WHITE PAPER

Efficient IT Infrastructure Saves More Than Just Energy Costs

It can Avoid the Need to Add new Data Center Capacity

Sustainability and space efficiency concerns are becoming more important in information technology (IT) infrastructure decisions. Many enterprises evaluate carbon footprint and energy usage as they evaluate data center modernization projects to move towards solutions that reduce both those metrics. As data continues to grow at 30% to 40% per year for most enterprises, more purchasing decisions will be biased towards efficient IT infrastructure that requires less hardware and uses less energy[1]. It will be as much a budget as a sustainability imperative.

In 2022, the amount of power required to run data centers on a global scale amounted to 1%-1.5% of all the electricity generated worldwide, or around 300 terawatts[2]. A terawatt is a billion kilowatts. An average data center in 2022 had generally around 100,000 square feet of floor space and consumed between 300 and 600 kWh per square meter (for that year)[3]. For comparison purposes, the typical American home consumes 55-100 kWh per square meter per year[4]. Storage infrastructure generally accounts for 20-25% of data center energy usage today, but that percentage is growing. The Gartner Group estimates that storage could consume as much as 40% of data center power budgets by 2030.

Anticipated increases in the storage floor space and power usage in the enterprise are driven primarily by two things: high data growth and rising energy costs. It's clear that enterprises can't just continue to add commodity off the shelf (COTS) disk devices to their storage infrastructures and expect to stay within both their floor space and power budgets over time. This is one of the primary reasons that Pure Storage has pursued a product strategy based on purpose-built flash storage devices. Our storage devices, called DirectFlash Modules (DFMs), deliver a storage density two to three times better and consume from 39% to 54% fewer watts per terabyte than our closest competitors today.

Within the next two years we expect our lead to increase as we release flash storage devices that have up to 10x the density that we expect competitors using COTS solid-state disks (SSDs) to be able to deliver. It is our core Purity storage operating system, however, that allows us to optimize the use of this flash media to deliver the industry's most efficient storage infrastructure by far, consuming significantly less power and floor space than alternatives.

We have large customers today whose storage purchase decisions were driven by energy and floor space considerations. When Meta, the parent company of Facebook, announced in December 2021 that they had awarded a 100 petabyte-plus storage infrastructure deal for their Artificial Intelligence Research Super Cluster (AI RSC) to Pure Storage, they noted that our solution had an 80% lower total cost of ownership (TCO) than alternatives. Our lower TCO was primarily due to our storage infrastructure efficiency which translated directly to fewer hardware components that consumed significantly less power and floor space.

Pure Storage customers routinely achieve energy savings of this magnitude. Admiral, a car insurance provider in the UK, reduced their storage floor space by 80% and cut power and cooling costs by 74% by moving to Pure Storage.

Barfoot & Thompson, New Zealand's largest privately held real estate agency, reduced their rack space by 75% and their power consumption by 80%. EV Group, a semiconductor manufacturer in Austria, reduced their storage energy consumption by 85%. St. Joseph's Health, a New Jersey-based healthcare provider, reduced their floorspace consumption by 75%. Northwest Independent School District in Fort Worth, Texas, reduced their rack space consumption by 75%. San Luis Obispo County, one of California's original counties, reduced their storage floor space by 75% and their power consumption by 59%. One of the world's largest banks based in Germany achieved an 88% reduction in energy usage and a 94% reduction in rack space consumption. These are just a few examples of the efficiencies enjoyed by Pure Storage customers.

The massive savings associated with improved storage infrastructure efficiencies have a transformative impact on overall costs. With our storage densities, we need far fewer devices to meet a given performance and capacity requirement, and that means we need significantly less supporting infrastructure (controllers, enclosures, fans, power supplies, cables, switches, etc.). Not only do we take up less floor space for an initial system—we take up less floor space to accommodate expansion. With our significantly smaller kit we also generate less heat than competitors, helping to lower cooling costs. Bringing a Pure Storage system in on technology refresh will free up data center floor space to provide more room for future expansion. With our storage densities today, and the lower capacity of COTS SSDs that our competitors must deploy to hit the same performance and capacity targets, we routinely take up 80% less rack space than our competitors.

For enterprises with only a petabyte (PB) or so of data overall, rack space savings of 80% may not translate to similar floor space savings. But many enterprises already have many PBs of data and are actively looking at how they will support tens of PBs in the near future. And that 80% rack space savings translates to significant floor space savings for enterprises managing a lot of data. Data centers house all types of IT infrastructure—not just storage—and all of that consumes energy and rack space as well. As IT managers look at scaling that infrastructure over time, it's not a matter of if they must consider data center floor space and power budgets—it's a matter of when.

How close are you to running out of data center floor space? If and when the limit of your existing data centers is reached it can force some uncomfortable decisions. Expanding beyond the floor space of existing facilities may be as easy as moving some workloads to the cloud and/or retiring others to make room for more critical workloads. But if neither of these options are feasible or they cannot clear enough space for critical new projects, then it is a very expensive step-function to acquire new data center capacity. Most enterprises will not be able to add new incremental data center capacity very easily due to the expense.

As power consumption has significantly increased worldwide, many data centers are facing looming power grid limitations to further expansion as well. IDC, a well-known technology analyst firm, released a survey in early 2022 that showed that in North America in 2021, 25% of IT organizations had experienced delays in IT deployments due to power or space constraints[5]. In late 2021, Loudoun County in northern Virginia (home of the world's largest concentration of data centers), limited new data center construction due to power grid limitations[6]. In Dublin, Ireland, EirGrid (the state-owned electricity operator for that region) said no new data center applications were expected to be granted a grid connection before 2028, impacting hyperscaler (AWS, Azure, Facebook, Equinix) expansion plans[7]. In 2022, the city-state of Singapore limited data center expansion to a 60 megawatt increase per year going forward. In the Meta AI RSC deployment mentioned above, power grid limitations in New York City disqualified their first IT infrastructure approach and forced them to go in a new, Pure Storage-based direction that was much more efficient in terms of both energy and floor space consumption.

Addressing Data Center Power Budget and Floor Space Limitations

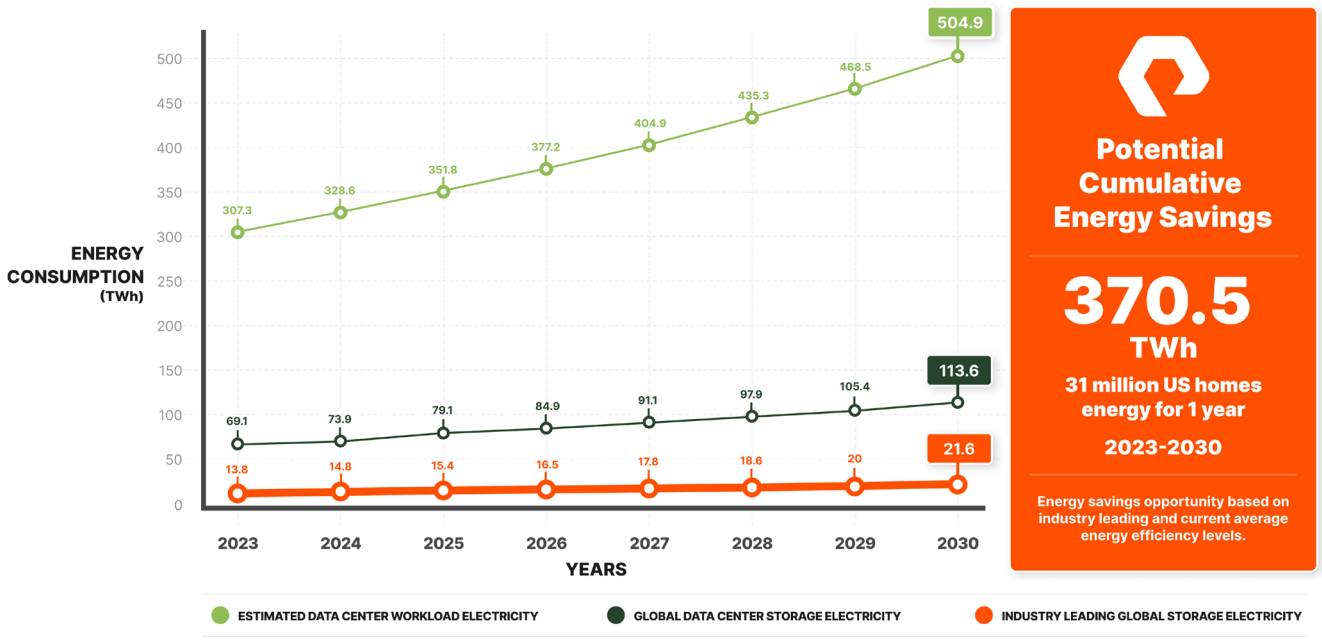
One way to address both of these concerns is to modernize IT infrastructure by moving to newer designs that are far more efficient in terms of energy and floor space consumption. While using both of those resources efficiently will be a goal for most IT organizations going forward, IT infrastructure efficiency takes on a much higher importance for CIOs that have already (or are just about to) reach their power budget and/or data center floor space limits. For IT shops facing that latter scenario, consolidation of existing kit onto more efficient infrastructure will be critically important as it can avoid a data center expansion that can cost hundreds of thousands to millions of dollars.

Power Usage Effectiveness (PUE) is a metric, created by the Green Grid (an industry group focused on data center energy efficiency), that can be used to measure the energy efficiency of a data center. PUE is determined by dividing the total amount of power entering a data center by the power used to run the IT equipment within it. PUE is expressed as a ratio, with overall efficiency improving as the ratio approaches 1.0. A PUE of 1.25 indicates that the power transformer efficiency loss, non-IT power consumption (ie. lighting), and the cooling required to dissipate the heat in a particular data center requires an additional 25% of the energy required to support the IT infrastructure. For example, if your data center consumes 100,000 kWh and 80,000 kWh of that is used to power the IT equipment, then the PUE is 1.25. According to the Uptime Institute, the worldwide average data center PUE was 1.58 in 2020, and that has remained basically flat since 2013. Newer data centers typically have PUEs between 1.2 and 1.4, but there is a lot of older data center capacity that is less efficient and difficult to upgrade (particularly where high availability is required).

Total Operating Efficiency (TOE) requires both improving PUE and also designing more efficient IT architectures using more power-efficient IT products. Having more efficient IT products and architectures also improves PUE by requiring less power and conditioned space in the first place. Much of the low-hanging fruit (e.g. hot/cold aisles, air-flow economizers, LED lighting, etc.) have already been implemented so much of the future improvements in TOE will have to come from more efficient IT infrastructure.

Within IT infrastructure, the major consumers of energy (in decreasing order) are servers, networking, storage and cooling. Given that cooling load is in direct proportion to the power consumed, it can be allocated proportionately to the power required by the IT equipment individually and not counted separately. Virtualizing and consolidating servers reduces both energy and floor space consumption, as does identifying and removing servers that are no longer in use, allowing compute infrastructure to operate much more efficiently. All power consumed in a data center is ultimately converted to heat, and the amount of cooling needed (and its energy consumption) will be directly correlated to the power consumption (and heat production) of servers, networking and storage. Strategies like hot and cold aisles, the use of air-flow economizers, locating data centers in colder climes, and general air flow improvement methods can help to reduce cooling costs without putting data center equipment at risk.

Moving to high density storage infrastructure, combined with the use of data reduction technologies like compression and deduplication and more effective strategies to locate and remove excess stored data, can significantly reduce acquisition costs and energy and floor space consumption. CIOs will need to ensure, however, that more efficient storage infrastructure can still meet evolving requirements for performance, availability, scalability, manageability and security. It's interesting to note that of the 300 terawatts of electricity consumed by data centers worldwide in 2022, roughly 68 terawatts went to power storage (22.7% of the 300 terawatt total). Hypothetically, had all that storage been based on Pure Storage, the consumption would only have been 13.5 terawatts. And it would have taken up 80% less floor space. That equates to a savings of roughly 20% of total data center power!



Hypothetically, if all storage infrastructure worldwide starting in 2023 ran on Pure Storage systems, by 2030 almost 371 terawatt hours of electricity would be saved. At an average cost per kilowatt hour during that time of $0.20, that would mean a savings of $74.1 trillion.

Our advantages in ESG and sustainability are based around strategies that cannot be easily copied by our competitors. Our product strategy is based on our use of our own optimized direct-to-flash software and flash device designs, and that has allowed us to build the industry's most energy and space efficient storage systems by far. Competitive systems that use enterprise COTS SSDs, which are based on consumer device designs, cannot match our systems for performance consistency under load, storage density, watts/TB, effective capacity utilization, media endurance and reliability, and longevity. With our expected increases in storage density, we will have up to a 10x capacity advantage over COTS SSDs by 2025, which will further widen the energy and floor space consumption savings between Pure Storage and competitive systems.

Pure Storage's Sustainable Storage Density and Capacity Utilization Advantages Will Grow Over Time

Because our competitors' products are based on software developed and optimized for hard disk drives (HDDs), they use COTS SSDs sourced from drive manufacturers for their all-flash systems. COTS SSDs employ a flash translation layer (FTL) that emulates HDDs, a feature that makes them easier to integrate into systems originally built for HDDs. FTLs introduce inefficiencies, though, that impact performance, storage density, effective capacity, media endurance, and ultimately system cost. This aspect of COTS SSD design will always hamstring competitive offerings relative to Pure Storage, which manages flash directly and globally through its core operating system, Purity, to get the most out of the media.

Pure Storage's DFMs do not emulate mechanical HDDs, allowing silicon-based flash media to be optimally managed in a way that significantly improves performance, storage density, effective capacity, media endurance and cost per usable TB relative to COTS SSDs. Today, SSD vendors are delivering 15TB devices in volume and plan to be shipping 30TB devices in volume within the next 12 months. Only one vendor (Solidigm) has spoken publicly about releasing a larger capacity SSD with an actual schedule—a 60TB SSD in 2025. The requirement for these devices to emulate HDDs presents performance challenges with SSDs that are 30TB or larger. By comparison, Pure Storage is shipping 48TB DFMs today, is adding 75TB DFMs later this year, will be adding 150TB DFMs within 18 months, and is planning for 300TB DFMs by 2026. The fact that we manage the flash media both directly and globally allows us to scale to larger device sizes without the same performance challenges that COTS SSDs have.

Avoiding the need to expand to new data center capacity as you manage high data growth has both a huge capital (CAPEX) and operating expense (OPEX) impact. New data center capacity imposes not only the energy costs to power new kit, but it also includes additional administrative, facilities and tax burdens. Pursuing infrastructure consolidation projects that allow you to stay within your existing data center capacity even as you expand have a far higher return on investment than purchasing new data center capacity. Pure Storage has a compelling value proposition to meet your data management and growth requirements while delivering independently validated industry-leading sustainability advantages that go farther than any other enterprise storage vendor in minimizing energy and data center floor space consumption.

One final benefit of more efficient storage solutions from Pure Storage is our proportionate reduction in e-waste. Our infrastructure efficiencies significantly reduce the supporting infrastructure (controllers, enclosures, fans, power supplies, switches, etc.), reducing what ultimately needs to be disposed of at end of life. Additionally, our Evergreen program and the greater longevity of our flash DFMs contribute to even further reductions in e-waste materials.

This discussion has focused on our sustainable competitive differentiation relative to all-flash systems based on COTS SSDs, but in closing it is important to point out that these same characteristics drive even greater sustainability advantages against hard disk drive (HDD)-based systems. The performance consistency under load, storage density, watts/TB, effective capacity utilization, media endurance and reliability, and longevity advantages of Pure Storage's all-flash systems are even greater against HDDs. While our efficiency advantages translate to a 2-5x reduction in energy and floor space consumption compared to competitive all-flash systems, they offer an up to 10x reduction compared to all-HDD systems. That is what allows us to deliver all-flash systems which compete directly with spinning disk systems for less latency-sensitive capacity-oriented workloads at the same $/GB price points for effective capacity.

Learn More

If you are looking to move to much more efficient storage infrastructure even as you modernize, we'd like to meet to discuss the business value we can deliver. We are better positioned than any other storage provider to maximize energy and data center floor space resources to meet your ESG and sustainability goals over the long term while continuing to provide the enterprise storage capabilities you need.

1 Evaluating Power and Cost-Efficiency Considerations in Enterprise Storage Infrastructure, IDC#US49354722, July 2022.
2 Data Centres and Data Transmission Networks, September 2022, International Energy Agency.
3 TechJury - 15 Crucial Data Center Statistics To Know in 2023, April 2023
4 Data Centres and Data Transmission Networks, September 2022, International Energy Agency.
5 IDC US Datacenter Operational Survey, December 2021
6 Loudoun County Puts Limits on Data Center Growth, Data Center Dynamics, October 2022
7 Amazon and Microsoft Want to Go Big on Data Centres but the Power Grid Can't Support Them, ZDNet, August 2022

PS2445-01 05/2023