



STORAGE NETWORKING WORLD

October 15-18, 2007 • Gaylord Texan • Dallas, Texas



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Beyond Green-wash

IT Data Center Power, Cooling & Environmental Topics

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Why are you here?

- What is your interest in power and cooling?
 - Boss said check it out
 - Currently have power or cooling issue
 - Power or cooling problems looming
 - Being “green” is a timely topic
- What are your “green” challenges?
 - Support additional IT equipment, lack floor space
 - Limited available power, UPS or backup resources
 - Need to cut spending on power and cooling
 - Environmental initiatives (RoHS, WEEE, LEED, etc.)



Green Storage Myths & Realities

- Myth: CO₂ emissions is prime focus of energy efficiency
 - Reality – It can be, however there is a supply and demand issue
 - Reality – Datacenters have dense power needs
 - Reality – Datacenters need reliable and stable power
- Myth: Green is the focus of reducing power and cooling
 - Reality – It can be, as well as for other reasons (supply / demand)
- Myth: HW costs more to power than to buy
 - Reality – Maybe for components, not for systems **yet**
Single low cost HDD with escalating power cost over time
 - Reality – New data centers can change perception
For example, \$10M of hardware needs a \$21M new datacenter



Some Green and Related Topics

- Some green stories include:
 - Carbon Credits to offset consumption
 - Focus on storage utilization, reduced data footprint
 - Apply software and management (Thin Provision, Virt. Etc.)
 - RoHS, WEEE, LEED, Green Grid, climate savers, etc...
- Some focus areas include:
 - Safe and ecological equipment disposal of ewaste
 - Reduce carbon output impact to meet green initiatives
 - Reducing power consumption (costs, energy footprint)
 - Improve storage effectiveness (performance and utilization)

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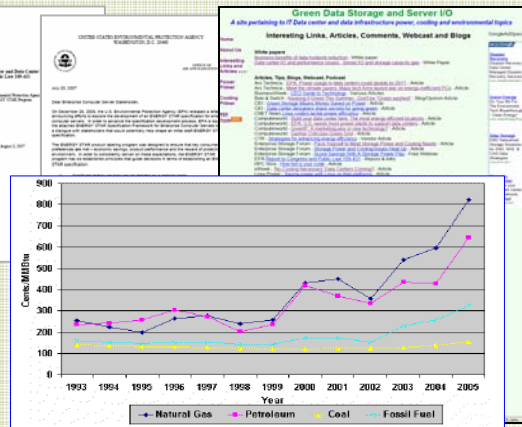
Awareness Continues To Grow

See free report “Analysis of EPA report to Congress (Law 109-431)” at www.storageio.com/xreports.htm

The GreenGrid
SNIA, SPC, EIA,
Affcom and others



| U.S. Electricity Usage | |
|------------------------|---------|
| Residential | 36.6% |
| Commercial | 35.6% |
| Industrial | 27.45% |
| Transportation | 0.0029% |
| IT Datacenters | 1.5% |



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Some “Green” Facts and Figures

- Data centers consumed 61 billion kWh in 2006
- U.S. Data centers used 1.5% of electricity in 2006
- IT power consumption about \$4.5B USD in 2006
- On average 50% of IT electricity is for cooling
- Emissions will vary by type of fuel being used (Western vs. eastern coal, petroleum and natural gas, hydro, nuclear, thermo, wind)
- 24 cubic foot refrigerator is 1.22 tons of CO₂/yr
- Chevrolet Tahoe produces 7 to 10 tons of CO₂/yr

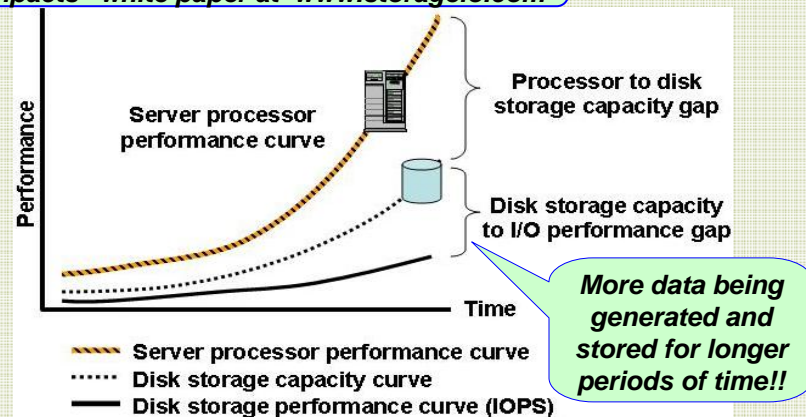
Actual CO₂ emissions vary by mileage, location, use and type of fuel

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What Is Driving “Green” and related Issues?

See “Data Center I/O Performance Issues and Impacts” white paper at www.storageio.com



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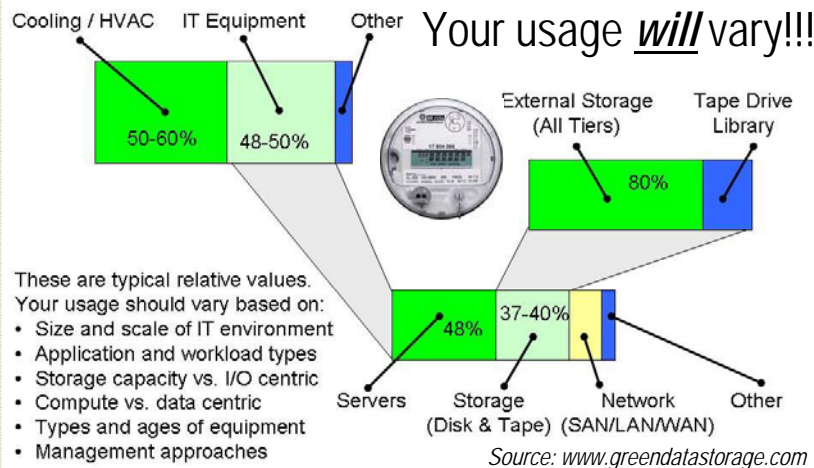
What Is Driving “Green” and related Issues?

- Continued growth and reliance on IT services
- Global ecological awareness issues and topics
- Data centers require access to reliable power
- Supply (fuel cost, production & transmission – G&T)
- Demand (more dense data centers)
- Density driving demand and availability issues
- Limits on available power footprint
 - Cost, production, transmission, geography, your facility

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Typical Data Center Power Usage



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Some Energy Terms and Metrics

| Measurement | Description | Comment |
|----------------|-----------------------|--|
| Kilowatts (kw) | Watts x 1,000 | One thousand watts, kWh |
| Megawatts (mw) | kW x 1,000 | One thousand kW |
| BTU/hour | watts x 3.413 | Heat in an hour from using energy British Thermal Units. |
| Watts | Amps x Volts | Unit of electrical energy power |
| DCE | Datacenter Efficiency | Ratio of how datacenter consumes power |
| PUE | Inverse of DCE | Power usage effectiveness |
| DCPE | Activity / Power | Datacenter Performance Efficiency |
| Amps | Watts / Volts | The flow rate of electricity |
| Watts | BTU x 0.293 | Convert BTU/hr to watts |
| Volts | Watts / Amp | Amount of force on electrons |

Source: www.greendatastorage.com

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Some Energy Terms and Metrics

| Acronym | Description | Comment |
|--------------------------|--|---|
| IOPS / kW | Energy per IOPS | IOPS per watt or kWh |
| GB / kW | Energy per capacity | Bandwidth or capacity per watt or kWh |
| Volt-Ampere(VA) | Volts x Amps | Sometimes expressed in Volt-Ampres |
| kVA | Volts x Amp / 1000 | Number of kilovolt-ampres |
| kW | kVA x power-factor | Power factor is the efficiency of a piece of equipments use of power |
| kVA | kW / power-factor | Kilovolt-Ampres |
| CO ₂ Emission | Average 1.341 lbs per kWh of electricity generated | Amount of average carbon dioxide (CO ₂) emissions from generating an average kWh of electricity |

Source: www.greendatastorage.com

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Various Approaches and Technologies

| | |
|-------------------------|---|
| Facilities tune-up | Optimize cooling, HVAC, data center assessment |
| Cabinets and conversion | Improved cooling for cabinets, better power conversion |
| Power down equipment | Power off, leverage variable power modes, sleepy drives |
| Semiconductor Storage | SSD, FLASH, RAM to improve on performance |
| MAID & IPM | Shift from power down to <u>I</u> ntelligent <u>P</u> ower <u>M</u> odes (IPM) |
| Technology replacement | Leverage faster, more energy efficiency technology |
| Tiered storage | Cache/SSD/Flash/RAM, HHDD, fat disks, fast disks, tape |
| Improve performance | Consolidate with faster technology and boost performance |
| Leverage fat drives | Use larger capacity drives at expense of performance |

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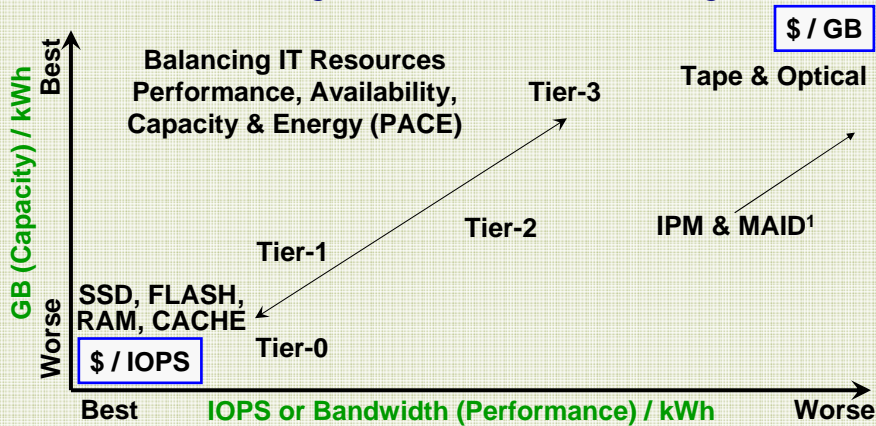
Various Approaches and Technologies

| | |
|--------------------------|--|
| Distribute workload | Leverage clustering to distribute storage and processing |
| Different RAID levels | Reduce number of drives to save on power consumption |
| Management tools | Thin provisioning, replication to sites with more power |
| Financial incentives | Energy rebates for efficient technology, carbon offsets |
| Data footprint reduction | Archive, compress, compact, single instance & de-dupe |
| Optical storage | Leverage various forms of optical for retention |
| Magnetic tape | Leverage tape for long term archive and retention |
| RoHS/WEEE/LEED | Recycling and ecological disposal of IT equipment |

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Performance, Availability, Capacity, Energy *Balancing "PACE" With Tiered Storage*



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Best Practices and Storage Management

- There is a cost to go green and using software
 - Software requires hardware that consumes power
 - Moving data requires energy (IOPS or Bandwidth per kW)
 - Virtualization improves utilization not performance
 - Provisioning tools mask allocation not actual usage
- Tiering and automated movement can help
 - However there is a cost to move and relocate data
 - Watch the number of MIPS needed per TB of data
- Reduce your data footprint and subsequent impact

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Reducing Your Data Footprint

- Develop an overall data foot reduction strategy
 - Improve performance and data protection
 - Leverage different techniques and technologies
- Archiving and pruning with data classification
 - Database, email, un-structured block and file
- Compaction/compression for on-line and off-line
 - Software, disk, tape or network-based appliance
- Single Instance Storage (SIS) & De-duplication
 - Initially targeted at backup and archive

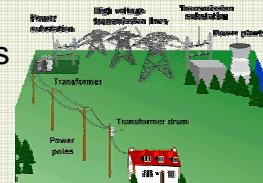


See free report “Business Benefits of Data Footprint Reduction”
at www.storageio.com/xreports.htm



HVAC, Cooling and Power Distribution

- Inefficient cooling and HVAC
 - Eliminate hot air blowing at cool intake of cabinets
 - Hot zones vs. cold zones, water cooling, special cabinets
 - Address airflow blockages, unused floor “cutouts”
- Power conditioning
 - UPS, battery backup, motor generators
 - Surge suppression, grounding
- Power distribution and conversion
 - Circuits not fully utilized yet allocated
 - AC to DC conversion and power factors of power supplies
 - 208 vs. 110, single vs. dual- or three-phase

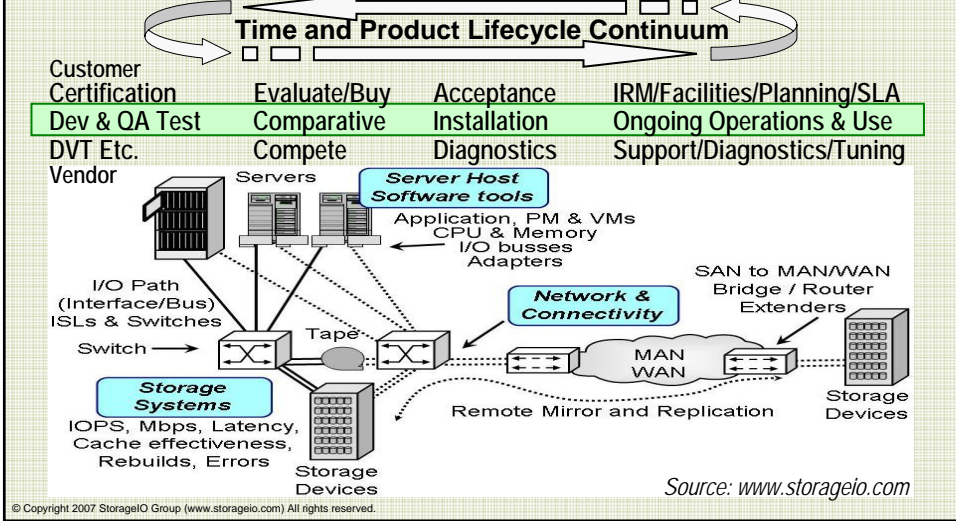




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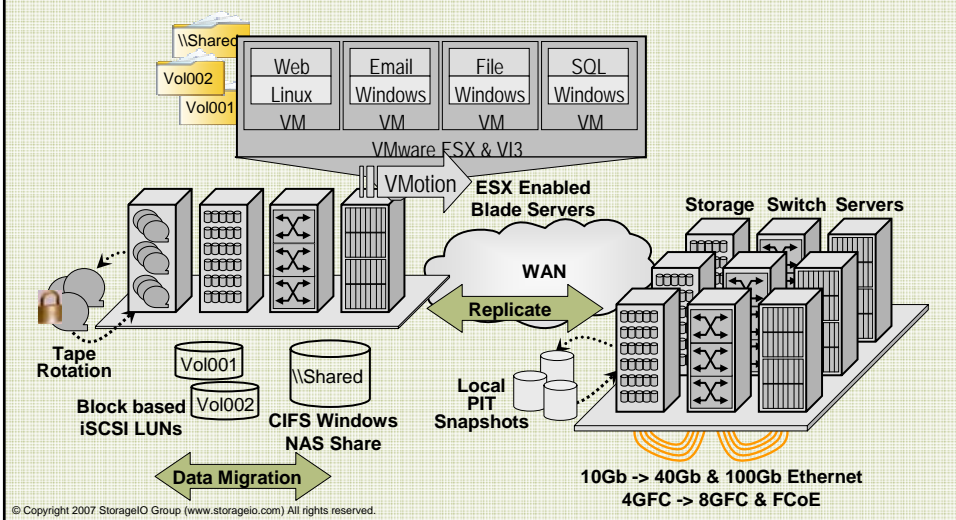
Storage Measurement Points of Interest



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Virtual Data Center – Solution or Aggravator?





Addressing Different Requirements

- Avoidance of power consumption - *lower kW use*
 - Powering down devices when not in use, usage limits
- Consolidation for energy efficiency to avoid waste
 - Larger capacity servers and storage, tiered resources
 - Look at *Capacity per kW or Watt*, leverage virtualization
- Performance enhancement for energy effectiveness
 - Increase performance doing more with what you have
 - Focus on *IOPS or Bandwidth per kW or Watt*
- HVAC & cooling optimizations – *Optimize what you have*
 - Improve air flow, optimize cabinets and placement



MAID and Intelligent Power Management (IPM)

- MAID becoming a popular term as is IPM
 - Power down disk drives when not in use; disk aerobics
 - Energy looks good vs. Tier-1, not so good vs. tape
- Not all MAID implementations are the same
 - Similarities to RAID technology maturity of early 1990s
 - Shift from propriety monolithic to more standard solutions
 - Leveraging off the shelf components and variable IPM devices
 - Performance impacts during large restoration
 - Several vendors doing variations of MAID using IPM



How Much Energy Is Needed to Power 100TB?

- Correct answer should be ***“It Depends...”***:
 - High capacity or high performance, Speeds and feeds
 - Assume 144TB “raw” using 192 750GB SATA disk drives in a single cabinet with dual RAID controller.
 - Assuming 20¢/kWh energy cost (includes cooling cost)
- Annual energy usage = 52,560 kWh (6 kWh x 24 x 365)
- Annual CO₂ emissions about 39.4 tons
- Annual energy cost about \$10,512

Note results will vary depending on type of storage solution, RAID configuration, performance or capacity centric, usage or workload, cooling overhead and local energy costs.



Leveraging Tiered Storage and New Devices

| Capacity | 73GB | 73GB | 73GB | 146GB | 300GB | 500GB | 750GB |
|---------------|-------|-------|-------|-------|-------|-------|-------|
| Speed (RPM) | 15.4K | 15.4K | 15.5K | 15.5K | 15.5K | 7.2K | 7.2K |
| Interface | 2GFC | 4GFC | 4GFC | 4GFC | 4GFC | SATA | SATA |
| Watts/hr | 18.7 | 15.8 | 15.2 | 17.44 | 21.04 | 16.34 | 17.7 |
| BTU/hr | 68.61 | 58.71 | 56.66 | 64.17 | 76.46 | 60.42 | 60.42 |
| Cap. Increase | N/A | N/A | N/A | 2x | 4x | 6.5x | 10x |
| Watts change | N/A | -2.9 | -4.5 | -1.3 | 2.3 | -2.4 | 1.04 |

| Total RAW Capacity | 16.4TB | 16.5TB | 16.8TB | 16.5TB |
|--------------------|------------|------------|--------|-----------|
| Drive capacity | 73GB | 146GB | 300GB | 750GB |
| Drive of type | 15K FC/SAS | 15K FC/SAS | 15K FC | 7.2K SATA |
| Number of drives | 224 | 112 | 56 | 22 |

Highest Performance Per Capacity

Cost & Power

Lowest Cost Per Capacity





Leveraging Tiered Storage and New Devices

| Storage Tier | Zero | One – Primary | 2 nd or 3 rd |
|--------------------------|---------------------|------------------|------------------------------------|
| Category | I/O Intensive | High Performance | Storage Centric |
| Drive Type | Multiple SSD's | 192x146GB 4GFC | 192 x 1TB SATA |
| Drive Speed | RAM Memory | 15.5K RPM | 7,200RPM |
| Footprint | One cabinet | One cabinet | One cabinet |
| Capacity | 1TB | 28TB | 192TB |
| Annual kWh | 39,420 | 72,270 | 72,270 |
| Average kWh | 3 | 5.5 | 5.5 |
| CO ₂ Emission | 26.43 Tons | 48.46 Tons | 48.46 Tons |
| Energy / Year | \$16,956.00 | \$13,008.60 | \$13,008.60 |
| BTU/hr | 15,977.52 | 164,486.52 | 164,486.52 |
| Characteristics | Highest performance | High performance | High capacity lowest cost |

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General Comments

- There are many facets to being “Green”
 - Some address real and relevant datacenter issues
 - RoHS, WEEE, Power, Cooling, Floor Space
 - There is a cost to being and going green
- Leverage energy efficiency and effective solutions
 - Shift focus from \$ / GB to effectiveness of solution
- Implement metrics and measurements
 - Usage & effectiveness of resources per service delivered
 - Capacity planning needs to include energy usage

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Closing Comments

- Density brings benefits (footprint) & issues (energy)
 - Datacenters use a small amount of total national power
 - However very dense and reliant upon available energy
- Many approaches depending upon your issues
 - Do more with what you have, address various mandates
- Understand energy efficiency vs. effectiveness
 - How much energy used vs. how much work can be done
- Have a balanced approach per footprint considering:
 - Performance, Availability, Capacity and Energy (PACE)



Where and How to Learn More

- ✓ “Resilient Storage Networks” (Elsevier)  *SNIA Recommended and endorsed Reading*
- ✓ Green Grid, Climate Savers, Afcom, EPA/DoE
- ✓ www.greendatastorage.com & www.storageio.com/portfolio.htm
- ✓ SPC (storage performance council) www.storageperformance.org
- ✓ SNW Sessions, SNWonline and Computerworld
- ✓ SNIA Education, Green Task Force and Green TWG
 - SNIA Web Site – www.snia.org
- ✓ SNW Exhibit Hall & Solutions Demo 



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Questions

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Thank You



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