ENERGY STAR®
Industry Focus – Development of Energy Performance Benchmarks for Data Centers

Santa Fe, NM
October 31, 2007

Today's Agenda

- Introduction
  - Goal of metrics
  - EPA and DOE programs
- Energy Usage in Data Centers
- Testing and Implementing Metrics
- Next Steps

Introduction

- Data center energy use rapidly increasing
  - Sector consumed about 61 billion KWh in 2006
    - Equates to ~1.5% total U.S. electricity consumption and ~$4.5 billion
    - Federal sector: ~6 billion kWh and ~$450 million
  - Projected to increase to 100 billion kWh in 2011
    - Equates to ~2.5% of total U.S. electricity consumption and ~$7.4 billion

Introduction

- Complex energy questions
  - Different configurations of equipment
  - Various types of output & processing required
  - Multiple power supply and cooling options
- Extremely dynamic industry
  - Challenge to develop metrics
  - Best metrics may change as technologies change
- Stand alone versus within a building

Metric Goals

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- Benchmark and profile data center energy use
- Compare similar data centers
- Track energy use over time and measure improvement in energy performance
- Design new high-efficiency data centers

Metric Goals

- Assess efficiency of power delivery and HVAC
  - IT load / total load
- Assess efficiency of IT equipment
  - Useful work / IT load
- Assess efficiency of entire data center
  - Useful work (FLOPS) / Energy (kw-hr)

Metric Goals

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- Ideal high level metric: useful work / kw-hr
- Challenge: how to measure “useful work” - teraflop or other alternative
- Next Steps to meet metric goals
  - Agree on “useful work” – challenge industry to reach consensus
  - Implement working metrics for end users – can begin with IT load / Total load ***(focus of today’s discussion)***

EPA ENERGY STAR for Commercial Buildings – Overview

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- Energy management program that provides proven solutions to help building owners and managers reduce their energy consumption
  - Help businesses protect the environment through superior energy performance
- Numerous tools & technical resources
  - National rating system for buildings to benchmark and track energy use
  - Energy management guidelines
  - Advice on design for energy efficient buildings
  - Online case studies and best practices
  - Calculators to track return on energy efficiency investments
  - Training
- Opportunities for national recognition

EPA ENERGY STAR for Commercial Buildings – Overview

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- 2006 ENERGY STAR results
  - $14 billion in savings
  - 37 million metric tons CE
  - Emissions of 25 million cars
  - 5% of total electricity demand

EPA ENERGY STAR for Commercial Buildings – Overview

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- Work in markets with a focus on:
  - Commercial Property (offices, retail, hotels)
  - Public Sector (government, education)
  - Healthcare
  - Small businesses and congregations
- Provide an online tool to rate energy performance on a scale of 1-to-100
  - Over 35,000 buildings have been rated
- Buildings that earn a 75 or higher can earn the prestigious ENERGY STAR label
  - Over 3,200 buildings have earned the ENERGY STAR
- Learn more: **www.energystar.gov/buildings**

EPA ENERGY STAR for Commercial Buildings – Rating System

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- Convey information about energy performance in a simple metric that can be understood by all levels of the organization

Is 10 MPG high or low for an automobile?

Fuel Efficiency

MPG

Is 90 kBtu/SF/YR high or low for an office building?

Energy Efficiency Rating

1 - 100

EPA ENERGY STAR for Commercial Buildings – Rating System

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- Monitor actual as-billed energy data
- Create a whole building indicator
  - Capture the interactions of building systems not individual equipment efficiency
  - Track energy use accounting for weather and operational changes over time
- Allow for peer group comparison
  - Compare a building's energy performance to its national peer group
  - Track how changes at the building level alter the building's standing relative to its peer group

EPA ENERGY STAR for Commercial Buildings – Data Centers

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- Partnerships with large end-users
  - Banking, financial services, insurance, internet commerce
- Partners operate stand alone data centers and data centers in larger office buildings
- Energy use in data centers is increasingly important to Partners
- Goals
  - Develop rating for stand alone data centers
  - Incorporate data centers into building ratings
- Needs
  - Agreement on concensus metrics
  - Monitored data on energy use in data centers
  - Ability for metrics to handle change

Save Energy Now Goals

Save Energy Now is a key strategy for engaging industry by introducing energy-saving opportunities and providing access to resources.

1. Educate managers and operations staff at all levels about the benefits of making energy efficiency a top priority
2. Assist industry in making reductions in energy consumption
3. Create momentum to significantly improve energy efficiency practices throughout the manufacturing sector and now for data centers

Save ENERGY Now

Save ENERGY Now

Save Energy Now: Products and Services

Tools

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

Information

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

Training

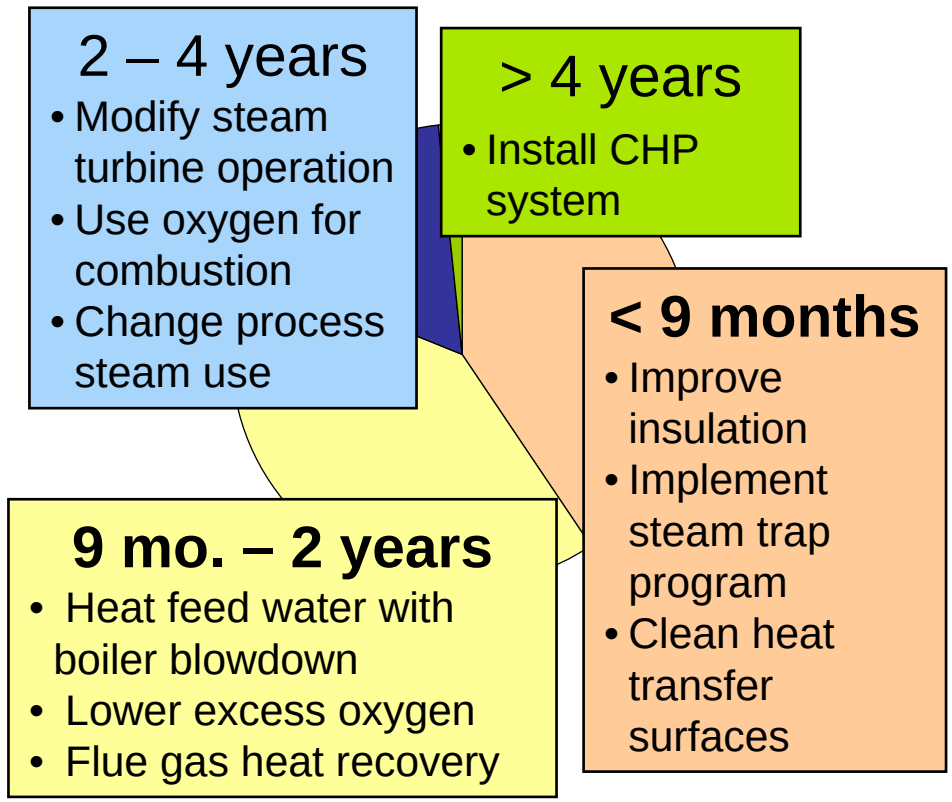
- Basic
- Advanced
- Qualified Specialist

Assessments

- Energy Savings Assessments
- Industrial Assessment Centers

DOE Save Energy Now - Results to Date

- 344 **US manufacturing plant**s energy assessments completed
- Natural gas potential savings = 60.4 trillion Btu/yr
  - Carbon dioxide avoided = 4.7 million metric tons/year
- Cost savings opportunity = $586 million per year
  - Savings implemented or planned = $330 million (180 plants)



Estimated Payback Periods for Recommended Actions

Save ENERGY Now

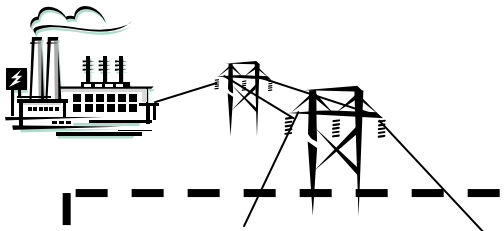
DOE experience with US manufacturing plants

- 16,000 plants have used tools, training and best practices
- 600+ energy assessments per yr
- Over 100 case studies
- Certification of over 500 energy experts (Qualified Specialists)
- ANSI accredited certification standards under development: demonstrates continual improvement in energy intensity

Creating capacity for Data Center energy efficiency

- Develop tools with training and energy assessment protocols
- Create case studies
- 200 “certified data center energy experts” by 2011
- Federal procurement policies using industry standards
- Possible certification standards

Metrics Help to Find Energy Efficiency Opportunities



- Load management
- Server innovation

- Better air management
- Move to liquid cooling
- Optimized chilled-water plants
- Use of free cooling

Power Conversion & Distribution

Server Load/ Computing Operations

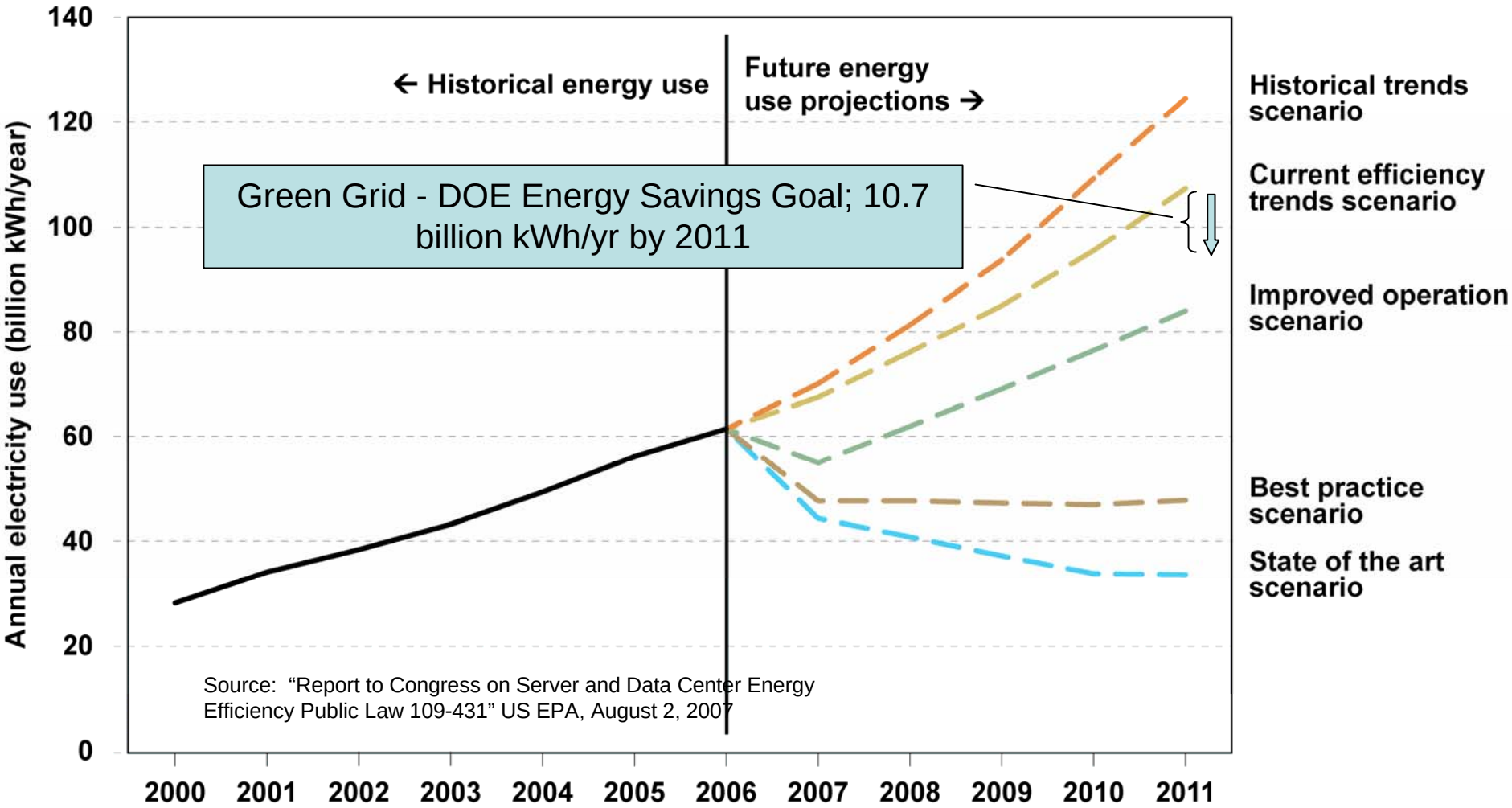
Cooling Equipment

- High voltage distribution
- Use of DC power
- Highly efficient UPS systems
- Efficient redundancy strategies

Alternative Power Generation

- On-site generation
- CHP applications
- Waste heat for cooling
- Use of renewable energy
- Fuel cells

Comparison of Projected US Data Center Electricity Use, All Scenarios, 2007-2011



What Is Needed?

- Assistance in identifying the best opportunities for savings at each data center through tools, training and outreach
- Outside validation to help convince management that addressing opportunities is feasible and cost-effective
- Corporate leadership to drive energy efficiency programs from CEO to data center operation staff

Data Centers in Federal Sector Too!

- Target Federal Sector Data Centers
  - Focus on DOE facilities initially
  - Identify largest federal data centers
- Develop federal procurement policies and industry standards
- Conduct energy efficiency demonstrations at federal facilities using Save Energy Now strategy; assessments, tools, protocols, technologies

FEMP
FEDERAL ENERGY MANAGEMENT PROGRAM

Save ENERGY Now

Need for Consensus Metrics

- Metrics need to integrate with and support tool development
  - Energy profiling tool (to be developed in next 6 months)
  - Sub-system analysis tools
- Supports implementation of Federal procurement policies for newly constructed Federal data center
- Supports Federal data center energy efficiency retrofits using third party financing
- Helps to communicate energy efficiency opportunity to decision makers
- Could support definition of most efficient data centers (ENERGY STAR)
- Could support possible certification process and industry recognition programs (ENERGY STAR and LEED) and standards (ASHRAE)

Today's Agenda

- Introduction
- Energy Usage in Data Centers
  - Opportunities for Improvement
  - Selecting a Performance Metric
  - Rating Systems
- Testing and Implementing Metrics
- Next Steps

Energy Usage in Data Centers

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energystar.gov

- Steve Greenberg - LBNL