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NETAPP WHITE PAPER

# Reducing Data Center Power Consumption Through Efficient Storage

Larry Freeman, NetApp, Inc.  
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## **AN EIGHT-POINT PLAN FOR FIGHTING POWER CONSUMPTION**

The NetApp® eight-point strategy for reducing storage power consumption helps you make use of today's technology to halt your growing power consumption at its source. By using your storage more efficiently, you can subtract machines and disks from the power equation, enabling you to reduce complexity; lower people, support, and service costs; and improve network efficiency and performance.

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## 1 HITTING THE LIMITS

Exponential data growth is a reality for most data centers. IDC Worldwide Disk Storage Systems Forecast 2006–2010 predicts that worldwide data will grow at a compound annual growth rate of 50.6% through the decade. This growth is a huge concern for IT managers. Until recently, continuous improvements in price/performance and \$/GB have made it both easy and affordable to solve storage concerns simply by adding more disks to existing storage systems. However, IT executives are discovering that there are limits to that easy growth: floor space, weight loads, rack space, network drops, power connections, cooling infrastructure, and even power itself are finite resources. Hitting any one of these limits significantly jeopardizes the ability of IT to meet the demands of business.

### A WATT IN MEANS A WATT OUT

“We’re at 100% of power capacity today. For every new watt I bring in, I’ve got to figure out how to take one out.”

—IT Executive, Global Financial Services Company, New York City

### HITTING THE FAN

Cooling is inextricably linked to power consumption. Every watt of power that enters the data center generates heat that must be removed from the environment—and to do so takes more power. As the heat increases, systems become more unstable, and component failure rates rise. The cost of power to cool a system is often as much as the cost of powering the system itself.

But cost is not the only issue. In some cases, rack densities generate more heat than existing cooling infrastructures can handle. Where there is no room for additional cooling infrastructure, there is no room for growth.

### POWER HUNGRY

Server density has been steadily increasing, inadvertently driving up data center power demands and cooling concerns. Increases in average server rack density are expected to drive average power consumption from 2kW per rack to 30kW per rack—and that’s only half the story. For each watt used by the server, A/C, power supplies, and other related equipment together require nearly 1.5 times that amount.

### PUTTING BUSINESS AT RISK

The combined effect of recent increases in the price of energy and the adoption of denser computing and storage architectures has driven energy costs for some data centers to 30% of their total operating budgets. If left unchecked, the cost to power IT equipment could exceed its acquisition cost in a matter of years. Without deliberate action, high energy costs will cripple an IT department’s ability to grow and change in support of the demands of the business.

### THE GREENING OF STORAGE

Environmental issues are gaining serious commercial momentum, and, fueled by the growing number of local and global green initiatives, they are rising ever more frequently up the corporate agenda. More power-efficient storage solutions provide for business growth while saving power. Every watt of energy saved in the data center is a watt that is removed from an organization’s carbon footprint and the global warming equation.

## 2 OUR EIGHT-POINT PLAN FOR FIGHTING POWER CONSUMPTION

The NetApp approach to fighting rapidly growing power consumption is simple: subtract machines and disks from the power equation by using storage more efficiently. This strategy has many corollary benefits: it lowers complexity, lowers people costs, lowers support and service costs, and improves network efficiency and performance. The NetApp eight-point strategy for reducing storage power consumption makes use of today's technology to halt growing power consumption at its source.

### 2-1 CONSOLIDATE SERVERS AND STORAGE

Servers alone can consume 50% of the power coming into the data center. So the first step in reducing power consumption is to attack the power problem where you can reap the most gains: consolidating and virtualizing application servers. To fully realize the benefits of server virtualization, you need to address the increased demands that virtualized servers pose for your storage infrastructure. NetApp storage solutions do for storage what server virtualization does for your servers. Figure 1 shows how we can help you save 50% or more compared to a baseline of traditional storage. And that's just the beginning. Buying and operating half as much storage means you reduce your power consumption and cooling load and free up space in your data center.

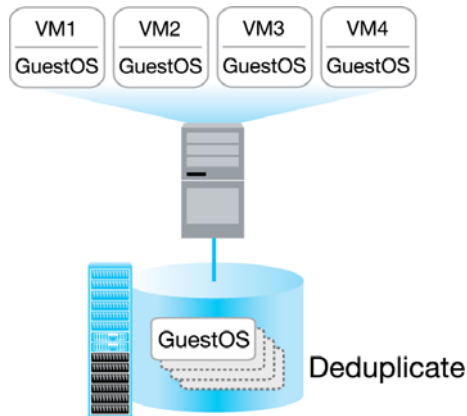


Figure 1) Save 50% or more using NetApp storage solutions.

After servers and cooling systems, storage is the next largest consumer of energy. In environments with lots of direct-attached storage, as much as 27% of the power going into the data center is consumed by storage. The explosive growth of Windows® data has led to a proliferation of Windows file servers and direct-attached storage units. This typically results in each application, project, or department having its own dedicated storage silo. With this type of architecture, underutilized storage in one area cannot be accessed from another area that might be short on storage. Not only are these server and storage assets poorly utilized, they are also difficult to manage, resulting in extremely high overhead costs. The proliferation of servers and storage is also causing companies to hit their limit on data center power and budgets for power, space, and cooling capacity. The old solution of simply adding more disks isn't sustainable. The answer: consolidation.

Figure 2 shows how the effect of consolidating direct-attached storage into network-attached storage (NAS) can bring you huge payoffs. By consolidating dedicated file servers and direct-attached storage into fewer shared resources, you can subtract dozens or even hundreds of servers and storage devices from your power and space equation, providing an immediate increase in total watts available in the data center. You also get the additional benefits of lower cost through increased storage efficiency. And your environment will be much more streamlined, resulting in increased agility and accelerated response to your business requirements.

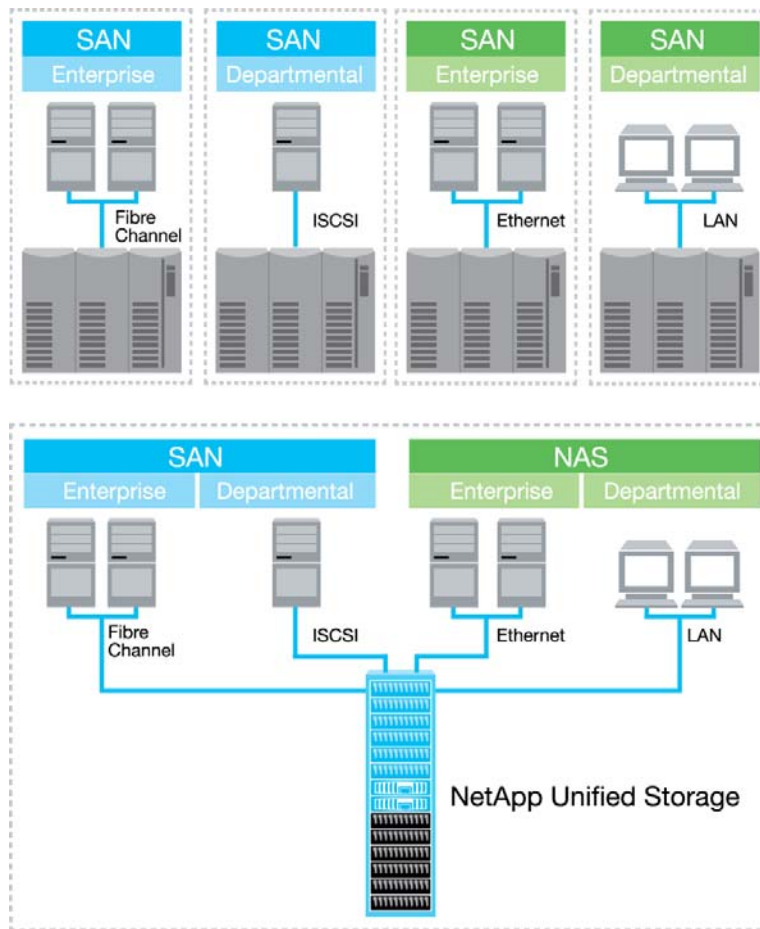


Figure 2) Consolidated servers and storage.

## 2-2 USE HIGHER-CAPACITY DRIVES

Using higher-capacity drives can significantly alter the storage power equation. Typical SATA disk drives consume about 50% less power per terabyte than Fibre Channel drives. They also offer the highest available storage density per drive, further helping to minimize power consumption. NetApp disk resiliency and data protection technologies have made SATA drives an increasingly viable alternative for a variety of enterprise applications. Companies are finding that SATA performance is capable of supporting far more applications than they originally thought possible.

### Dramatic Benefits of Higher-Capacity Drives

Table 1 shows the dramatic savings that can result from upgrading legacy storage systems. For instance, replacing 11 older systems with a newer, high-capacity system can actually increase capacity by 16% while consuming 81% less power and 93% less space than was required for the old systems. With this arithmetic, it doesn't take very long to achieve a significant return on your investment.

Table 1) Potential savings from higher-capacity drives.

	Old Systems	New Systems	Improvement
Number of systems	4 x FAS980 5 x FAS960 1 x FAS940	1 x FAS3140	10 controllers consolidated onto a single FAS3140
Disk storage	18 x DS14 with 144GB FC drives	3x DS14 with 1TB SATA drives	
Power consumption* (kWh) * Does not include power for cooling.	75,731	11,940	84% improvement
Rack space (cubic feet)	66U	12U	82% improvement
Total raw capacity (GB)	36TB	42TB	17% improvement

### 2-3 PROTECT AGAINST DISK FAILURES USING FEWER DRIVES

High-capacity SATA drives can store larger amounts of data per drive than Fibre Channel disk drives, making disk drive resiliency essential. For increased data reliability, NetApp offers double parity RAID-DP®. Compared to RAID 10 data mirroring, RAID-DP offers 46% greater storage utilization<sup>1</sup>. In addition, RAID-DP provides superior fault tolerance by recovering from the simultaneous failure of two drives. Other RAID levels can tolerate only a single drive failure.

### 2-4 DEPLOY SPACE-EFFICIENT DISK-TO-DISK BACKUP AND RECOVERY

Data backups are a fact of life in enterprise data centers. If your data is changed unexpectedly, a system is compromised, or a site is lost, backup enables you to recover your intellectual property, sales data, and other critical business information. Without backup and recovery, the potential for liability, missed revenue, and lost productivity is staggering.

With NetApp SnapVault® software, you can increase the efficiency of your disk-to-disk backup system by dramatically reducing the physical storage requirement for backups and simplifying recovery. Once a complete copy of the primary data is stored, each subsequent SnapVault backup stores only the data blocks that have changed since the previous backup. This means each subsequent backup copy consumes only a small amount of disk space, enabling you to maximize utilization of your existing storage investments. This efficiency also allows you to retain backups on disk for longer periods of time, enabling faster and simpler file recovery.

### 2-5 INCREASE UTILIZATION

According to industry estimates, storage utilization rates average 25% to 40%. That means 60% to 75% of all storage capacity that is being powered goes unused. Not only is such a low utilization rate a waste of storage, it is a waste of power.

In most systems, storage administrators allocate and dedicate storage space to a particular volume or LUN at the time of its creation. This creates two significant administrative challenges: (1) once a volume is created on physical storage, its size is extremely difficult to change, and (2) once storage is allocated to a particular application, it is not available for another use. Since it is difficult to predict actual storage requirements, application administrators typically request much more space than they think they will need to protect themselves should they need more storage down the line. This common practice guarantees overallocation. NetApp FlexVol® technology enables thin provisioning, which lets your storage administrators quickly and dynamically resize flexible volumes, eliminating the need for overallocation.

With NetApp FlexVol technology, utilization rates average 60%<sup>2</sup>. In fact, many of our customers are safely overprovisioning and driving utilization rates to 100% or more. FlexVol maximizes performance and capacity utilization by making all disks available to all data sets through a common pool of storage. Disk space that is no longer needed by a particular application can be returned to the free pool and made available to other applications as their storage needs grow. Increasing utilization 50% results in a corresponding reduction in the number of disks that are required to meet your storage needs.

## 2-6 DEDUPLICATE DATA

Countless copies of data files consume vast amounts of storage. The average UNIX® or Windows disk volume contains thousands or even millions of duplicate data objects. As data is created, distributed, backed up, and archived, duplicate data objects are stored unabated across all storage tiers. The end result is inefficient utilization of your data storage resources.

Deduplication technology helps you optimize your storage resources by freeing up capacity used for storing redundant data. NetApp FAS systems include deduplication, a technology that eliminates duplicate data regardless of the amount of redundant data stored on primary, backup, or archival disk arrays. Deduplication helps you save energy by reducing the need to continuously add more storage capacity for your redundant data storage.

## 2-7 ELIMINATE STORAGE OVERHEAD FOR TESTING AND DEVELOPMENT

Testing and development require numerous copies of your data, putting huge additional demands on your storage infrastructure.

NetApp FlexClone® technology lets you make multiple, instant virtual copies of your data with virtually no storage overhead. As with NetApp Snapshot™ technology, FlexClone stores only data that changes between a parent volume and a clone. FlexClone can instantly clone data volumes and data sets without needing additional storage space at the time of creation. This capability enables you to allocate many individual, writable copies of data in a fraction of the space that would typically be required.

Additionally, with NetApp FlexClone technology, you can now simultaneously perform activities that once had to be performed sequentially due to previous storage limitations, increasing the speed of testing and deploying new applications.

## 2-8 MEASURE YOUR POWER EFFICIENCY

Our last step is something that we encourage you to do on an ongoing basis to get a handle on your storage power consumption: measure the power efficiency of your storage systems.

One common measure of power consumption is watts per terabyte (W/TB). This measure can be misleading, however, when comparing machines that operate at different efficiency levels. A better way of evaluating storage power consumption is to measure watts per usable terabyte. This can be expressed with the following formula:

$$\frac{\text{Watts to power system}}{\text{Total system TB} \times \% \text{ System Utilization}} = \text{Watts per Usable TB}$$

To calculate the power efficiency of a particular storage system, divide the total watts per system by the total number of terabytes in that system times the system utilization. Your system utilization is equal to the percentage of your disks that are actually available for use. Figure 3 shows how this calculation reveals important differences between seemingly similar systems.

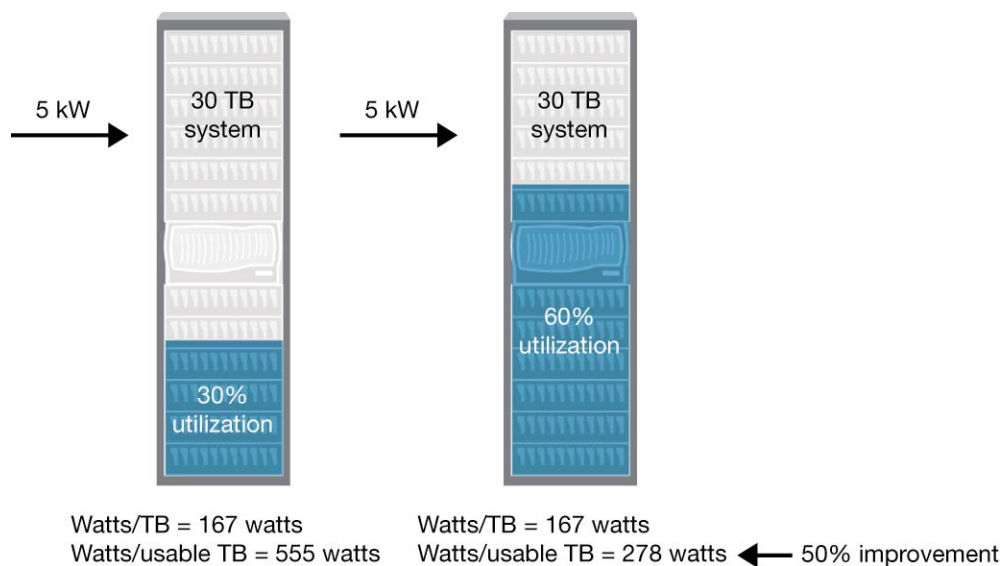


Figure 3) Power savings with NetApp storage systems.

### 3 LOOKING AHEAD

We believe that following these steps will help you reduce power consumption, provide enough headroom for your data center to grow, and protect the ability of your storage infrastructure to support the demands of your business for many years to come. In the meantime, we will continue to look for ways to improve the efficiency of storage systems at every level.

Here are some of the power-saving technologies that are currently being explored by our industry: larger SATA drives, in-line hardware data compression, file deduplication, flash memory, improved power supply efficiency, energy-efficient CPUs, DC power, and intelligent control of the speed of individual drives in response to demand. Today, there is no single solution for reducing storage power consumption, and similarly, future reductions will be attained through a combination of efforts attacking the issue on all fronts.

### 4 THE NETAPP COMMITMENT

Like many companies, our rapid business expansion and corresponding growth in data have placed continuous pressure on our own IT and data center infrastructures. With a 30% annual growth rate, simply adding more disks to our installed storage systems was not a viable long-term solution.

Our IT team experienced challenges in three key areas:

- Low storage utilization. Overall storage utilization per volume was less than 40%. In many cases, additional spindles had been deployed to provide adequate application performance, resulting in unused capacity.
- Aging hardware. This project focused on a variety of older hardware, including 34 F760s, 14 F820s and F840s, and two F880s. These systems were running older versions of the Data ONTAP® operating system, which did not allow the team to take advantage of advanced features such as FlexVol technology. These older systems also use lower-capacity drives with lower overall storage density, resulting in a storage environment with a large number of storage systems and greater management complexity.
- Space, cooling, and power constraints. The 50 storage systems involved in this project had a combined maximum power consumption of 329kW and required additional power to meet cooling needs. Our current data center has 6,500 square feet, of which 70% is built out for use. Building out the remaining 30% would require significant retrofits to add power.

To address these challenges and increase efficiencies in our data center, we implemented a storage consolidation plan based on the eight points described in this document. This consolidation yielded significant results:

- Increased storage utilization from less than 40% to an average of 60%.
- Reduced storage footprint from 25 racks to six.
- Replaced 50 storage systems with 10.
- Decreased direct power consumption by 41,184kWh per month.
- Eliminated nearly \$60,000 in annual electricity costs.
- Eliminated 27.28TB (50%) of data.
- Realized substantial capacity and performance gains.

Through the efforts of a multifunction NetApp team (and, in California, with the efforts of our utility, PG&E), we have been able to eliminate inefficiencies throughout our IT systems and facilities to accommodate our growth and extend the lives of our data centers. Our experience is a useful example of how real savings can happen when you involve a multidisciplinary team and take a holistic approach. Our experience also illustrates how you really can make use of today's technology to halt your growing power consumption at its source.

**Table 2) Reducing power consumption in NetApp's data center.**

<b>Asset/Item</b>	<b>Original</b>	<b>After Consolidation</b>
Storage footprint	100%	25%
Application data	55.7TB	28.42TB
Rack space	24.83	5.48
Disk utilization	<40%	>60%
Storage power consumption	329kW (max)	69kW (max)
Estimated annual power savings	0	\$60,000

## 5 CONCLUSION

With data centers consuming 1.5% of all electricity in the United States<sup>3</sup>, equivalent to 5.8 million average households, runaway power consumption is an issue that simply must be addressed. At NetApp, we take this responsibility seriously. We will continue to devote our resources and talents to developing innovative products and technologies that will help you overcome the challenges that power consumption realities pose to your success and enable your business to go further, faster. Not only will you save real dollars and deliver on your efficiency challenges, you'll also contribute to the health of our planet and deliver on your green objectives.

### ADDITIONAL READING

For more information, check out these other papers at [www.netapp.com](http://www.netapp.com):

- "NearStore Storage Efficiency," TR-3539
- "Maximizing Storage Utilization," white paper, WP-7003-1106
- "The NetApp Storage Efficiency Guide," white paper, WP7022-1208

<sup>1</sup>NetApp testing.

<sup>2</sup>Customer-reported utilization data.

<sup>3</sup>[www.energystar.gov/ia/partners/prod\\_development/downloads/EPA\\_Datacenter\\_Report\\_Congress\\_Final1.pdf](http://www.energystar.gov/ia/partners/prod_development/downloads/EPA_Datacenter_Report_Congress_Final1.pdf).