



U.S. Department of Energy  
Energy Efficiency and Renewable Energy

*federal energy management program*

# Energy Efficient Data Centers

***Federal Utility Partnership Working Group***

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**Williamsburg, VA**



# Why Data Centers?

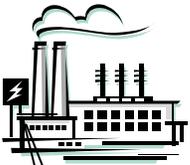
- **Data centers are highly energy intensive and growing at a rapid rate**
  - Consume 10 to 100 times more energy per square foot than typical office building
- **Data centers consumed about 45 billion kWh in 2005 and 61 billion kWh in 2006**
  - This accounts for nearly 1.2% and 1.5% of all U.S. electricity respectively
- **At current rate, power requirements for data centers could double in 5 years**

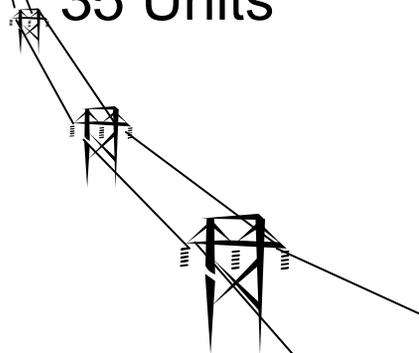




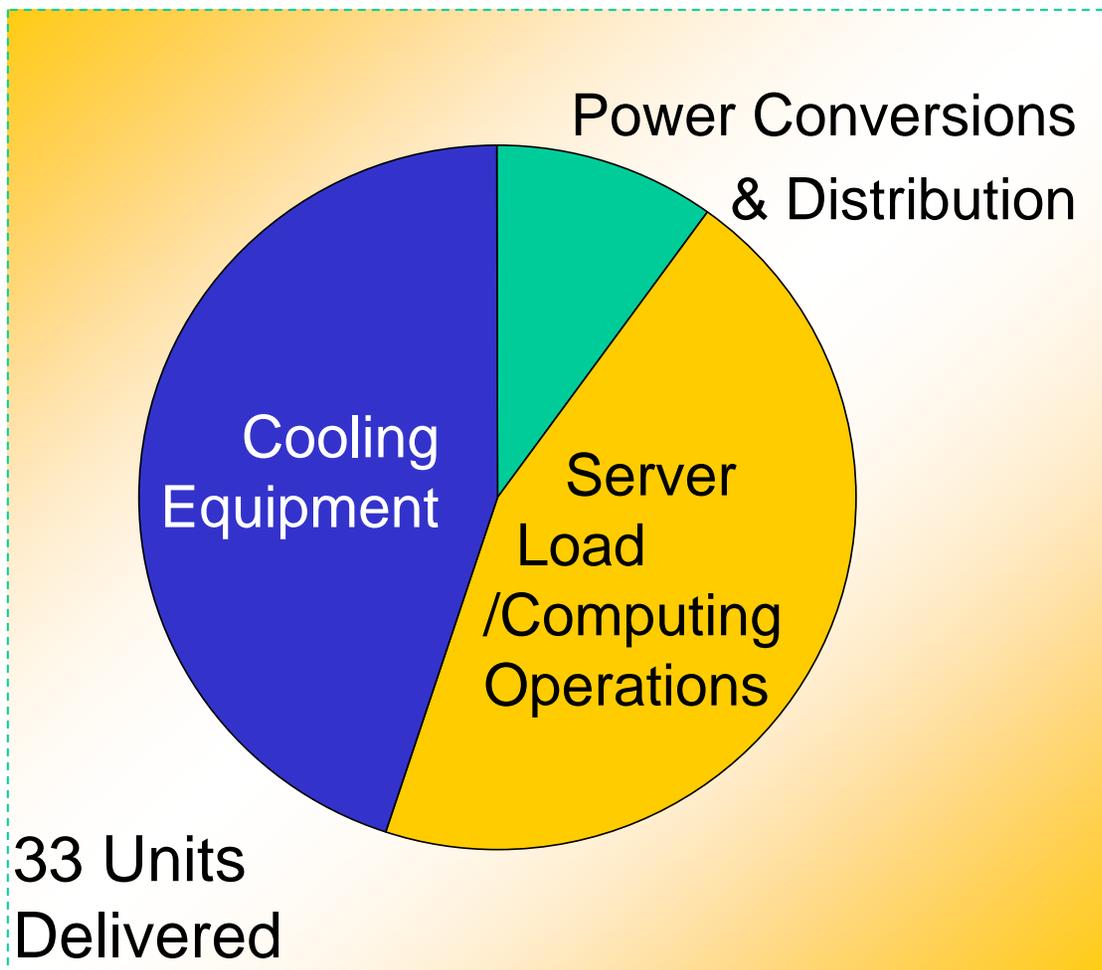
# Typical Data Center Energy Use

 100  
Units

 35 Units

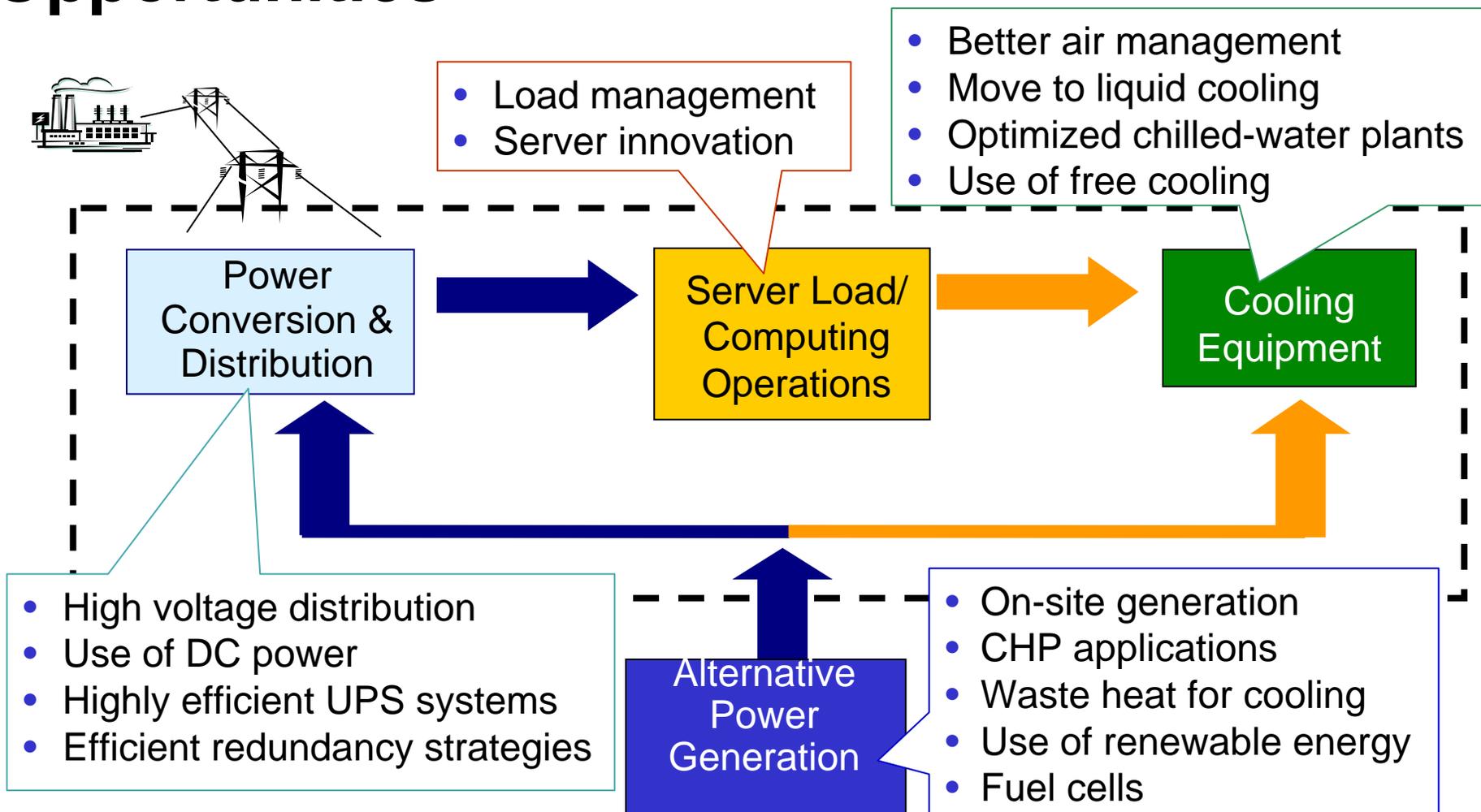


33 Units  
Delivered





# Energy Efficiency Improvement Opportunities





**Authorized by the Energy Independence and Security Act of 2007 (EISA), it is a joint effort between:**

- DOE – Industrial Technology Program (ITP)  
<http://www1.eere.energy.gov/industry/>
- DOE – Federal Energy Management Program (FEMP)  
<http://www1.eere.energy.gov/femp/>
- EPA – EnergyStar® Program  
<http://www.energystar.gov/>



# What DOE Is Doing

- **DOE and Green Grid MOU**
  - Signed in September 2007
- **MOU focuses on:**
  - Devising best energy management practices in data centers
  - Common Energy Assessment Protocol and Tool Suite
  - Robust training program
  - Certified specialists to assist with data center operations
  - Common metrics and benchmarking process for data centers to self-assess their level of energy efficiency





- **Save 20 billion kWh per year by 2015**
  - Equivocates to savings of nearly \$2 billion
  - About equal to annual electricity use in 1.8 million American homes
- **Potentially defer need to build 2,300 MW of new generating capacity**
  - Avoiding 3.4 million metric tons of carbon emissions (like taking 675,000 cars off the road)
- **Extend life and capacity of existing data center infrastructures**





## Industrial Technologies Program Save Energy Now



- Create DC Pro tool, best practices and training
- Work with industry to develop common metrics
- Develop and demonstrate best available technologies



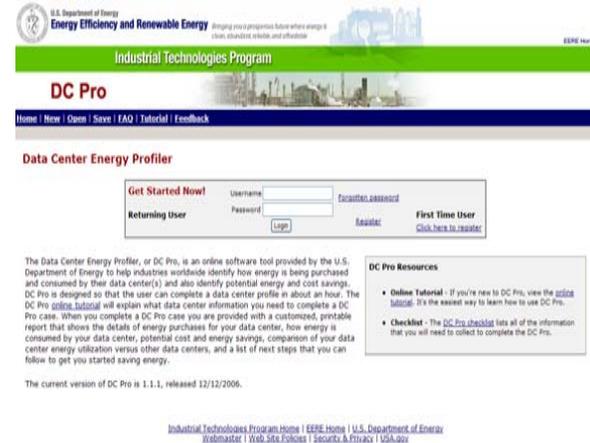
## Federal Energy Management Program

- Raise awareness of Federal facility and IT managers to opportunities to increase data center energy efficiency
- Encourage deployment of the Save Energy Now tools, best practices
- Sponsor training workshops



## Tools to define baseline energy use of data center and identify key energy-saving opportunities

- Determine general performance of the data center
- Benchmark subsystems
- Assess energy savings potential
- Track energy intensity improvement
- Provide quantification of key metrics including cost (\$), primary energy (Btu), and carbon



## DC Pro Tool: now available

<http://dcpro.ppc.com/>



# Many areas can be improved...

## Cooling

- Air Management
- Free Cooling - air or water
- Environmental conditions
- Centralized Air Handlers
- Low Pressure Drop Systems
- Fan Efficiency
- Cooling Plant Optimization
- Direct Liquid Cooling
- Right sizing/redundancy
- Heat recovery
- Building envelope

## Electrical

- UPS and transformer efficiency
- High voltage distribution
- Use of DC power
- Right sizing/redundancy
- Lighting - efficiency and controls
- Standby generation On-site generation
- Premium efficiency motors

## IT

- Power supply efficiency
- Standby/sleep power modes
- IT equipment fans
- Virtualization
- Load shifting
- Memory management and efficiency



## Lawrence Berkeley National Laboratory Computational Research & Theory Facility

<http://www.lbl.gov/>

### Major Project Objectives

- Significant improvement in energy efficiency
- A High-Performance Computing (HPC) facility with minimal cooling infrastructure

### Efficiency Opportunities

- Hot and cold aisle containment
- Outside air cooling
- IT equipment with the ability to operate in an expanded range of temperatures & humidity



## National Renewable Energy Laboratory Energy Systems Integration Facility

<http://www.nrel.gov/>

- Includes a state-of-the-art High-Performance Computing (HPC) Data Center
- Will feature technologies to enable best-in-class energy performance

### **Possible Design Components:**

- Outside air for cooling
- No perimeter Computer Room Air Conditioning (CRAC) units
- Data center separately metered from the rest of the building
- Dashboard to monitor energy use
- Biodiesel generators for data center critical power backup



## Lawrence Berkeley National Laboratory Data Center Retrofit

### Features

- Curtains for improved airflow
- Virtualization
- Wireless sensor network to enable operators to monitor data center status, temperature, humidity, under-floor pressure, & computer room air conditioning power use AND to visualize, track, & fine-tune changes

### Results

- 7% increase in IT load with 8% less fan energy
- Computer room air conditioning (CRAC) unit set points 3°F warmer
- Fewer hot spots
- One 15-ton and one 30-ton CRAC unit turned off

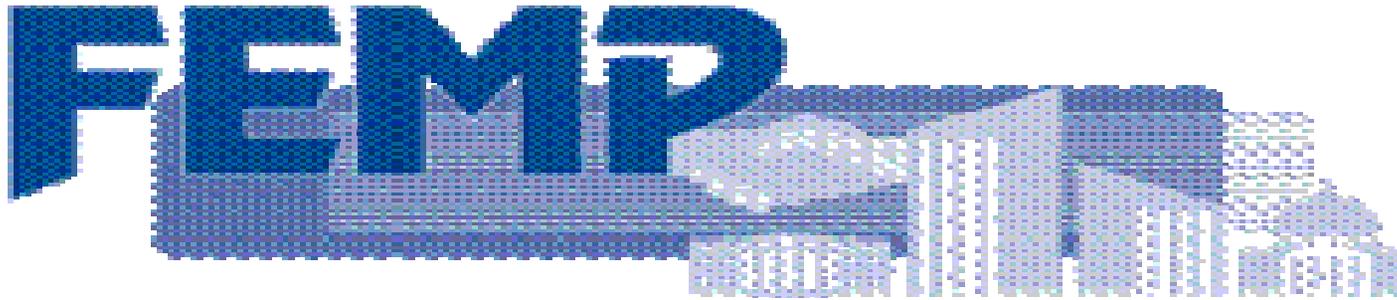


## Technical Assistance

- Document Best Practices Case Studies
- Telephone support for
  - DC Profiler and further assessment tools
  - :Benchmarking

## Training

- *Save Energy Now* in Federal Data Centers
- Webinars
- [DataCenters21](#)



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