



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

DOE Data Center Energy Efficiency Program

Save
ENERGY
Now



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

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DOE Industrial Technologies Program

Working to improve the energy efficiency of U.S. industry

U.S. industry consumes 32 quadrillion Btu per year -- almost 1/3 of all energy used in the nation

Partnerships with energy-intensive industries are key to ITP's success:

- 5 quads of energy savings, 86 MMTCE reduction

Save Energy Now is working to reduce industrial energy intensity 25% by 2017





Data Centers are INFORMATION FACTORIES

...Resembling large
industrial facilities





Containing Specialized Equipment





Save Energy Now: Products & Services

Tools

- Process Heating
- Steam Systems
- Plant Energy Profiler
- Motors & Pumps
- Fans



Information

- Website
- Information Center
- Tip Sheets
- Case studies
- Webcasts



Training

- Basic
- Advanced
- Qualified Specialist



Assessments

- Energy Savings Assessments
- Industrial Assessment Centers



Save
ENERGY
Now



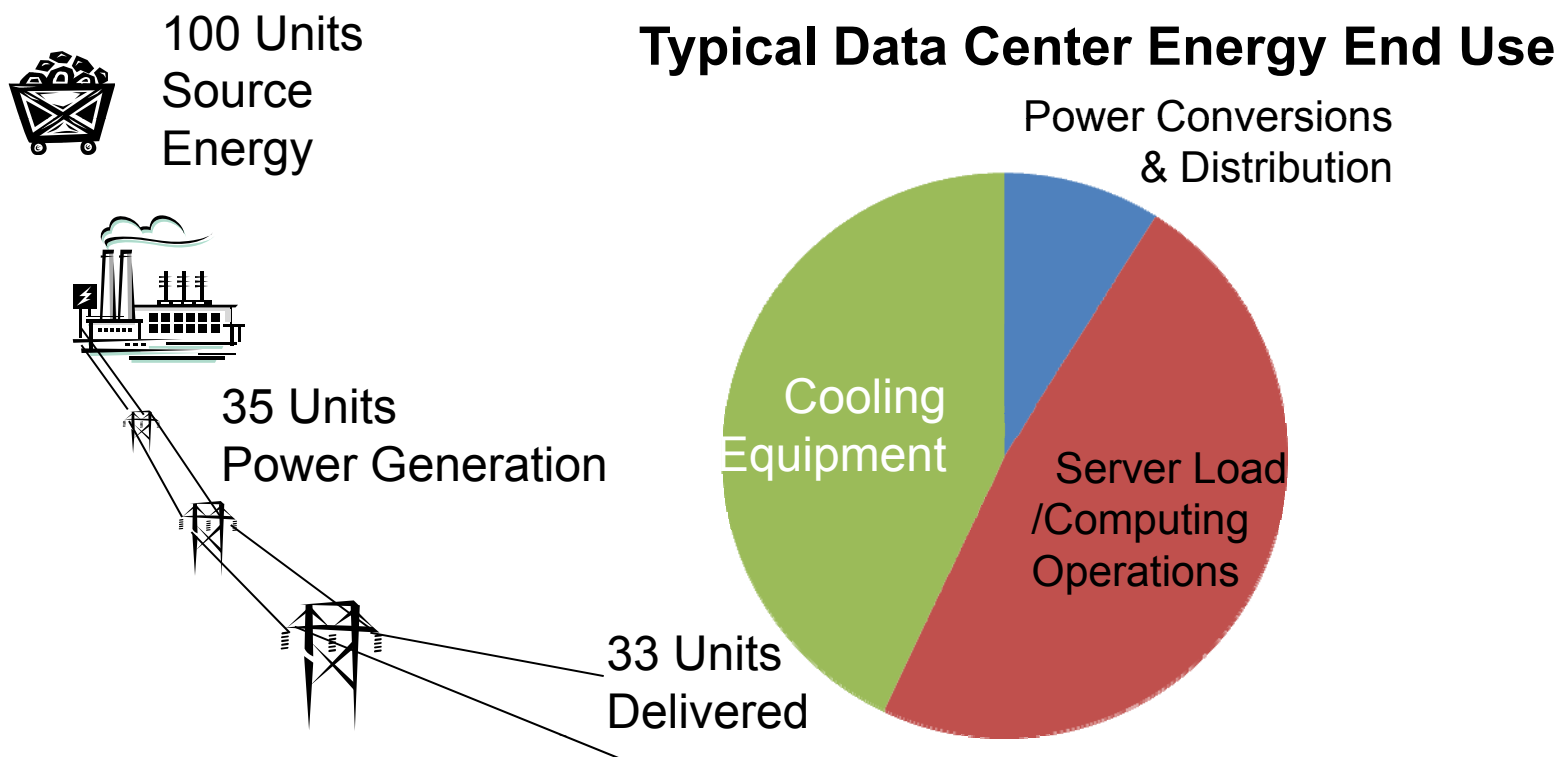
Energy Issues Abound

- **Data centers are an important and growing market**
- **Data centers are energy intensive**
 - Server racks now designed for more than 25+ kW
 - Typical facility ~ 1MW, can be > 20 MW
 - Cost of electricity approaching capital cost of IT equipment
 - 1.5% of all electricity in the U.S. in 2006 (\$4.5 Billion)
 - Growing at 12% per year (will double in 5 years)
 - Power and cooling constraints in existing facilities
 - Utility distribution constraints
- **Currently no consistent metric to measure output**
- **Perverse incentives -- IT and facilities costs separate**



Data Center Energy Efficiency = 15% (or less)

(Energy Efficiency = Useful computation / Total Source Energy)





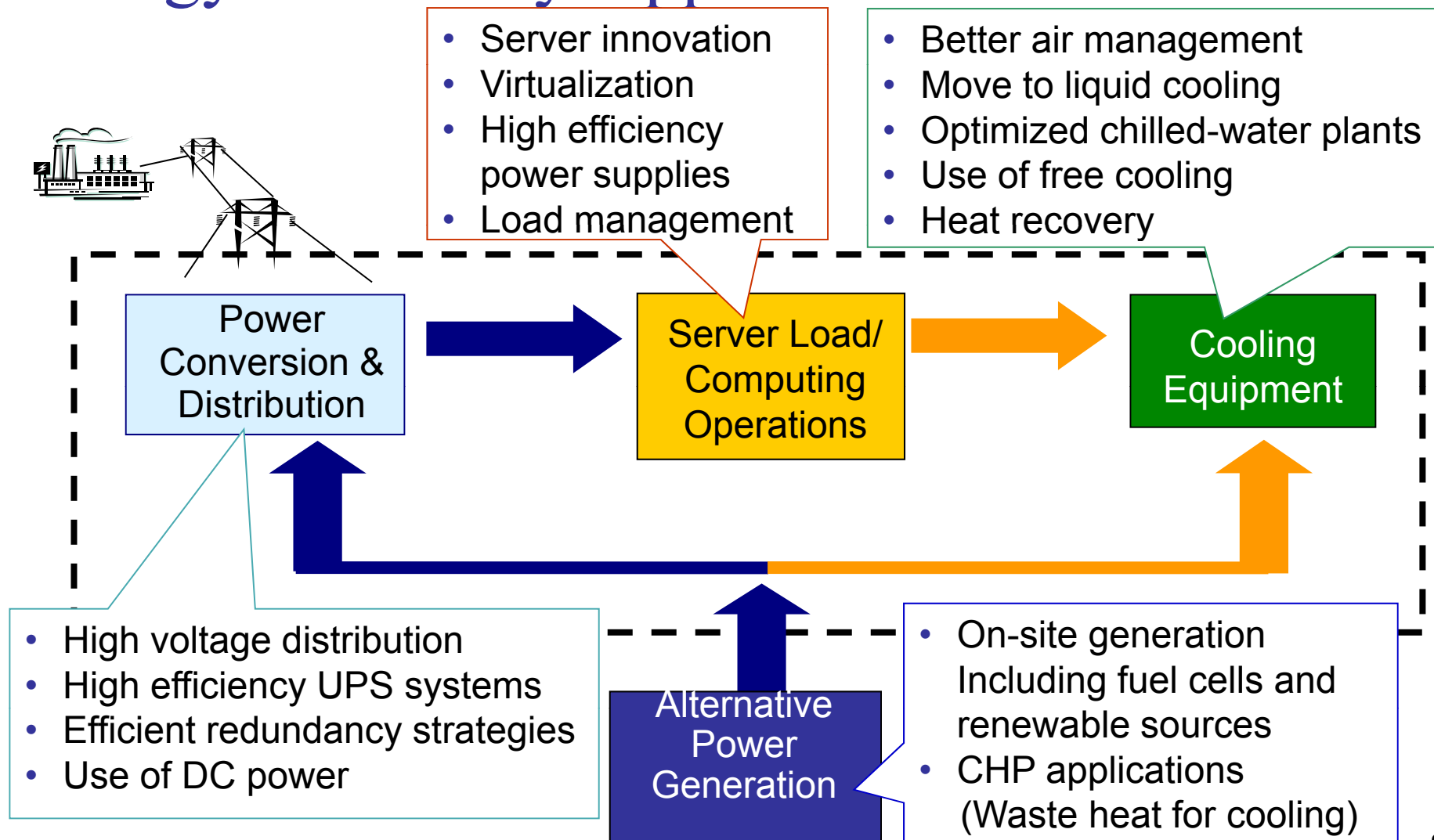
Potential Savings

- 20-40% savings typically possible
- Aggressive strategies – better than 50% savings
- Extend life and capacity of existing infrastructure
- Save Energy Now has developed tools to:
 - Estimate where energy is going
 - How use compares to others
 - Identify savings opportunities





Energy Efficiency Opportunities





DCiE = Data Center Infrastructure Efficiency

$$\text{DCiE} = \frac{\text{Energy for IT Equipment}}{\text{Total Energy for Data Center}}$$

Typical DCiE (Data Center Infrastructure Efficiency) < 0.5

- IT electrical and cooling systems are far from optimized
- Less than half of the energy is for the servers

Power Utilization Effectiveness = PUE = 1 / DCiE
Typical PUE > 2.0



Data Center Performance Varies in Cooling and Power Conversion

DCiE

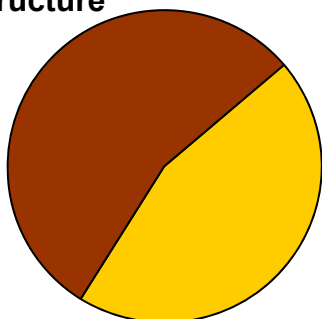
Data Center Infrastructure Efficiency

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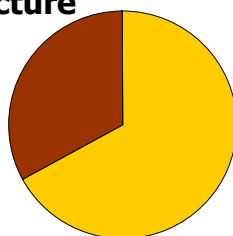
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Infrastructure



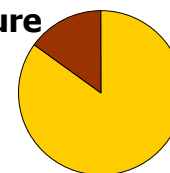
Typical Practice
DCiE < 0.5

Infrastructure



Better Practice
DCiE = 0.7

Infrastructure



Best Practice
DCiE = 0.85

IT Energy

IT Energy

IT Energy



DCeP = Data Center Energy Productivity

$$\text{DCeP} = \frac{\text{Work Output of Data Center (Bytes)}}{\text{Total Energy for Data Center (BTU)}}$$

DCeP under development by Green Grid consortium



DC Pro tool 2008 results

- Over 1,000 people have registered to use tool
- 15 companies beta tested, including 11 Green Grid companies
- Companies using tool in procurement specs and energy management team planning

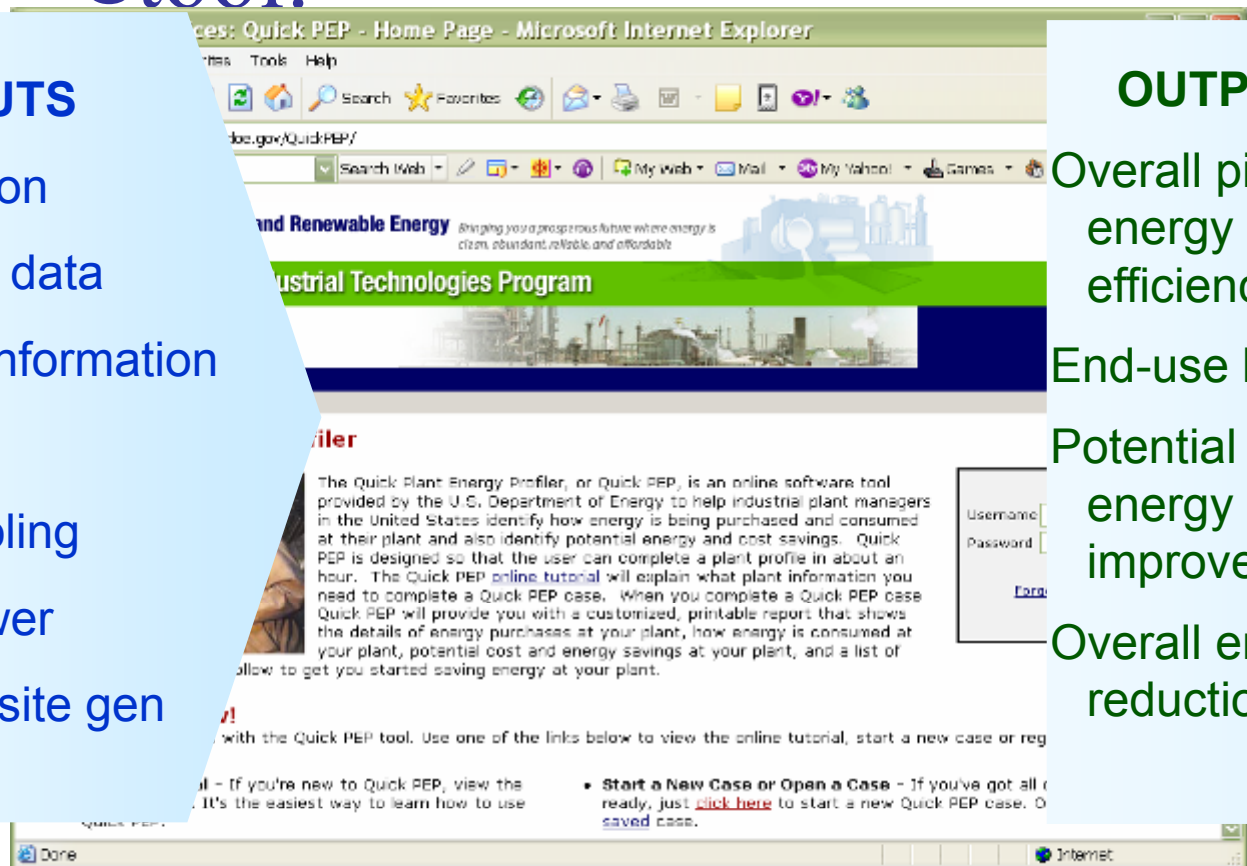




Save Energy Now On-line profiling tool: "Data Center Pro"

INPUTS

- Description
- Utility bill data
- System information
- IT
- Cooling
- Power
- On-site gen



OUTPUTS

- Overall picture of energy use and efficiency
- End-use breakout
- Potential areas for energy efficiency improvement
- Overall energy use reduction potential



2008 Case Study Results

- Lucasfilm and Verizon case studies with potential cost savings identified of \$343,000 and \$181,000 per year, respectively
- Additional case studies desired





Lucasfilms Case Study

Data Center Overview

- Located at the Presidio of San Francisco National Park
- 23-acre facility/13,500 square feet (data center)
- Houses a render farm (cluster of computers that work to process digital images), file servers, and storage systems
- More than 4,300 processors
- Cooled by a central chilled water plant serving the Lucasfilm campus
- Receives back-up power through UPS systems





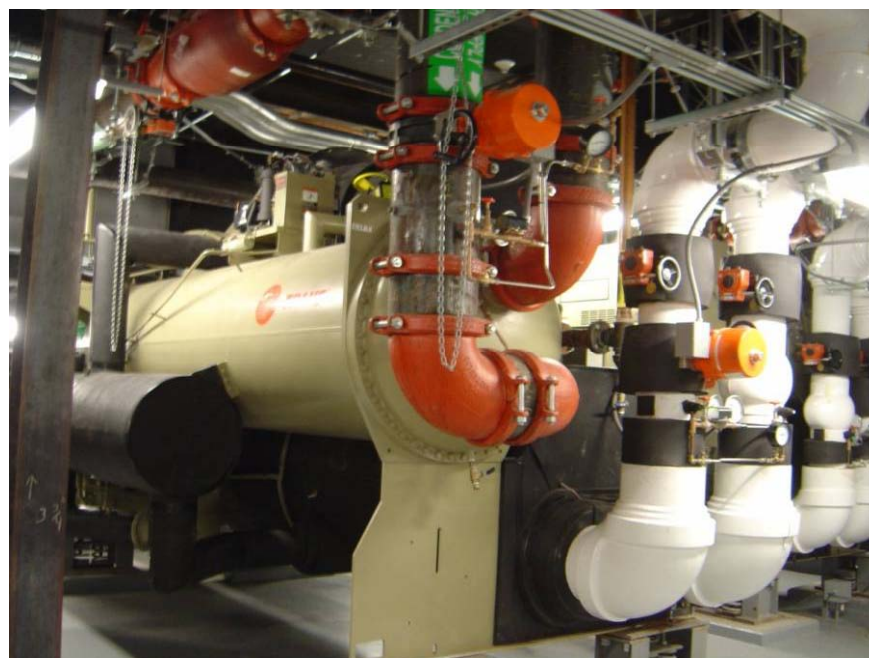
Case Study: Lucasfilms Ltd. (cont'd)

Recommended Solutions and cost savings

- Remove redundant UPS systems (\$12,000/year)
- Turn servers off during downtime (\$30,000/year)
- Stage chillers to maintain high load factor (\$10,000/year)
- Operate UPS in switched by-pass mode (\$98,000/year)
- Improve air flow (\$89,000/year)
- Implement water-side economizer (\$103,000/year)
- Install lighting controls (\$1,000/year)

Estimated Savings and Payback

- Cost Savings: \$343,000
- Energy Savings: 3,109,200 kWh
- Implementation costs: \$429,500
- Payback: 1.2 Years

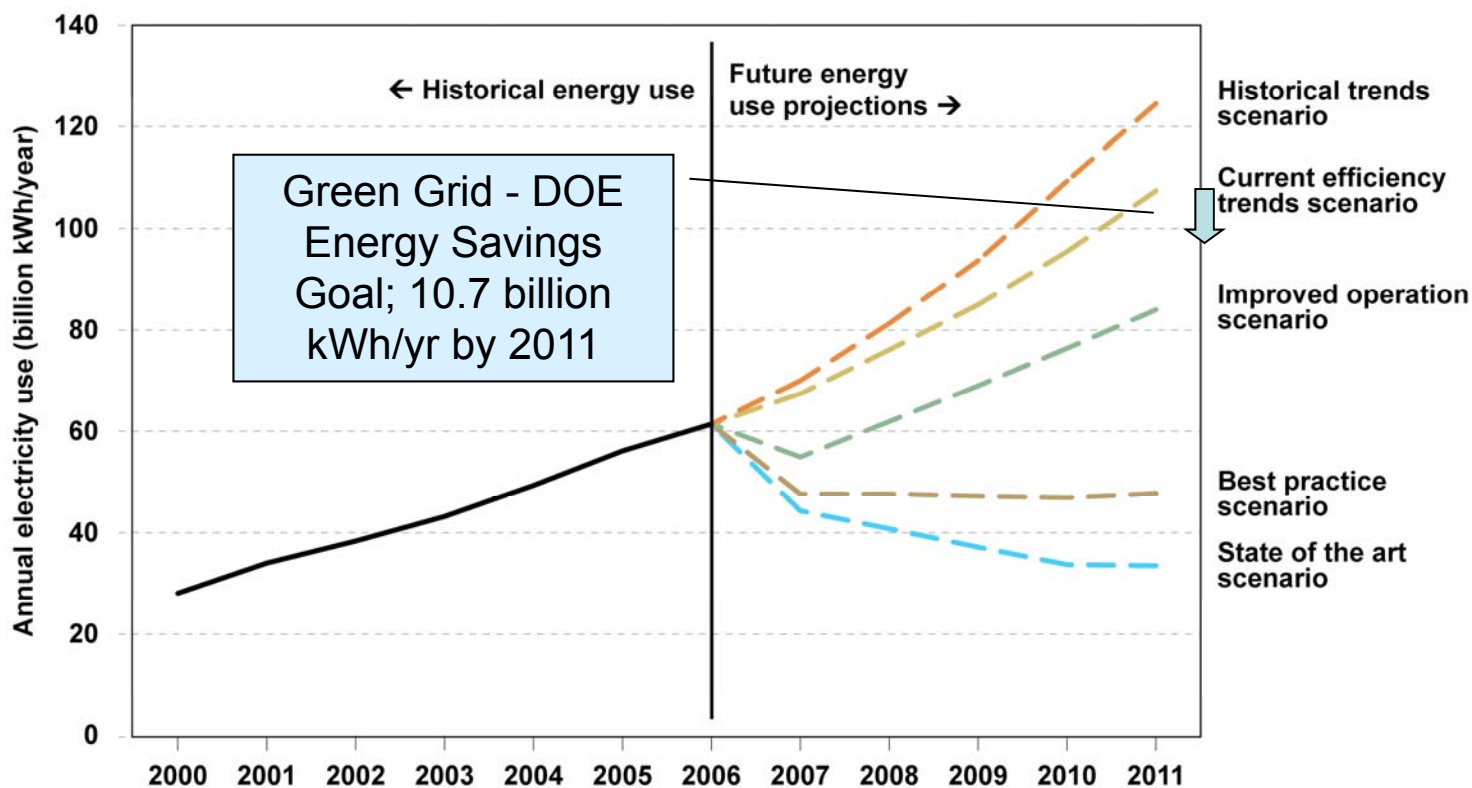




DOE-Green Grid Goal for Energy Savings

2011 goal is 10% energy savings overall in U.S. data center

- 10.7 billion kWh
- Equivalent to electricity consumed by 1 million typical U.S. households
- Reduces greenhouse gas emissions by 6.5 million metrics tons of CO₂ per year





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Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

Industrial Technologies Program

- DC Pro tool suite & training
- Metrics & energy baselining
- Qualified specialists
- Case studies
- Certification of continual improvement
- Recognition of high energy savers
- Best practice information & training
- Best-in-Class guidelines
- R&D - technology development



Federal Energy Management Program



- Best practices showcased at Federal data centers
- Pilot adoption of Best-in-Class guidelines at Federal data centers
- Adoption of to-be-developed industry standard for Best-in-Class at newly constructed Federal data centers

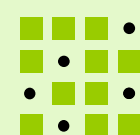
EPA

- Metrics
- Server performance rating & ENERGY STAR label
- Data center ENERGY STAR performance benchmarking



Industry

- Tools
- Metrics
- Training
- Best practice information
- Best-in-Class guidelines
- IT work productivity standard



Information Technology Industry Council
 Leading Policy for the Innovation Economy





2008 Activity

- Tools and Assessment Protocols
 - DC Pro tool v1.0 released
 - Electrical assessment tool beta released
 - IT module initiated with Green Grid
 - Air management assessment tool alpha released
 - HVAC Tool – in development
- Training
 - Pilot trainings (5)
 - Developing joint training with ASHRAE and Green Grid



By 2011



Products

- DC Pro tool
- Assessment protocols
- Training curriculum
- Case studies
- Best practices
- Best-in-Class guidelines
- Technology R&D and demonstrations

Market Delivery

- 200 Data Center Certified Energy Practitioners
- Suppliers
- Engineering firms
- Utilities
- Associations and technical societies

Data Center Results

- 10 billion kWh per year saved
- 3,000 people trained on tools and assessment protocols
- 1,500 data centers improve energy efficiency > 25%
- 200 data centers improve energy efficiency >50%



2009 Activity

- Tools and Assessment Protocols
 - Improve DC Pro tool
 - IT module released
 - Air management released
 - HVAC tool initiated
- Training
 - ASHRAE-Green Grid-DOE pilot trainings
 - Hold data center trainings at multiple events
- Develop and pilot Data Center Certified Energy Practitioner program
- Develop R&D program



Calls to Action

- More case studies – especially data centers improving more than 25%
- Use DC Pro tools and provide feedback
- Staff and customers participate in training workshops
- Staff become Data Center Certified Energy Practitioners
- Participate in potential data center technology demonstration program



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www.eere.energy.gov/industry

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Information Tech. R&D program

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Links to Get Started:

DOE Website: Sign up to stay up to date on new developments
www.eere.energy.gov/datacenters

Lawrence Berkeley National Laboratory (LBNL)
<http://hightech.lbl.gov/datacenters.html>

LBNL Best Practices Guidelines (cooling, power, IT systems)
<http://hightech.lbl.gov/datacenters-bpg.html>

ASHRAE Data Center technical guidebooks
<http://tc99.ashraetcs.org/>

The Green Grid Association – White papers on metrics
http://www.thegreengrid.org/gg_content/

Energy Star® Program
http://www.energystar.gov/index.cfm?c=prod_development.server_efficiency

Uptime Institute white papers
www.uptimeinstitute.org

