The webinar will start momentarily....

U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Webinar: Accessing Onboard Server Sensors for Energy Efficiency in Data Centers

October 25, 2021

FEMP Federal Energy Management Program

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

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CENTER OF EXPERTISE
FOR ENERGY EFFICIENCY IN DATA CENTERS

Webinar Agenda

Agenda	
I.	Introduction
II.	Context of Accessing Onboard Server Sensors
III.	Network Protocols/Interfaces and Management Solutions
IV.	Resources and Q&A

Learning Objectives

- Increase the awareness of the important ENERGY STAR for Computer Server document from EPA and key server parameters for energy efficiency work.
- Gain the necessary basic understanding of network protocols and interfaces, which play an important role in pulling out the onboard sensor data.
- Recognize the major categories of Data Center Management Solutions that can be used for accessing the server and its onboard sensor data.
- Understand the many options for readily available Data Center Management Solutions.

Context of Accessing Onboard Server Sensors

What are Onboard Sensors?

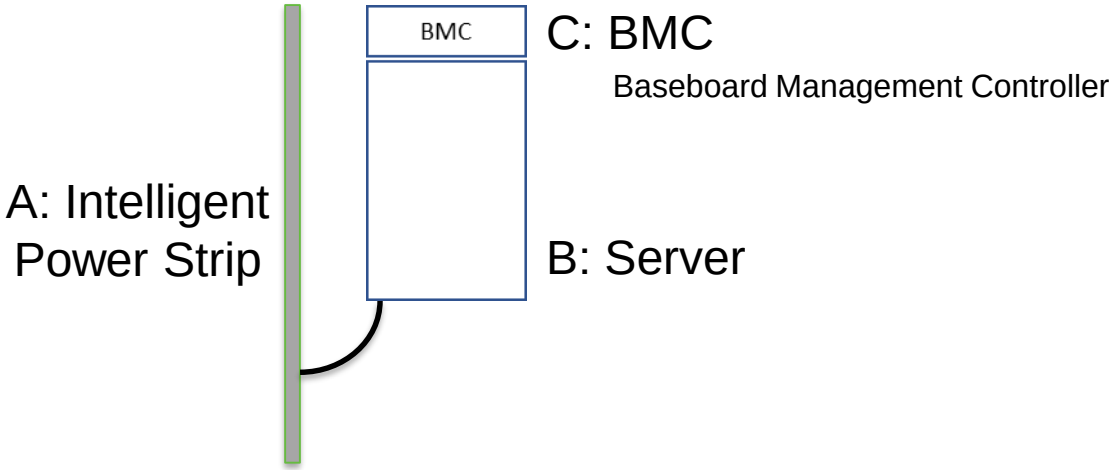
A number of onboard sensors are built into servers to provide support for the server operation. Here is a key list of critical sensors for energy efficiency work in data centers:

- Processor (CPU) utilization
- Input power
- Intake air temperatures.

How to Access Onboard Sensors?

There are three main ways of accessing data from a server:

A. External sensors, e.g., intelligent power strip
B. Onboard sensors through the server's operating system
C. Onboard sensors through BMC hardware.



Example with server input power monitoring.

Why Using Onboard Sensors?

There are many benefits with using the built-in or onboard server sensors. Here are some examples:

- No need to purchase external sensors/equipment
- More granular readings (at every single server)
- Less maintenance (no need to re-arrange sensors)
- In other words, more cost effective.

Purpose of Webinar

Unfortunately, accessing onboard server sensor data is often not well understood. The objective of this webinar and the underlying report is to make this technology better known to help increase the use of these sensors and thereby be in a better position to manage both IT and facility energy.

ENERGY STAR for Computer Servers

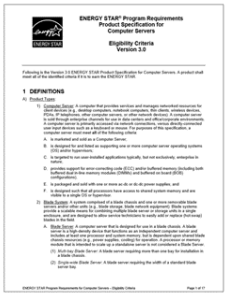
Section Objective

Section Objective

Increase the awareness of the important ENERGY STAR for Computer Server document from EPA and key server parameters for energy efficiency work.

ENERGY STAR Specification

EPA's ENERGY STAR (2018) specification for computer servers states that access to the following parameters must be provided for all certified servers:



ENERGY STAR® Program Requirements
Product Specification for
Computer Servers

Eligibility Criteria
Version 3.0

1 DEFINITIONS

- CPU utilization
- Intake air temperatures
- Input power.

These parameters are at the core of energy efficient data center operation. The fact that this information is part of the ENERGY STAR requirements is a testament of the importance of these parameters.

The data must be made available in a published or user-accessible format that is readable by third-party, non-proprietary management software over a standard network.

ENERGY STAR Product Finder

From the ENERGY STAR (2021a) Product Finder, you can select from hundreds of certified energy efficient servers from companies like Dell, HP, and IBM. There are also ENERGY STAR rated UPSs, storage products, and networking equipment.

Network Protocols and Interfaces

Section Objective

Section Objective

Gain the necessary basic understanding of network protocols and interfaces, which play an important role in pulling out the onboard server sensor data.

Network Protocols and Interfaces

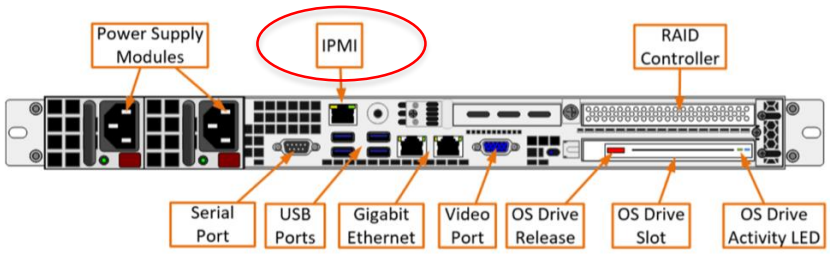
A “network protocol” defines the rules for exchanging information on the connecting point between network devices. The protocol defines the rules, syntax, semantics, and synchronization of communications and possible error recovery methods. Examples: SNMP and HTTP.

A “network interface” is the actual connecting point between two adjacent network devices. A physical interface can be a connector and a virtual interface can be an Application Programming Interface (API). Examples: IPMI and Redfish.

Baseboard Management Controller (BMC)

The BMC is specialized hardware attached to the motherboard of a managed server. It is the heart of the controller with the main processor where the IPMI or Redfish is implemented through an Application Programming Interface (API).

The BMC acts like an intelligent middleman, which operates on stand-by power. A BMC is included on just about every server. It operates independently of the operating system of the managed server and allows administrators to manage the device remotely. This is a significant benefit compared to accessing onboard sensors through the server's operating system. The BMC is accessed through a separate management port on the server.

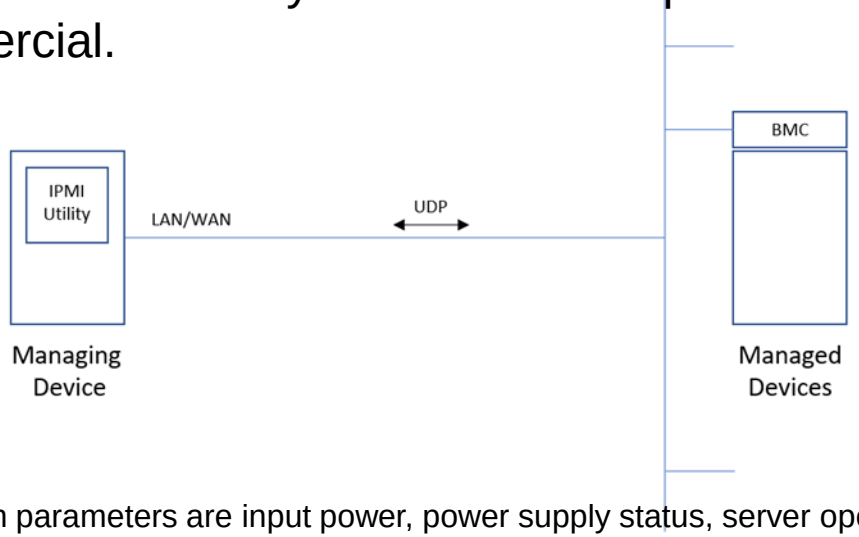


Intelligent Platform Management Interface

The Intelligent Platform Management Interface (IPMI) runs on the BMC for server physical hardware-level access.

IPMI is one of the most used acronyms in server management. It is a vendor-neutral standard defining a set of interfaces for monitoring server physical health* and more. IPMI became popular due to its acceptance as a standard monitoring interface by hardware vendors and developers. The specification is supported by more than 200 computer vendors. There are many available IPMI specific utility tools, both free and commercial.

The IPMI Model



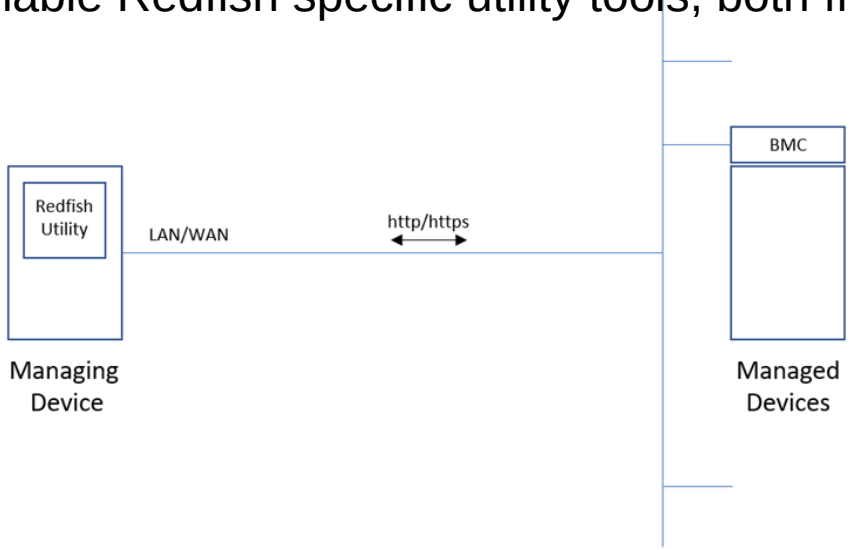
* Examples of server physical health parameters are input power, power supply status, server operational status, internal fan status and speeds, intake air temperatures, and processor CPU power usage.

Redfish Interface

The Redfish interface also runs on the BMC hardware for server physical hardware-level access. Most servers come with both IPMI and Redfish.

Redfish, the de-facto successor to IPMI, is a relatively new global, open server hardware management standard. Similar to IPMI, Redfish is an interface serving as a connecting point between two adjacent network devices. It is nationally and internationally recognized by ANSI and ISO, respectively. Redfish provides functionality well beyond IPMI. There are many available Redfish specific utility tools, both free and commercial.

The Redfish Model



Data Center Management Solutions

Section Objective

Section Objective

Recognize the major categories of Data Center Management Solutions that can be used for accessing the server and its onboard sensor data.

Network Protocol/Interface Agnostic

The free and commercial utility tools that were mentioned in the previous section are *specific* to a particular network protocol or interface. In contrast, the Data Center Management tools provide more *versatile* solutions. They are network protocol and interface agnostic.

Data Center Management Tools

Data center management solutions can be divided into:

- Data Center Networking tools, focusing on the IT equipment and IT connectivity
- Data Center Infrastructure Management (DCIM) tools, focusing on the support infrastructure, such as cooling and electrical systems
- Hybrid software tools may collect and analyze the physical health of a variety of devices.

These tools start to integrate to meet the need for a more holistic view of the data center.

Data Center Networking, DCIM, and Hybrid Tools

Section Objective

Section Objective

Understand the many options for readily available Data Center Management Solutions for accessing server onboard sensor data.

Versatile Tools

Selecting a commercial Data Center Management tool for accessing motherboard data makes the collection process simpler, without requiring much IT network expertise.

What the three tools discussed in this section have in common is that they allow agentless, multi-vendor, multi-protocol, and scanning and detection of devices. These features make it easier to manage data centers.

The products in this webinar should be considered as examples of general product categories. Neither LBNL nor DOE endorses any particular products.

DELL OpenManage NM

OpenManage NM is an example of a Data Center Networking Tool. It provides a unified management system and automates common network management operations. A relatively new feature is server physical hardware-level access for discovery, management, and monitoring from the BMC. It exposes parameters such as server intake air temperature, input power, and CPU utilization. This type of data is needed for your energy efficiency efforts. The IT department usually already has this type of tool.

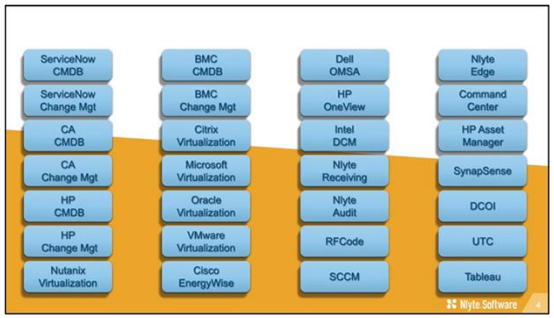
The tool helps network administrators manage and monitor the network from a single web GUI interface console, using Internet Explorer or Chrome.

OpenManage NM Web GUI interface.
Other companies with similar products include HPE and Extreme Networks.

Nlyte DCIM

Nlyte DCIM is an example of a Data Center Infrastructure Management Tool. Investing in this type of full-featured DCIM tool may be overkill if only limited data is desired. Nlyte can morph into something that resembles an Integrated Data Center Management solution, which brings together different disciplines to deliver better outcomes. A rich set of connectors to other tools and additional Nlyte modules is available. This solution can provide the data you need for your energy efficiency efforts, and the facilities group may have it.

The Federal Data Center Optimization Initiative includes a requirement to use DCIM tools. Nlyte has an enterprise agreement with the Department of Energy (DOE).



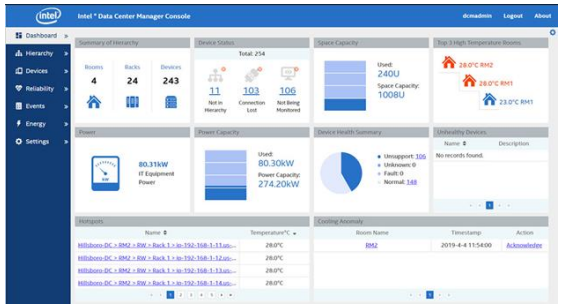
Nlyte Connectors and Modules.

Other companies with similar products include Schneider Electric and Sunbird.

Intel Data Center Manager (DCM)

DCM is an example of a hybrid tool, categorized as a hybrid of a Server Management Tool and a DCIM tool. It provides a platform for IT and facilities professionals to assess energy consumption and reliability issues in a nimble package with a stand-alone, web-based GUI dashboard application. DCM takes advantage of the onboard sensors in devices - it talks directly with the devices' motherboards and then use analytics to extract actionable information.

It can monitor not only servers but also network and storage equipment as well as the power chain equipment such as Power Distribution Units (PDUs) and Uninterruptable Power Supplies (UPSs).



Intel DCM Stand-Alone Console.

Other Solutions

Go-it-Alone Solutions

If you consider using an in-house developed solution to access the onboard data, the ENERGY STAR Power and Performance Data Sheet has useful information. Specifically, it provides information on compatible network protocols and interfaces for data collection. These sheets can be found on the vendors' websites generally under Server Specifications.

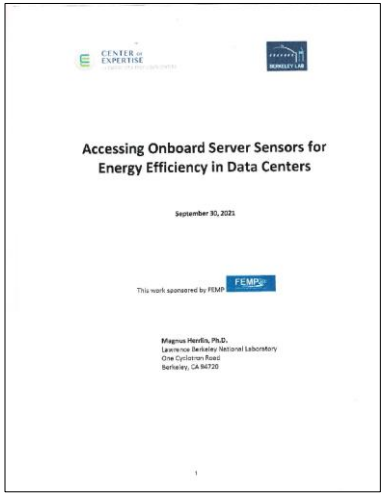
The table below shows an example of the Power and Temperature Measurement and Reporting section of the ENERGY STAR Power and Performance Data Sheet for a server. In this case, the data collection can be done through the IPMI interface.

Input Power Available & Accuracy?	Yes, +/- 5% for 20%-100% of max PSU load
Input Air Temp Available & Accuracy?	Yes, +/- 2°C
Processor Utilization Available?	Yes
Other Data Measurements Available & Accuracy?	
Compatible Protocols for Data Collection	IPMI
Averaging method and time period	Power: 1 min running average of 2s interval samples. Temperature: no

Example of ENERGY STAR Power and Performance Data Sheet (detail).

Master Document

The bulk of this slide presentation is a summary of the LBNL (2021) document “Accessing Onboard Server Sensors for Energy Efficiency in Data Centers”.


Accessing Onboard Server Sensors for Energy Efficiency in Data Centers

September 30, 2021

This work sponsored by FEMP

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

Summary

- An overview of EPA's ENERGY STAR for Computer Servers was presented since this specification provides a wealth of relevant information, including key server parameters for energy efficiency work.
- The most important network protocols and interfaces (IPMI and Redfish) for pulling out the onboard server sensors data were reviewed to provide some basic network understanding.
- The major categories of versatile Data Center Management Solutions that can be used for accessing the server and its onboard sensor data were discussed. These solutions include Networking tools, DCIM tools, and Hybrid tools.
- Finally, examples of readily available commercial Data Center Management Tools were provided. Some basic information was also provided if you decide to go it alone.

References

DOE Tool Suite
http://datacenters.lbl.gov/tools

ENERGY STAR, 2021a. ENERGY STAR Product Finder
ENERGY STAR Certified Enterprise Servers | EPA ENERGY STAR

ENERGY STAR 2021b. Active Certifications
https://data.energystar.gov/Active-Specifications/ENERGY-STAR-Certified-Version-3-0-Enterprise-Serve/qifb-fcj2/data

ENERGY STAR, 2018. ENERGY STAR Computer Server Specification Version 3.0
www.energystar.gov/products/spec/enterprise_servers_specification_version_3_0_pd

LBNL, 2021. Accessing Onboard Server Sensors for Energy Efficiency in Data Centers
http://datacenters.lbl.gov/resources/accessing-onboard-server-sensors

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 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 (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

- Better Buildings webinar series
- Nine on-demand FEMP data center trainings
- Center of Expertise Webinars
- Data Center Energy Practitioner Trainings

LBNL's Center of Expertise (CoE)

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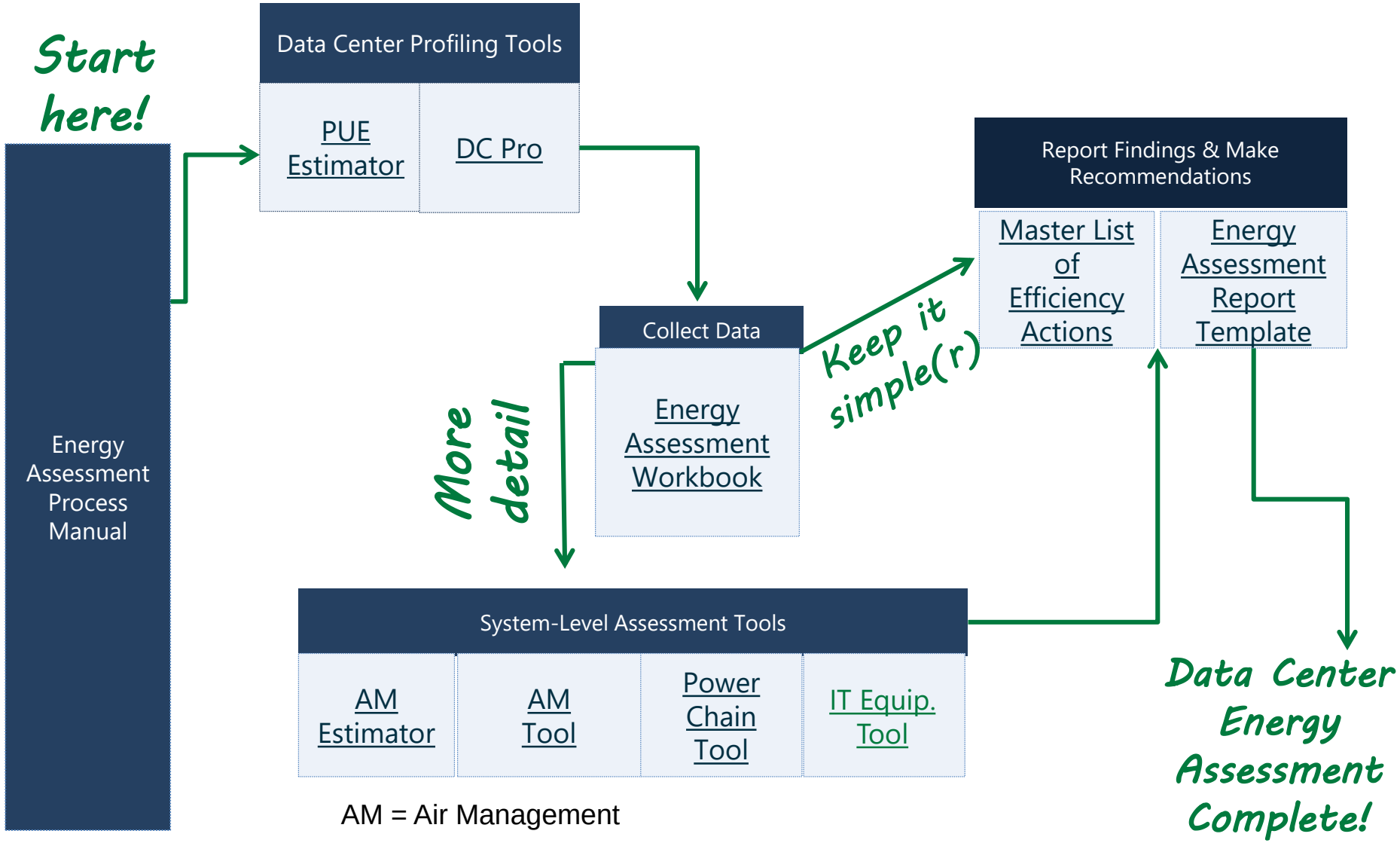
CoE Data Center Energy Efficiency Toolkit



AM = Air Management

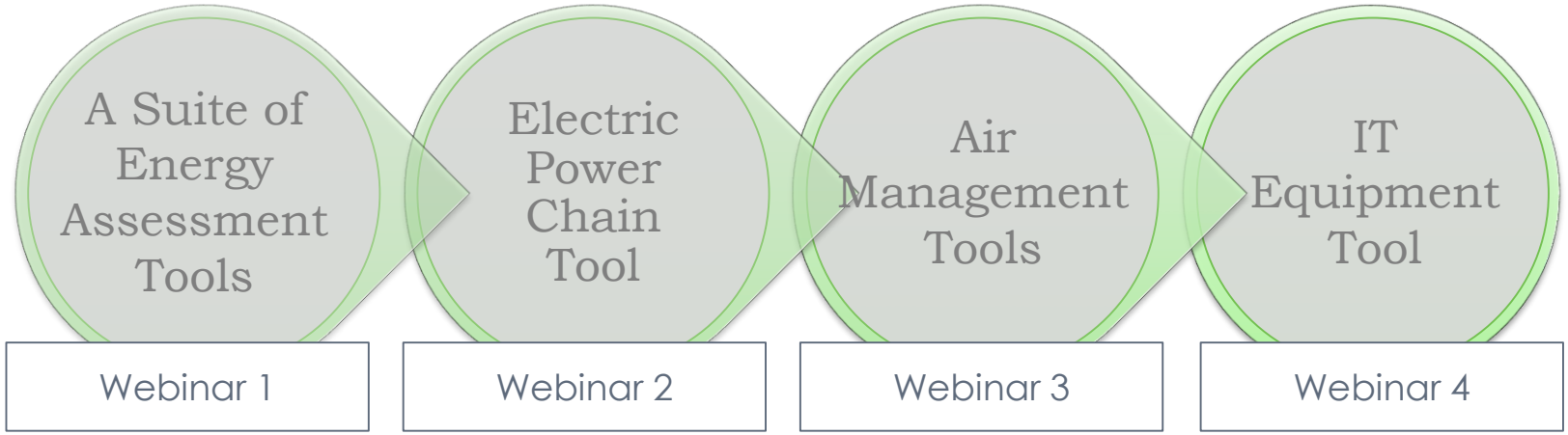
DOE Tool Suite

- 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.

http://datacenters.lbl.gov/tools

Previous Four-Part Webinar Series

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

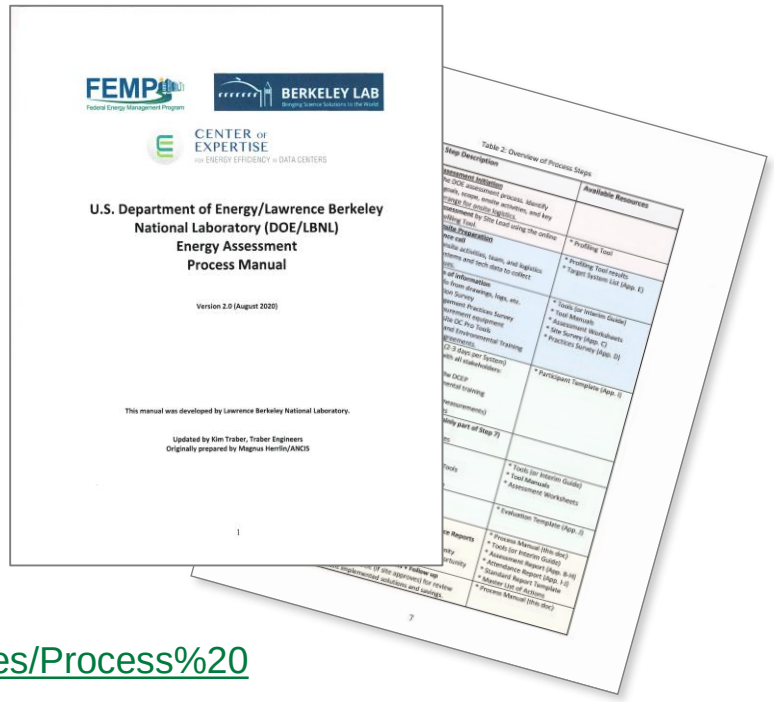


https://www.wbdg.org/continuing-education/femp-courses/fempodw049

Slides from Webinars 2, 3, and 4 at
datacenters.lbl.gov/resources/energy-efficiency-toolkit-series
datacenters.lbl.gov/resources/energy-efficiency-toolkit-series-air
datacenters.lbl.gov/resources/energy-efficiency-toolkit-series-it

Energy Assessment Process Manual

- The Process Manual provides administrative step-by-step instructions for conducting an energy assessment before, during, and after the onsite assessment
- Multiple appendices include useful templates for the assessments.



https://datacenters.lbl.gov/sites/default/files/Process%20Manual%20DOE%20v2_080320_0.pdf

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.

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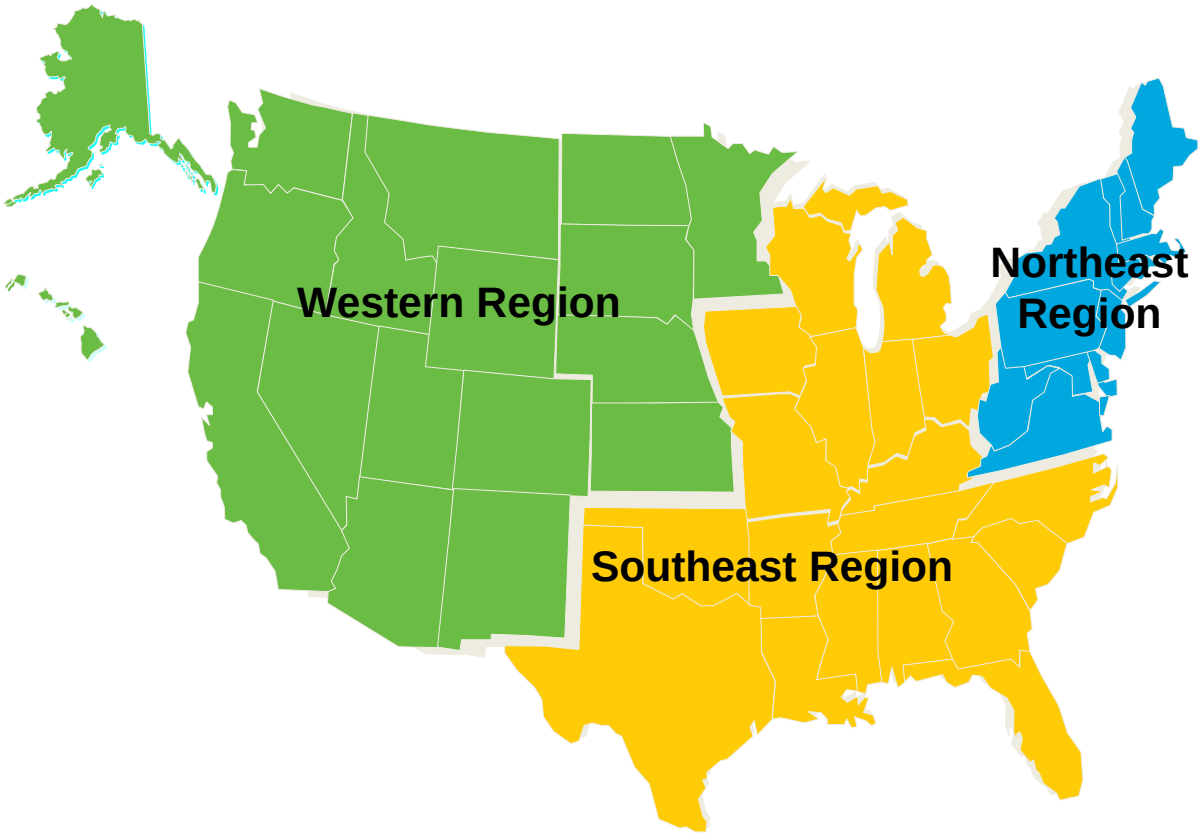

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Questions?

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ACCREDITED IACET PROVIDER

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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/femplw05132021

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.