ENERGY STAR

ENERGY STAR® Computer Server Stakeholder Meeting

July 9, 2008

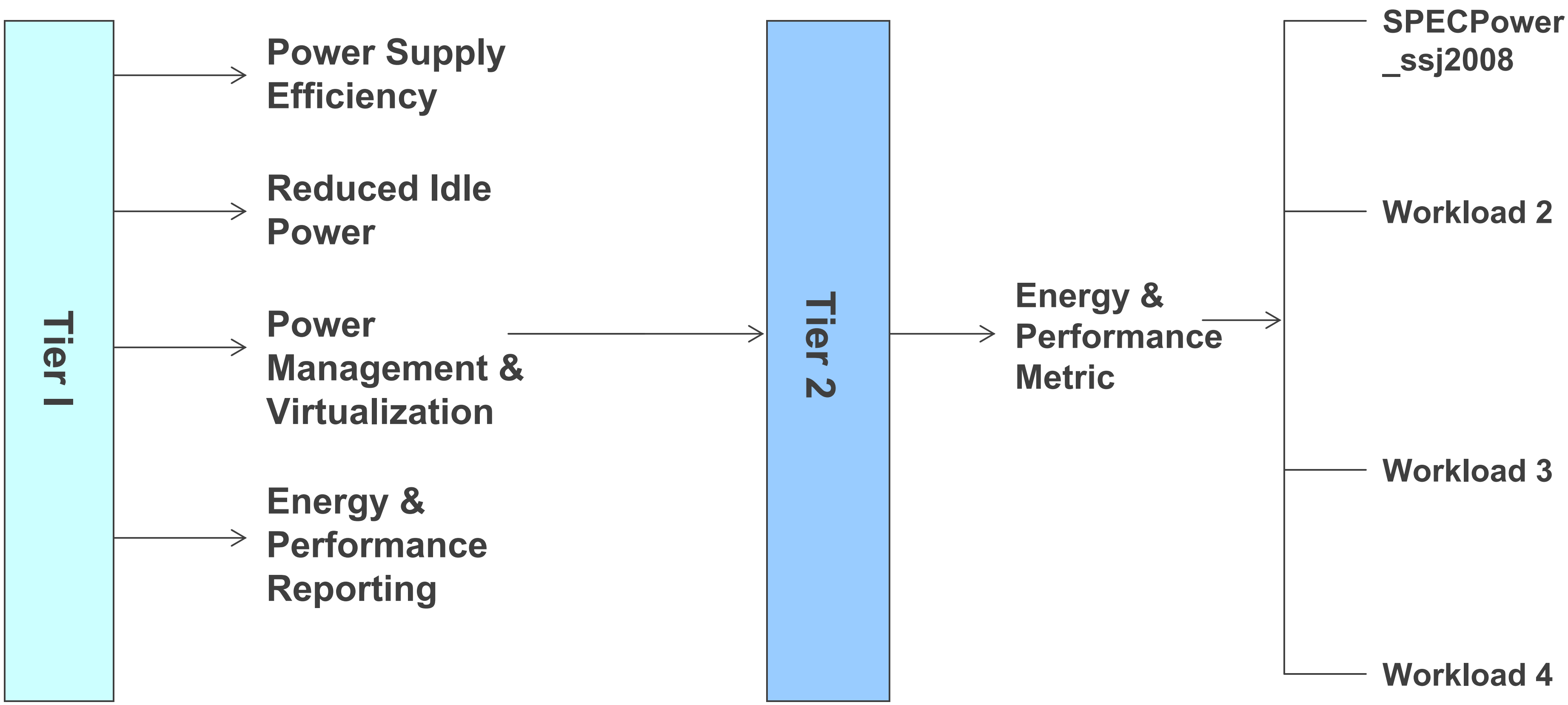
Redmond, WA

EPA

Background

- **January 06:** EPA Data center conference
- **December 06:** Server spec process initiated
- **July 07:** Framework document released
- **August 07:** EPA Report to Congress published
- **October 07:** Stakeholder meeting
- **February 08:** Draft 1 spec released
- **April 08:** On-line stakeholder meeting and revised definitions document released
- **Today July 9, 2008:** Stakeholder meeting

Vision: ENERGY STAR Specification



Effective Date Timeline

January 2009 **2011/2012**

Development Guiding Principles

ENERGY STAR represents **top 25%** of performers in energy efficiency

Server graphic: www.sun.com

Goals and Purpose of Meeting

- Share new data and info collected by EPA
- Continue discussions on key spec elements
  - Power supply efficiency / Net Power Loss
  - Idle power
  - Power management
  - Reporting requirements
- Identify areas for additional research and clear next steps toward Draft 2
- Solidify EPA's approach for finalizing spec by end of the year

Meeting Agenda

- European Union Perspective – Jan Viegand
- Discussion on Key Spec Elements
  – Topics/format will follow discussion document
  – Open discussion format
- Lunch Break – 12 noon
  – Additional breaks as needed
- Discussion on Tier 2 items, time permitting
- Timeline and Next Steps

European Union Perspective

Definitions and Scope *cont.*

- Proposed revisions:
  - Broader general computer server definition (product exclusion under Qualifying Products)
  - Removed WOL from required characteristics
  - Removed reference to EN55022:1994 (EMC Directive)
  - Included "rack mountable" requirement
  - Added statement to clearly state which servers are NOT eligible (e.g. procurement)

ENERGY STAR IT Coverage

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Servers

- Volume/Mid-Range
- Blades and Chassis
- AC-DC/DC-DC units

✓Marketed/sold as server
✓Server OS and/or Hypervisors
✓1+ processors/sockets
✓Rack-mountable
✓Dedicated Mgmt Controller (service processor)
✓RASM features
✓ECC and/or buffered memory (DIMMS, BOB)

Computers

- Laptops
- Desktops
- Workstations

Networking Equipment

Storage Equipment

High Performance (4+ processor)

Questions for Discussion

- How common are tower form units utilized?
  - Does "available in rack mountable form factor" eliminate any products used in data centers?
- Do the power supply definitions accurately represent the types of products available?
- Some stakeholders feel that a more detailed taxonomy is still needed
  - What are the key subcategories that should be defined? Is a similar taxonomy needed for blades?

Power Supply Efficiency

- Exploring two approaches
  - Power supply energy efficiency
  - Net power loss
- Interest in 10% loading as many current systems experience operation at this level
  - i.e., redundant configurations
- Interest in including DC-DC servers if test procedure can be developed and data made available within given EPA timeline

Why Focus on Power Supplies in a Server Spec?

- The power supply is an energy bottleneck for the entire server – all energy used by the server flows through it.
- Power supply savings can be achieved in all servers, regardless of hardware configuration, work load, or application
- IT power supply efficiency already a focus of successful utility programs, computer industry initiatives, ENERGY STAR's desktop/laptop/workstation specifications, and various procurement specifications

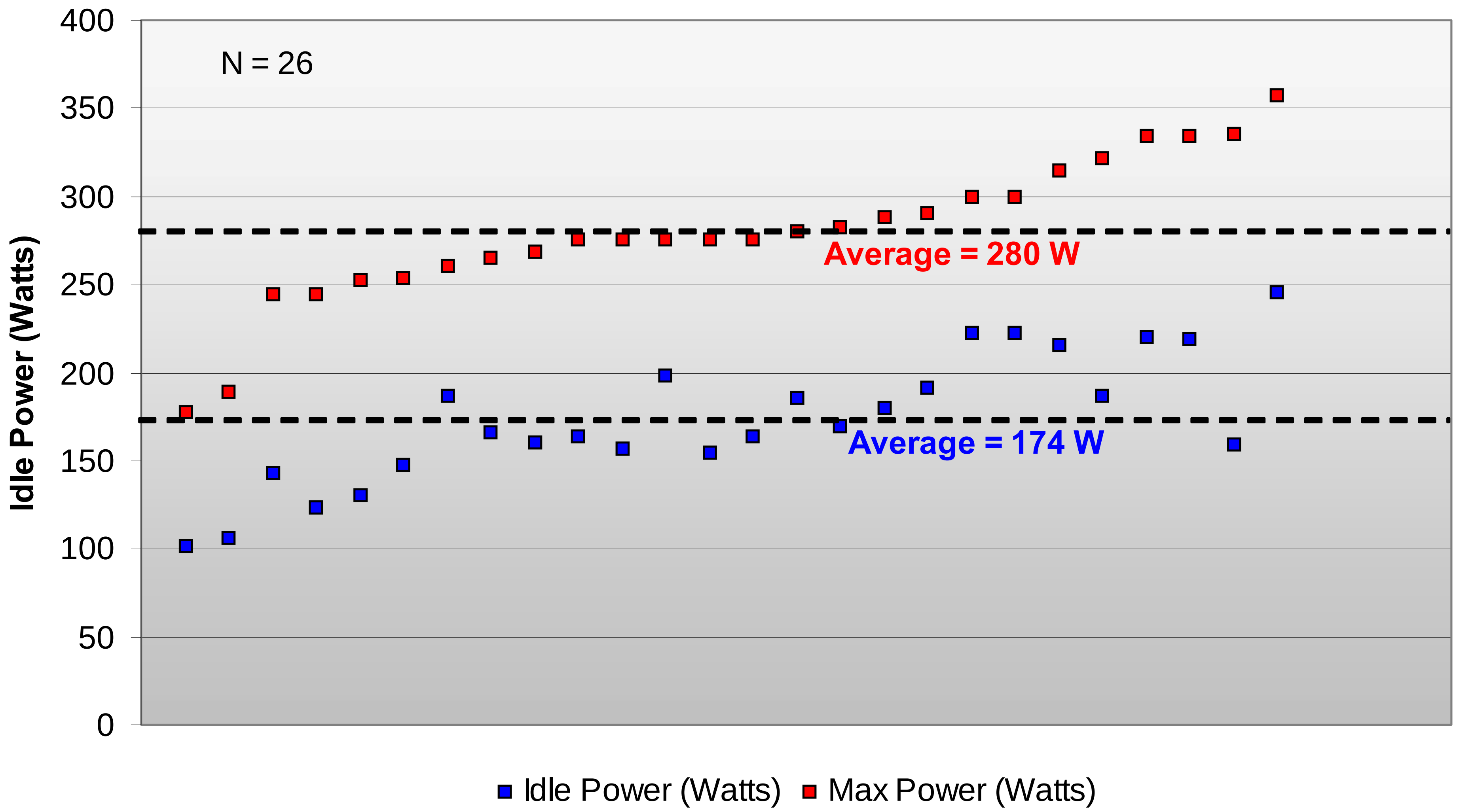
How Could Server Power Supply Efficiency Be Addressed?

- **Conventional approach is to specify minimum percentage efficiencies (dc watts out/ac watts in) across a range of standard % load conditions in the laboratory**
- **Advantages**
  - EPS and desktop computer precedent
  - Simple and repeatable in lab
  - Useful for encouraging new designs from PSU manufacturers
- **Disadvantages:**
  - Requires power supplies to perform efficiently in power ranges where they may not operate (e.g., 100%), and can give insufficient attention to where they *do* operate
  - Ignores benefits of right-sizing
  - Ignores impact of redundancy choices (two 85% efficient PSU's use more energy than one)
  - Fails to address real-world PSU interactions with server

Other Approaches

- **Choose two operating conditions that bound the range of dc power a server will likely draw in operation: idle and max**
- **Choose an approach for evaluating PS efficiency at those two end points:**
  - **Specify maximum power losses as a function of dc wattage delivered for all servers**
  - Specify absolute maximum power losses at idle and max for different categories of servers
  - Specify maximum power losses as a function of power supply size
  - Specify minimum % efficiency for power supplies at idle and max

Idle Power and Max Power for Public SPECpower Results for 2P Systems

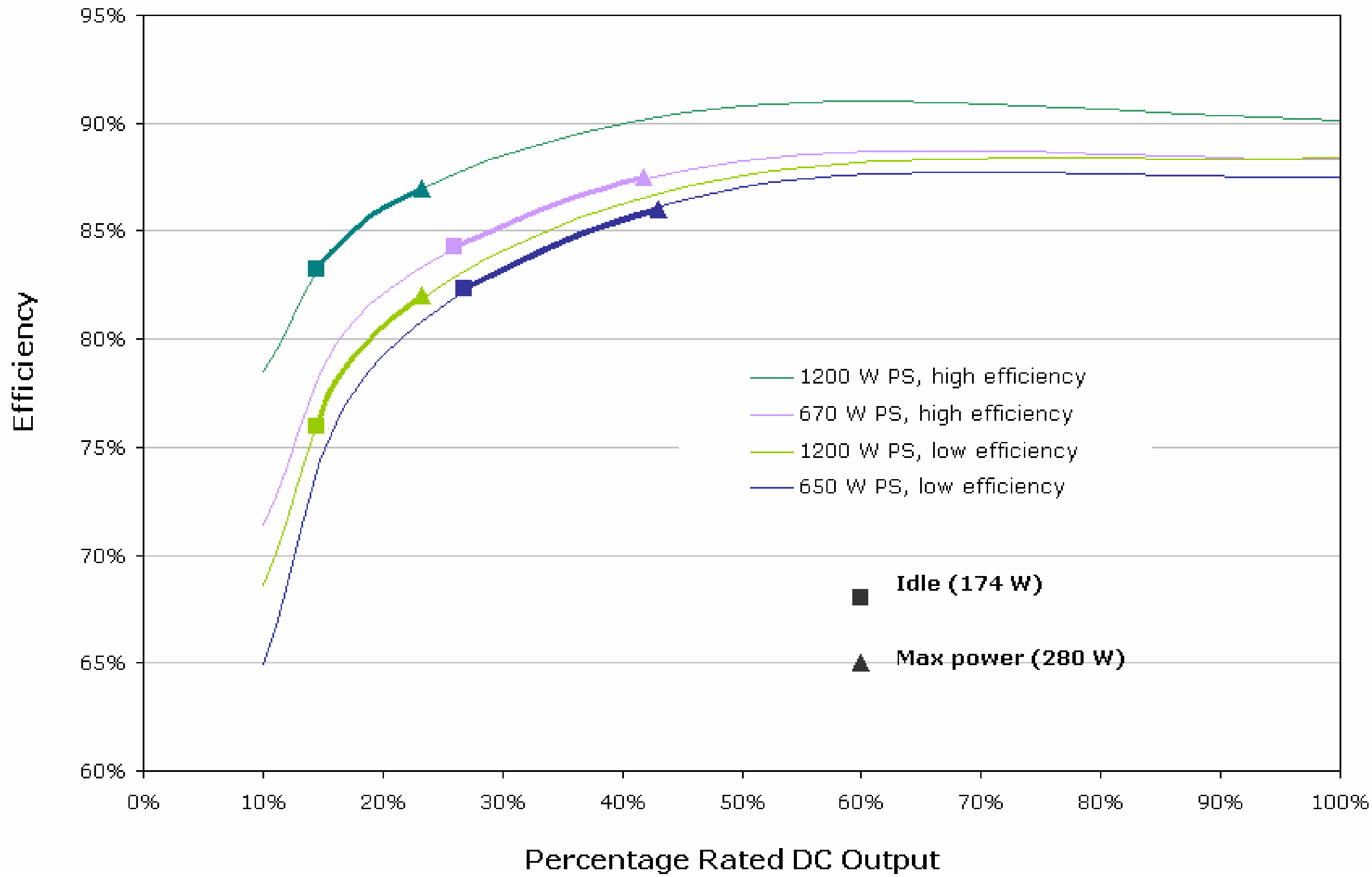


Testing the Approach with Actual Products

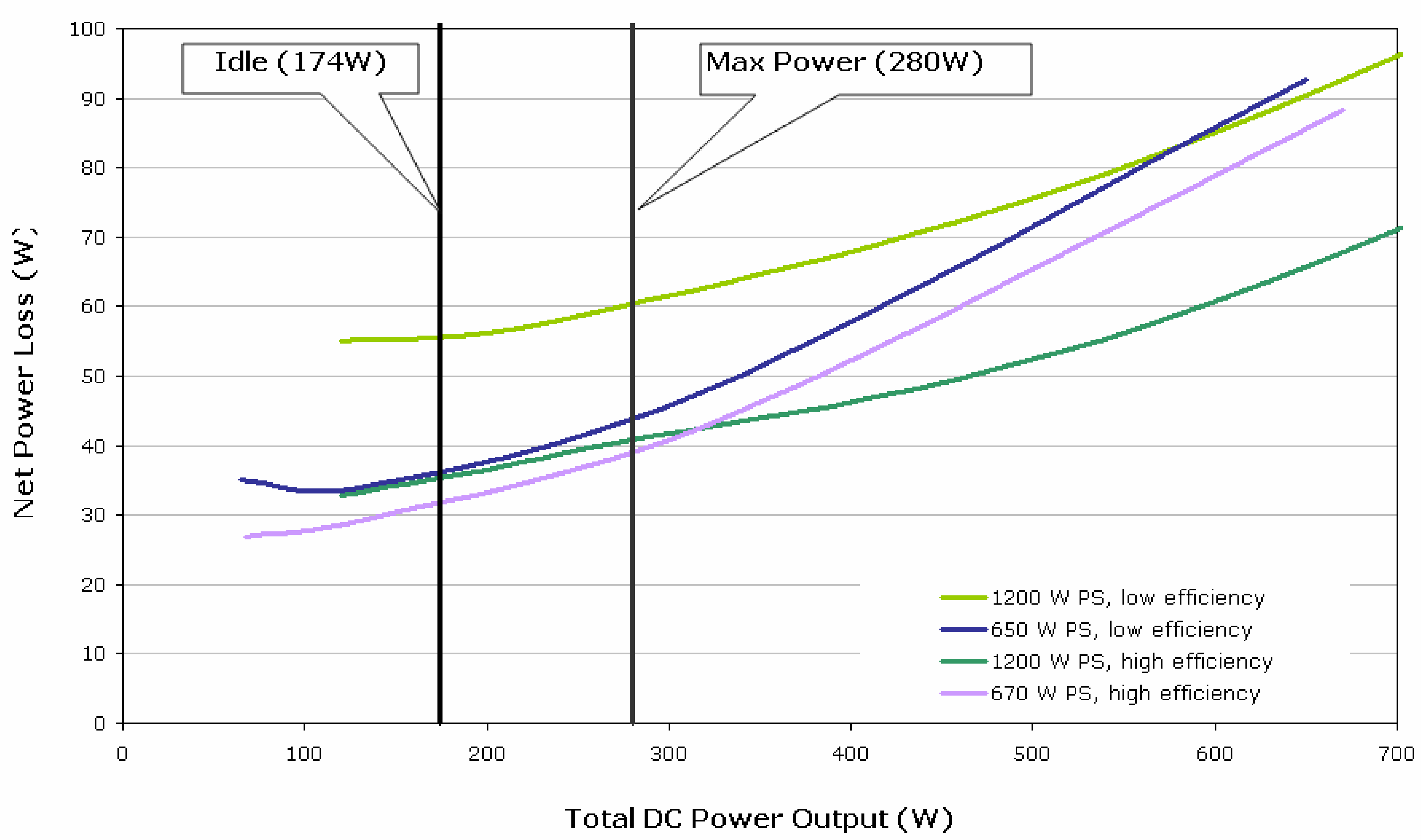
Power Supply Model	% Load (N)		Net Power Loss (N)		% Load per PSU (2N)		Total Net Power Loss (2N)	
	Idle	Max Power	Idle (W)	Max power (W)	Idle	Max Power	Idle (W)	Max power (W)
Right-Sized PS, Low Efficiency								
Right-Sized PS, High Efficiency								
Over-Sized PS, Low Efficiency								
Over-Sized PS, High Efficiency								

Choosing 8 different combinations of power supply size, efficiency and redundancy allows us to see how real power supplies would perform meeting average idle and max loads in servers.

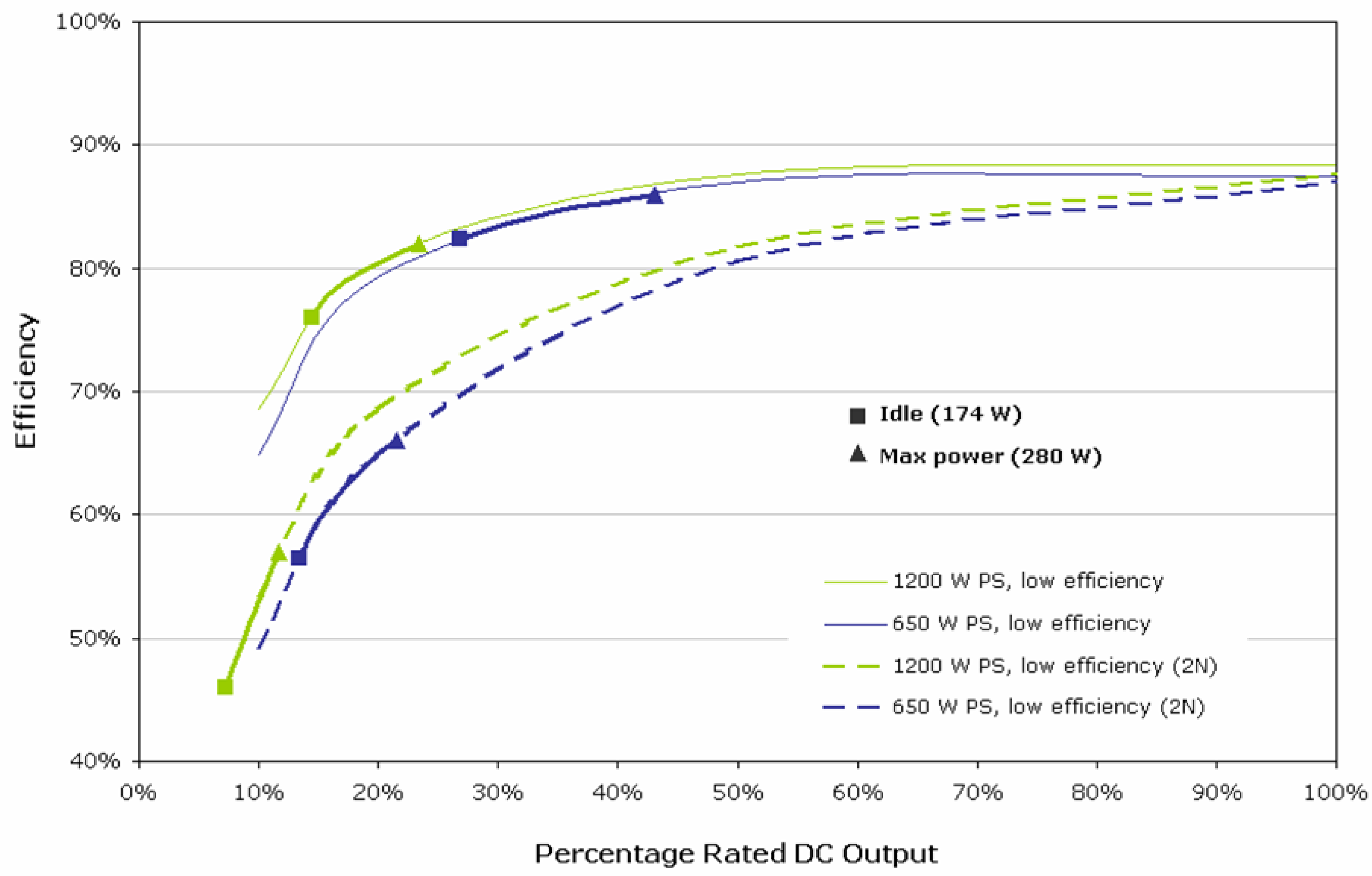
Effect of PSU Size and Efficiency on Operating Efficiency (N)



Effect of Size and Efficiency on Net Power Loss (N)



Effect of PSU Size and Redundancy on Operating Efficiency



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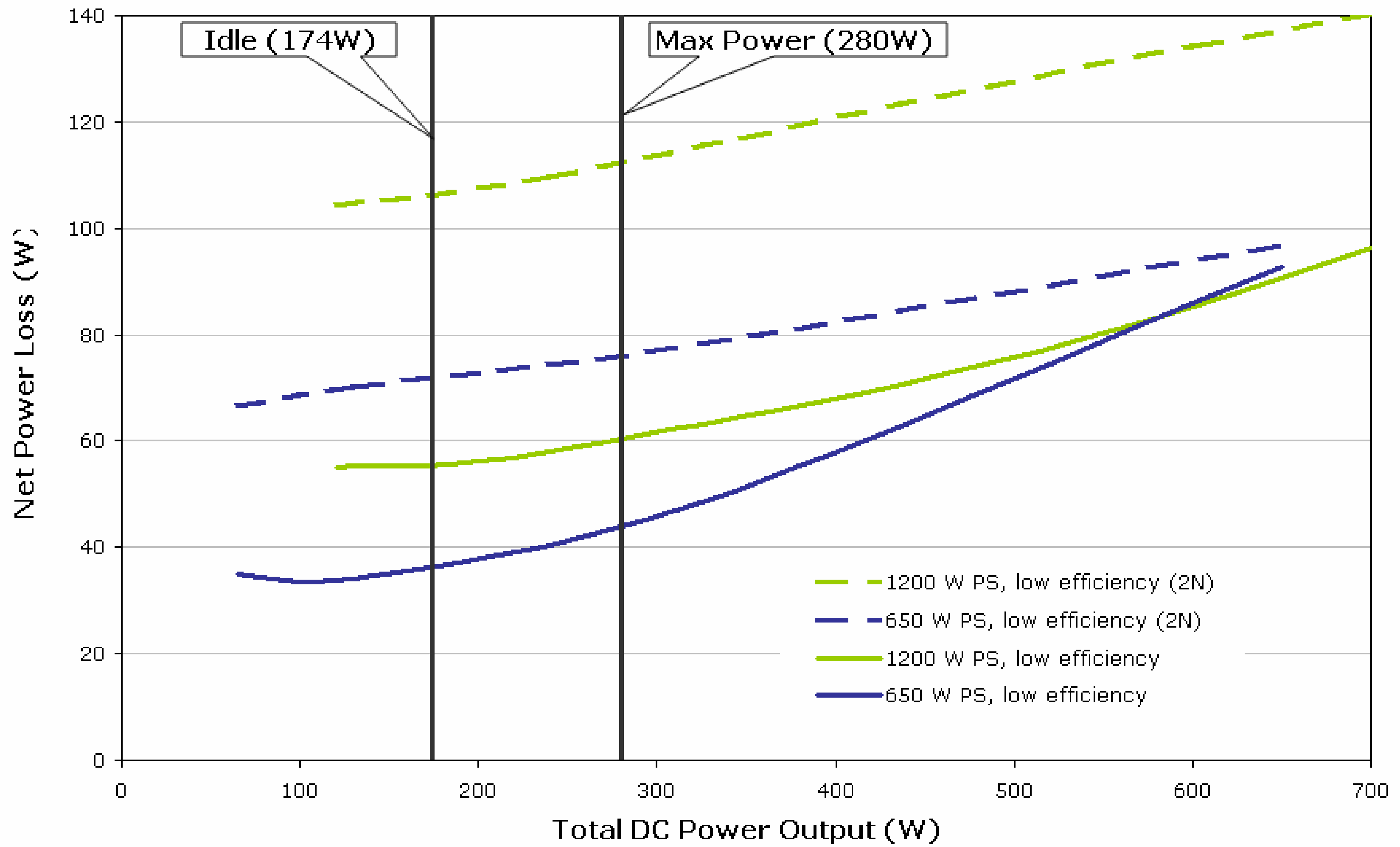
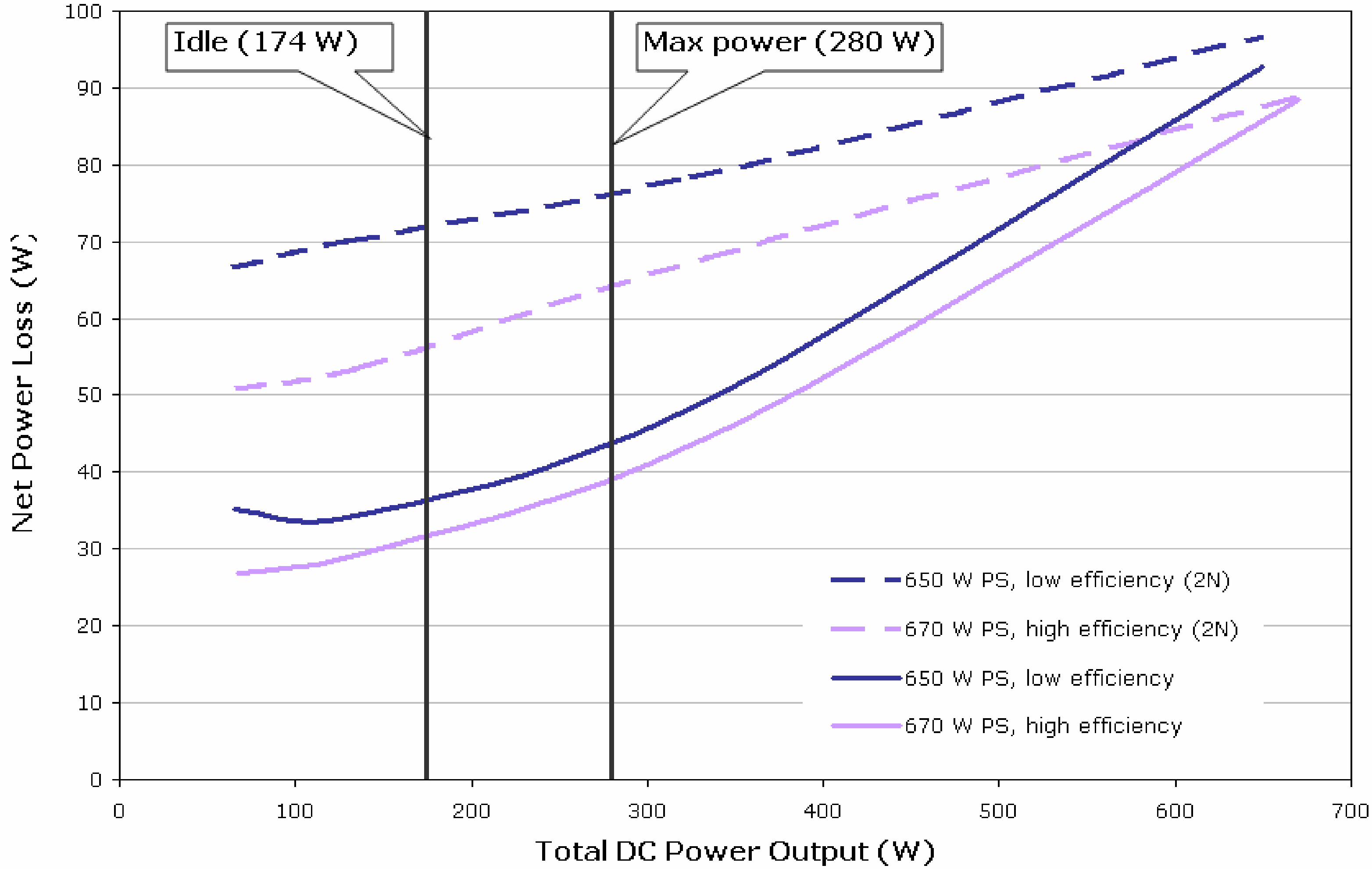
Effect of PSU Size and Redundancy on Net Power Loss



Effect of Efficiency and Redundancy on Net Power Loss (N,2N)



Summary of Results from Actual Products

Power Supply Models	% Load (N)		Net Power Loss (N)		% Load per PSU (2N)		Total Net Power Loss (2N)	
	Idle	Max Power	Idle (W)	Max power (W)	Idle	Max Power	Idle (W)	Max power (W)
650 W, Low Efficiency	27%	43%	37	43	13.5%	21.5%	72	77
670 W, Higher Efficiency	26%	42%	32	39	13%	21%	56	64
1200 W, Low Efficiency	15%	23%	55	60	12.5%	11.5%	108	112
1200 W, Higher Efficiency	15%	23%	36	40	7.5%	11.5%	64	68

Recommendations

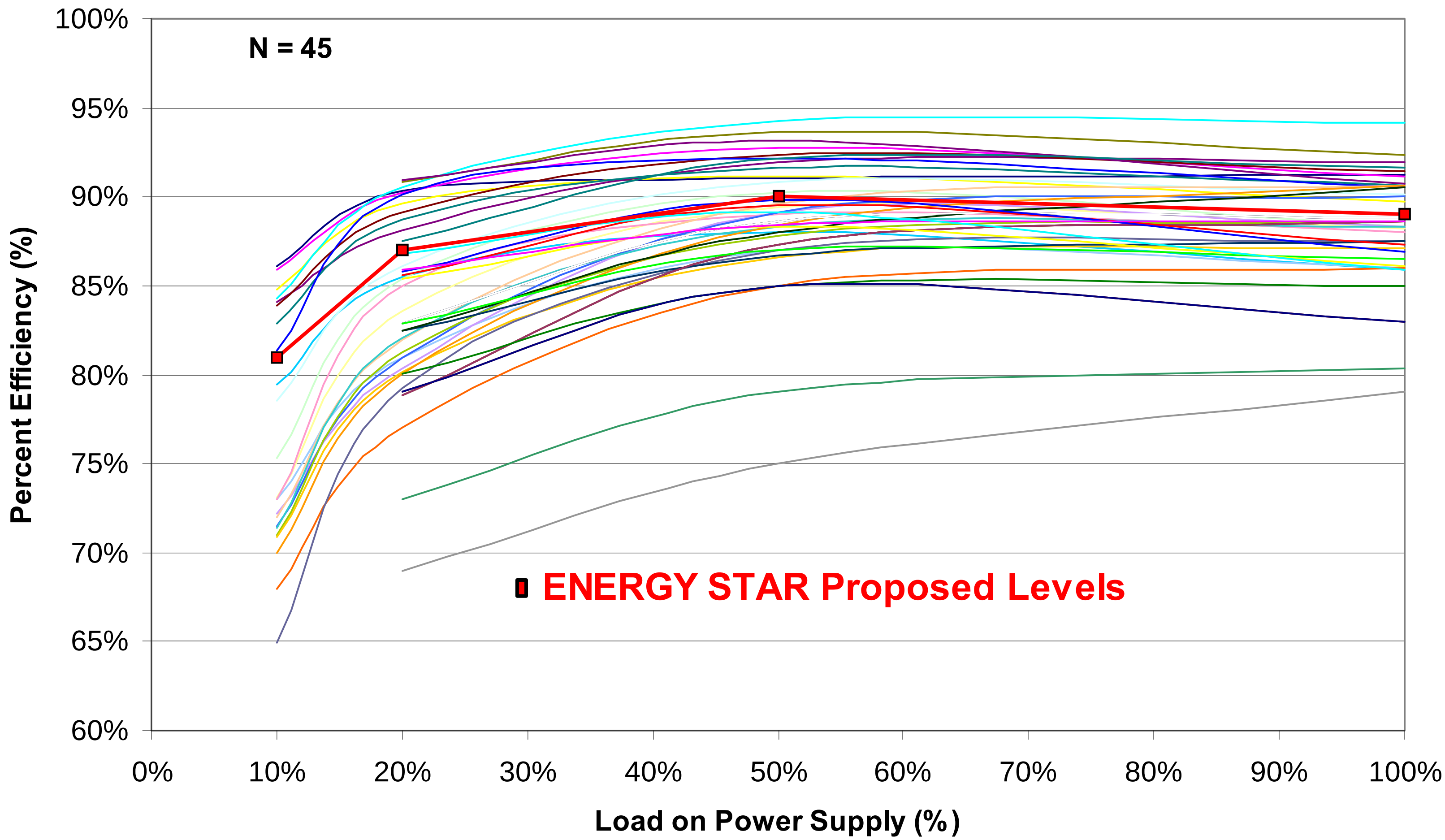
- Propose an ENERGY STAR specification limiting power supply losses as a function of dc power delivered at idle and max power for all included server types (continuous curve of watts lost vs. dc watts delivered)
- Employ SPEC's definitions and test procedure for determining idle and max power use
- To determine losses, test power supplies in operation with their intended server or calculate losses at dc idle and max power levels from a curve fit to detailed laboratory test data

Power Supply Analysis

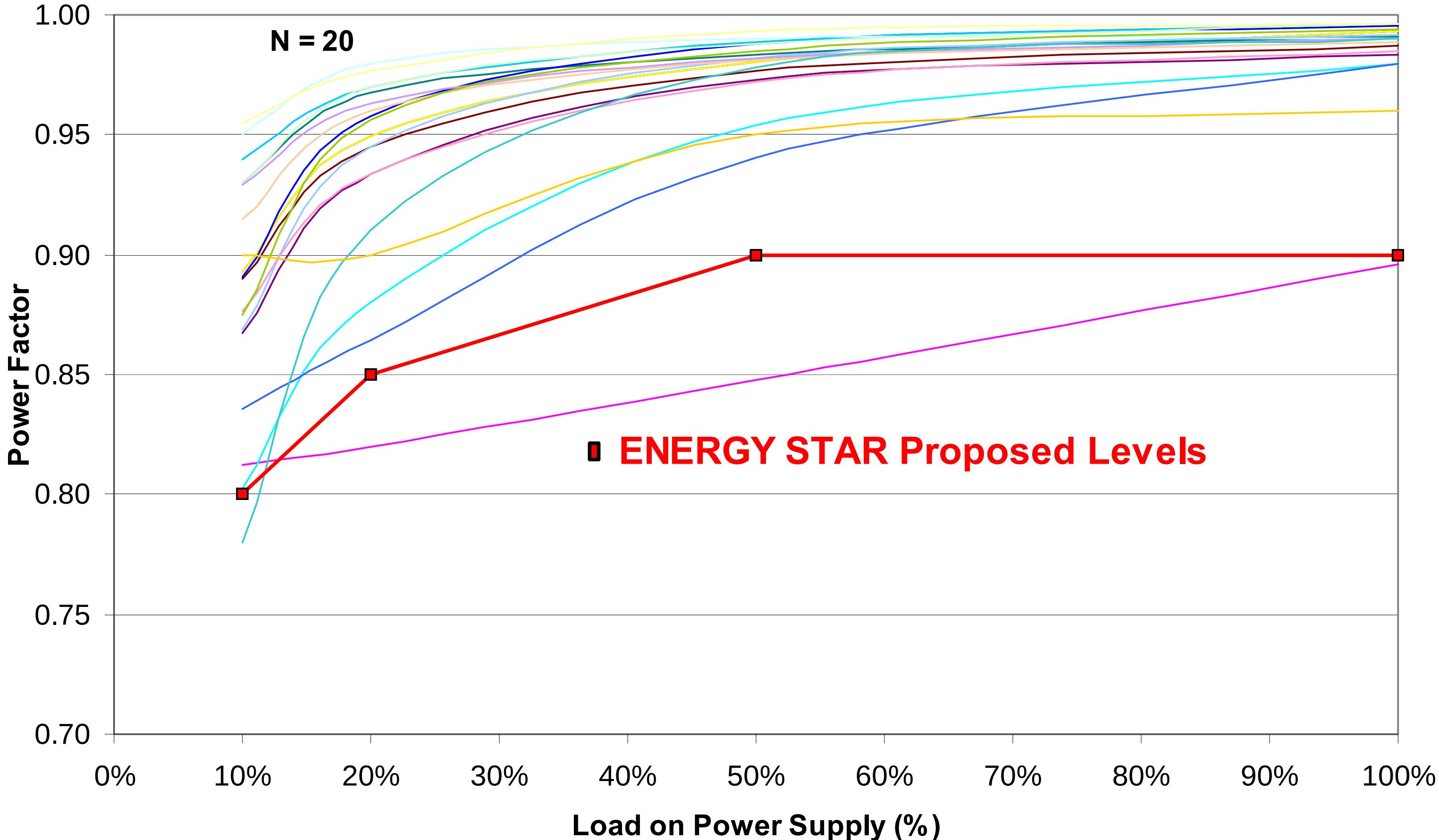
- Collected data from 45 single-voltage PSUs from 8 manufacturers, all will be currently available Q1 2009
- 23 units included 10% load data, 22 units did not
  - For those without, 10% was not factored into the analysis (i.e. if it passed at 20%, 50% and 100% it was assumed to pass)
- 4 out of 8 (50%) of Manufacturers have passing models

Output Power Range	≤ 500 W	> 500 W ≤ 1,000 W	> 1,000 W ≤ 1,500 W	> 1,500 W	Unknown	Total
Count	6	16	13	7	3	**45**
Pass Active	1 (16.7%)	2 (13.3%)	6 (50%)	2 (28.6%)	0 (0%)	**11 (25.5%)**

Power Supply Efficiency Curves

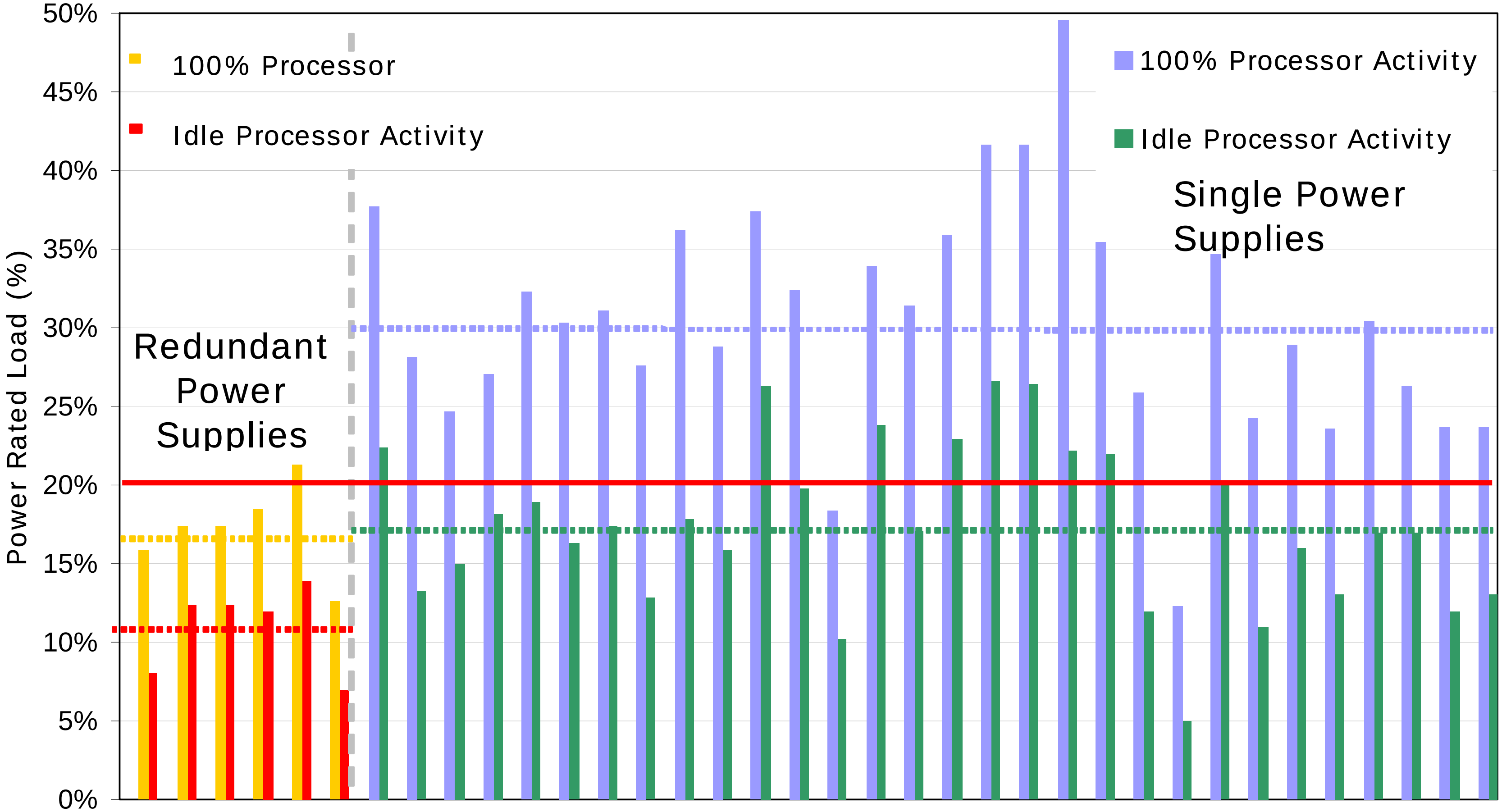


Power Supply Power Factor



- Proposed Power Factor requirement only eliminates the worst case
- 18/20 (90%) meet power factor requirements

Power Supply Loading – SPEC Data



- Most servers idling <u>below</u> 20% power supply load.
- 5 out of 6 redundant servers <u>never surpass</u> 20% power supply load.

Questions for Discussion

- Comments on proposed power supply levels?
- Interest in net power loss approach?
- If EPA were to allow for certain exemptions, would the 10% load requirement be reasonable?
  - How could EPA be assured that solutions that seek to avoid operation at 10% will be used in practice?
- Could power supplies be effectively categorized such that units with fans for internal cooling and fans for system cooling might be parsed out?

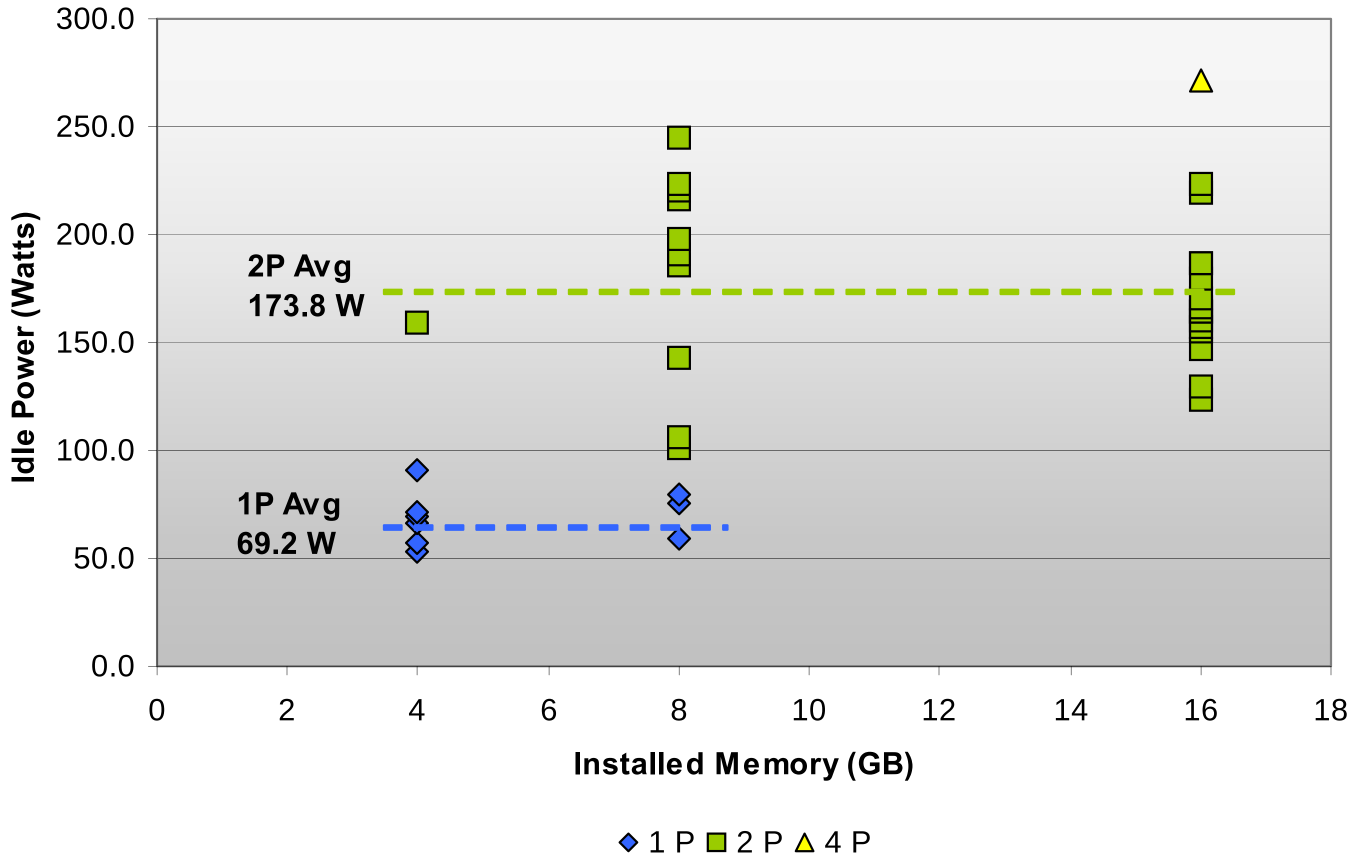
Idle Power Requirements

- EPA continues to be interested in idle
  - End users: “servers continue to spend significant time in idle & low utilization”
  - Market penetration of virtualization still low & not all servers will be good candidates
  - Simplest, best indicator of power use at low utilization
- End users should have access to this info

Idle Power Analysis

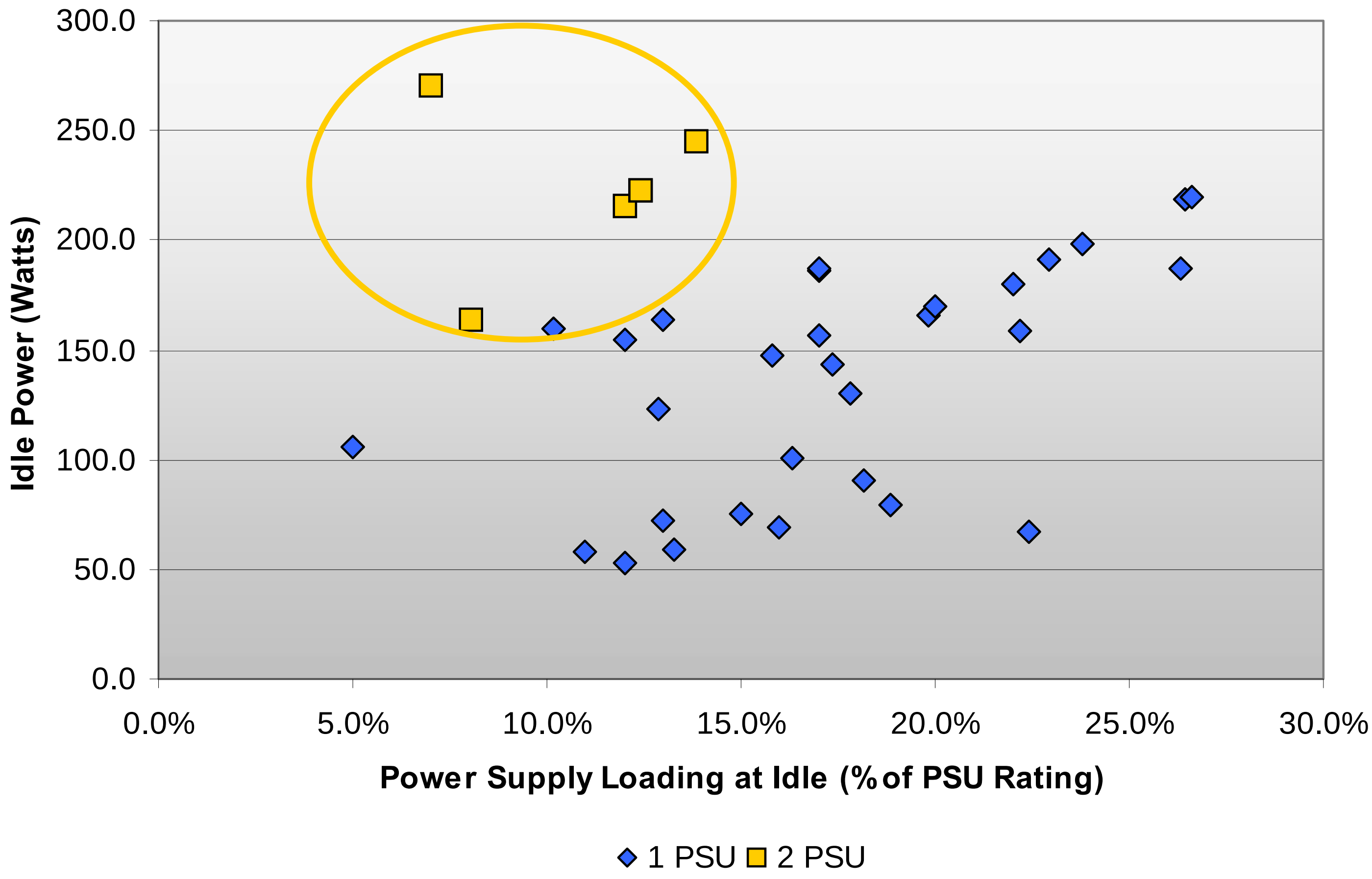
- EPA analyzed the public SPECpower data available at http://www.spec.org/power_ssj2008/
  - 36 from units from 9 manufacturers as of 6/18/08
    - 9 each 1P systems
    - 26 each 2P systems
    - 1 each 4P systems
  - Calculated PSU loading at Idle and Max by assuming the average power supply curve from PSU efficiency data collected to date

Idle by Processor Numbers and Installed Memory



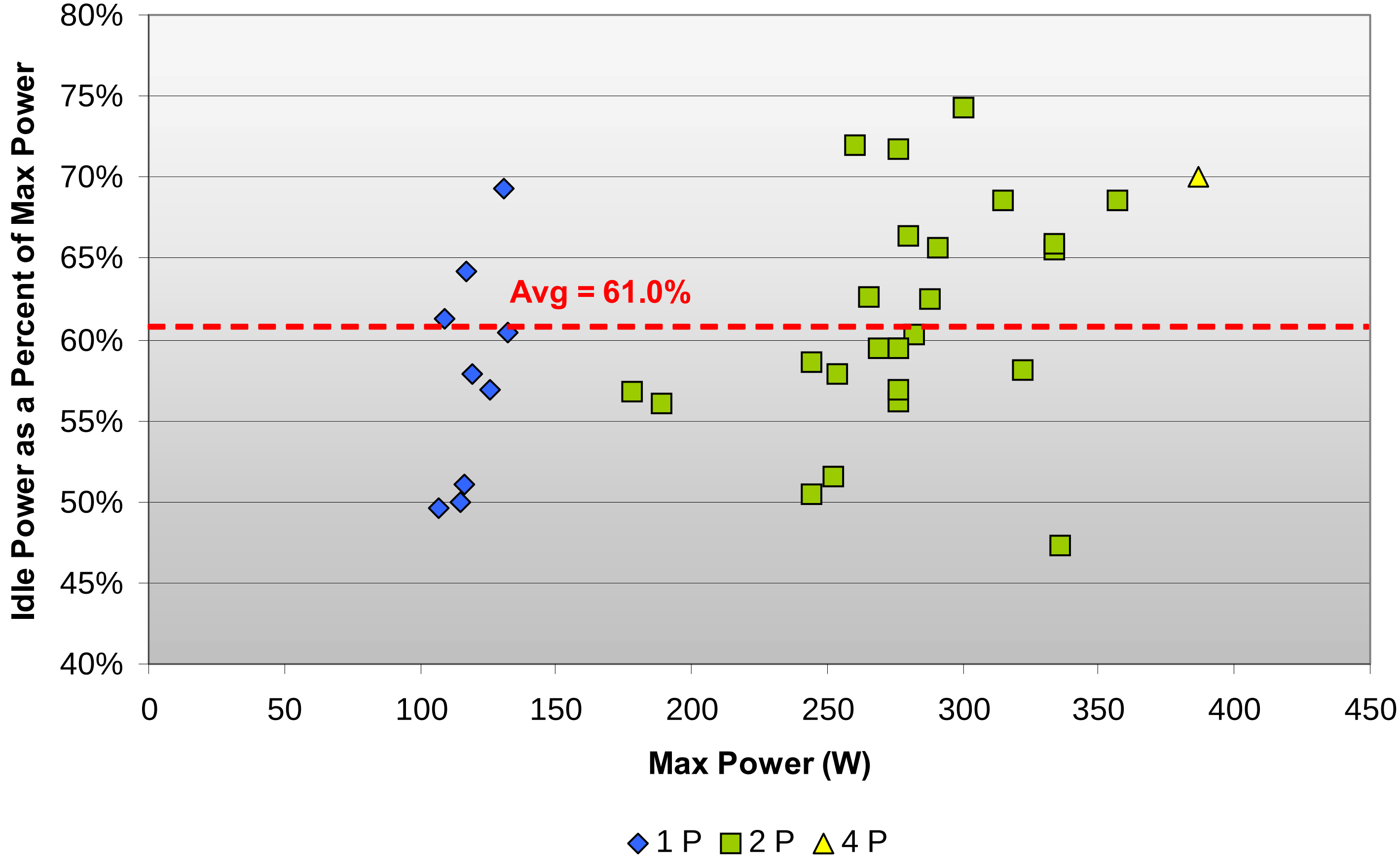
- Noted difference for # CPUs
- Relationship to installed memory not as clear

Idle Power *cont.*



- Redundant PSU systems with low PSU loading have higher idle

Idle Power as % of Max



- Scaling Idle to maximum power appears to work across processor #s and different power ranges

Questions for Discussion

- Would end users find it beneficial to know energy use in idle?
- Are there discernable differences in energy performance tied to hardware or other characteristics?
- Could idle be set as a % of max power?
- What are the challenges of using SPECPower ssj_2008 to measure/report idle performance?
- Could EPA create a special category for severs likely to be virtualized?

Performance Reporting

- Consistent reporting provides a level of transparency regarding performance characteristics in addition to ENERGY STAR requirements
  - End users can compare both on ENERGY STAR qualification, other characteristics and performance criteria

Example Performance Sheet

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ENERGY STAR® Qualified Product Data Sheet
[SERVER MODEL NAME AND NUMBER]

(Manufacturer must report for Maximum and Minimum Configurations)

- System Characteristics
  - Form factor (e.g., 1u, 2u, blade chassis, etc.)
  - Available processor sockets
  - Processor information (model number, speed, # of cores, etc.)
  - Memory information (memory types, # Dimms, Dimm Size, etc.)
  - Power supply – number, redundancy, and size (Watts)
  - NIC information (#, speed)
  - Hard drive information (#, speed, size)
  - Installed operating systems (for purposes of testing)
  - Other hardware features / accessories
- Air Flow Rate Information/Delta T
  - Total power dissipation for max load configuration
  - Air temperature rise at exhaust of server for max load configuration (i.e., temperature rise across system at 100% load)
  - Size, position, and porosity of the inlet and exhaust grids/vents, including open, perforated, slotted, grille, mesh, etc.
  - Airflow characterization????
  - Delta T?????
- Available Power Management Features
- Virtualization Capability (e.g., type of embedded hypervisor, etc.)
- Power and Performance Data
  - Benchmark used and type of workload
  - Benchmark performance score*
  - Maximum power*
  - Minimum power*
  - Idle power*
  - Power supply performance/net power consumption
  - Estimated kWh/year**
- Link to manufacturer supplied savings calculator for customer specific configuration

**Based on manufacturer choice of performance benchmark.*
***Assumptions TBD.*

System Characteristics

Air Flow Rate

PM Features

Virtualization Capability

Power/Performance Data

Mfg Web site

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Questions for Discussion

- What characteristics are key to decision making process?
- How best can the data be presented that is intuitive and helpful to the end user?
- What opportunities exist to highlight key PM features and benchmarking scores on the data sheet?

Power Management/Virtualization

- Power management: important element of data center management strategy
  - However, many servers are shipped with these features disabled
- EPA is interested in requiring a number of power management features be included and enabled
  - Variable speed fan control, processor scaling, virtualization capability, etc.

Questions for Discussion

- What are some of the key PM features being used today – and in the near future?
- What are the pros and cons for including PM as a reporting vs. a qualification requirement?
- How will the ENERGY STAR specification stay current if prescriptive PM criteria are included?
- Do end users see this as an important piece to the decision making process?
- Should prescriptive power management solutions go away with an idle requirement?

Effective Date

- EPA continuing to work toward a January 2009 effective date
  - Partnering manufacturers will be able to qualify and label servers immediately
- Tier 2 research will start in parallel to this Tier 1 process
  - Full scale effort to begin after the Tier 1 is finalized (Feb/March)

Timeline

- **Draft 2** – August 2008
- **Comment Deadline** – September 2008
- **Draft 3** – October 2008
- **Comment Deadline** – October 2008
- **Final Draft** – November 2008
- **Comment Deadline** – December 2008
- **Final Spec** – January 2009
- **Tier 2 Initiated** – Feb/March 2009
- **Tier 2 Effective Date** – 2011/2012

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