Better Buildings Webinar Series

We'll be starting in just a few minutes….

Tell us…please send your response to the webinar organizers via the question box:

What topics are you interested in for future webinars?

Better Buildings
U.S. DEPARTMENT OF ENERGY

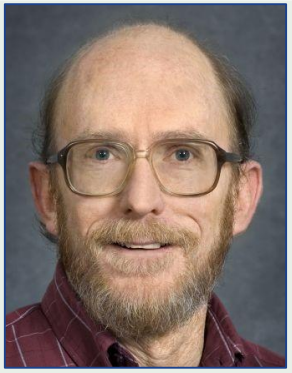
Big Results in Small Places

Exploring the Untapped Energy Efficiency Potential of Small Data Centers

Jan 9, 2018
3:00-4:00 PM ET

U.S. DEPARTMENT OF ENERGY

Today's Presenters

Name		Organization
Daniel Robinson		DOE, EERE, FEMP
Steve Greenberg, P.E.		LBNL

Better Buildings Data Center Initiatives

Data Center Challenge:

- Organizations have pledged to reduce energy consumption in their portfolios by 20 percent within 10 years

Challenge Partners:

- CenturyLink
- Digital Realty Trust
- eBay Inc.
- Facebook
- Intel Corporation
- Intuit
- IO Data Centers
- Iron Mountain Data Centers
- Michigan State University
- Sabey Data Center Partners
- Schneider Electric

Better Buildings Data Center Initiatives

Data Center Accelerator:

- Organizations have pledged to improve the energy efficiency of one or more data centers of 100 kW or greater IT load by at least 25% within 5 years.

Accelerator Partners:

- Argonne National Laboratory
- Defense Health Agency (DHA)
- Environmental Molecular Sciences Laboratory
- Georgia Institute of Technology
- Indiana University
- Lawrence Berkeley National Laboratory
- Lawrence Livermore National Laboratory
- Los Alamos National Laboratory
- National Energy Research Scientific Computing Center
- National Renewable Energy Laboratory
- Oak Ridge National Laboratory
- Stanford University
- State of Michigan
- The Home Depot
- Department of Defense Defense Information Systems Agency (DISA)
- U.S. Department of Justice Drug Enforcement Agency
- Department of Veterans Affairs (VA)
- Environmental Protection Agency (EPA)
- National Aeronautics and Space Administration (NASA)
- Social Security Administration
- University of Colorado
- University of Iowa
- Virtustream
- Waste Management

Steve Greenberg

LBNL

U.S. DEPARTMENT OF ENERGY

Agenda

- Why small data centers are important
- Simplest Measures
  - Information Technology (IT)
  - Cooling
  - Electrical distribution
- Still simple, a little more work
  - IT refresh and virtualization
- Higher-level investment, but very cost-effective
  - Move data center functions elsewhere
  - Implement IT and infrastructure power monitoring
  - Capital upgrades to cooling system
- Training for IT and Facility Staff
- Resources

Why Small Data Centers are Important

- Definition: “Small” is less than 5,000 square feet of computer floor
- Have nearly half of the total servers
- Use 40 billion kWh/yr in the US (~$4 billion)
- Embedded data centers often dominate the entire building’s energy use even though they are a small fraction of the total floor area
- Have challenges in terms of good management:
  - Typically no one person in charge, and no one’s full-time job
  - Security risks
  - Computing and supporting infrastructure energy not monitored
- Have large energy-saving opportunities, typically 20 – 40%. 30% savings would result in ~$1 billion per year in savings, across US data center industry.

Simplest Measures

- Turn off unused servers
- Improve server power management
- Improve air management
- Increase temperature setpoints toward the high end of the range set by the American Society of Heating, Refrigerating, and Air-conditioning Engineers (ASHRAE)
- Turn off active humidity control
- Minimize requirements for Uninterruptible Power Supplies (UPS)

Turn off unused servers

- Known as “comatose” or “zombie” servers: they do no useful work, but use
  - Power
  - Space
  - Cooling
- Estimated 20-30% of servers are comatose

- An idle server uses
  - ~50% of full-load power (100% utilization)
  - ~75% of typical load power (25% utilization)

What to do:

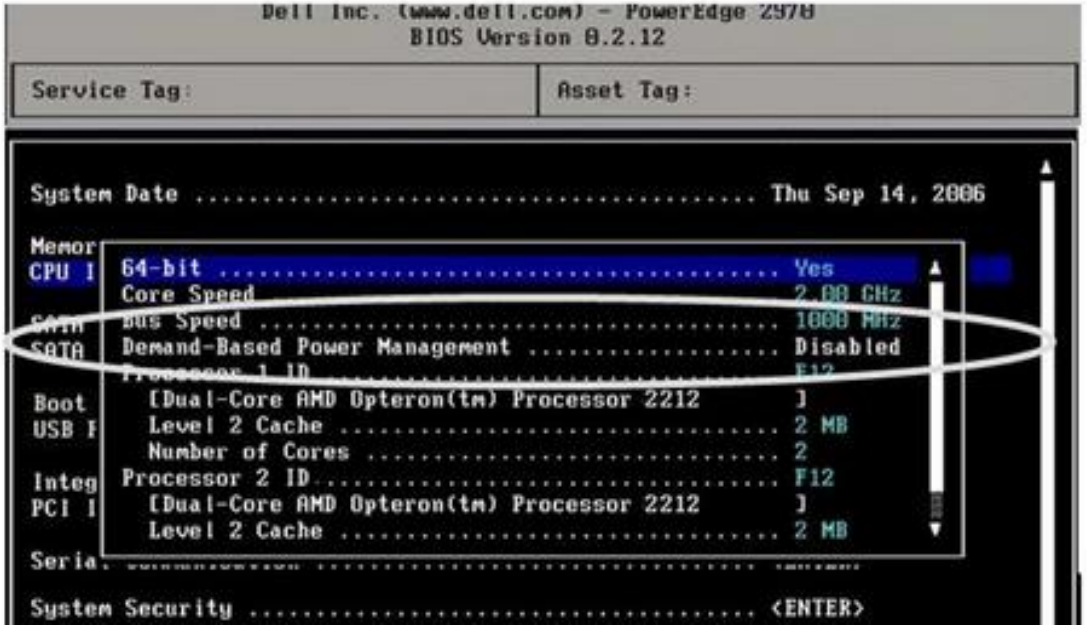
- Establish and maintain a list of what’s running on each machine
- Shut down unused servers

Improve server power management

- Most servers are shipped with power management turned on
- Most servers in use have power management turned off

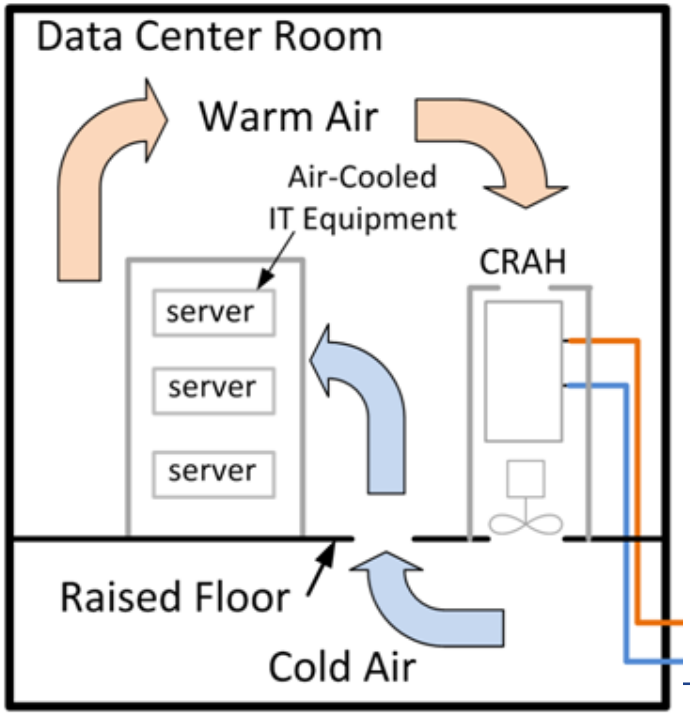
What to do:

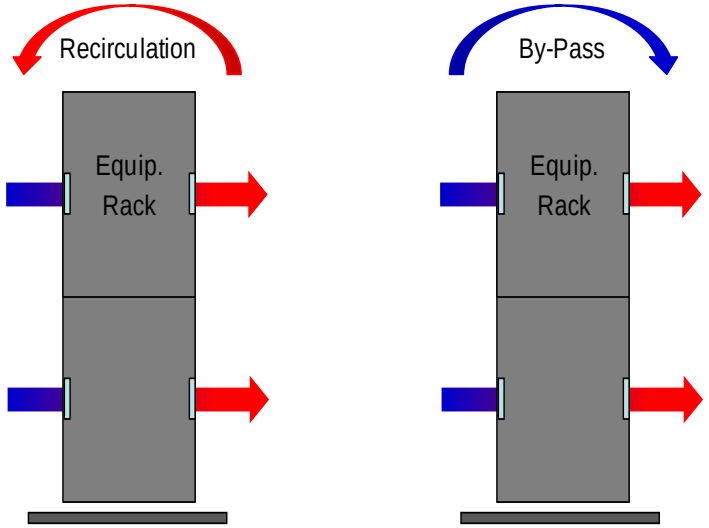
- Check power management settings and enable
  - Processor
  - OS (Operating System) /hypervisor
  - BIOS (Basic Input/ Output System)



Improve air management

- Cool supply air *ideally* gets from cooling equipment to the Information Technology (IT) inlet without mixing with hot discharge air
- Hot discharge air *ideally* returns from the IT exhaust to the cooling equipment without mixing with the cool supply air





Note: CRAH (Computer Room Air Handler) is the cooling equipment

Improve air management, con't

What to do:

- Clear the desired air path (e.g. abandoned and cluttered cables)
- Block the undesirable air paths
  - Within and between racks
  - Cable and conduit cutouts from under floor and into ceiling plenum
  - Rack tops and row ends

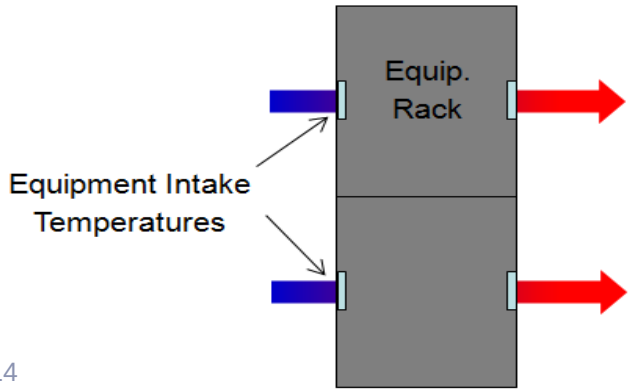
Pictures courtesy of ANCIS Incorporated

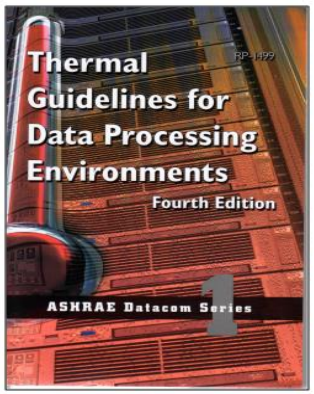
Benefits:

- Allows increased supply air temperature (reduced cooling energy)
- Allows reduced air flow (reduced fan energy)

Increase air temperature setpoints toward the high end of the ASHRAE range

- IT inlet temperature is what matters
- ASHRAE ranges:
  - Recommended range (rounded): 65 to 80° F
  - Allowable ranges (A1 - A4): 59 to 90° F (A1) … 41 to 113° F (A4)
- NOT the same as the temperature setpoint for the CRAC (Computer Room Air Conditioner) or CRAH (Computer Room Air Handler), especially for units controlled on return air
- Ensure good air management first before changing control setpoints to avoid hotspots
- Enables savings in chiller or CRAC compressor energy



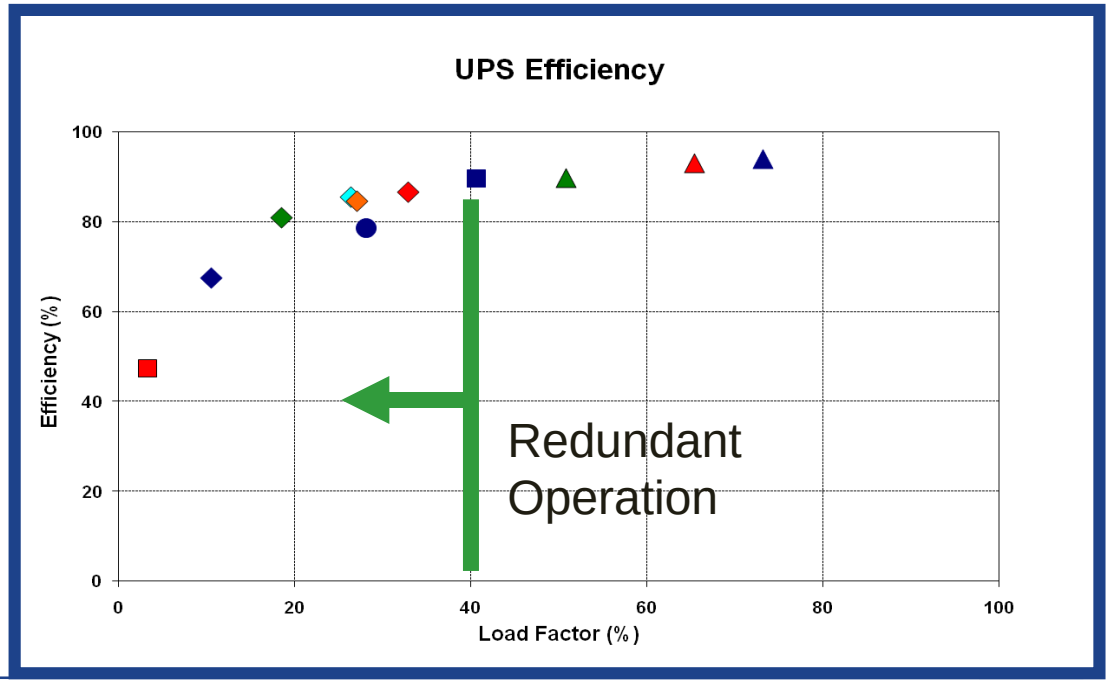


Turn off active humidity control

- Wider ASHRAE range (as of 2015, and retroactive) means that little if any control is required
- Recommended range: 15.8° to 59° F dewpoint temperature (a measure of absolute humidity) and 60% RH (relative humidity) at the IT inlet
- CRACs and CRAHs are often set
  - to 45-55% RH (much too tight)
  - based on the return air (rather than IT inlet or supply air)
- Adjusting setpoints or turning off humidity control results in:
  - Humidification savings
  - Dehumidification savings
  - Often both
  - 28% cooling savings at LBNL - eliminated humidity control

Minimize Uninterruptible Power Supply (UPS) requirements

- Unnecessary redundancy leads to inefficiency
- Many applications can be shut down and restarted without adverse effects
- Critical applications should be considered for moving to a larger data center or the cloud
- Analyze UPS needs
  - Minimize number and size
  - Use ENERGY STAR UPS units
  - Use Eco-mode
  - Savings can range from ~10 - 50% of IT load



Source: LBNL Benchmarking study

Still simple, a little more work

- Refresh the oldest IT equipment with new high-efficiency equipment
- Consolidate and virtualize applications

Refresh the oldest IT equipment with new high-efficiency equipment

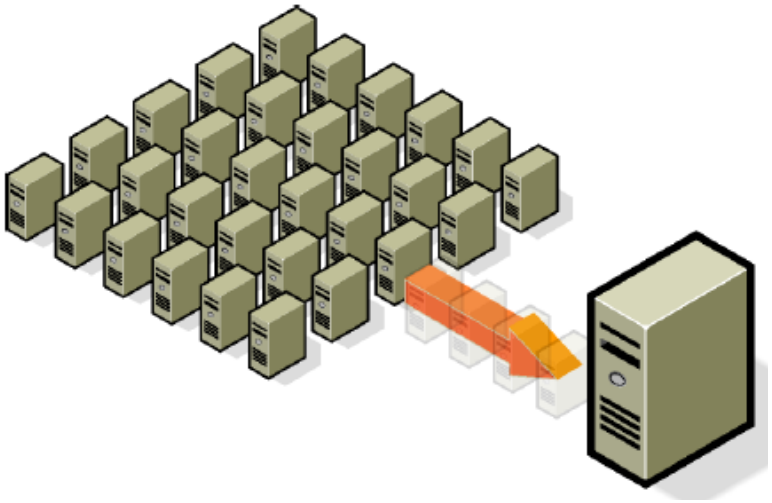
- New equipment is more powerful and gets more computing per watt plus better power management
- More virtualization potential
- Energy and software cost savings typically justifies a faster refresh rate

What to do – Procure:

- ENERGY STAR
  - Servers
  - Networking equipment
  - Storage
- Solid-state drives (vs. hard disks)
- 80-Plus power supplies (ENERGY STAR requirement)
  - ~5-20% savings possible with more efficient power supplies

Consolidate and virtualize applications

- Most servers operate with very low utilization (5-15% on average)
- Servers at typical loads (5-15% utilization) use roughly 75% of average peak power
- Big opportunities:
  - Virtualization (running multiple software applications on one physical machine)
  - Consolidation (using fewer machines to accomplish the computing task)
- Energy savings from power and cooling reductions
- Space savings



Higher-Level Investment, but Very Cost-Effective

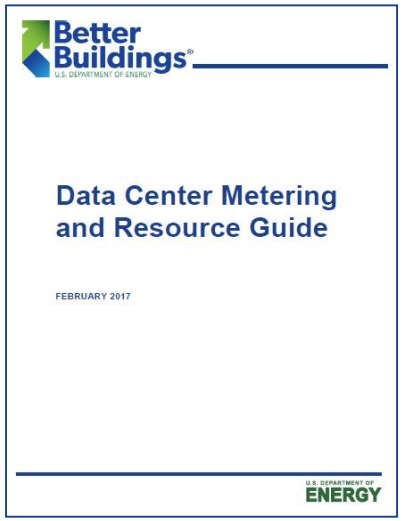
- Move applications and/or hardware to higher-efficiency internal or external data center or to the cloud
- Implement IT and infrastructure power monitoring
- Install Variable-Speed Drives on cooling system fans
- Install rack and/or row-level cooling
- Use air-side economizer
- Implement dedicated room cooling (vs. using central building cooling)

Move to higher-efficiency internal or external data center or to the cloud

- Energy savings typically possible by moving applications or machines to
  - Larger data center
  - Co-location center
  - The cloud
- Better security
- Better redundancy
- Better efficiency
- In evaluating options, consider
  - Mandates
  - Moving cost
  - Total ongoing cost of staying vs. moving

Implement IT and infrastructure power monitoring

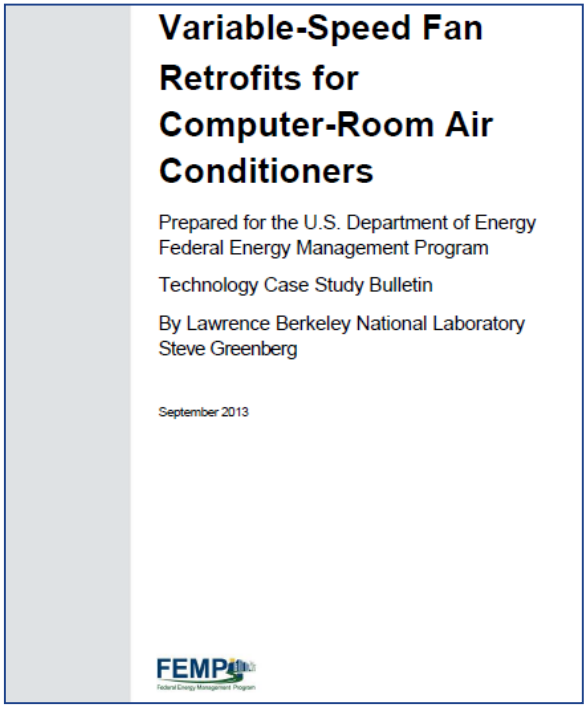
- Doesn't save energy by itself, but it informs the process
- Track performance of power and cooling systems and monitor IT
- Power Usage Effectiveness (PUE) as a metric
  - Ratio of total data center energy to IT energy
  - Measure of infrastructure energy overhead
    - Over 2.0—large opportunity
    - Under 1.5—good
    - Under 1.2--excellent
- Data Center Metering Webinar and Resource Guide
  - Guide: datacenters.lbl.gov/resources/data-center-metering-and-resource-guide
  - Webinar slides: datacenters.lbl.gov/resources/data-center-metering-and-power-usage



Install Variable-Speed Drives on cooling system fans

- CRACs or CRAHs typically have constant-speed fans
- Air flows are typically higher than needed, especially once air management is improved
- 20% air flow reduction results in ~50% savings in fan energy
- 22-32% overall cooling system savings in FEMP case studies:

datacenters.lbl.gov/resources/variable-speed-fan-retrofits-computer-room-air-conditioners



Install rack and/or row-level cooling

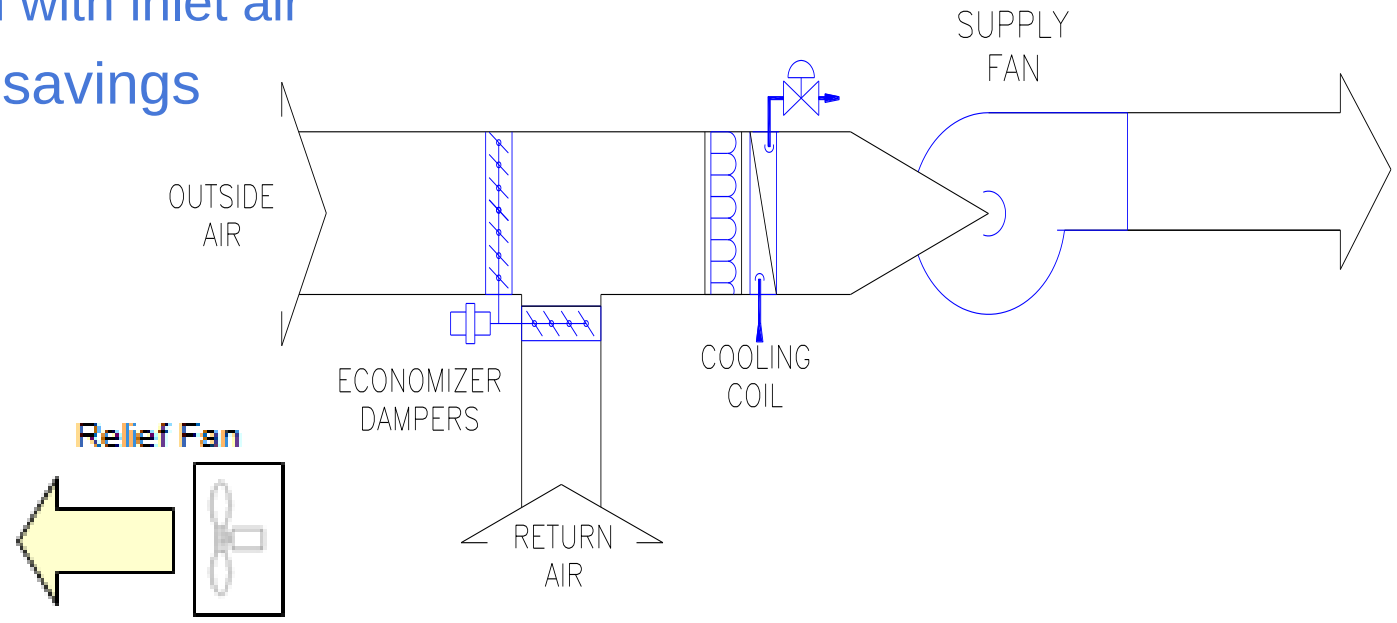
- Applicable when racks are being replaced or newly installed
- Moves cooling closer to the heat source (Closer = More Efficient)
- Various types
  - In-row
  - Rear-door (shown)
  - In-rack

Benefits:

- Closer cooling system is more efficient and so generates less heat that needs to be removed
- Higher chilled water temperature:
  - Makes the cooling plant more efficient
  - Allows “free cooling” for more of the year (water-side economizer)

Use an air-side economizer

- Uses outside air when conditions are suitable
- Needs outside wall or roof for adequate access to large airflow
- Can be
  - air-handling unit
  - CRAC or CRAH with outside air capability
  - Exhaust fan with inlet air
- Large energy savings from reduced operation of cooling compressor



Implement dedicated room cooling (vs. using central building cooling)

- Dedicated unit allows main building system and plant to operate on normally occupied schedule instead of continuously
  - Allows for cooling operations independent from rest of the building
  - A small, imbedded data center can cause a central plant to operate when the rest of the building doesn't require it

What to do:

- Use high-efficiency unit - high SEER (Seasonal Energy Efficiency Ratio)
- Specify outside-air economizer
- Control based on IT inlet temperature

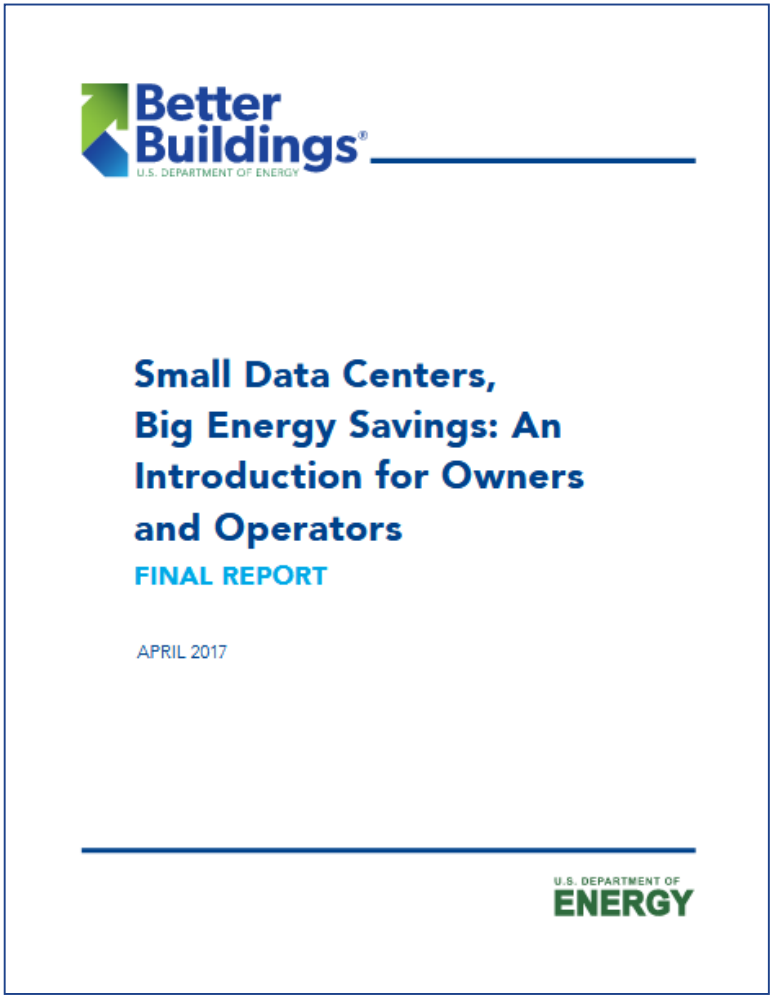
Sources of Training for Facilities and IT Staff

- Utility companies
- ASHRAE: www.ashrae.org
- Federal Energy Management Program (FEMP): http://eere.energy.gov/femp/training
- Center of Expertise for Energy Efficiency in Data Centers
- Data Center Energy Practitioner
  - Required by the Data Center Optimization Initiative
  - datacenters.lbl.gov/dcep

Resources

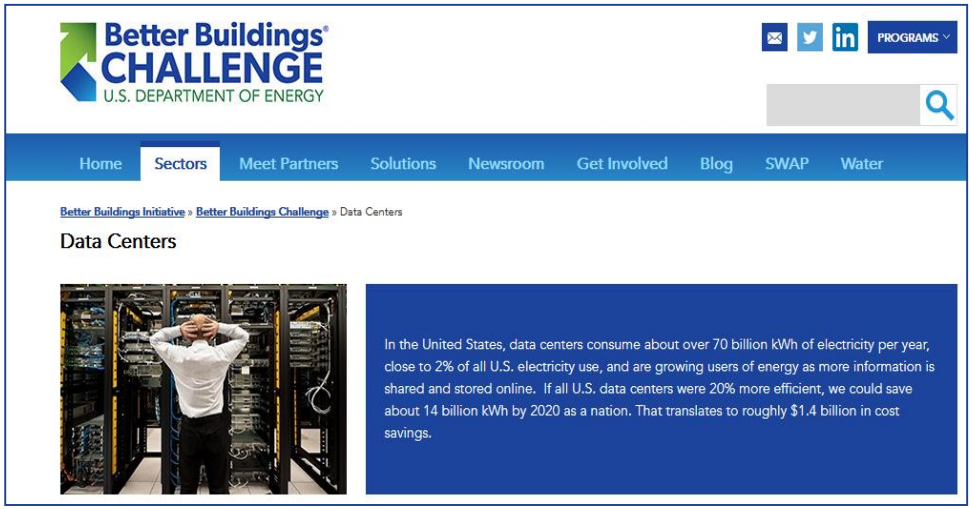
- Small Data Center Guide:

betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/Better Buildings Data Center Accelerator - Small Data Center Energy Savings Guide.pdf



More Resources

Better Buildings Solutions Center: betterbuildingssolutioncenter.energy.gov/challenge/sector/data-centers



Center of Expertise for Energy Efficiency in Data Centers: datacenters.lbl.gov

Resources, con't.

- DOE Air Management Tools
  datacenters.lbl.gov/tools/5-air-management-tools
- Humidity Control in Data Centers
  datacenters.lbl.gov/resources/Humidity-Control-Data-Centers
- Data Center Metering and Resource Guide
  datacenters.lbl.gov/resources/data-center-metering-and-resource-guide
- Variable-Speed Fan Retrofits for Computer-Room Air Conditioners
  - Case study of 3 small data centers
  datacenters.lbl.gov/resources/variable-speed-fan-retrofits-computer-room-air-conditioners
- Data Center Optimization Initiative (OMB): https://datacenters.cio.gov/
- ENERGY STAR Equipment: energystar.gov/products/office_equipment/

Questions?

- Slides will be posted on line on the Better Buildings Solution Center

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Q & A

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Additional Resources

- Small Data Centers Guide
- Better Buildings Solutions Center – Data Centers
- Center of Expertise for Energy Efficiency in Data Centers

Better Buildings Webinar Series

Buildings that Rebound:

Resiliency Strategies for Commercial Buildings and Communities

Tuesday, February 6, 2018 | 3:00 - 4:00 PM ET

REGISTER TODAY

As the energy sector is subject to more external risk due to natural and human events, more developers and building owners are discussing resilient building design. Join this webinar to learn about the technologies and strategies being pursued to address resilience

Additional Questions? Please Contact Us

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