



Top 10 Ways to Save Energy in Your Data Center

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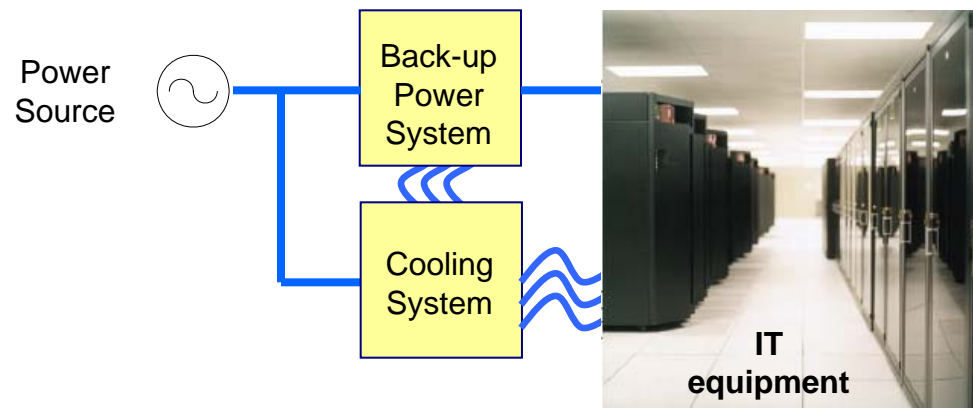
Why Save Energy in Your Data Center ?

- Energy Usage in your data center has grown 2 – 3x in last 3 years
- Lifetime (3 yr.) Energy costs to support a server will soon exceed its acquisition costs
- Energy costs will continue to increase
- Through 2009, energy costs will emerge as the second-highest operating cost (behind labor) in 70% of DC facilities worldwide*
- Corporate responsibility to reduce greenhouse gas emissions
- Allows you to do **“more with less”**
 - Reduces your operating cost
 - Extends use of existing resources
 - Lowers / Delays capital investment of site infrastructure
- **Many low-hanging management options and proven technologies to reduce your energy consumption by 50% without compromising availability of your data center**

* Source: Gartner; Meeting the DC power and cooling challenge

Power Usage in a Data Center

Power Delivery in a Datacenter

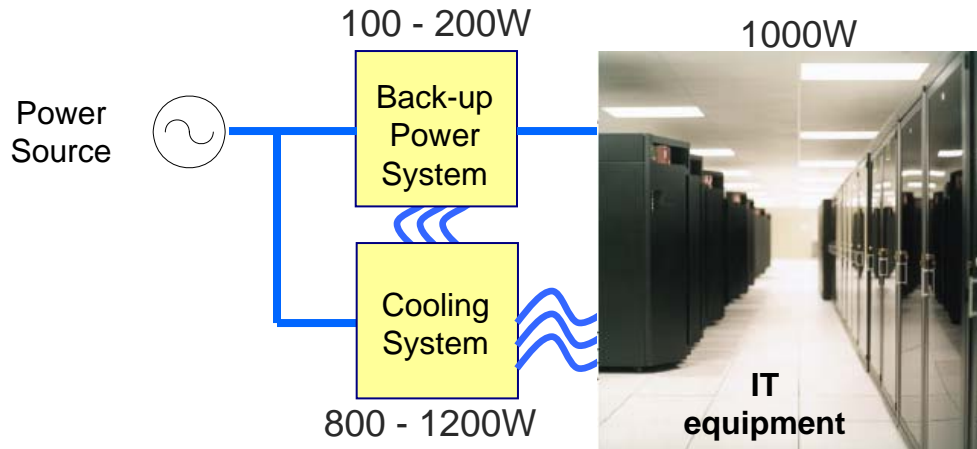


Key Data Center Systems – Power Usage

- Servers and other IT equipment
- Power distribution and protection systems
- Data center cooling systems

Improving Data Center Efficiency

Power Delivery in a Datacenter



$$\text{IT Efficiency} = \frac{\text{IT Output}}{\text{IT Input Power}}$$

$$\text{Data Center Site Infrastructure Efficiency} = \frac{\text{IT Input Power}}{\text{Total Site Power}}$$

$$\text{Data Center Efficiency} = \text{IT Efficiency} \times \text{Data Center Site Infrastructure Efficiency} = \frac{\text{IT Output}}{\text{Total Site Power}}$$

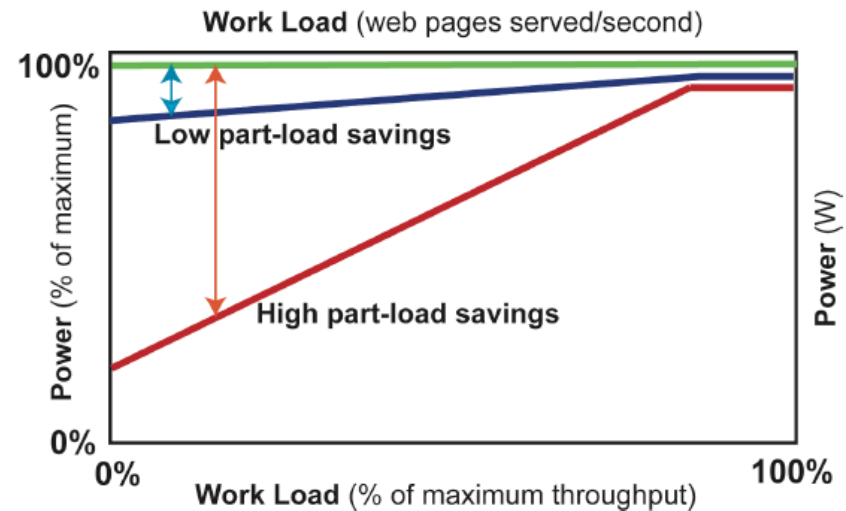
- Improve IT efficiency
 - Maximize IT output while lowering input power
- Improve Site Infrastructure Efficiency
 - Reduce Losses & inefficiency in back-up power & cooling systems

Poor Utilization of IT Assets

Typical Utilization Rates^a

- Servers: 5-15%
- PCs: 10-20%
- Direct-attach Storage: 20-40%
- Network storage: 60-80%

IT Input Power vs. IT Output^b



A typical x86 server consumes between 30% and 40% of its maximum power when idle

a)Source: VMware, Microsoft, EMC

b) Source: Nordman, Bruce. 2005. Metrics of IT Equipment — Computing and Energy Performance. Berkeley, CA:

Improving IT Asset Utilization

- Turn-off idle IT equipment
- Retire unused software applications
- Effective software (eliminate extra CPU cycles, ie “*bloatware*”)
- Virtualization of workloads
- Consolidation
 - servers, storage, networks, datacenter

Virtualization

Technology

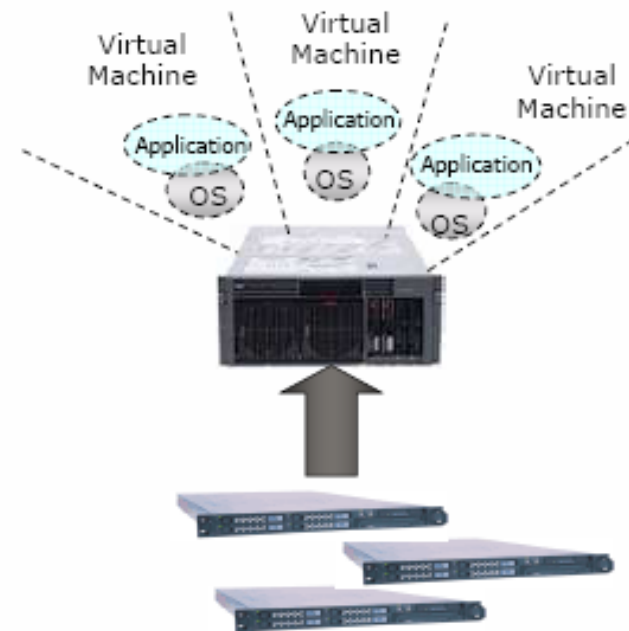
- Aggregates servers and their storage
- Multiple operating systems and applications, separate Virtual Machines

Energy Savings Benefits

- Dramatically higher hardware utilization (5x – 20x)
- Allows you to reduce number of power consuming servers

Example

- 1000 servers down to 200
- 500W / server and 500W for site infrastructure
- Annual Energy Savings @\$0.10/kWhr = \$700k



Consolidation – Blade Servers

Technology

- More dense than rack-optimized servers because of shared resources, such as power, fans, networking, and storage, are not physically located on individual blades.



Energy Savings Benefit

- Blade servers typically will require 10 to 25% lower power/cooling for the same computing capacity



Example

- 1000 effective servers
- 20% Savings
- Annual Energy Savings @\$0.10/kWhr = \$175k

Consolidation - Storage

Technology

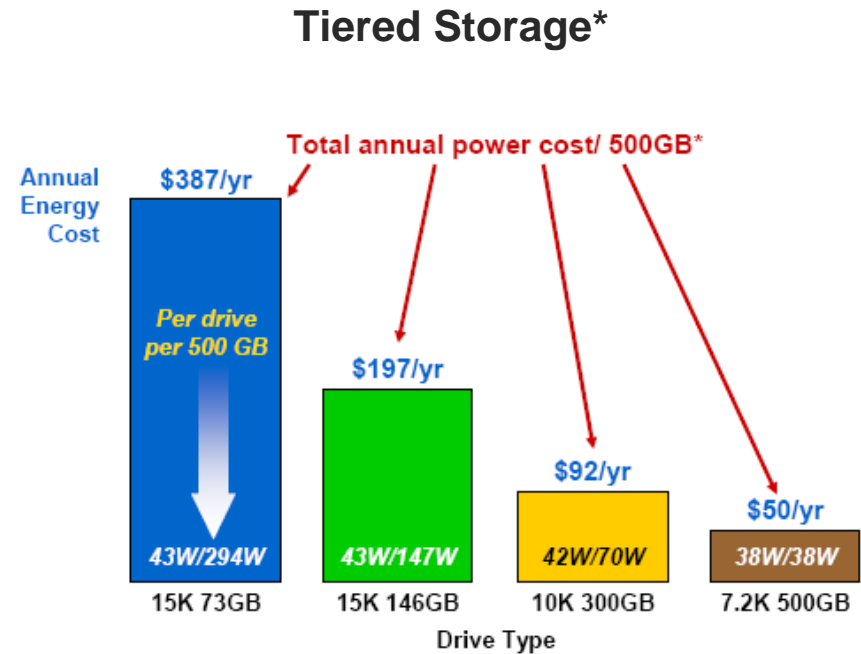
- Use Tiered storage for different workloads
- Consolidate storage to improve utilization

Energy Savings Benefit

- Lower capacity drives consume more power per GB

Example*

- 44 mid-tier system (885 TB in 146 GB drives) to 2 High-end systems (934 TB in 146 GB and 300 GB drives)
- 50% Energy Savings
- Annual Energy Savings @ \$0.10/kWhr = \$130k

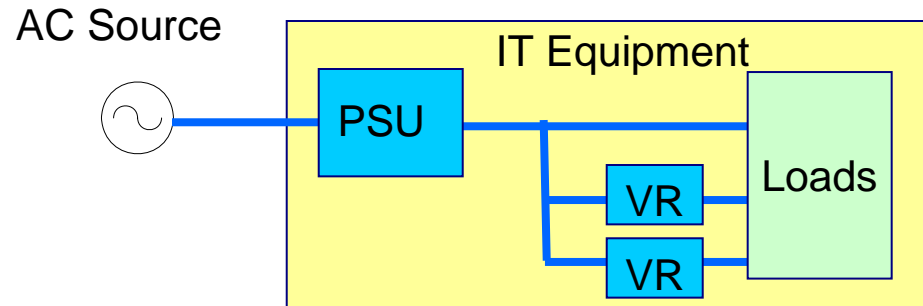


* Source: EMC

Power Consumption by the IT Equipment

Typical Server Power Budget

- Processing Loads: 55%
- Power Supply Unit (PSU): 26%
- Voltage Regulators (VR): 12%
- Miscellaneous Loads: 7%



- Improving CPU efficiency
 - Lower power consumption processor chips & multi-core technology
 - Power Management feature
- Improving power conversion efficiency in PSU and VR
 - High efficiency PSU and VR

CPU Power Management Feature

Technology

- Enables the CPU to optimize power by dynamically switching among multiple performance states (frequency & voltage combinations) based on CPU utilization, without having to reset CPU.

Energy Savings Benefit

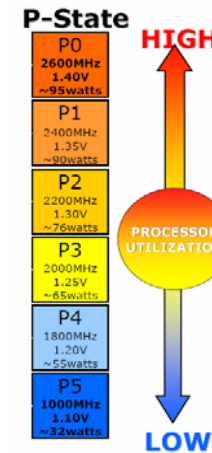
- Can lower power consumption without compromising performance and improves performance /watt

Example

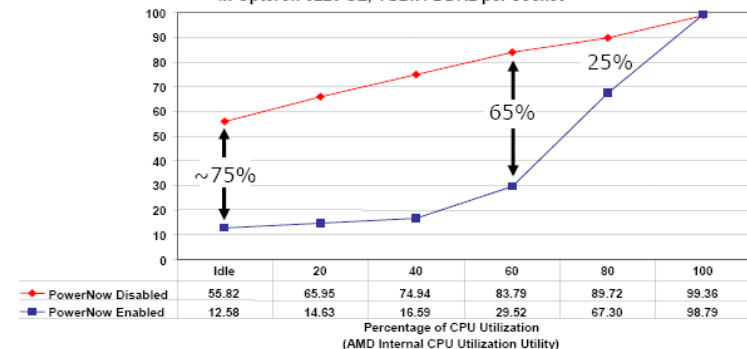
- 1000 effective servers
- 20% Savings
- Annual Energy Savings @\$0.10/kWhr = \$175k

* Source: AMD

Processor Performance State*



Affects of CPU Utilization and AMD PowerNow™ Technology on VDD Core Power Consumption
4x Opteron 8220 SE, 1GBx4 DDR2 per socket



Power Supply Efficiency

Technology

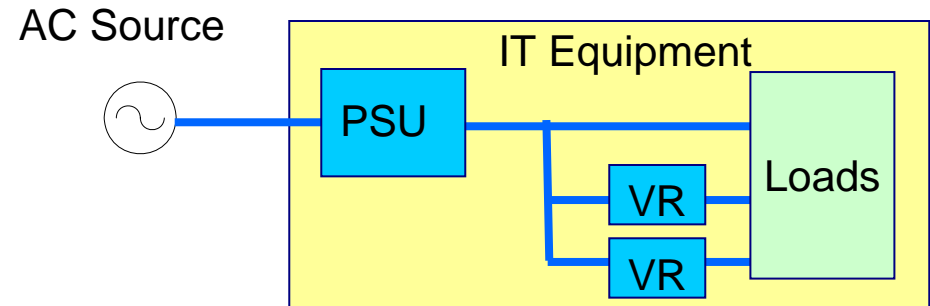
- High efficiency power conversion being promoted by EPA and major vendors offer 80PLUS-certified power supplies (www.80plus.org)
- Flat energy conversion efficiency over wide load range

Energy Savings Benefit

- Can lower power & cooling needs by 15%

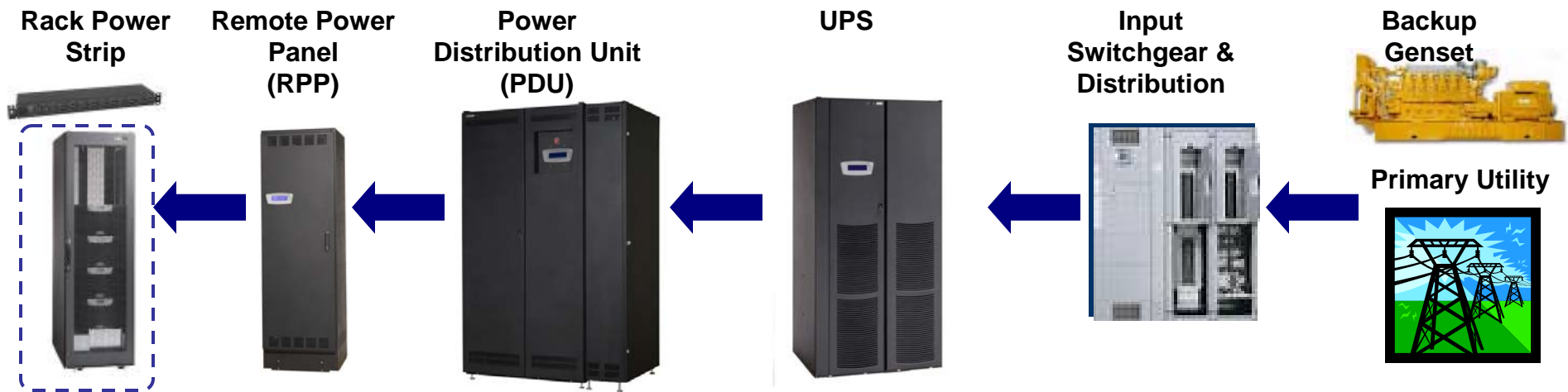
Example

- 1000 servers @500W/server
- 15% Savings
- Annual Energy Savings @\$.10/kWhr = \$130k



- Nominal Power Conversion Efficiency = 60%
 - PSU Efficiency: 80%
 - VR Efficiency: 75%
- Best in Class Power Conversion Efficiency = 75%
 - PSU Efficiency: 90%
 - VR Efficiency: 85%

The Data Center PowerChain

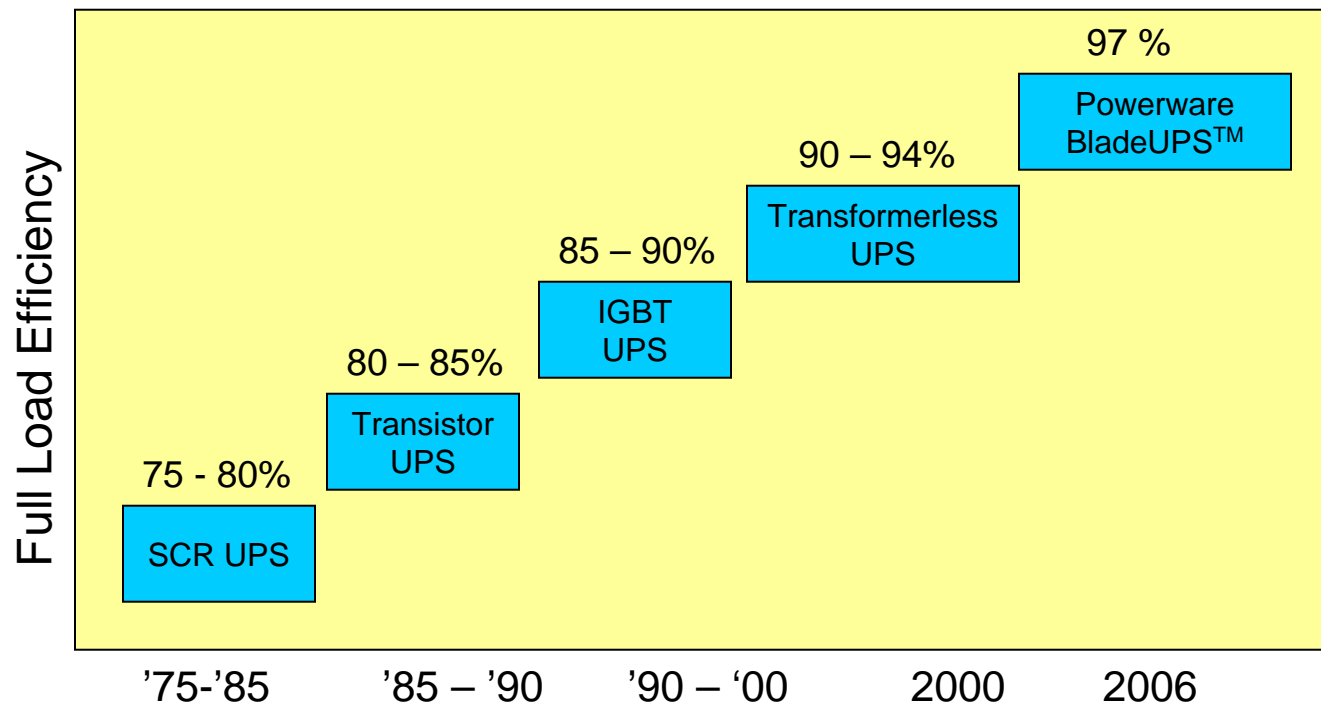


The Data Center PowerChain encompasses power delivery from the incoming utility feed to the IT equipment in an enclosure

- Key Components contributing to power loss in back-up power system
 - UPS (Uninterruptible Power Supply) efficiency: 80 to 95%
 - PDU (w. transformer) efficiency: 94 to 98%

UPS Energy Efficiency

UPS Energy Efficiency Improvements



Powerware BladeUPS: 12 kW Building Blocks Scalable to 60kW (N+1) in a 19" Rack



UPS Energy Efficiency

Technology

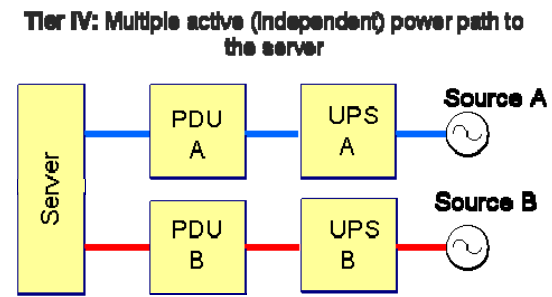
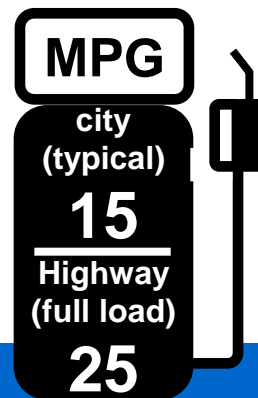
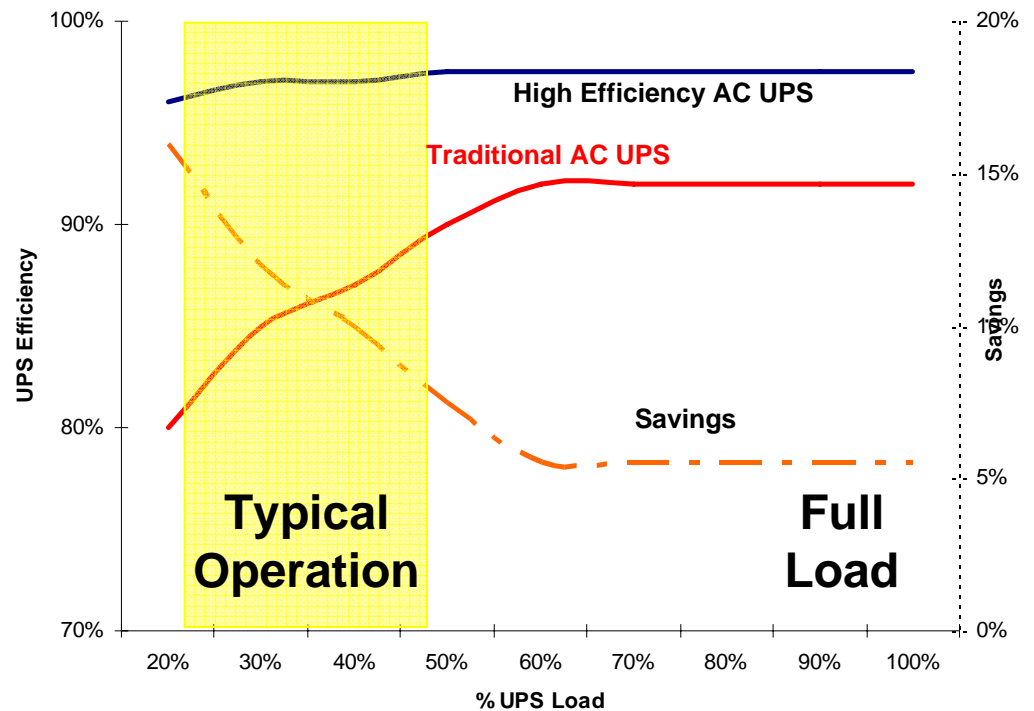
- High efficiency UPS solutions available today.
- Flat energy conversion efficiency over wide load range

Energy Savings Benefit

- Improved efficiency of 5% to 15% across full load range

Example

- 1000 servers @500W/server
- 10% Savings
- Annual Energy Savings @ \$0.10/kWhr = \$86k



Input Voltage Choice

Overview

HP ProLiant DL380 Generation 5 (G5)



Power Supply Specification - AC	Part number		380622-001			
	Spare Kit		403781-001			
Operational Input Voltage Range (Vrms)	90 to 264					
Frequency Range (Nominal) (Hz)	47 to 63 (50/60)					
Nominal Input Voltage (Vrms)	100	120	208	220	230	240
Max Rated Output Wattage Rating	800	850	1000	1000	1000	1000
Nominal Input Current (A rms)	10.0	8.8	5.85	5.5	5.2	4.97
Max Rated Input Wattage Rating (Watts)	980	1035	1193	1186	1172	1169
Max. Rated VA (Volt-Amp)	1000	1056	1217	1210	1196	1193
Efficiency (%)	81.5	82	84	84	85	85.5
Power Factor	0.98	0.98	0.98	0.98	0.98	0.98
Leakage Current (mA)	0.44	0.52	0.91	0.96	1.00	1.00
Max. Inrush Current (A peak)	30	30			30	
Max. Inrush Current duration (mS)	3	3			3	



- Virtually all IT equipment is rated to work from 100V to 240V AC input
- 2% Efficiency gain by using 208V instead of 120V
- 3% Efficiency gain by using 230V instead of 120V

230/400VAC v. 120/208VAC Power Distribution

Technology

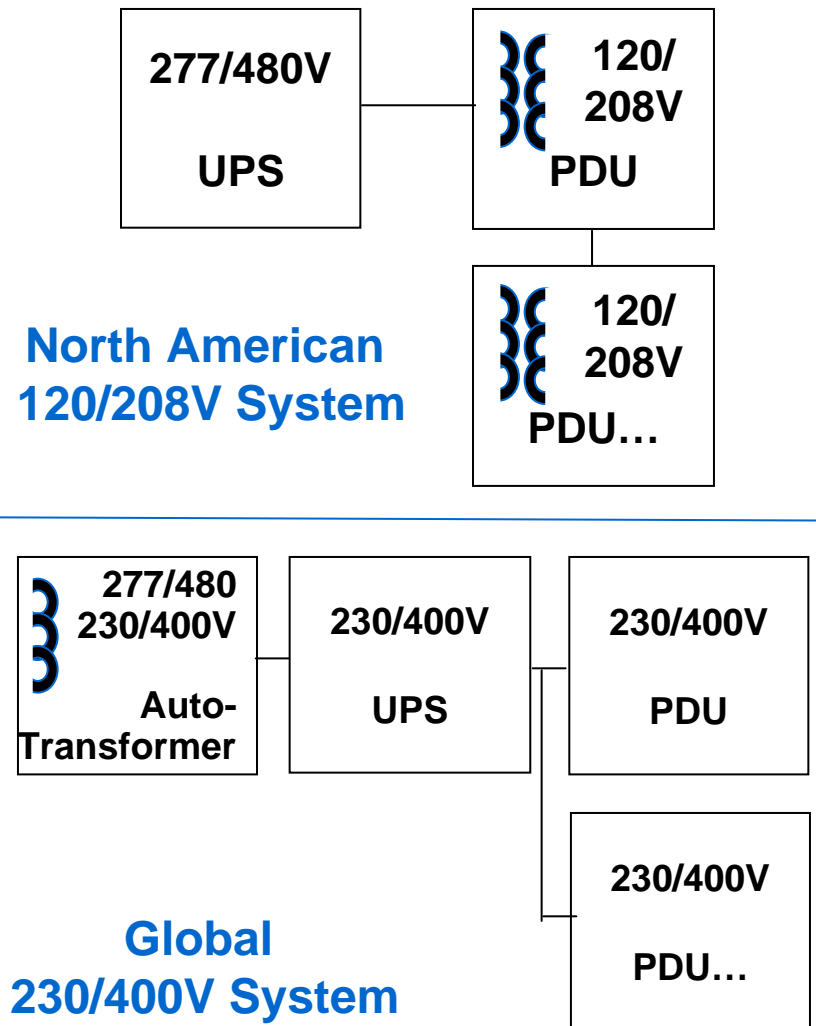
- 230/400 VAC is a global platform for power distribution
- Eliminates need for PDU transformer to step-down 480V to 208V

Energy Savings Benefit

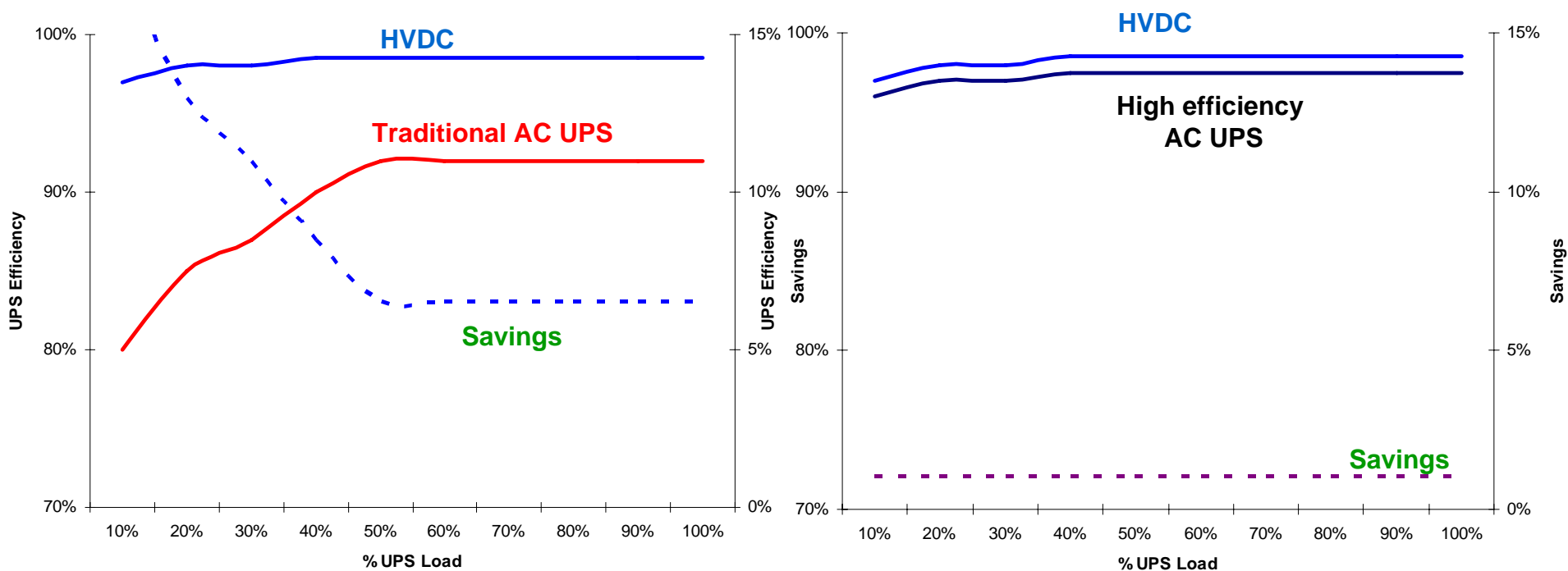
- Improved efficiency of 5% (3% from eliminating transformer and 2% from IT equipment power supply)

Example

- 1000 servers @500W/server
- 5% Savings
- Annual Energy Savings @ \$0.1/kWhr = \$43k



DC power versus AC power



- High voltage DC (Direct current) power provides marginal energy efficiency improvements when compared to state-of-the-art AC UPS & distribution systems

Technology Issues with High Voltage DC

- Development of HVDC IT equipment
- Fault protection and Arc Flash
- IT and Facility safety standards

Improving Cooling Efficiency

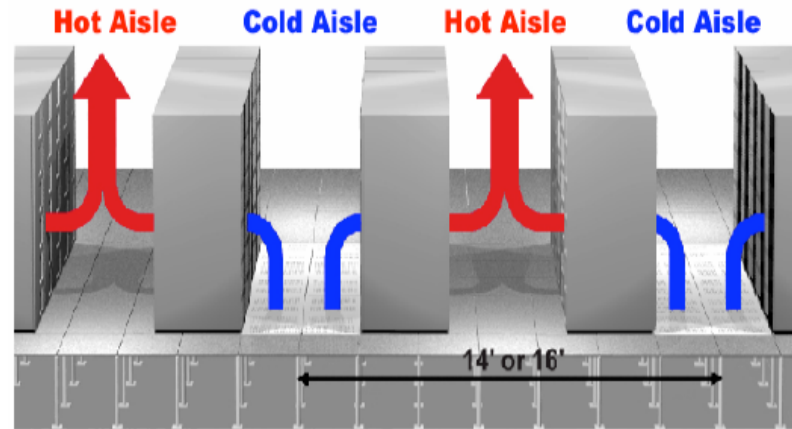
Best Practices

- Use hot aisle/cold aisle enclosure configurations
- Use blanking panels inside equipment enclosures
- Seal cable cutouts to minimize “bypass airflow”
- Humidity and temperature settings according to ASHRAE guidelines

Technology Options

- Air handlers and chillers that use efficient technologies such as variable frequency drives (VFD)
- Air-side or water-side economizers
- Close coupled cooling

Hot aisle/cold aisle configuration*

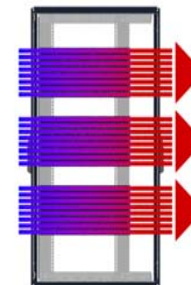


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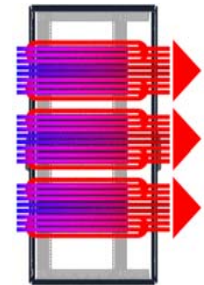
Seal cable cutouts



With Blanking Panels



Without Blanking Panels



* Source: Uptime Institute

Improving Cooling Efficiency

Technology

- Assess quick-fix opportunities to improve existing cooling system deployment efficiency
- Implement energy efficient cooling technologies

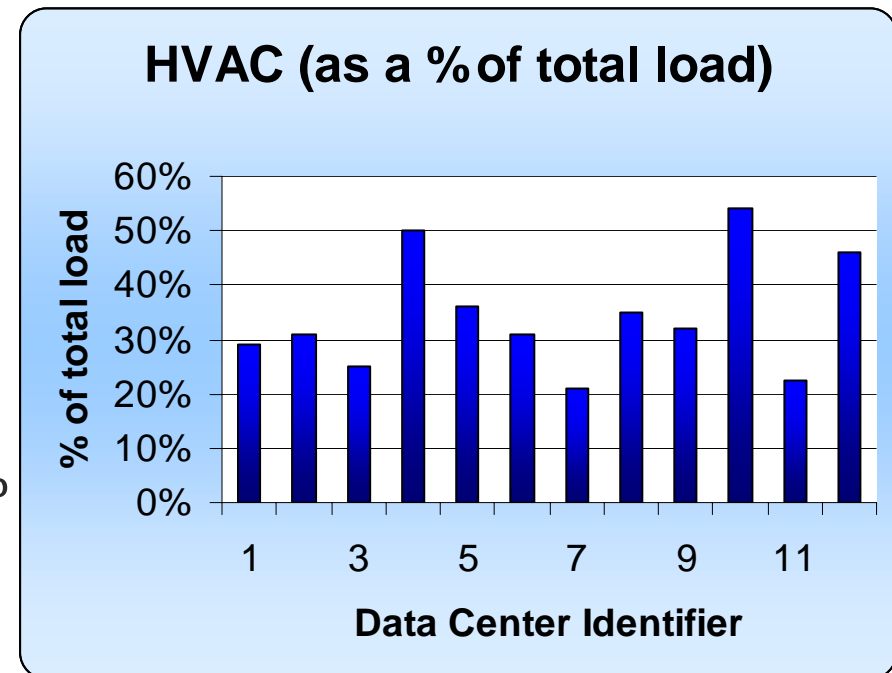
Energy Savings Benefit

- Cooling systems consume most energy after IT Equipment
- Improved efficiency of 15% to 40%

Example

- 1000 servers @500W/server
- 25% Savings
- Annual Energy Savings @ \$0.10/kWhr = \$109k

Lawrence Berkley Research of
Datacenter sites



Large variability in cooling
efficiencies

Top 10 Ways to Save Energy in your Data Center

1. Turn-off idle IT equipment
2. Virtualize
3. Consolidate
4. Use / Enable CPU power management feature
5. Use high efficiency IT equipment power supplies
6. Use high efficiency UPS
7. Adopt power distribution at 208V / 230V
8. Adopt cooling best practices
9. Assess the utilization and efficiency issues (opportunities) in your data center
10. Prioritize actions to reduce the energy needs of your datacenter.

Summary

- Audit your utilization rates and energy efficiency of your current data center
- Identify and prioritize steps to reduce the energy needs of your datacenter.
- Include energy efficiency in the TCO analysis when procuring new IT, back-up power and cooling equipment
- For new data centers include energy efficiency as one of the key requirements in the design criteria.
- Achieving 50% reduction in your data center energy usage is a systems opportunity which involves managing and optimizing use & deployment of IT systems back-up power and cooling system.
- Ensure executive level sponsorship and form a cross functional team to develop an energy strategy for your IT operations.

Contact Information

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The logo consists of the word "EATON" in a bold, blue, sans-serif font. The letter "O" is stylized as a solid blue circle.