ENERGY STAR Server Specification Working Group

ENERGY STAR Workshop to Discuss Server and Data Center Initiatives

Santa Fe, New Mexico

October 31, 2007

Overview

Goal of Discussion Today

- Identify and discuss potential criteria for an ENERGY STAR specification for servers
- Identify challenges and new ideas

Structure of Discussion

- Technical staff will lead attendees through each criterion --- open floor discussion but time is very limited
- Attendees will identify key points of the discussion to share with the larger group

What is ENERGY STAR?

- Protects the environment through superior energy efficiency
- No tradeoffs in performance or quality
- Cost effective (2nd price tag)
- Government backed symbol providing valuable, unbiased information – source of authority
- Binary (Y/N)
- Power of the individual to make a difference

ENERGY STAR Strategies

Residential

Labeled Products
-- 50+ products / 1700 manufacturers
-- 10-60% more efficient than widgets)
Labeled New Homes
-- 30% more efficient
Home Improvement Services
-- beyond products components
-- ducts / home sealing
-- whole home retrofits

Commercial / Industrial

Corporate energy management
-- benchmarking, goals, upgrades (management, systems more

-- whole building labeling for excellence
--technical assistance

Labeled Products
-- for plug loads -- not system

Industrial
Small business initiative

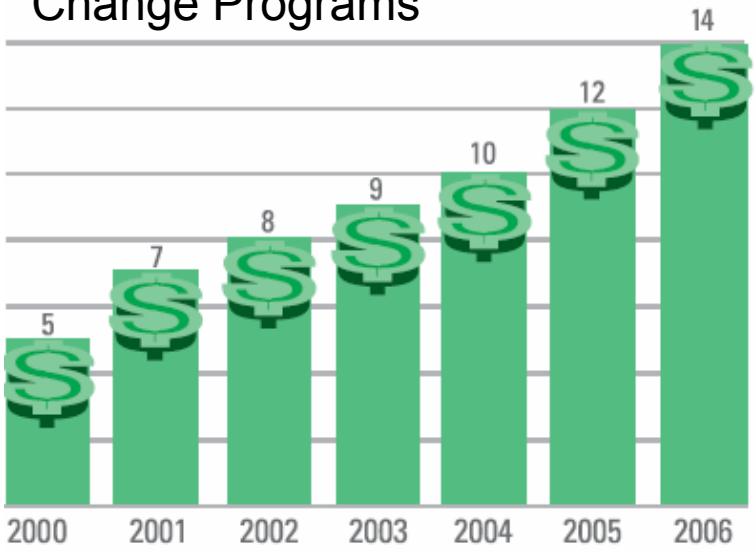
ENERGY STAR is International

- Agreements in place with government agencies in various countries to promote certain ENERGY STAR qualified products
  - Australia (office equipment and consumer electronics)
  - Canada (broad range of products)
  - EU (office equipment)
  - Japan (office equipment)
  - New Zealand (office equipment and consumer electronics)
  - Taiwan (office equipment)

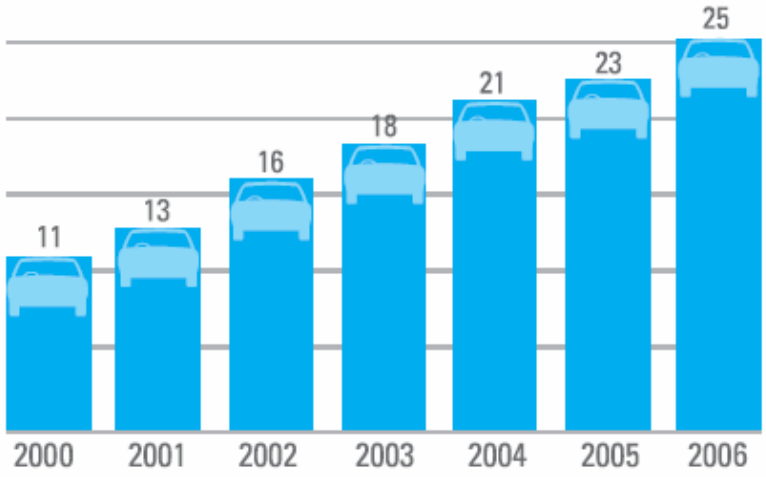
Program Accomplishments - 2006

In 2006, Americans with the help of ENERGY STAR:

- Prevented 37 million metric tons of GHG emissions– equivalent to 25 million vehicles
- Saved $14 billion on energy bills
- Lowered their energy use by 170 billion kilowatt hours – almost 5% of US electricity sales
- Delivered 1/3 of total US GHG emissions reduction from EPA's Climate Change Programs



UTILITY BILL SAVINGS
(in billions)



EMISSIONS SAVED IN
VEHICLE EQUIVALENTS (in millions)

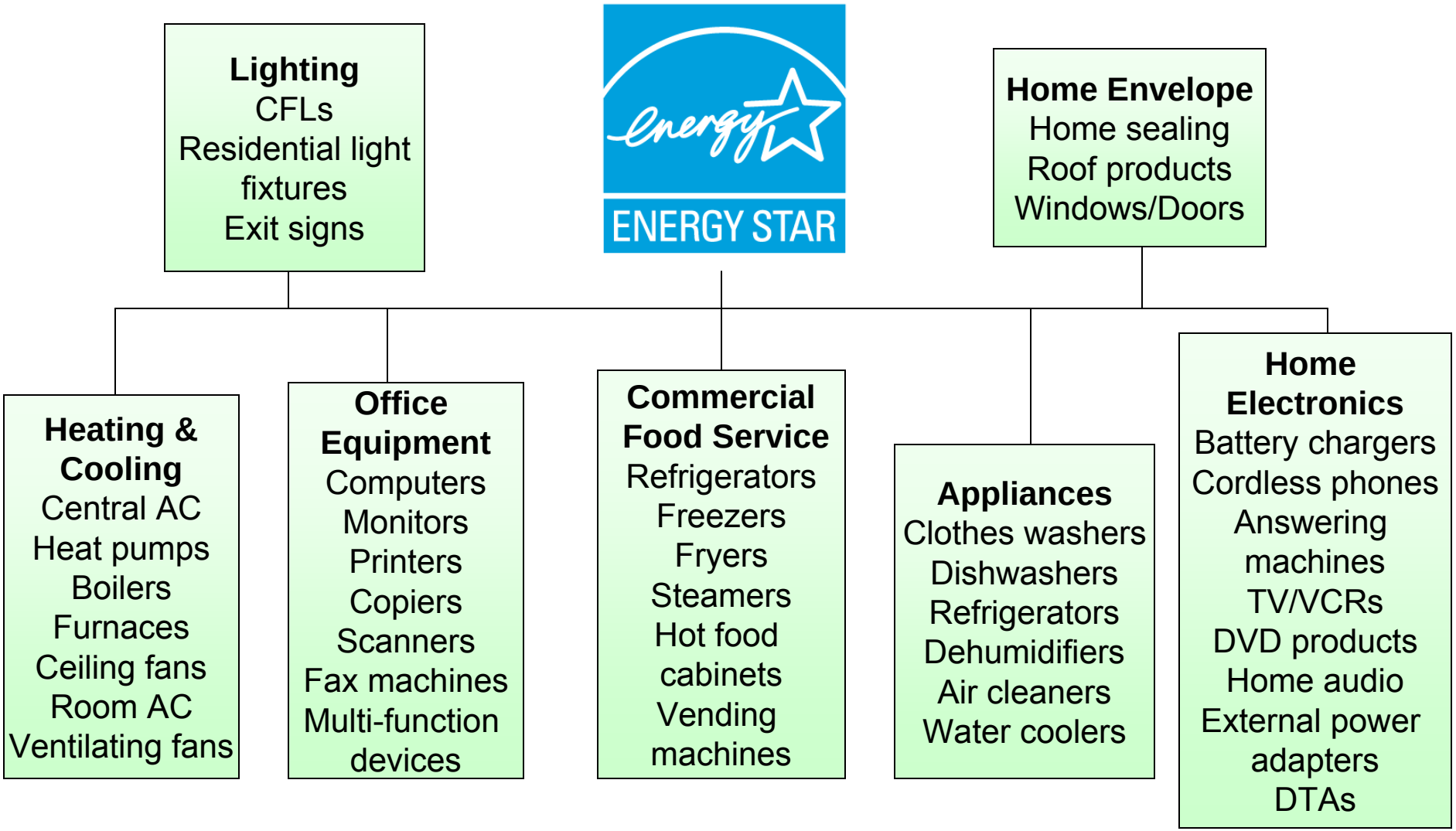
Program Accomplishments cont.

- Public awareness of ENERGY STAR is over 65%
- Engaged 9,000 organizations in manufacturing, delivery, adoption of energy efficiency
- Helped consumers purchase more than 2 billion qualified products from 1,700 manufacturers across 50 product categories
- Over 725,000 new homes are ENERGY STAR; almost 10% of new homes starts across the country are ENERGY STAR
- Tens of thousands of buildings benchmarked, thousands of buildings improved

Protecting Integrity of the Label

- Self-certification program – works due to competitive market place and active consumer groups (Consumer Reports)
- EPA monitors use/protects integrity of brand
  - Information on products and appropriate logo use required as condition of partnership
  - Routine checking of manufacturer submitted information
  - Selective product testing
  - Pulling from retail shelves – twice annually
  - Customer calls
  - Manufacturer information on competitors
  - Designed supplemental testing program for problem areas -- lighting products
  - Track all advertisements (reports monthly)
  - All printed press coverage– daily, monthly
  - Web report –qtly
  - Integrity Report - annually
  - Insure correct use of mark: all violations dealt with; coordinate with EPA OGC
- Complementary reinforcing package

50+ Product Categories Are Covered by ENERGY STAR in the US



Why Servers?

Server energy demand drives data center power & cooling needs

- Lower HVAC costs
  - 1 to 1.5 kWh HVAC savings for every kWh saved at the plug
- Reduce CO2 emissions
  - 1kWh ≈ 1.6 lbs of CO2
- More computing space, increase computational density --- server racks now at 25 kW load
- Customers are asking for more energy efficient products for the data center

International Interest

- IT equipment central to the global economy
- Issues faced within the datacenter shared worldwide
- EPA is working with UK, EU, Canada, and China to harmonize efforts in the data center sector

Spec Development Guiding Principles

- Cost-effective efficiency
- Performance maintained or enhanced
- Significant unit and national energy savings potential
- Efficiency can be achieved through several technologies
- Product differentiation and testing are feasible
- Labeling can be effective in the market

Specification Setting Process

Server Spec Development Activities

- Draft server specification framework document released **July 20, 2007**
  - No performance levels proposed
  - Questions for discussion & potential criterion
  - More than 20 sets of comments received
- Based on comments and discussion today, EPA will develop a Draft 1 specification for review and comment by end of this year
- **Target final spec: Spring/Summer 2008**

Potential Server Specification Criteria

Basic Definitions of a Server

- **Basic Server Definition:** A computer dedicated to providing services to other computers or appliances (i.e. clients).
- Characteristics of Enterprise Servers:
  - Redundancy (including "hot-swappable" components)
  - Processor scaling (# of processors/cores)
  - Memory capacity and type (e.g., # of Dimms, ECC memory)
  - Capable of utilizing external storage (NAS/SAN)
  - Dedicated management controllers
  - Other components (internal disks, network adapters, option slots)
  - Rack Space (e.g., 1u, 2u, 3u, etc.)
  - "Server class" operating systems

Basic Definitions, cont.

- Characteristics of Blade Servers
  - Chassis to support individual servers with some shared resources on the back plane (power supplies, wiring, cooling, etc.)

Question

- What are some key components and/or characteristics that define a server?

Product Coverage

- Intends to cover all server types for the Tier 1 specification (including large servers), with the possible inclusion of desktop-derived servers for Tier 2
- Bulk of savings will come from “volume” and blade servers, so specification development will focus on these products

Question

- Can a simple Tier 1 specification also include storage and networking equipment?

Expanding to Storage Equipment

- Information is increasingly becoming digital which drives the market for storage equipment
  - 25% yearly growth in external hard disks
  - Increasing energy use in the data center
- Strategy on Storage

  Tier 1: Cover under server specification based on power supply efficiency

  Tier 2: Develop a more holistic specification based on an industry developed/agreed upon performance metric
- If storage cannot be included with server Tier 2, EPA will keep an eye on this product for potential future development

Criterion #1: Power Supply Efficiency

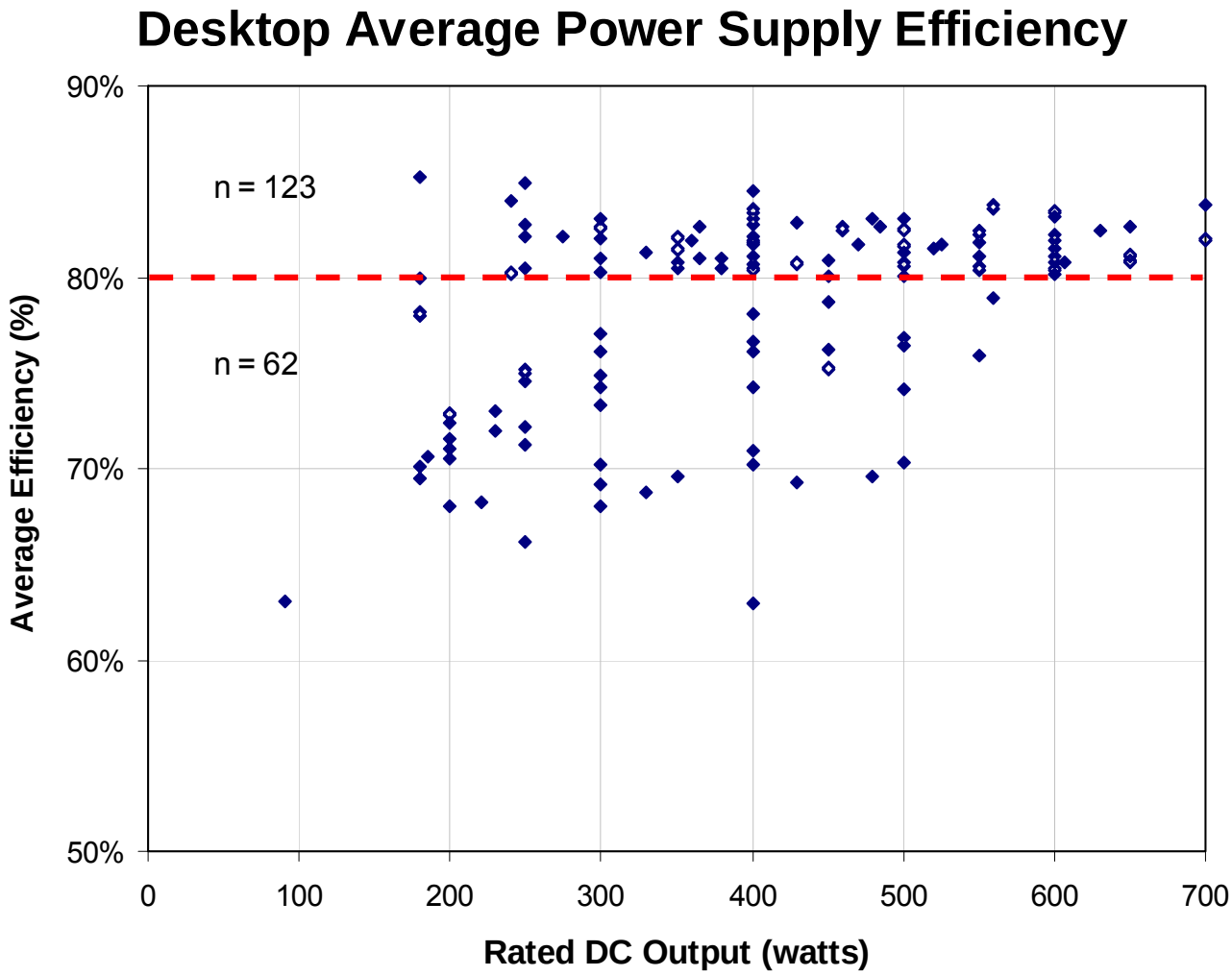
- Why cover power supply efficiency?
  - Save energy in all modes of operation
  - Build off experience and relationships developed with V4.0 computer specification revision
- What would the criterion be based on?
  - Conversion efficiency at 10%, 20%, 50% and 100% loads
  - No-load power consumption
  - Minimum power factor, possibly at all load points
  - Test procedure developed by EPRI / Ecos Consulting: www.80PLUS.com/servers.htm
- Alternate Idea – Net power consumption
  - Ac input power minus dc output power during server operation

Power Supply Efficiency cont.

Questions

- Multi-voltage vs. single-voltage server power supplies
- How should the effects of cooling fans be accounted for?
- Is testing at only 208 VAC or 230 VAC acceptable, and does it properly characterize the efficiency of the PS in operation?
- How could a specification account for products with shared power supplies (e.g., blade sy stems or dc power at the rack level)?

The market demonstrated by 2006 that desktop power supplies could exceed 80% average efficiency across a wide range of sizes



Two Types of Server Power Supplies

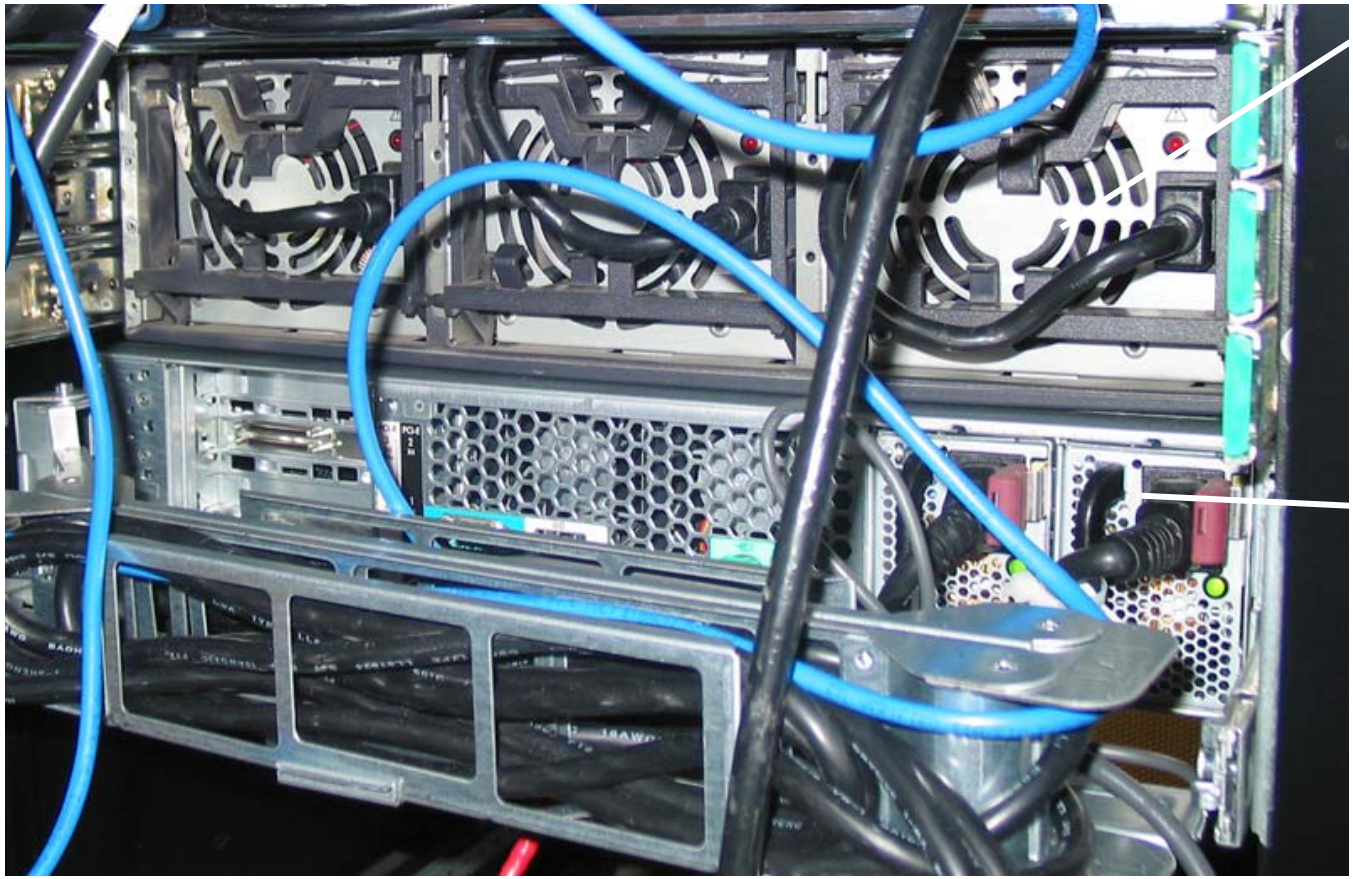
Multiple Output

- Multiple output voltages
- Typically run on “low line” or 115 Vac
- Commonly non-redundant
- Usually have standardized connectors
- **Already covered by 80 PLUS and ENERGY STAR desktop-derived servers**

Single Output

- Typically “high line” (230 Vac) input
- Commonly configured redundantly
- Usually have custom connectors and “voltage sense” feedback systems
- Often single output voltage
- Mounted in IT/telecom rack
- **Focus of 80 PLUS Servers Program**

Server Power Supplies in the Data Center



Redundantly configured 2U server power supplies

Redundantly configured 1U server power supplies

Background on Test Procedure

Draft Test Protocol for Calculating the Energy Efficiency of Server Power Supplies

Revision 1.1
May 4, 2007

Electric Power Research Institute (EPRI)
Brian Fortenbery
Tom Geist
Chris Trueblood
Baskar Vairamohan

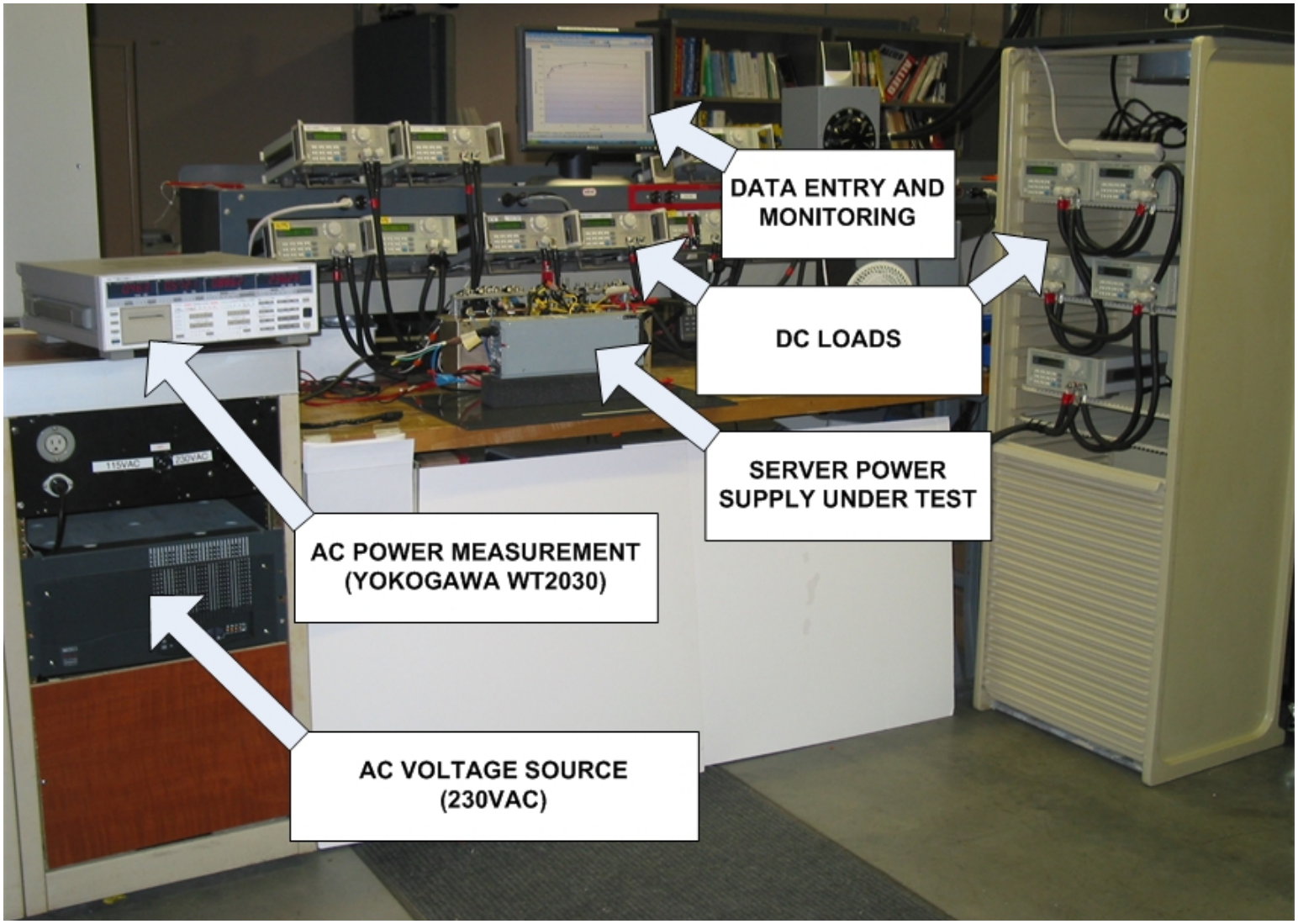
Ecos Consulting
Chris Calwell
Peter May-Ostendorp
Ryan Rasmussen

Sponsored by:

Bonneville Power Administration
Pacific Gas & Electric
Natural Resources Canada
The Energy Trust of Oregon
Northwest Energy Efficiency Alliance
Snohomish PUD
PacifiCorp
Southern California Edison

- Modified from previous internal power supply test procedure to address unique server conditions
- Key step to enable fair, consistent product measurement and comparison
- Incorporated industry feedback on key issues such as how to address fan power use

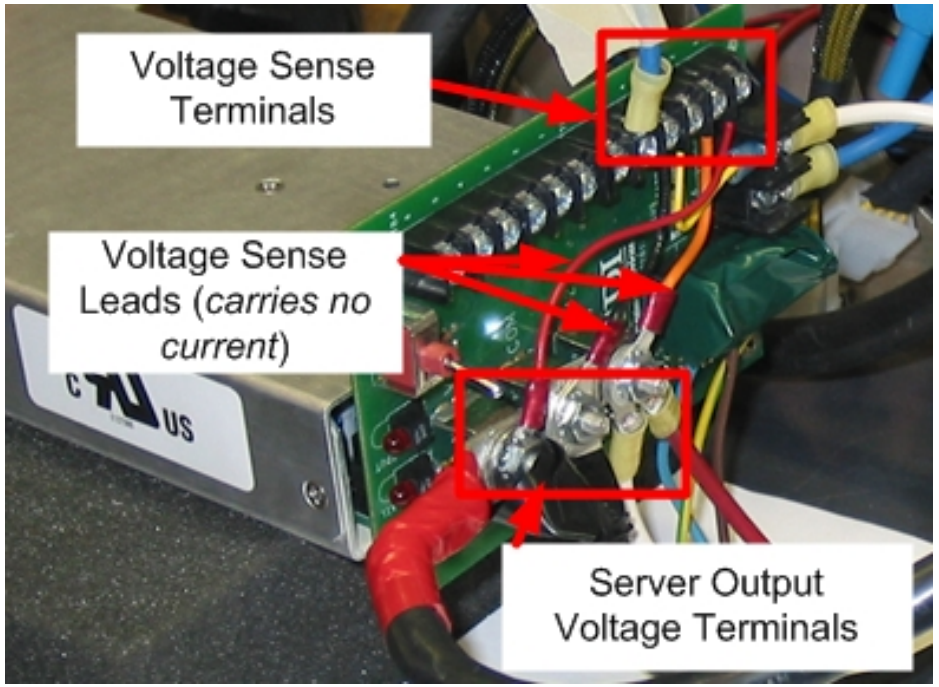
Power Supply Test Setup

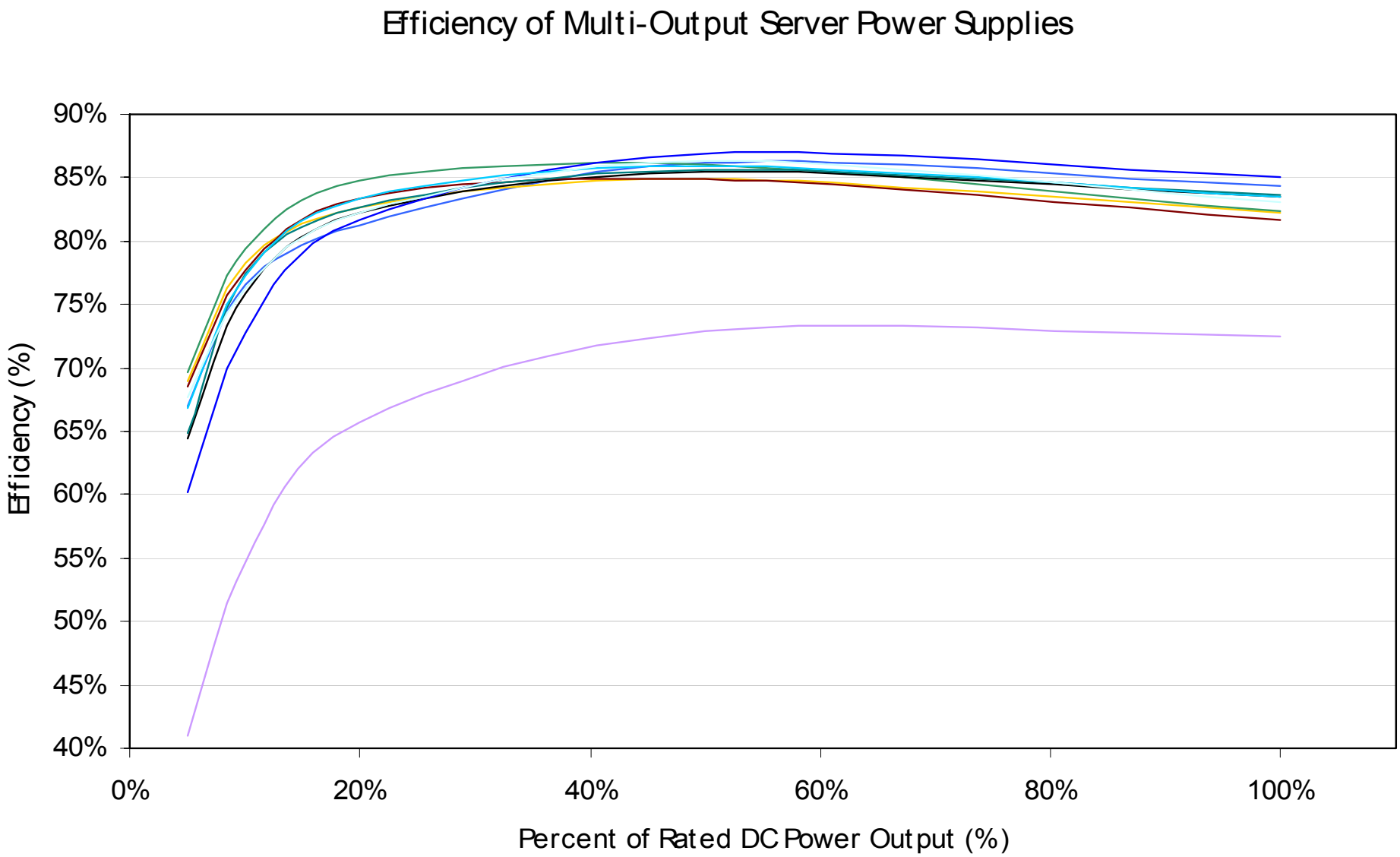


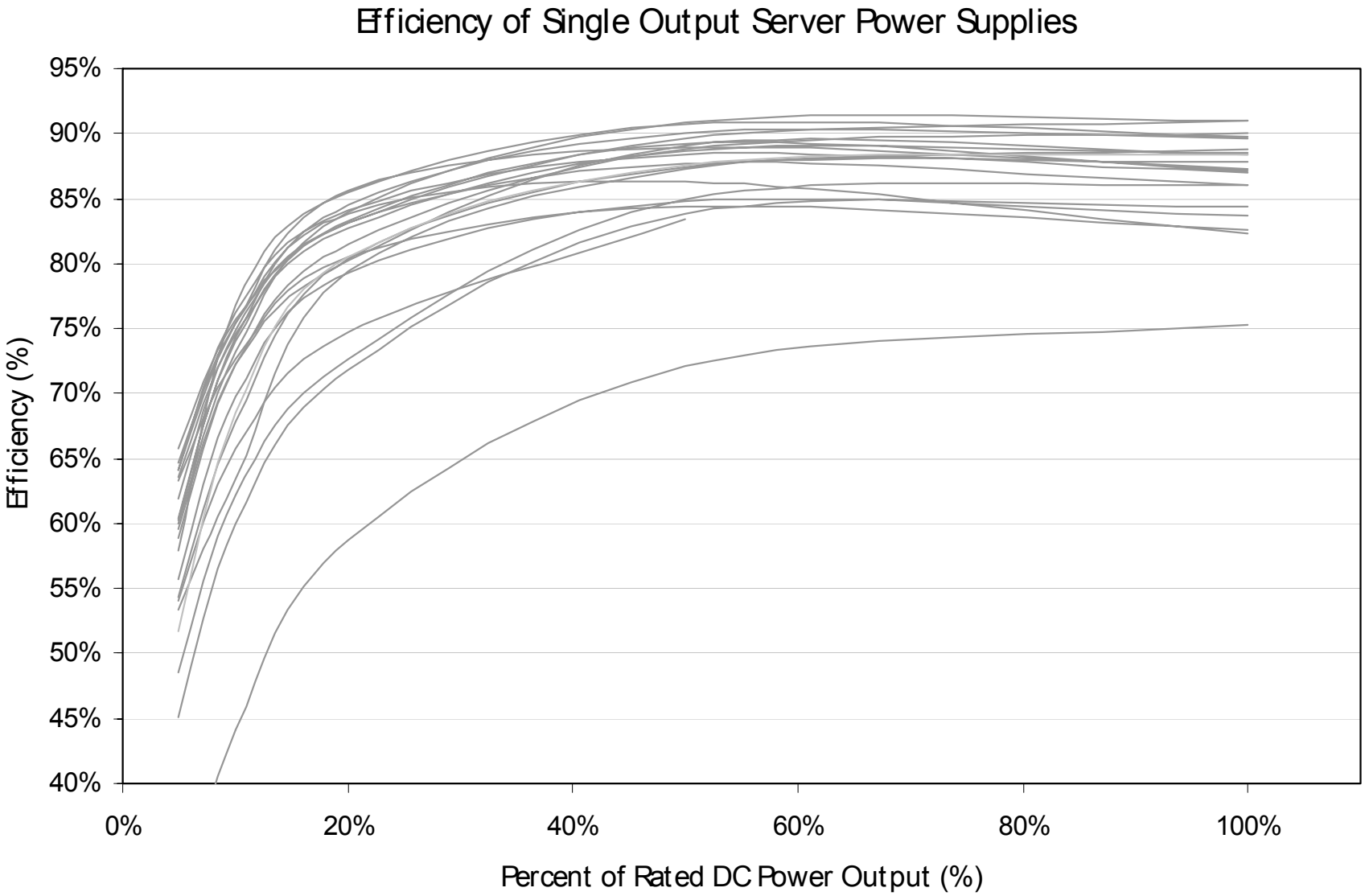
Voltage Sensing Feedback Systems

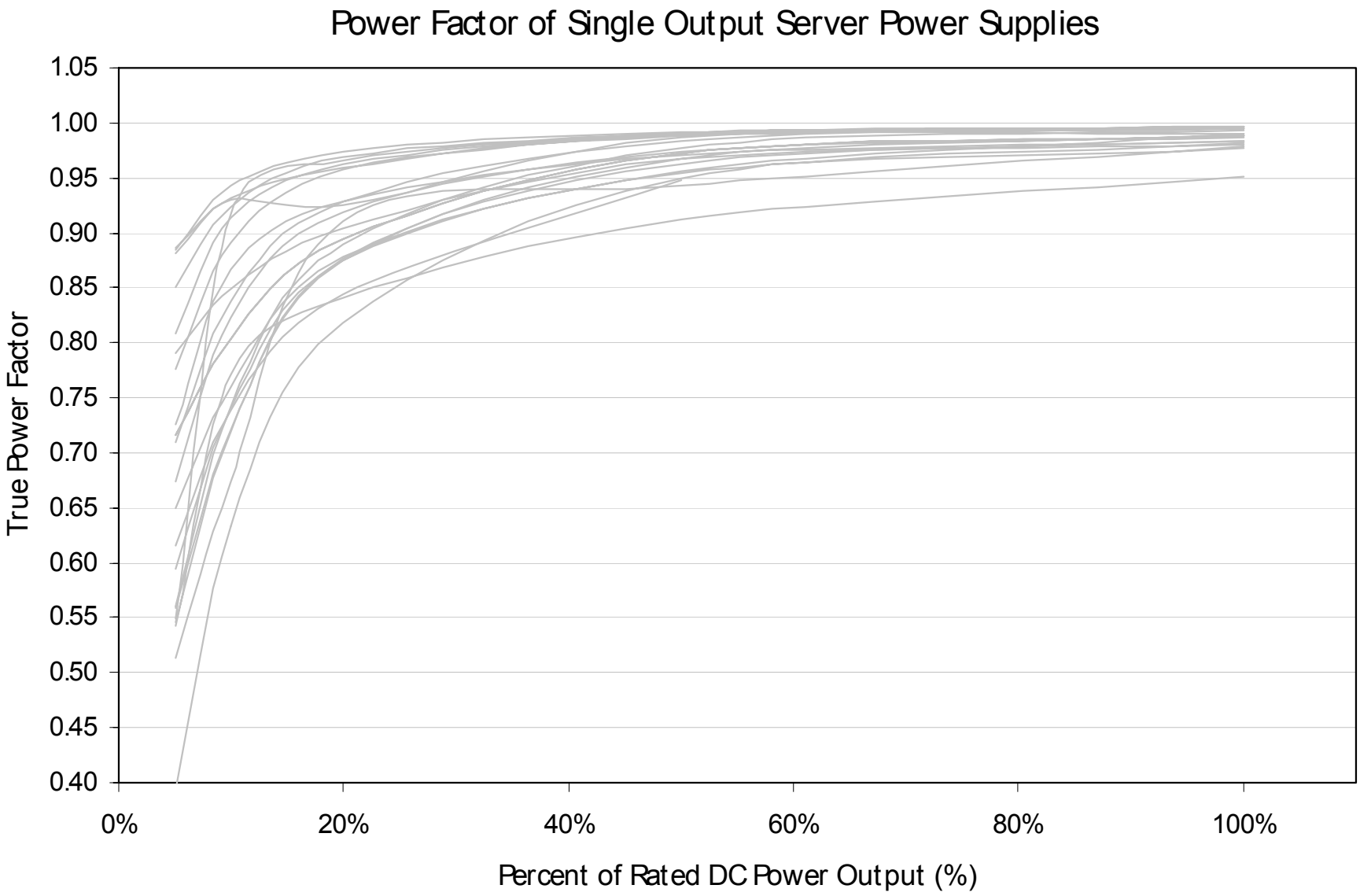
- Certain server power supplies use a combination of wire sensors to detect whether an individual voltage output is giving the correct voltage to attached equipment
- Power supplies may not function properly if these sensors are not connected

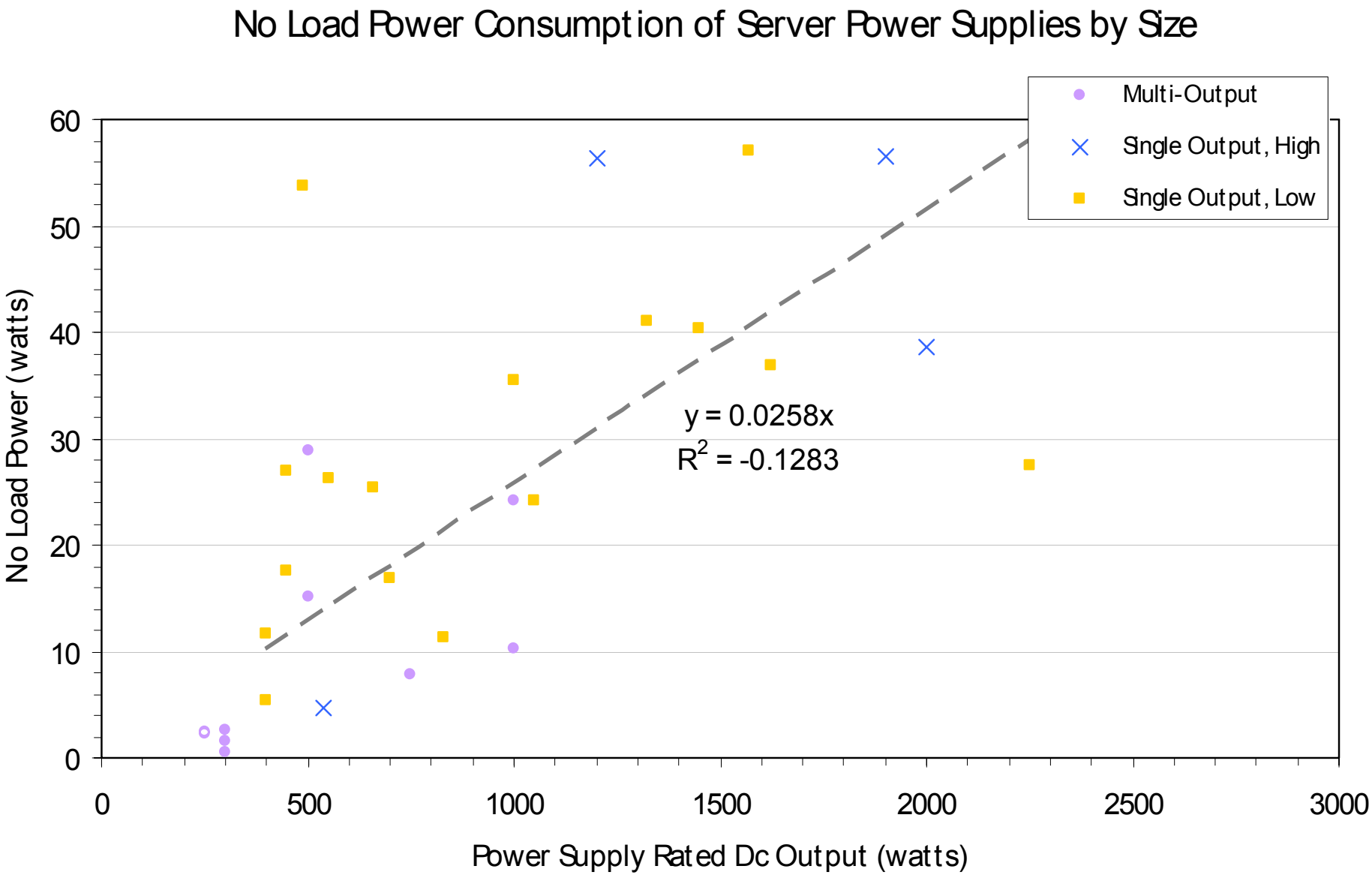
- Solution: new server test method specifies that voltage sensing wires (if present) be connected as per manufacturer guidelines during measurement




Efficiency of Multi-Output Server Power Supplies
90%
85%
80%
75%
70%
65%
60%
55%
50%
45%
40%
Efficiency (%)
0%
20%
40%
60%
80%
100%
Percent of Rated DC Power Output (%)

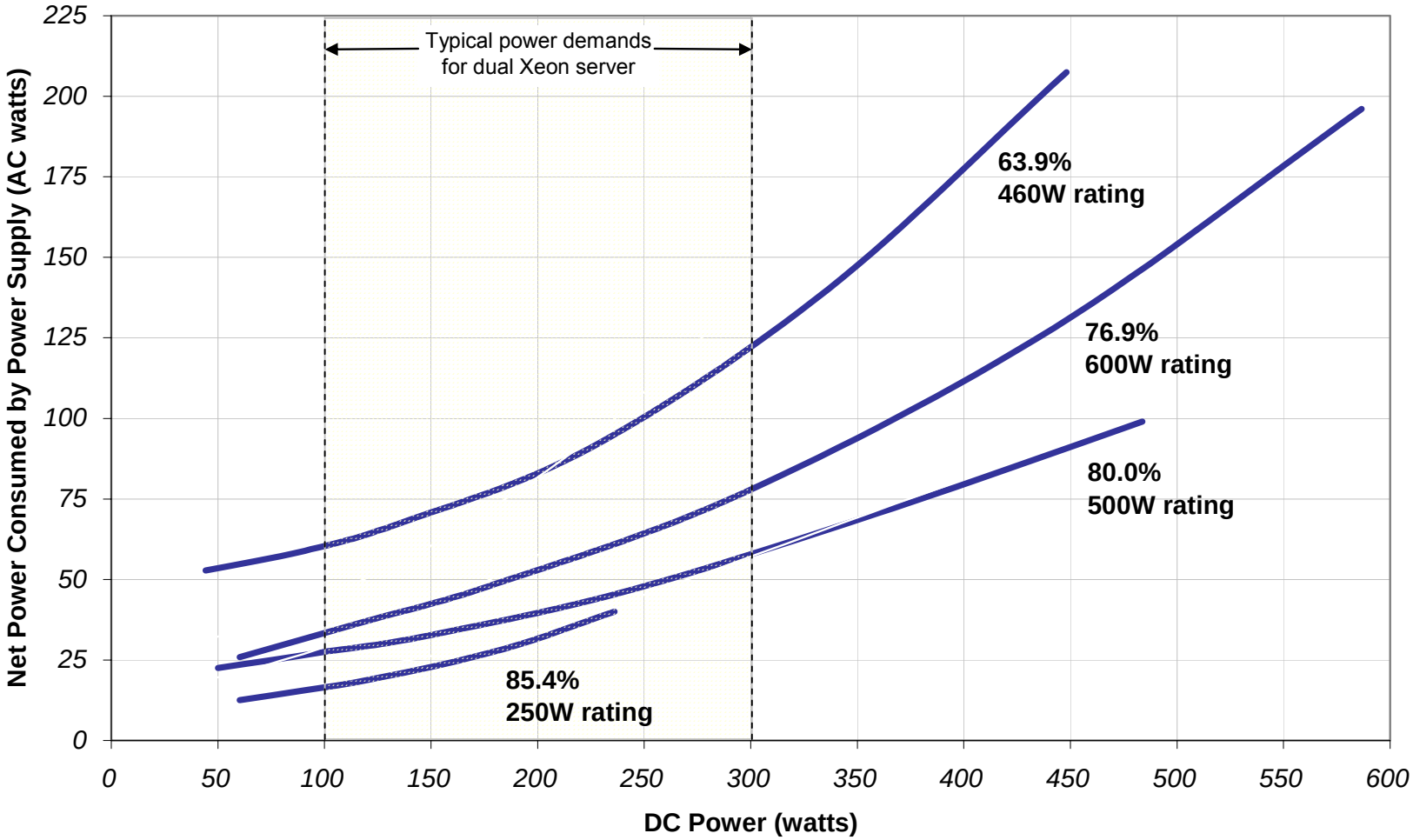

Efficiency of Single Output Server Power Supplies
95%
90%
85%
80%
75%
70%
65%
60%
55%
50%
45%
40%
Efficiency (%)
0%
20%
40%
60%
80%
100%
Percent of Rated DC Power Output (%)


Power Factor of Single Output Server Power Supplies
True Power Factor
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0%
20%
40%
60%
80%
100%
Percent of Rated DC Power Output (%)


No Load Power Consumption of Server Power Supplies by Size
Multi-Output
Single Output, High
Single Output, Low
y = 0.0258x
R2 = -0.1283
No Load Power (watts)
Power Supply Rated Dc Output (watts)
0
10
20
30
40
50
60
0
500
1000
1500
2000
2500
3000

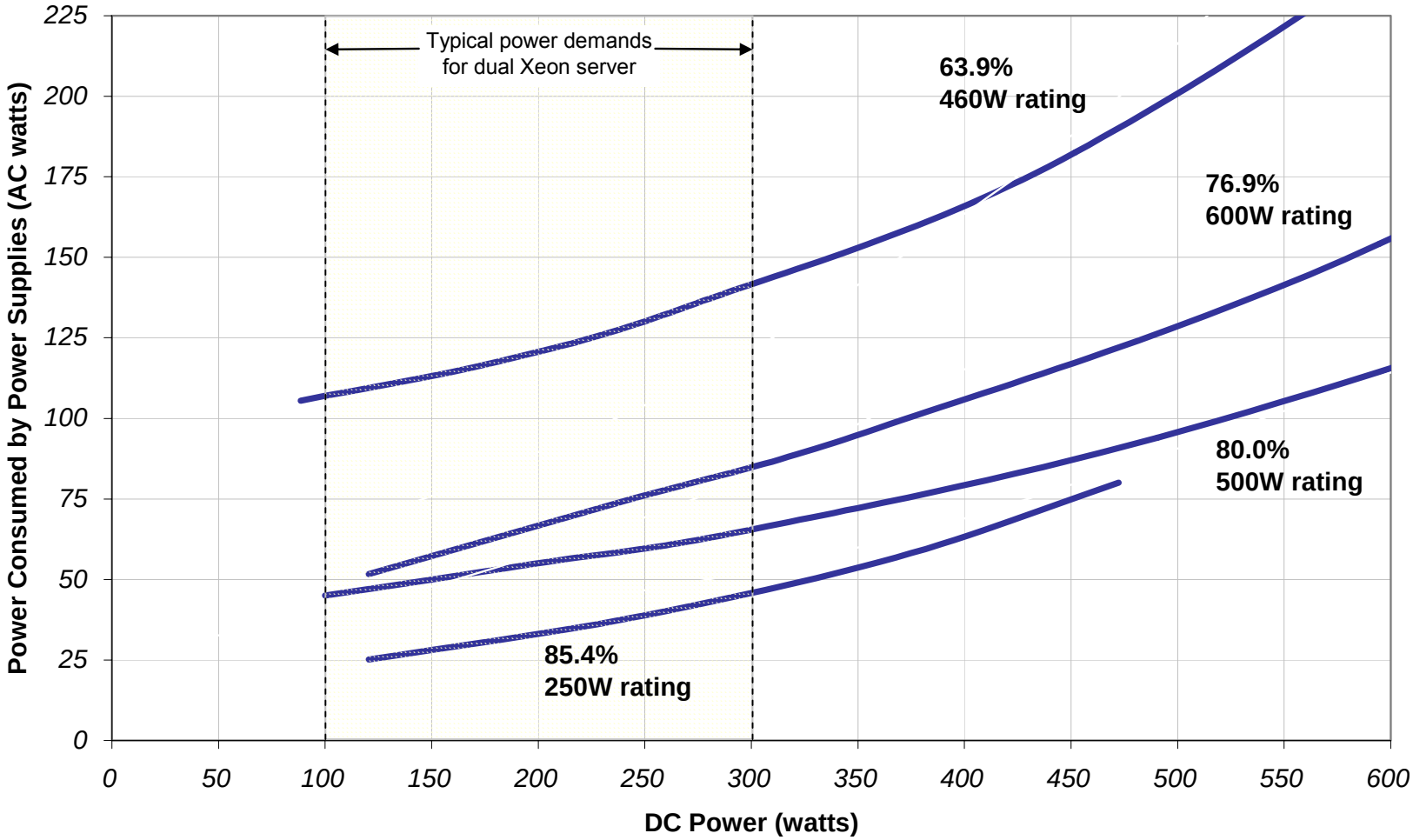
Power Consumed Through Server Power Supply Inefficiency

for a single power supply system (N)



Power Consumed Through Server Power Supply Inefficiency

for a redundant, dual power supply system (2N)



Observations on Power Supply Data

- Data shows a large spread of efficiencies at different load points
- Efficiency drops off rapidly below 20% load, but many server power supplies operate below 20% - especially in redundant configurations
  - 10 % test condition included in test procedure
- Single Voltage server supplies generally have higher efficiency than multi-voltage PC supplies
  - Operates at higher voltage for increased efficiency
  - Eliminating less efficient 5V and 3.3V buses improves the overall efficiency of the power supply for the same power rating

Criterion #2 - Idle Mode Energy Consumption?

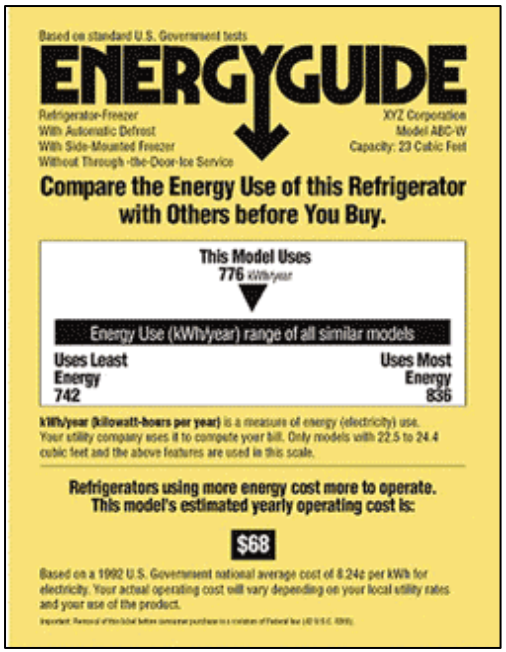
- Why Idle mode?
  - Measured data shows that servers spend large periods of time idling
  - Idle mode involves zero latency
  - Relatively easy to measure

Questions:

- Are manufacturers already addressing / measuring idle?

Criterion #3 – Standardized Reporting and Labeling

- Why provide standardized information?
  - Consistency in the marketplace
  - Allow consumers to compare performance, capability, and power use of the server, to inform purchasing decisions
  - Recognize that right sizing and proper static provisioning is a key aspect to achieving energy efficiency


Based on standard U.S. Government tests

ENERGYGUIDE

Refrigerator-Freezer
With Automatic Defrost
With Side-Mounted Freezer
Without Through-the-Door-Ice Service

XYZ Corporation
Model ABC-W
Capacity: 23 Cubic Feet

Compare the Energy Use of this Refrigerator with Others before You Buy.

This Model Uses
776 kWh/year

Energy Use (kWh/year) range of all similar models

Uses Least Energy
742

Uses Most Energy
836

kWh/year (kilowatt-hours per year) is a measure of energy (electricity) use. Your utility company uses it to compute your bill. Only models with 22.5 to 24.4 cubic feet and the above features are used in this scale.

Refrigerators using more energy cost more to operate.
This model's estimated yearly operating cost is:

$68

Based on a 1992 U.S. Government national average cost of 8.24¢ per kWh for electricity. Your actual operating cost will vary depending on your local utility rates and your use of the product.

Standardized Information cont.

- What would the criterion be based on?
  - System characteristics / specifications
  - Results from SPECpower benchmark
  - Comparison of benchmark score and power usage with typical models within the same class of device
  - Other information
    - Additional benchmarking scores, workloads or power measurements were applicable

Questions

- What additional information could be provided?
- How should information be presented to purchasers – product labels or other means of reporting?

Criterion #4 – Power Management

- Why cover power management?
  - Many servers not operating consistently at high utilization
  - Should scale power use to utilization where possible, and reduce number of operating machines at times of low utilization

- What would the criterion be based on?
  - **Idea:** Provide a list of power management techniques and require a small number. For example, must meet 2 out of 5:
    - Processor voltage/ speed scaling
    - Power capping
    - Others???
    - Low Power (Sleep) Mode
    - Fan speed scaling

Power Management cont.

Questions

- What technologies are available for power management in servers?
- What might the criteria look like?

Criterion #5 – Access to Operational Data

- Why require access to power and temperature data?
  - Monitor status of equipment in real time
  - Ability to measure provides the ability to manage
  - Allow system to easily plug into monitoring and management systems

- Criterion could be based on:
  - Proper sensors to measure air temperature (input and output) and power draw of server/components
  - Standardized Ethernet protocol to collect information

Power/Temperature Data cont.

Questions

- What data should be measured?
- Do a sufficient number of current products on the market have this ability?
- Could collaboration with the Distributed Management Task Force (DMTF) or use of the Simple Network Management Protocol (SNMP) produce such a standard?
- Could reported data include processor utilization?

Criterion #6 - Virtualization

- Why cover Virtualization?
  - allows for reduction of the number of servers
  - increases utilization rates
  - low cost, large savings, shorter term
- Difficult to specify on unit basis and measure savings --- similar to power management

Questions

- How can EPA specify support for virtualization?
  - Support for number of virtual images?
  - Utilization potential of the virtualized server?
  - Others???

Potential Tier 2 Requirements

Server Performance Benchmark

- January 2006 **SPEC Power and Performance** Committee began development of benchmark for evaluating energy efficiency of servers
- Working prototype has been developed --- final product by the end of 2007

Questions:

- Is the benchmark all inclusive, are there others?
- Required reporting of SPEC score under Tier 1?

Potential Tier 2 Requirements cont.

Network Speed Scaling

- Why --- Reduces power and allows other connected devices to reduce power (e.g., switches and routers)
- How --- Specify IEEE 803.3az (Energy Efficient Ethernet) which should be appearing in products in the Tier 2 time frame

Others?

How Can Various Specs and Marketing Initiatives Best Drive Efficiency Improvements?

- Importance of measuring products in a systematic, standardized fashion with round-robin testing among certified labs to ensure consistency
- Sequential vs. simultaneous branded efficiency levels
- Role of private sector procurement efforts like Climate Savers
- Role of utility-funded financial incentives and third-party product testing and certification efforts (80 PLUS)
- Role of federal labeling program (ENERGY STAR) for federal purchasing and industry benchmarking
- Need for real-world field testing to verify savings measured in the lab

Discussion Wrap-Up

- Definitions and product coverage
- Identification of key criteria
- Areas for additional research and data collection
- Items for Tier 2 consideration
- Additional considerations (e.g., timing)
- Next Steps

More Information

- Specification Development process
  - www.energystar.gov/productdevelopment
- Data Center Initiatives
  - www.energystar.gov/datacenters
- Technical Questions / Comments
  - Arthur Howard, ahoward@icfi.com
  - Chris Calwell, ccalwell@ecosconsulting.com
  - Brian Fortenbery, bfortenbery@epri.com