance energy performance in datacenters.

Featured Work

- Electrical Power Chain Tool
- NEW! Accessing Onboard Server Sensors for Energy Efficiency in Data Centers
- NEW! Computer Server Selection Guidelines for Energy Efficiency and Decarbonization in Data Centers

Visit us at http://datacenters.lbl.gov
## Webinar Agenda

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### Learning Objectives

- Understand the overall energy assessment process
- Recognize basic opportunities to save energy
- Recognize the DOE data center energy assessment simulation tools
- Be aware of the DOE DCEP energy assessment training
The objective of this webinar is to provide data center energy assessment tips and discuss relevant parts of the CoE* Data Center Energy Assessment Toolkit. These tools provide a comprehensive resource for your assessments.

The DOE DCEP training program provides more in-depth information on the Toolkit and on energy assessments in general.

*Center of Expertise for Energy Efficiency in Data Centers at Berkeley Lab
Context of Energy Efficiency and Decarbonization in Data Centers
Importance of Energy Efficiency

In 2014, energy consumed by data centers was around 1.8%* of the total electric energy consumed in the US. This is a large amount of energy for a single type of facility.

Since energy is a cost to the data center, energy efficiency is an important business consideration. There are also growing regulatory, compliance, and market pressures to reduce energy use as well as CO$_2$ release.

The Energy Assessment Process
A “tool” refers to any resource for facilitating energy assessments.

http://datacenters.lbl.gov/Tools

Multiple appendices include useful templates for the assessments.

https://datacenters.lbl.gov/resources/dcep-process-manual
General Opportunity
Avoid Excessive Redundancy

For most energy-consuming systems and equipment, redundancy is a major driver for energy inefficiencies.

Redundancy is intended to ensure reliability and make systems fault tolerant. But, when several pieces of equipment are included for redundancy purposes, they will operate below their rated power.
IT Equipment Opportunities
IT Drives Demand for Power/Cooling

• IT equipment requires significant power.
• All IT power is released as heat to the space.
• This heat must be removed from the data center.
• Reduced IT power draw will also lower energy use of other support systems.
• Thus, energy saving measures at the IT equipment level are especially rewarding.
ENERGY STAR for Servers

- ENERGY STAR Computer Server Specification Version 4.0 (2023)
- Requirements for PSU efficiency and Power Factor
- Requirements for power management (enabled by default)
- Requirements for access to power consumption, processor utilization, and intake air temperature

https://www.energystar.gov/products/spec/energy_star_computer_servers_version_4_0_pd
Federal Requirements

It is a federal requirement to purchase ENERGY STAR certified IT equipment (Energy Policy Act of 2005, Sec. 104) and agencies should consider EPEAT-registered equipment (DCOI M-19-19 and M-21-05).

EPEAT (Electronic Product Environmental Assessment Tool) registered equipment has additional energy benefits.

https://datacenters.lbl.gov/ServerSelectionGuidelines
IT Usage Effectiveness (ITUE)  (always >1.0)

ITUE = Total IT Equipment Energy / Compute Component Energy

The ITUE is a “PUE-type” metric for the IT equipment rather than for the data center infrastructure (more about PUE later).

The metric is typically in the range of 1.3 (high efficiency IT) - 1.7 (low efficiency IT).

Selecting energy efficient servers and operating them energy efficiently can have a profound impact on overall energy efficiency and decarbonization in data centers.

This research report provides guidelines on how to select energy efficient servers.

https://datacenters.lbl.gov/ServerSelectionGuidelines
There are a number of IT consolidation approaches but virtualization may be the most powerful.

Virtualization consolidates applications from under-utilized IT equipment onto fewer, better utilized hardware. Idling servers can consume up to 60% of full power.
Decommissioning

Decommissioning is a quick way to reduce energy use
- Shutdown and removal of long-term idle equipment
- Retire legacy hardware
- Even in well-managed centers, 15-30% servers are idle
Accessing Onboard Server Data

This research report provides a roadmap to accessing server data, among them computational utilization. The ENERGY STAR required data are retrieved by using onboard sensors rather than using external ones.

http://datacenters.lbl.gov/resources/accessing-onboard-server-sensors-energy
Takeaways

• Remove server waste (idling/unused servers)
• Consolidate under-utilized gear (optimize utilization)
• Use ENERGY STAR certified gear
• Access onboard server data
Air Management Opportunities
What is Air Management?

The goal is to minimize mixing of hot and cold air streams by reducing air recirculation of hot air and reducing by-pass of cold air. The result is reduced energy use and better thermal space conditions.
Managing Blanking Panels

Blanking panels seal openings in equipment racks. Managing these panels is especially important in hot and cold aisle environments.
Perforated floor tiles should *only* be placed in the cold aisles and match the need of the IT gear. Too little or too much supply air results in poor conditions.
Maintain Tight Raised Floors

A large fraction of the air from the air-handlers is often lost through leaks in the raised floor.

Grommets for cable penetrations reduce the floor leakage (Upsite Technologies)

Unsealed cable cut-out in floor under equipment rack
Intake Air Temperature Guidelines

Intake air temperatures for IT equipment are specified by ASHRAE and NEBS. Operate near max. Level of compliance can be demonstrated with the Rack Cooling Index (RCI).

<table>
<thead>
<tr>
<th>(@ Equipment Intake)</th>
<th>Recommended (Facility)</th>
<th>Allowable (Equipment)</th>
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<tr>
<td><strong>Temperature</strong></td>
<td></td>
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<tr>
<td>Data Centers</td>
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<tr>
<td>Class A1</td>
<td>65° – 80°F</td>
<td>59° – 90°F</td>
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<tr>
<td>Class A2</td>
<td>65° – 80°F</td>
<td>50° – 95°F</td>
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<tr>
<td>Telecom</td>
<td>65° – 80°F</td>
<td>41° – 104°F</td>
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ASHRAE Reference: ASHRAE (2021); NEBS References: Telcordia (2012 and 2001)

Air Management + EPEAT* Servers

EPEAT-registered servers must be able to operate in the ASHRAE Allowable Class A2 or higher. This allows higher data center temperatures than air management alone, which further reduces the cooling energy.

* Electronic Product Environmental Assessment Tool, Global Electronics Council

https://epeat.net
It is not necessary to collect temperature data for every IT rack. Measuring every other/third rack is generally fine.

If external probes are used, three probes per measured IT rack is recommended. Using the onboard server sensors provides benefits over using external sensors.

Frontal view of an IT rack row.
More Information: Thermal Guidelines

This Berkeley Lab research report provides guidance on temperature and humidity for IT equipment and IT equipment spaces as well as how to show compliance with those physical parameters.

http://datacenters.lbl.gov/resources/thermal-guidelines-and-temperature
How to Realize Energy Savings

Realizing energy savings is a two-step process:

1. Physically arrange the space to promote separation of hot and cold air. These measures by themselves do not save energy but rather enable savings.

2. To realize the savings at least one of two actions must be taken: Increase the supply air temperature and/or decrease the supply airflow rate.

Finally, air management is a prerequisite to many energy efficiency measures.
Takeaways

• Minimize mixing of hot and cold air
• *Enable* energy savings by applying physical air management measures
• *Realize* savings by adjusting supply temp and/or airflow
• Operate near the max recommended intake temperature
• Use the RCI metric to ensure thermal compliance
Cooling Opportunities
Benefits with Higher IT Intake Air Temperatures

- Improved DX System efficiency
- Improved Chilled-Water System efficiency
- More hours for air- or water-side free cooling
Comparison of Different Cooling Systems

Direct expansion (DX) systems use CRAC units whereas chilled-water systems use CRAH units.
Why Liquid Cooling?

Liquid cooling allows heat to be transferred to the liquid closer to the heat source, which will improve cooling energy efficiency.

The increased efficiency is driven by improved chiller performance and greatly improved opportunity for free cooling.

In addition, liquid cooling can manage high IT load densities.
Easy Step to Liquid Cooling: Rear-Doors

- Simple design
- Passive technology
- Relies on server fans
- Potentially room neutral
- Chilled or tower water

Graphic courtesy of Coolcentric
Takeaways

• Operate with higher IT equipment intake air temperatures
• Use air- or water-side economizers where possible
• Use water-cooled (vs. air-cooled) DX units and chillers
• Consider chilled-water systems for larger data centers
• Liquid cooling reduces energy use and helps manage dense IT loads
Electric Power Chain Opportunities
Causes of Electrical Energy Inefficiency

• System Configuration
  • Excessive redundancy – low utilization
  • Lack of scalable, modular design

• Lack of Metering and Metrics

• Design & Sizing Concepts
  • Oversized equipment
  • Legacy lighting and controls
Defining the Infrastructure Metric PUE

Power Usage Effectiveness (PUE) (always >1.0)

PUE = Total Facility Energy / IT Energy

A PUE of 2 means that the infrastructure uses the same amount of energy as the IT equipment.

Note: PUE does not address IT efficiency (but ITUE does).


For proper designations, derivatives, and declarations of PUE see ISO IS30314-2
Optimizing UPS Efficiency

- UPSs are generally the largest source of losses in the electrical system
- Requirement to purchase ENERGY STAR UPSs for federal data centers
- Maximize the UPS utilization
- Install modular UPSs for load optimization/reliability
Takeaways

• High equipment utilization is the most important factor for electrical efficiency
• Align facility power and IT requirements to reduce over-sizing
• Specify premium equipment, especially UPSs
• Require energy metering and reporting
Master List of Data Center Energy Efficiency Measures
Data Center Energy Efficiency Toolkit

http://datacenters.lbl.gov/Tools
Master List of DC Energy Efficiency Measures

• Living encyclopedia of data center EEMs*
  – An essential desk reference
  – 250 energy-saving measures

• For each EEM, the Master List explains the principles involved and how energy savings are generated plus tips on implementation

* EEM = Energy-Efficiency Measure
Simulation Tools
Simulation Tools in the Toolkit

The online high-level (profiling) DC Pro tool covers all major energy consuming systems in data centers.

Three Excel system-level tools, on the other hand, focus on a single energy-consuming system (IT, HVAC, or Electrical) to produce a more accurate estimate of energy savings.
Data Center Profiler (DC Pro)

Start here!

Data Center Profiling Tools
- PUE Estimator
- DC Pro

Collect Data, Consider Energy Efficiency Actions
- Energy Assessment Worksheet
- Master List of Efficiency Actions

System-Level Assessment Tools
- IT Efficiency Tool
- AM Estimator
- AM Tool
- AM Packages Tool
- Power Chain Tool

Report Findings & Make Recommendations
- Energy Assessment Report Template

AM = Air Management

http://datacenters.lbl.gov/Tools
The DC Pro Tool

DC Pro was developed to estimate energy savings associated with improved data center design and operation. It provides:

– What-if scenarios
– Hands-on recommendations
– Power Utilization Effectiveness (PUE)
– Energy Use Distribution

The DOE Data Center Optimization Initiative (DCOI) requests all “tiered” federal data centers to conduct an energy assessment every few years using DC Pro and certified Data Center Energy Practitioners (DCEPs).
Data Center System-Level Simulation Tools

AM = Air Management

http://datacenters.lbl.gov/Tools
Commonalities (shared features)

The system tools were developed to estimate energy savings at the system level. All three tools have the following features in common (in addition to tool-specific features).

- What-if scenarios
- Hands-on recommendations
- Energy and cost savings
- CO₂ reductions
- Simple payback for energy-saving measures
- Export/import data to/from other system tools
Data Center Air Management Look-Up Tables

Start here!

Energy Assessment Process Manual

Data Center Profiling Tools
- PUE Estimator
- DC Pro

Collect Data, Consider Energy Efficiency Actions
- Energy Assessment Worksheet
- Master List of Efficiency Actions

System-Level Assessment Tools
- IT Efficiency Tool
- AM Estimator
- AM Tool
- AM Packages Tool
- Power Chain Tool

Report Findings & Make Recommendations
- Energy Assessment Report Template

Almost done

AM = Air Management

http://datacenters.lbl.gov/Tools
Air Management Look-Up Tables

Want a quick and easy way to estimate air management savings without a simulation tool?


https://datacenters.lbl.gov/resources/air-management-packages-tool
Data Center Training Courses
Data Center Energy Practitioner (DCEP)

Start here!

Energy Assessment Process Manual

Data Center Profiling Tools
  PUE Estimator
  DC Pro

Collect Data, Consider Energy Efficiency Actions
  Energy Assessment Worksheet
  Master List of Efficiency Actions

System-Level Assessment Tools
  IT Efficiency Tool
  AM Estimator
  AM Tool
  AM Packages Tool
  Power Chain Tool

Report Findings & Make Recommendations
  Energy Assessment Report Template

Keep it simple(r)

More detail

Data Center Assessment Complete!

http://datacenters.lbl.gov/Tools

AM = Air Management
DCEP Training Courses

This comprehensive training provides more in-depth information on energy assessments than presented in this webinar. There are three courses:

• **Generalist (one day):** It provides a basic review of all energy-consuming systems, DC Pro, and the Electrical Tool.

• **HVAC Specialist (two days):** This is an in-depth look at HVAC systems and the Air Management Tool.

• **IT Specialist (one day):** This course is an in-depth examination of IT systems and the IT Equipment Tool.
Official DCEP Website and LinkedIn Group

Website
• Program overview/description
• Training calendar, sign-up
• List of program developers, instructors, and practitioners

LinkedIn Group
Anyone interested in energy efficiency in data centers can join. We monitor and respond to questions and post news.

http://datacenters.lbl.gov/DCEP

https://www.linkedin.com/groups/9223041/
Summary

The objective of this webinar was to discuss the overall energy assessment process in data centers without going too much into details. More in-depth information is provided by the DCEP training courses, which provide a wealth of information for those performing energy assessments in data centers.

In this webinar, we initially provided an overview of the CoE Data Center Energy Assessment Toolkit and the administrative energy assessment process in data centers. We continued by providing hands-on basic energy-saving tips as well as reviewing the CoE simulation tools.
Resources and Q&A
FEMP’s Data Center Program

FEMP’s data center program assists federal agencies and other organizations with optimizing the design and operation of energy and water systems in data centers.

**Assistance**
- Project and technical assistance from the Center of Expertise including identifying and evaluating ECMs, M&V plan review, and project design review
- Support agencies in meeting OMB’s Data Center Optimization Initiative requirements

**Tools**
- Data Center Profiler (DC Pro) Tools (x2)
- Air Management Tools (x3)
- IT Equipment Tool
- Electrical Power Chain Tool
- Energy Assessment Worksheets
- The Energy Assessment Process Manual

**Key Resources**
- Better Buildings Data Center Challenge and Accelerator
- Small Data Centers, Big Energy Savings: An Introduction for Owners and Operators
- Data Center Master List of Energy Efficiency Actions

**Training**
- Data Center Energy Practitioner (DCEP) Trainings
- Better Buildings webinar series
- Nine on-demand FEMP data center trainings
- Center of Expertise Webinars
Berkeley Lab’s Center of Expertise (CoE)

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Featured Work

Electrical Power Chain Tool

NEW! Accessing Onboard Server Sensors for Energy Efficiency in Data Centers

NEW! Computer Server Selection Guidelines for Energy Efficiency and Decarbonization in Data Centers

Visit us at http://datacenters.lbl.gov
Federal Project Executive

Federal Project Executives (FPEs)

Scott Wolf
Western Region
360-866-9163
wolfsc@ornl.gov

Doug Culbreth
Southeast Region
919-870-0051
culbrethcd@ornl.gov

Tom Hattery
Northeast Region
202-256-5986
thomas.hattery@ee.doe.gov
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mkherrlin@lbl.gov
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Questions?
The National Institute of Building Sciences’ (NIBS) Whole Building Design Guide (WBDG) hosts the FEMP training program’s learning management system (LMS).

The WBDG LMS:

- Allows for taking multiple trainings from multiple organizations through one platform.
- Houses the assessments and evaluations for all accredited courses.
- Allows you to:
  - Track all of your trainings in one place.
  - Download your training certificates of completion.
- Eases the CEU-achievement process.

Visit the WBDG at www.wbdg.org to view courses and create an account.
IACET Credit for Webinar

To receive IACET-Certified CEUs, attendees must:

• Attend the training in full (no exceptions).
  – If you are sharing a web connection during the training, you must send an e-mail to Elena Meehan (elena.meehan@ee.doe.gov) and indicate who was on the connection and who showed as connected (will reflect in the WebEx roster).

• Complete an assessment demonstrating knowledge of course learning objectives and an evaluation within six weeks of the training. A minimum of 80% correct answers are required for the assessment.

To access the webinar assessment and evaluation, visit:

https://www.wbdg.org/continuing-education/femp-courses/femplw02142023

If you have a WBDG account and enrolled previously, simply log in and click the Continuing Education tab on the user account page. Click Proceed to Course next to the course title.