Data Centers

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

FEC WEBINAR

November 2010

Will Lintner
Federal Energy Management Program

FEMP Federal Energy Management Program

FEMP Facilitates the Federal Government's implementation of sound, cost-effective energy management & investment practices to enhance the nation's energy security & environmental stewardship

FEMP is Here to Help You Achieve Results!

Get up to speed with guides & resource publications

***Become engaged** with training & awareness workshops*

***Benchmark** sites using DCPro*

***Conduct assessments** to determine appropriate efficiency measures*

***Implement** energy efficiency projects!*

- ***Save Money***
- ***Reduce Loads***
- ***Save Energy***
- ***Reduce Emissions***

The Case for Change

- The number of Federal data centers and server closets has increased from approximately 400 in 1998 to almost 2100 today.
- Major agencies' IT spending increased from about $45 billion in 2001 to nearly $75 billion today.
- Data center energy use doubled from 2000 to 2006. The EPA predicted that under current trends, data center energy use would almost double again between 2006 to 2011.
- Data centers could account for approximately 10 to 15 % of Federal facility energy use.

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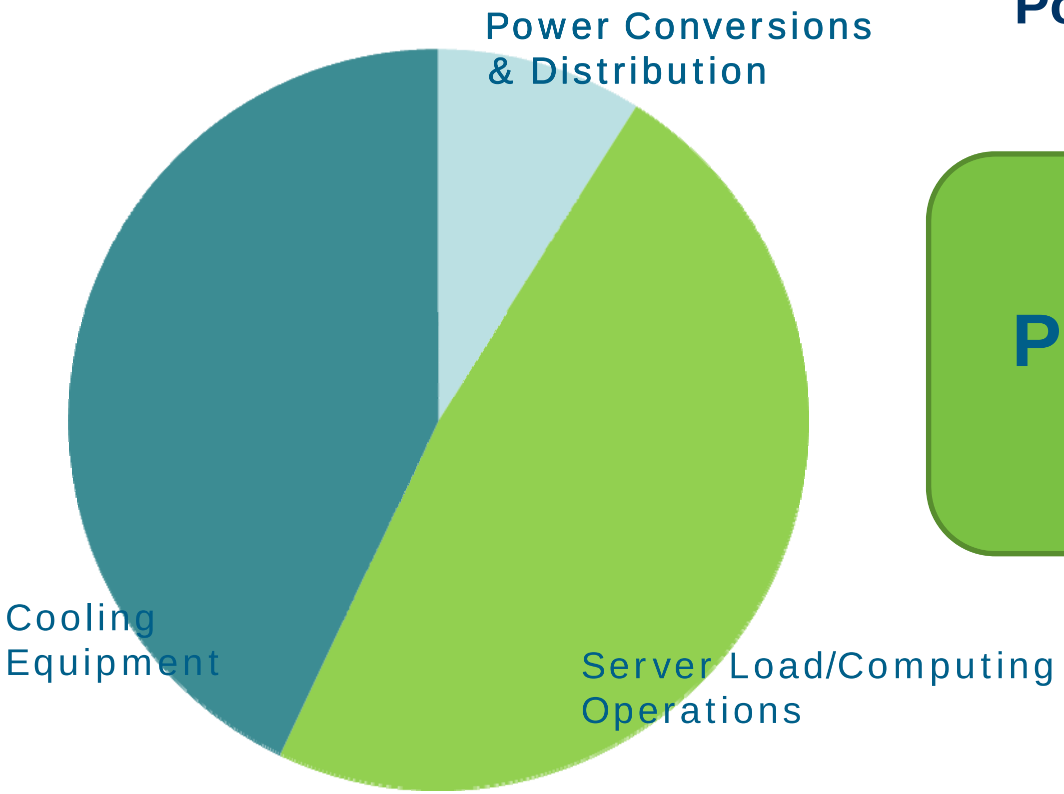
Federal Leadership in Environmental, Energy & Economic Performance directs Federal agencies to:

(i) Promote electronics stewardship, in particular by:

- **(i) Ensuring procurement preferences for EPEAT-registered electronic products;**
- **(ii) Establishing and implementing policies to enable power management, duplex printing and other energy-efficient of environmentally preferable features on all eligible agency electronic products;**
- **(iii) Employing environmentally sound practices with respect to the agency's disposition of all agency excess o r surplus electronic products;**
- **(iv) Ensuring the procurement of EnergyStar and FEMP-designated electronic equipment**
- **(v) Implementing best management practices for energy-efficient management of servers and Federal data centers**

Typical Data Center Energy End Use

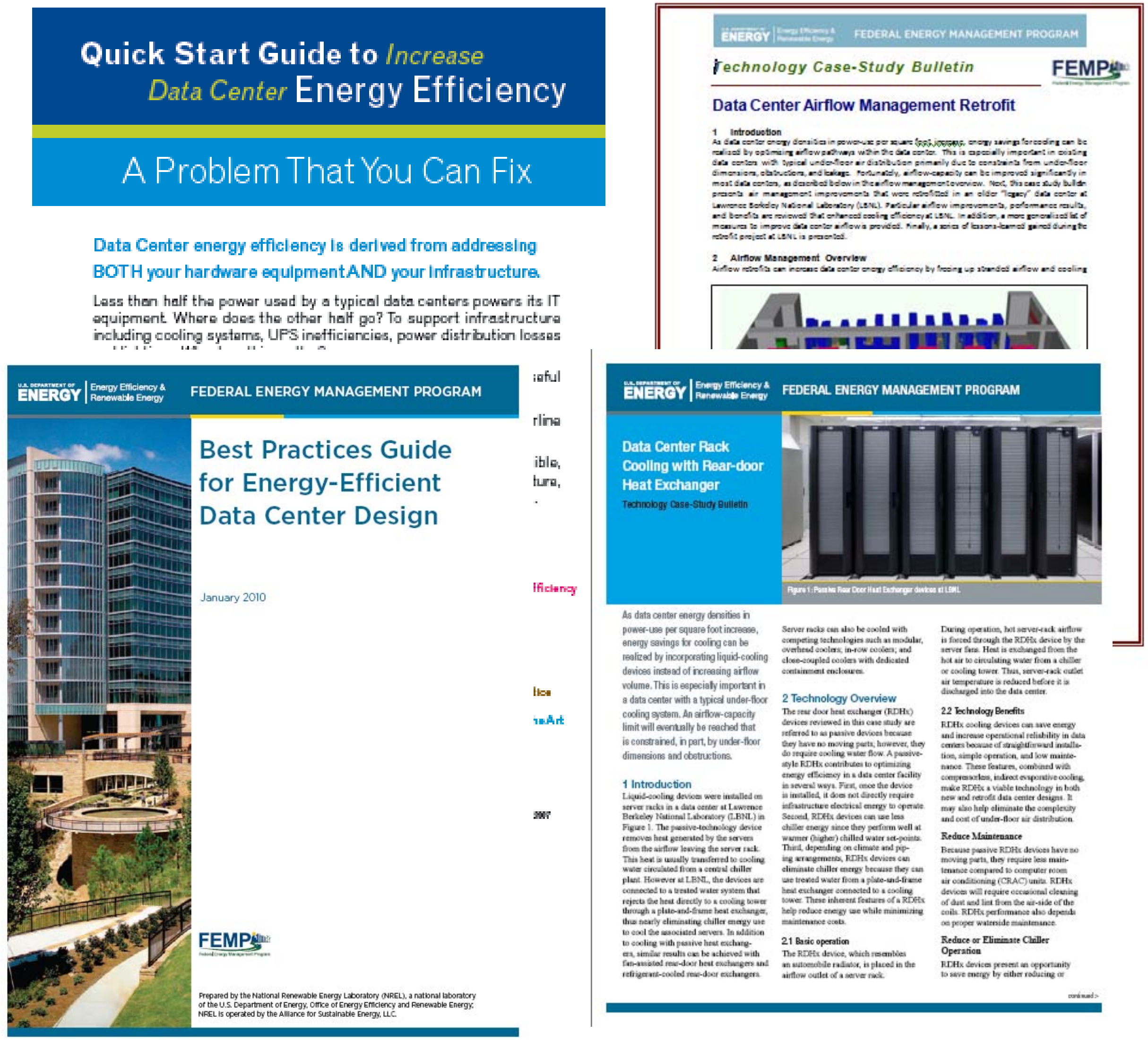


Power Usage Effectiveness (PUE)

$$\text{PUE} = \frac{\text{Total Data Center Power}}{\text{IT Power}}$$

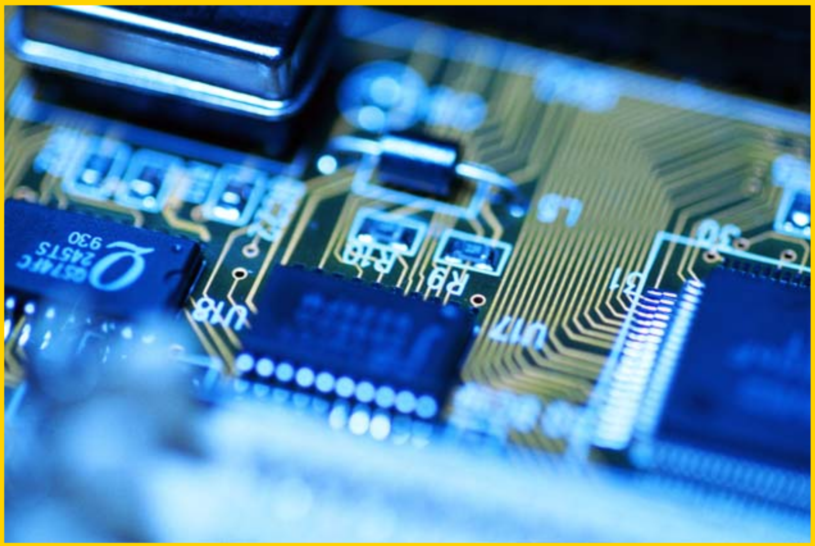
Recent Data Center Resources

- Best Practices Guide
- Benchmarking Guide
- Data Center Programming Guide
- Technology Case Study Bulletins



DOE/ASHRAE Awareness Training

- *One-day training*
- *Target audience: data center operators*
- *No prequalifications*

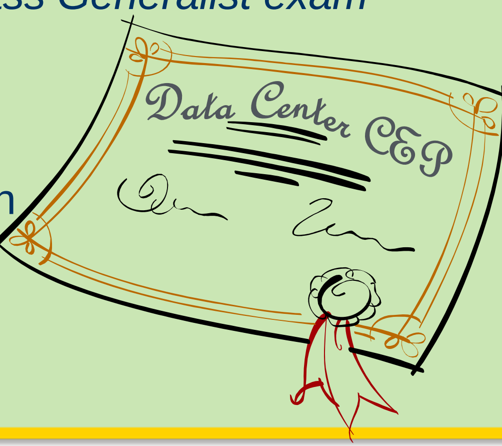


Data Center Energy Practitioner (DCEP) Program - Generalist

- Three-day workshop with two options:
  - Training certificate (not yet available)
  - Training & exam (In pilot stage)
- Target audience: DC personnel, consultants, & service providers.
- Next: **San Francisco, November 15-18**

DCEP - SPECIALIST

- Pre-qualifications: *Pass Generalist exam*
- Practitioner tracks:
  - HVAC
  - Electrical & IT coming soon



Metrics & Benchmarking

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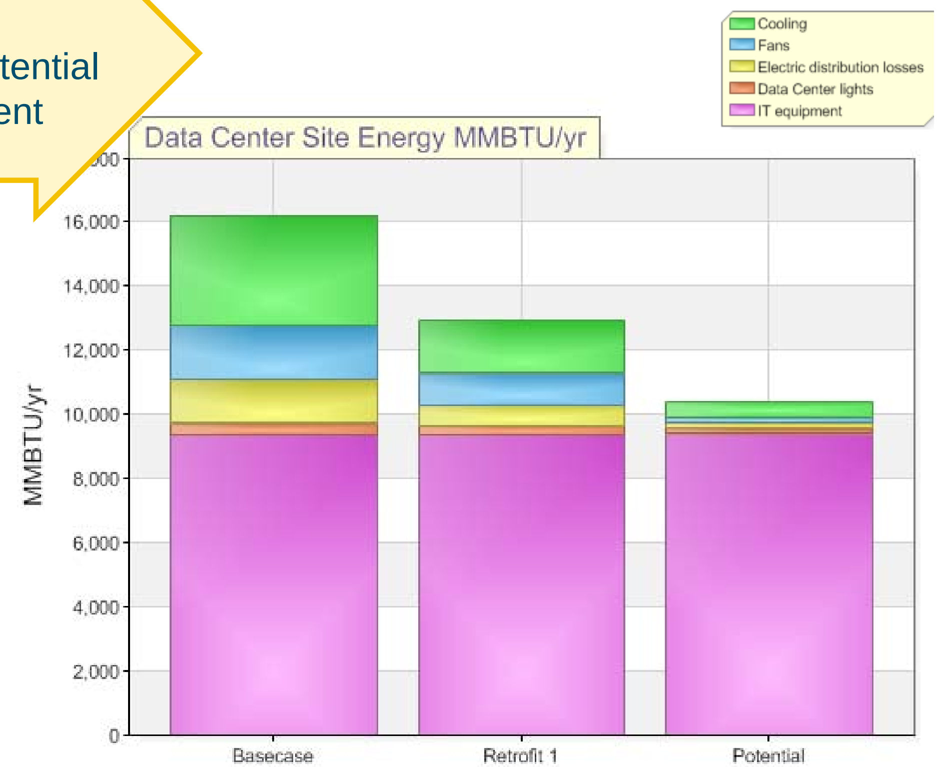
Data Center Profiling Suite (DC-PRO)

- Designed for data center owners &operators
- Diagnoses how energy is used within a data centers
- Determines ways to save energy and money.
- Contains additional components for more detailed air management & electrical assessments - IT & HVAC components coming soon

Save ENERGY Now

Inputs
- Utility bill data
- Systems information
- Facility description

Outputs
- End-use break out
- Energy reduction potential
- Areas for improvement



Power Usage Effectiveness

$$PUE = \frac{Total\ Facility\ Power}{IT\ Equipment\ Power}$$

Standard	Good	Better
2.0	1.4	1.1

Heating, Ventilation & Air-Conditioning System Effectiveness

$$\text{Effectiveness} = \frac{kWh/yr_{\ IT}}{kWh/yr_{\ HAVAC}}$$

Standard	Good	Better
0.7	1.4	2.5

Airflow Efficiency

$$\frac{\text{Total Fan Power (W)}}{\text{Total Fan Airflow (cfm)}}$$

Standard	Good	Better
1.25W/cfm	0.75 W/cfm	0.5 kW/cfm

Cooling System Efficiency

$$\frac{\text{Average Cooling System Power (kW)}}{\text{Average Cooling Load (ton)}}$$

Standard	Good	Better
1.1 kW/ton	0.8 kW/ton	0.6 kW/ton

Collaboration

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FEDERAL PARTNERSHIP FOR GREEN DATA CENTERS

- The Federal Partnership for Green Data Centers was created in 2009 to advance the energy efficiency and renewable energy use goals of the Energy Independence and Security Act of 2007 (EISA 2007) as they relate to data centers.
- The group meets these goals by
  - Facilitating communication between member agencies.
  - Disseminating best practices for data center energy efficiency
  - Working with private sector to share information on new technologies with the Federal Government

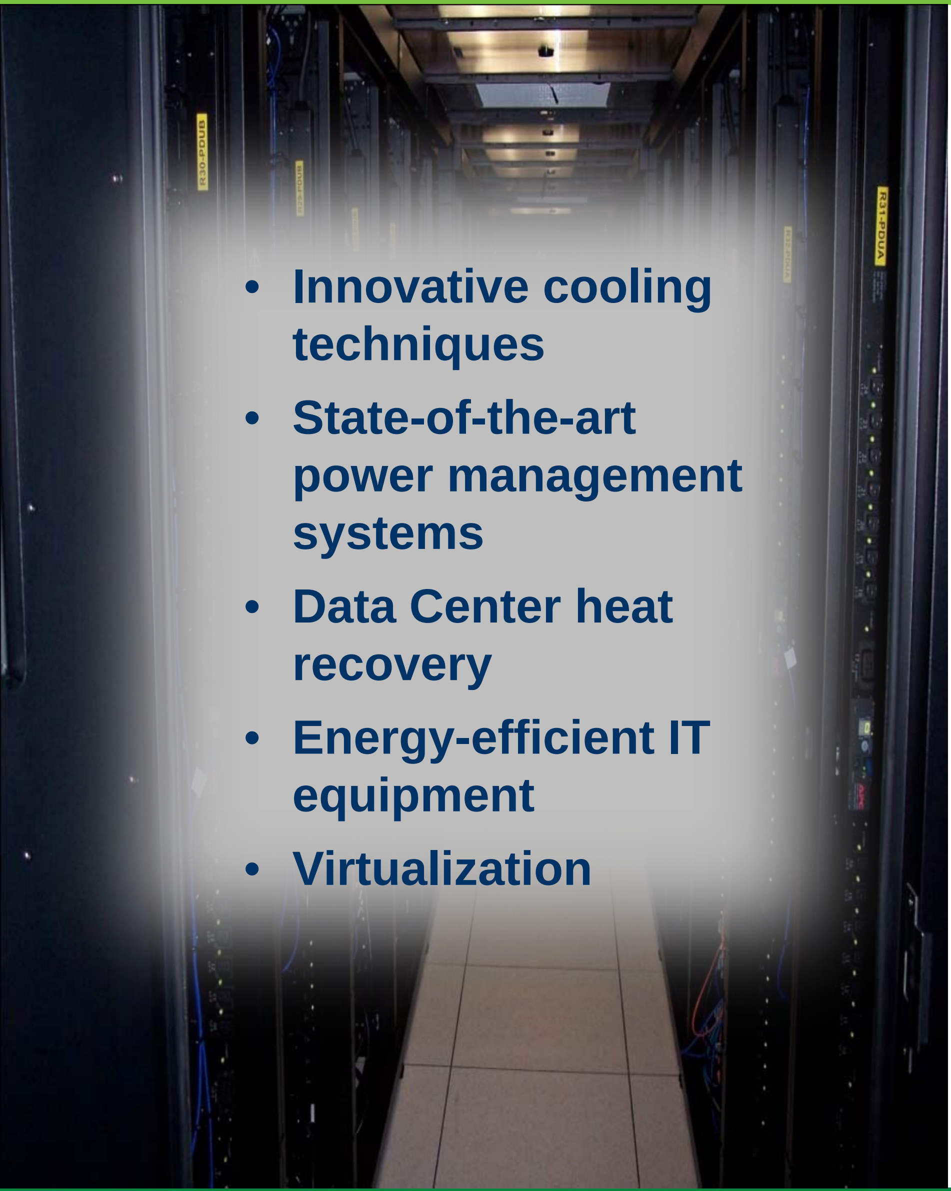
http://www1.eere.energy.gov/femp/program/fpgdc.html

ENERGY EFFICIENT HIGH PERFORMANCE COMPUTING WORKING GROUP (EE HPC WG)

- The Energy Efficient HPC Working Group (EE HPC WG) will target both public and private HPC owners, operators and users to increase collective knowledge and stimulate demand for energy efficient HPC.
- Three sub-groups
  - Infrastructure
  - Computing systems
  - Conferences

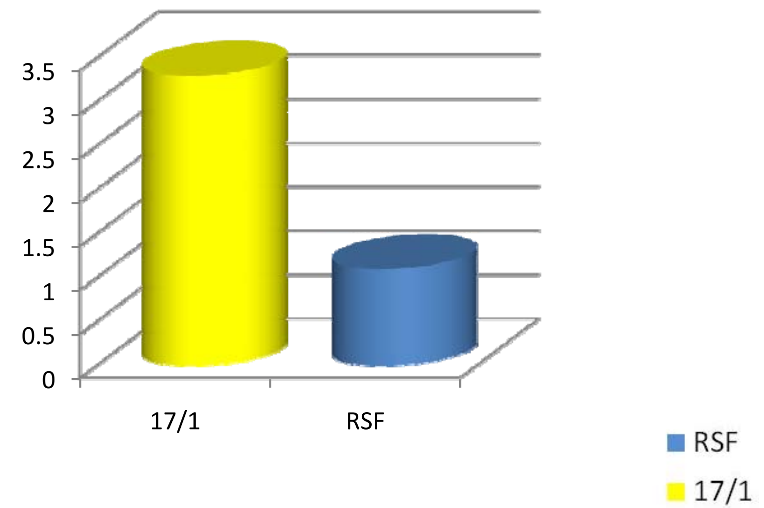
http://eehpcwg.lbl.gov/home

NREL
Research Support Facility

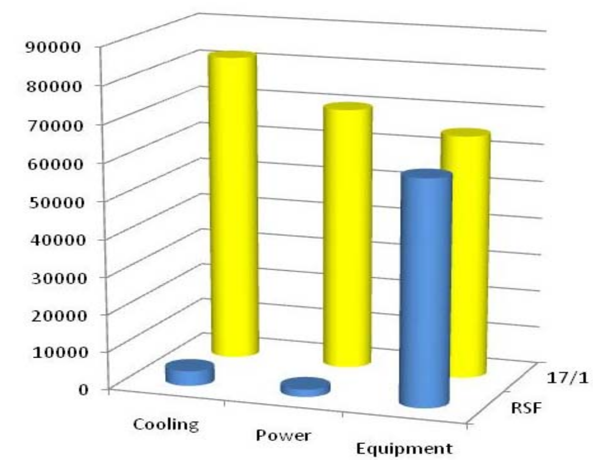


- **Innovative cooling techniques**
- **State-of-the-art power management systems**
- **Data Center heat recovery**
- **Energy-efficient IT equipment**
- **Virtualization**

Power Usage Effectiveness



Data Center Power Usage



Argonne Leadership Computing Facility

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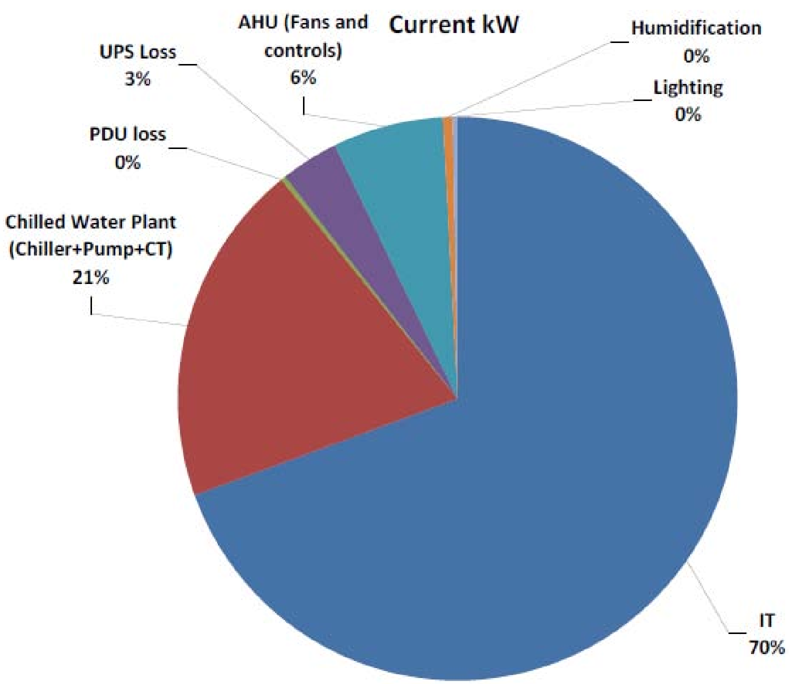
Argonne NATIONAL LABORATORY

Sample Recommendations

- Disable dehumidification
- Seal floor leaks
- Add integrated waterside economizer to CHW plant
- Install occupancy sensors to control lights
- Optimize cooling plant controls

Argonne	Current	After ECMs
Total Electrical Demand	1,866 kW	1,718 kW
PUE	1.46	1.34
Annual CO2 Emissions	15,200 tons	13,980 tons



Implementing suggested changes would decrease facility power from 1,866 kW to 1,718 kW, curbing emissions by 1,220 tons of CO_2 per year.

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Data Center Assessments

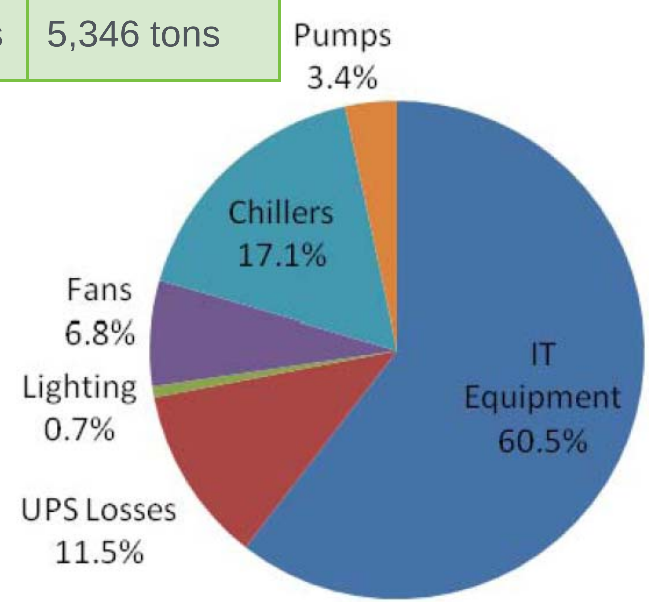
Proposed ECMs:

- Full cooling system retrofit
- Installation of supply ducts in electrical room
- Retrofit lighting

Total Cost of $252,499

# 1	Current	After ECMs
Total Electrical Demand	775 kW	718 kW
PUE	1.65	1.53
Annual CO2 Emissions	5,771 tons	5,346 tons

Implementing suggested changes would save $160,020 and decrease emissions by <u>425 tons of CO_2</u> per year.



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http://www1.eere.energy.gov/femp/program/data_center.html

http://www1.eere.energy.gov/industry/datacenters/

Supplemental Slides:

Best Practices

AIR SUPPLY BEST PRACTICES

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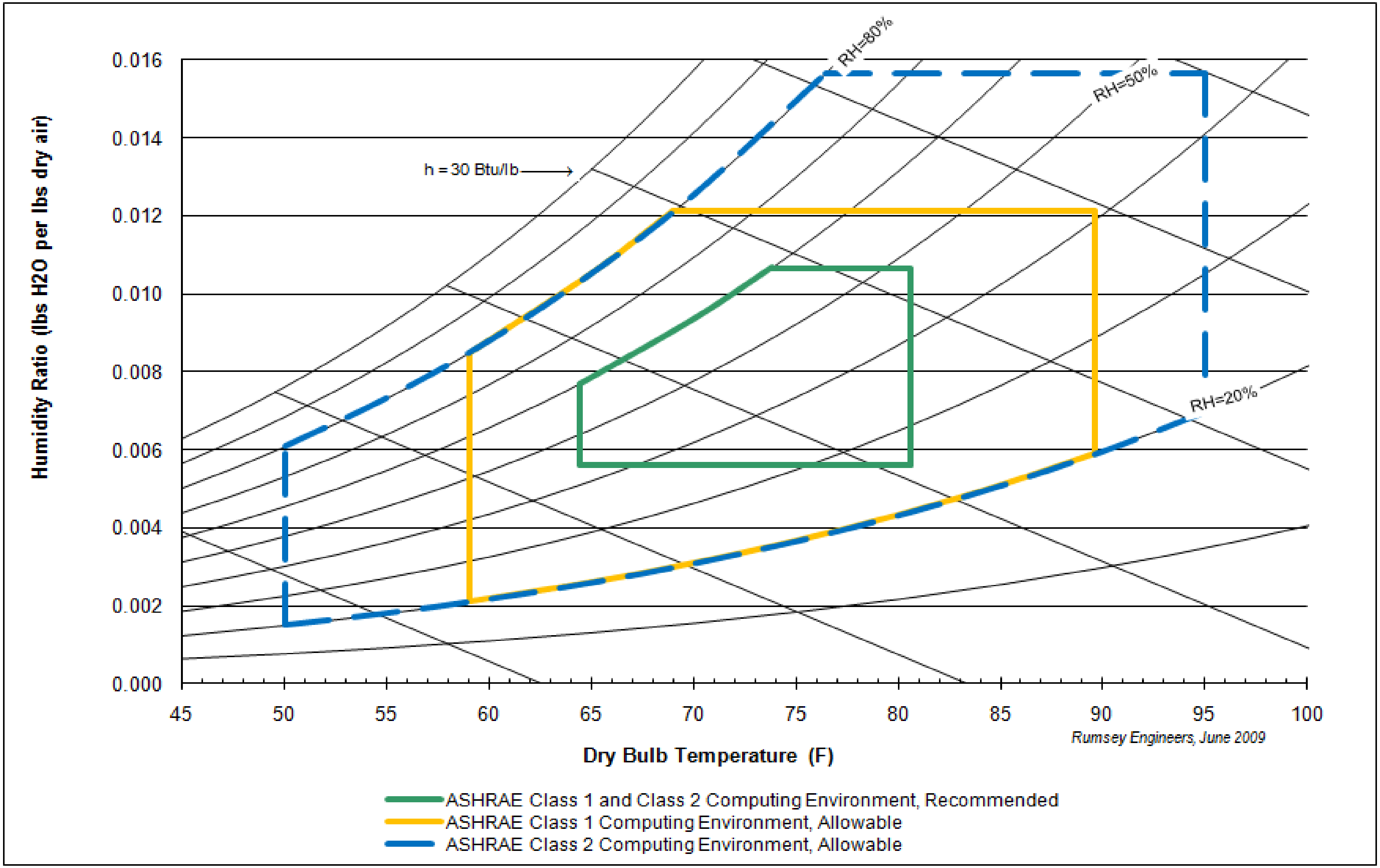

Air Management Best Practices

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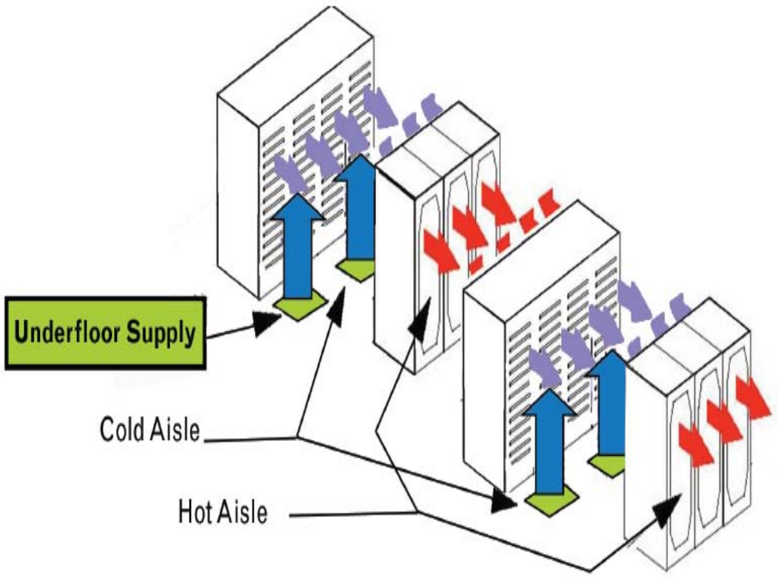
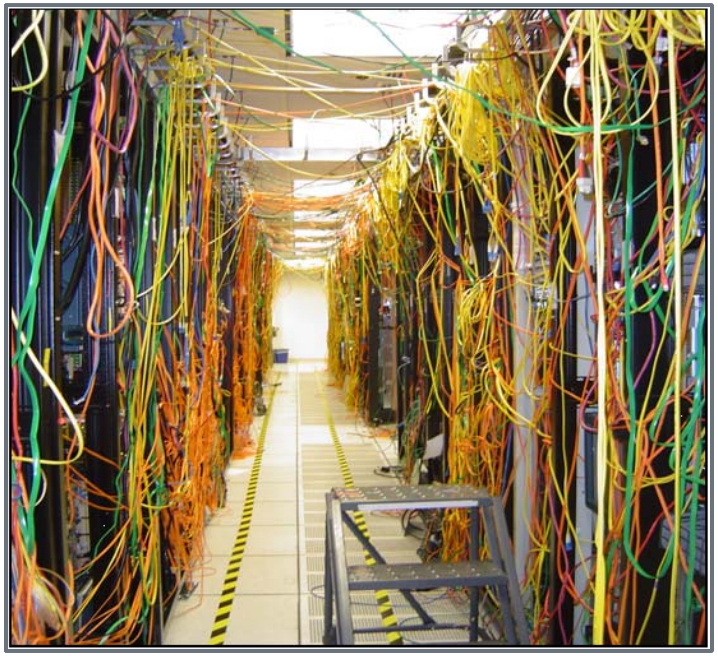


Hot aisle / cold aisle isolation decreases mixing of intake and exhaust air, promoting efficiency.

- Ensure cables are well managed
- Use a minimum clear height of 24 inches under raised floor installations.

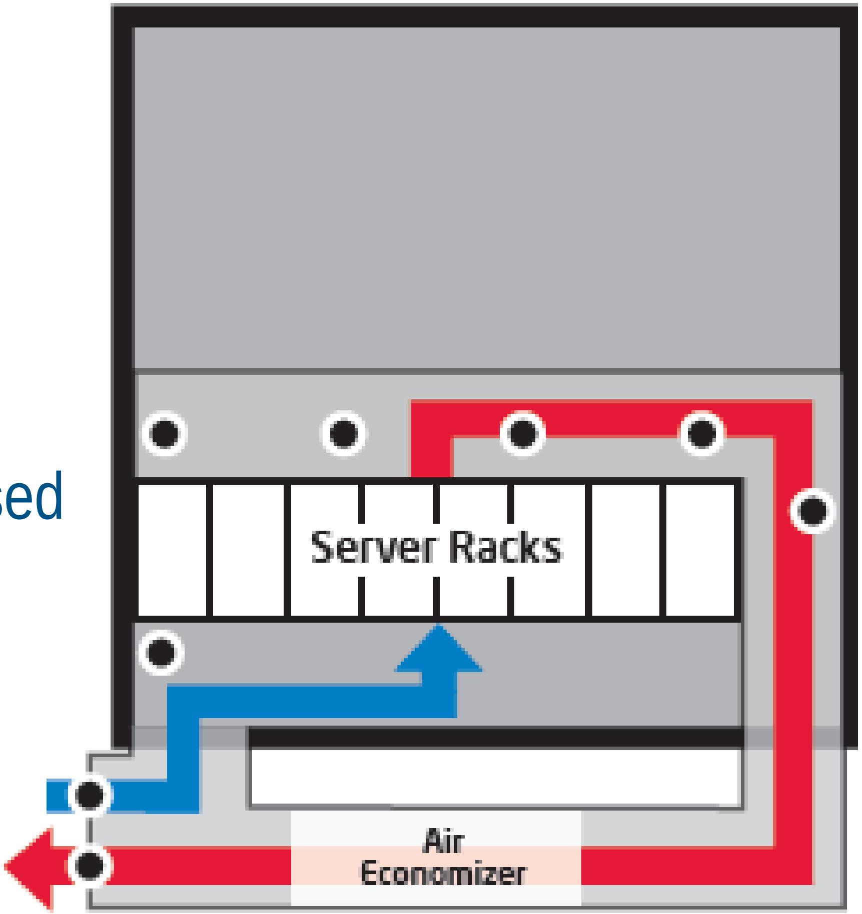


Direct Liquid Cooling

- Transferring waste heat to a liquid at or near the server, rather than exhausting it into the room.

Free Cooling

- In mild climates, outside air can be used to cooled with an airside economizer
- Evaluate humidity and contamination concerns



Air Economizer

Electrical Systems Best Practices

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UPS

- Critical loads only on UPS

Redundancies

- Eliminate redundancies wherever possible

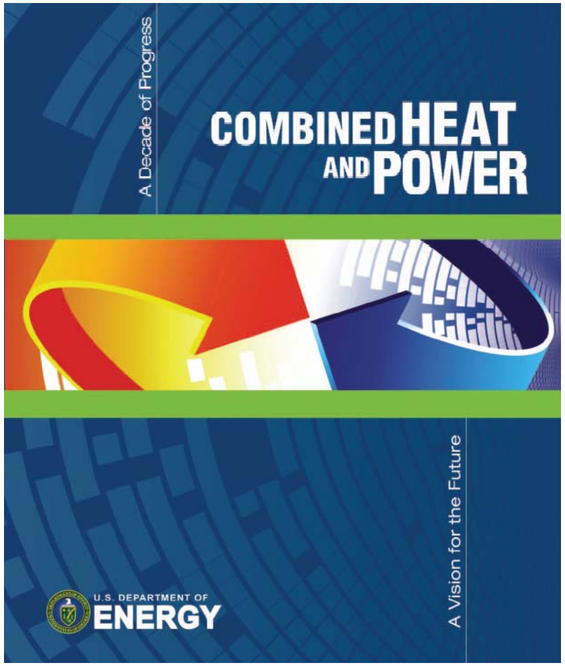
Lighting

- Install occupancy sensors
- Install lights in aisles, not over racks

Other Best Practices

On Site Generation

- On site generation can expand options for data center location
- Renewable energy possibilities – on site renewable energy
- Combined Heat & Power (CHP) – generates energy & useful heat at once



Energy Reuse

- Waste heat from data centers can most effectively be used for low temperature heating applications such as preheating ventilation

IT Systems Best Practices

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Servers

- Choose *variable speed fans*
- Enable *power management capabilities*!
- EnergyStar Servers

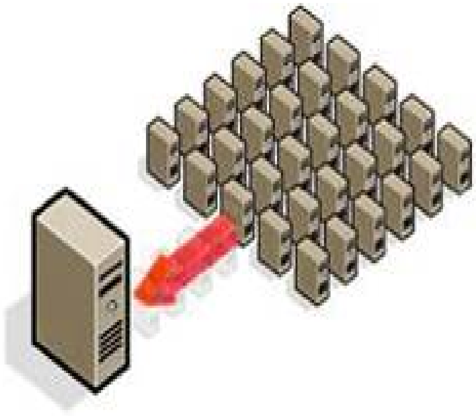
Power Supplies

- Optimal load level: 40-60%
- 80 PLUS Program offers certification of efficient power supplies

Storage Devices

- Take superfluous data offline
- Use thin provisioning technology

Consolidation



- Group hardware with similar heat load densities
- Practice virtualization