Data Center Toolkit Webinar Series:
Part 4 – Introducing the New IT Equipment Energy Assessment Tool

January 21, 2020
Webinar Logistics

- This webinar is being recorded. The Q&A section will not be made publicly 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

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# Webinar Agenda

## Agenda

<table>
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<th>Introduction</th>
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<td>II.</td>
<td>Context of IT Tool and Common Energy-Saving Measures</td>
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<tr>
<td>III.</td>
<td>Demonstration of IT Tool</td>
</tr>
<tr>
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<td>Resources and Q&amp;A</td>
</tr>
</tbody>
</table>

## Learning Objectives

- Educate data center stakeholders on the **context** of IT equipment energy management in data centers and the **role** of the new IT Tool in the DOE/LBNL DC EE Toolkit.
- Educate stakeholders on identification of energy-saving **opportunities** at the IT level, including virtualization and consolidation, and the **use** of the IT Equipment Tool.
- Educate stakeholders in the DOE energy assessment **process** as it relates to IT equipment energy management.
- Educate stakeholders in ways in which the tool contributes to a concrete **plan of action** and budget and engender institutional support.
Fourth in a Four-Webinar Series

This training series introduces a broad toolkit for identifying energy-saving opportunities in data centers.

- **A Suite of Energy Assessment Tools**
  - Webinar 1
  - [https://www.wbdg.org/continuing-education/femp-courses/fempodw049](https://www.wbdg.org/continuing-education/femp-courses/fempodw049)

- **Electric Power Chain Tool**
  - Webinar 2
  - Recorded version in development

- **Air Management Tools**
  - Webinar 3
  - Recorded version in development

- **IT Equipment Tool**
  - Webinar 4
  - Today
Data Center Energy Efficiency Toolkit
DC EE Toolkit - Calculators

- Data Center Profiler ("DC Pro"), online
- PUE Estimator, online
- Air Management Tool, Excel
- Air Management Estimator, Excel
- Electrical Power Chain Tool, Excel
- IT Equipment Tool, Excel.

IT Equipment Tool is temporarily located at: https://datacenters.lbl.gov/tools/9-it-equipment-energy-assessment-tool

It will be located permanently here (with the other tools) early 2021: http://datacenters.lbl.gov/tools
Context of the IT Equipment Energy Assessment Tool
Motivation for the IT Equipment Tool

• A large part of data center energy is used by IT

• Significant opportunities for IT improvements

• IT no longer off-limits for energy efficiency efforts

• IT energy savings cascade through most support systems, multiplying savings

• High return on investment
Total Savings for One Watt Saved At the IT Equipment

Source: Intel Corp.
IT Tool Helps Comply With Federal Requirements

The IT Equipment Tool will help agencies comply with several federal requirements:

- Energy Independence and Security Act of 2007 (EISA)
- Executive Order 13834 (2018)
- The Data Center Optimization Initiative/FITARA
- Energy Act of 2020

By identifying energy conservation measures, use of the IT Equipment Energy Assessment Tool and the data center assessment process furthers such FEMP initiatives as the ESPC/UESC program, the 50001 Ready program and the Energy Efficient Product Procurement Program.
What does the IT Tool do?

- Details various energy-saving measures
- Estimates energy and carbon savings in:
  - IT equipment
  - Support systems
- Provides tailored, hands-on recommendations
Opportunities
Key Energy-Saving Opportunities

• **Removing** (decommissioning) long-term idling IT equipment.

• **Consolidating** applications from underutilized IT equipment onto fewer servers, leading to increased computational utilization.

• **Replacing** (refreshing) IT equipment with new energy efficient gear.
Removing Unused Servers

• Physically retire inefficient or unused equipment

• The Uptime Institute reported 15%–30% of servers are ON but not being used

• Decommissioning process includes:
  – Regularly inventory and monitor
  – Consolidate/retire poorly utilized hardware.
Replacing: IT Efficiency Increases ~90x Every Decade

Source: Koomey et al. 2011

Regression results:
N = 80
Adjusted R-squared = 0.983
Comps/kWh = \exp(0.4401939 \times \text{Year} - 849.1617)
Average doubling time (1946 to 2009) = 1.57 years
Consolidating: Virtualize Servers & Storage

- Run many “virtual” machines on a single “physical” machine
- Consolidate underutilized physical machines, increasing utilization
- Energy is saved by shutting down underutilized machines
Replacing: Old Servers Underperform

Age Distribution
- 64% 2007 & Earlier
- 32% 2008, 2009
- 4% 2010–Current

Energy Consumption
- 35% 2007 & Earlier
- 5% 2008, 2009
- 32% 2010–Current
- 60% 2010–Current

Performance Capability
- 93% 2007 & Earlier
- 4% 2008, 2009
- 3% 2010–Current

Data collected at a Fortune 100 company; courtesy of John Kuzma and William Carter, Intel
Tour of the IT Tool

Note: This is an introduction to the IT Equipment Tool not a tutorial. The Data Center Energy Practitioner (DCEP) program provides an in-depth training on the tool, available at http://datacenters.lbl.gov/DCEP
IT Equipment Tool

The IT Tool is a free Excel tool for assessing the IT energy status and providing recommendations and potential energy and carbon savings.

[Image of Excel tool screenshots]

datacenters.lbl.gov/Tools
Tool structure as well as user input forms and output data are described in this manual.

Appendices provide in-depth information on a number of useful topics.

This document is the official resource in using the DOE/LBNL IT Equipment Tool.
How is the Tool Used?

First, the user fills in data and answers questions on up to six input screens. Each screen includes basic guidance for entering the data correctly.

Second, based on this user input, numerical results and recommended actions are given on two output screens.

Let’s take a quick tour...
Inventory: Structure for Organizing IT Data

- Yellow cells are input cells.
- Nine (9) Tabs (sheets)
- Class Descriptions
- Power Summary
- Inventory

First, provide a description of each IT Equipment Class and its Power Performance level (Table 1). The Classes are defined by the user in the next step.

Second, enter the IT inventory and assign Classes (Table 2a). The IT Types are equipment with similar power draw. Actual and Max Power are per unit.

Third, the Tool compiles the user input into Tables 2b and 3.
Inventory - Tool Provides Potential Actions

The tool provides potential actions for managing IT equipment inventory. The table shows the equipment class descriptions, the number of units, actual and max power, and potential actions for consolidation and removal. The tool helps group equipment into defined classes and provides potential actions for power performance level management.
Server Power Performance Curves

Power Performance is the ratio between Power Utilization and Computational Utilization. In turn, utilization is Actual Utilization to Max Utilization.

This slide shows three actual 2U servers representing three levels of Power Performance (blue curves in first set of three charts*), and the generalized performance curves developed for the IT Tool (far right).

* SpecPower
**Energy Saving Measures**

### Class 1

<table>
<thead>
<tr>
<th>Energy-Saving Measures</th>
<th>Current Conditions</th>
<th>Target Conditions</th>
<th>Energy Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adding</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Removing</td>
<td>800</td>
<td>4,000</td>
<td>20.0</td>
</tr>
<tr>
<td>Replacing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modifying</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consolidating</td>
<td>7,000</td>
<td>14,000</td>
<td>50.0</td>
</tr>
<tr>
<td>Clouding</td>
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<td></td>
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</tr>
<tr>
<td>Unchanged</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Universal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>7,800</td>
<td>18,000</td>
<td>43.3</td>
</tr>
</tbody>
</table>

**Table 3 Total**  
7,800 18,000

**Save Total**  
2,310

**Include this form? If Yes, IT Tool will check for Errors.**

**Yes**  
**ERRORS Found**

Yellow cells are input cells.
Numerical Results - Overview

- Power Utilization
- IT Power Savings
- Infrastructure Power Savings
- Total Energy Savings
- Total Energy Cost Savings
- Total Carbon Savings

Yellow cells are input cells.
**Numerical Results - Detail**

**Power Utilization**
- Current: 60.0%
- Target: 71.4%

**IT Power Savings**: 8,210 W

**Infrastructure Power Savings**: 4,105 W

**Total Energy Savings**: 107,879 kWh/year

**Total Energy Cost Savings**: 12,946 $/year

**Total Carbon Savings**: 118,667 lbs/year

**PUE = Data Center Total Energy / IT Energy**

**Scalers**
- PUE: 1.50
- Energy Price: 0.12 $/kWh
- Emission Rate: 1.10 lbs/kWh

*Yellow cells are input cells.*
## Questions - Generates Best-Practice Recommendations

<table>
<thead>
<tr>
<th>#</th>
<th>Question</th>
<th>Yes/No</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Have you defined “Critical Values” (hot-button issues that are top-of-mind of executives) for the IT project?</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>Have you identified the organizational stakeholders for the IT project?</td>
<td>No</td>
</tr>
</tbody>
</table>

Yellow cells are input cells.
## Recommendations - Based on Question Responses

<table>
<thead>
<tr>
<th>#</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CRITICAL VALUE: Since energy savings alone are likely not an important justification for energy assessment projects, it is critical that the assessor articulates both the total value and the critical value (hot buttons) to the business.</td>
</tr>
<tr>
<td>2</td>
<td>STAKEHOLDERS: There are many stakeholders. The obvious ones are Facilities and IT, but that’s far from all. You have to crawl each thread of this web to identify those who may benefit from the project or potentially be harmed.</td>
</tr>
</tbody>
</table>
Input Examples:
Key Energy-Saving Opportunities
Class 1 has Three Energy-Saving Measures:

- Adding
- Removing
- Consolidating

### Removing (Decommissioning)

<table>
<thead>
<tr>
<th>Current Power</th>
<th>Target Power</th>
<th>Power Reduction</th>
<th>Power Save</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adding</td>
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<td></td>
<td>400</td>
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<td></td>
<td>800</td>
<td>20.0</td>
<td>800</td>
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<tr>
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<tr>
<td></td>
<td>7,000</td>
<td>50.0</td>
<td>48.5</td>
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<td></td>
</tr>
</tbody>
</table>

Table 3 Total: 7,800 18,000  
Save Total: 2,310

Include this form? If Yes, IT Tool will check for Errors.  
Yes


- Removing Long-Term Idling IT Equipment (see Inventory)
- Enter Current Actual and Max Power (yellow cells)
- Tool calculates Power and Computational Utilization
- Tool calculates Power Save.

Note: ERROR message shown here intentionally to show the ERROR functionality
Replacing (Refreshing)

Class 3 has Two Energy-Saving Measures:
- Replacing
- Unchanged

- Replace IT equipment with new energy-efficient gear
- Enter Current Actual and Max Power (yellow cells)
- Enter Target Power Reduction Factor (yellow cell)
- Tool calculates Target Actual and Max Power
- Tool calculates Power and Computational Utilization
- Tool calculates Power Save.

Table 3 Total | 11,200 | 13,800 | Save Total | 5,000
Include this form? If Yes, IT Tool will check for Errors. Yes No ERRORS Found
Class 1 has Three Energy-Saving Measures:

- Adding
- Removing
- Consolidating

### Table 3 Total

<table>
<thead>
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</thead>
<tbody>
<tr>
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<td></td>
<td></td>
<td>Adding</td>
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<td>4,000</td>
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<tr>
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<td>Replacing</td>
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<td>0.00</td>
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<td>50.0</td>
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<td>Clouding</td>
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<td>18,000</td>
<td>43.3</td>
<td><strong>Total</strong></td>
<td>7,800</td>
<td>18,000</td>
<td>43.3</td>
<td>2,310</td>
<td></td>
</tr>
</tbody>
</table>

Include this form? If Yes, IT Tool will check for Errors.  
Yes  
ERRORS Found

- Consolidate Sub-Utilized IT Equipment (see Inventory)
- Enter Current Actual and Max Power (yellow cells)
- Enter Target Actual and Max Power (yellow cells)
- This data may come from integrator and/or vendor
- Tool calculates Power and Computational Utilization
- Tool calculates Power Save.

Multiple appendices include useful templates for the assessments.

Descriptions of all tools, guides and templates in the toolkit and their relationships to one another.

Plan of Action
Holistic Approach - Takeaways

An IT energy assessment should never be looked at in isolation. Data centers are complex environments with numerous interconnected energy consuming systems (IT, electrical, cooling, air management).

The data center should be viewed in a holistic way. This may often be difficult considering the disconnect between the facilities staff and the IT staff in many data centers.

The Tool Suite provides the Tools and the Process Manual helps in organizing the work.
Resources and Q&A
FEMP’s Data Center Program assists federal agencies and other organizations with optimizing the design and operation of data centers. Design and operation of energy and water systems in data centers to enhance agency’s mission.

**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
- El. Power Chain Tool
- IT Equipment Tool
- Air Management Tools
- 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**
- Better Buildings webinar series
- Nine on-demand FEMP data center trainings
- Center of Expertise Webinars
- Data Center Energy Practitioner (DCEP) Trainings
LBNL’s Center of Expertise (CoE)

Explore the diverse activities that CoE is engaged in.

Use CoE’s Energy Efficiency Toolkit

Filter CoE’s many resources by type and topic.

Choose from upcoming live webinars, pre-recorded trainings, and in-person Data Center Energy Practitioner (DCEP) trainings.

Search resources by topics of interest.

Follow us on Twitter @DataCenterCoE

Visit us at datacenters.lbl.gov
CoE Data Center Energy Efficiency Toolkit

Start here!

Data Center Profiling Tools
- PUE Estimator
- DC Pro

Collect Data
- Energy Assessment Workbook

System-Level Assessment Tools
- AM Estimator
- AM Tool
- Power Chain Tool
- IT Equip. Tool

AM = Air Management

Report Findings & Make Recommendations
- Master List of Efficiency Actions
- Energy Assessment Report Template

More detail

Data Center Energy Assessment Complete!

Keep it simple(r)
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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/femplw01212021b

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.
Backup Slides
Data Center Profiling Tools (online)

**DC PRO**

A comprehensive “early stage” data center profiling tool
- Estimates PUE as well as a breakdown of the current and potential energy use distribution
- Provides a tailored list of best practice recommendations
- Exports results to PDF or Excel

**PUE ESTIMATOR**

A quick calculator that generates Power Usage Effectiveness (PUE)
- Only asks questions required to estimate PUE
- Uses same algorithm as DC Pro
- Exports results to PDF or Excel

DC Pro and PUE Estimator can you found on the CoE website.
The AM Tool was developed to fast-track energy savings in data centers. It provides:

- Reduction of supply airflow
- Increase in supply air temp
- Conformance with Thermal Guidelines
- Reduction in energy and energy-cost for fans and chillers
- Air management recommendations.

The Air Management Estimator = simplified Air Management Tool

http://datacenters.lbl.gov/Tools
This resource presents energy savings for chillers and supply fans in a new tabular format for various upgrade scenarios.

<table>
<thead>
<tr>
<th>AM Measure (AM Tool)</th>
<th>Reference</th>
<th>P1</th>
<th>P2 Matched</th>
<th>P3</th>
<th>P4 Target</th>
<th>P5</th>
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<tbody>
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<td>N/A</td>
<td>N/A</td>
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<td>L</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>H</td>
</tr>
<tr>
<td>4: Blanking Panels</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td></td>
<td></td>
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<tr>
<td>5: Floor Leakage</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td></td>
<td></td>
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<tr>
<td>6: Tile Placement</td>
<td>L</td>
<td>M</td>
<td>H</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>7: EC-Class</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8: CAV/VAV (CRAC)</td>
<td>L (CAV)</td>
<td>L (CAV)</td>
<td>H (VAV)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9: CRAC Modularity</td>
<td>M (2) or H (3)</td>
<td>M (2) or H (3)</td>
<td>M (2) or H (3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10: Cable Management</td>
<td>L</td>
<td>L</td>
<td>L</td>
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</tr>
</tbody>
</table>

http://datacenters.lbl.gov
This tool helps identify energy opportunities in the electrical power chain.

It quantifies the energy and cost savings of the selected measures and calculates the payback periods.

This updated version (March 2020) offers a wider array of UPS load factors, control options, and updated efficiency curves.

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

• Living encyclopedia of all data center EEMs
  – Recognized as an essential desk reference for data center energy efficiency – top download for CoE
  – >250 energy-saving changes in components, operations or other actions

• Several tools recommend common EEMs:
  – DC Pro, Air Management Tool, Electric Power Chain Tool

• The Master List contains all common EEMs, plus many others that do not appear elsewhere in the toolkit.

• For each EEM, the list explains the principles involved and how energy cost savings are generated, plus tips on implementation and more in-depth references.