White Paper

EMC, VNX and ENERGY EFFICIENCY

Providing industry leadership and customer value

Abstract

This white paper explains the value EMC® places on energy efficiency across the corporation and in particular in the VNX™ product family. The VNX-specific energy efficient features within the VNX product family, the associated tools EMC has created for customers to use with all products, and EMC's corporate focus on energy efficiency within the Office of Sustainability are included.

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Executive summary

It is apparent to corporations and end users that the increasing demand for energy and the continuous supply of energy are at constant odds with each other. Efforts to find new sources of supply and attempts to conserve energy have received a tremendous amount of focus in the media. It is with this in mind that we focus this paper on EMC®'s strategy for energy efficiency from both a corporate and a product perspective.

Throughout the evolution of EMC's product portfolio, a consistent emphasis has been placed on optimizing energy efficiency. This paper focuses on the specific product improvements implemented in the VNX™ product family that highlight EMC's leading energy efficiency strategy. Included among the improvements is the introduction of Flash technology, high-efficiency power supplies, and adaptive cooling. In addition to these hardware features, this paper discusses the incorporation of capacity optimizing software features including FAST VP, Compression, and Virtual Provisioning, while highlighting the value they bring to energy efficiency.

In addition to the above product features, EMC recognized the importance of understanding and effectively planning for the energy footprint for all products. To this end, we have included the capabilities EMC provides in its Power Calculator.

Finally, we provide insight into EMC's corporate activities to lower its overall energy footprint through the Office of Sustainability.

Audience

This paper is intended for customers who have requirements to optimize their energy footprint and can leverage the attributes of the VNX product family. It is also valuable for customers who would like to understand how companies have established corporate priorities related to their own energy footprint and have begun implementing actions to achieve the related goals.

Introduction

One of the major goals for the VNX platforms has been, and continues to be, requiring the lowest cost, and consequently the least energy, to support customer requirements related to capacity, performance, availability, reliability, security, and so forth, in other words, providing for the lowest cost of operation.

This goal is achieved via two primary focal areas:

1. Device efficiencies utilizing state-of-the-art solid-state disks, high-efficiency power supplies, and adaptive cooling.
2. Effective system usage through software-based capacity management solutions such as Virtual Provisioning and compression.

In addition to the specific VNX product focus, EMC provides systemic tools that are used with all products, with a primary focus on initial planning and design.

Finally, EMC has established the Office of Sustainability with a goal of insuring EMC is a leader in analyzing and adopting practices that lead to operational efficiencies. This includes energy efficiency, materials selection, reclamation, and so forth in manufacturing, transportation, and ongoing customer support.

The four topics this paper discusses are:

1. VNX energy efficient technologies
2. EMC Tools for customers
3. Compliance
4. EMC's Office of Sustainability

VNX energy efficient technologies are further sub-divided into hardware and software functionality. Hardware features covered include the following:

1. Flash/solid state drive (SSD) technology
2. High-capacity hard disk drive (HDD) technology
3. High-efficiency power supplies
4. Adaptive cooling

Software features include the following:

1. FAST VP
2. Virtual provisioning
3. Compression and deduplication
4. Snapshots
5. HDD spindown

VNX energy efficient technologies - hardware

Flash/SSD technology

For years, we have known that SSD storage is a highly efficient technology. However, until recently, it was not possible to use this technology in a cost-effective manner.

This is no longer the case. EMC became the innovative force driving the use of SSD technology in enterprise-class storage arrays. SSDs provide much higher I/O performance levels than HDD devices; in fact on a per WATT, SSDs provide on the order of 50x to 100x higher performance than HDDs. As a result, your desired performance is achieved using fewer drives which significantly reduces system power.

The VNX product family, in particular, is the first EMC family to introduce this technology. With the recent introduction of the VNX5500-F, EMC now has the first "all Flash" Array.

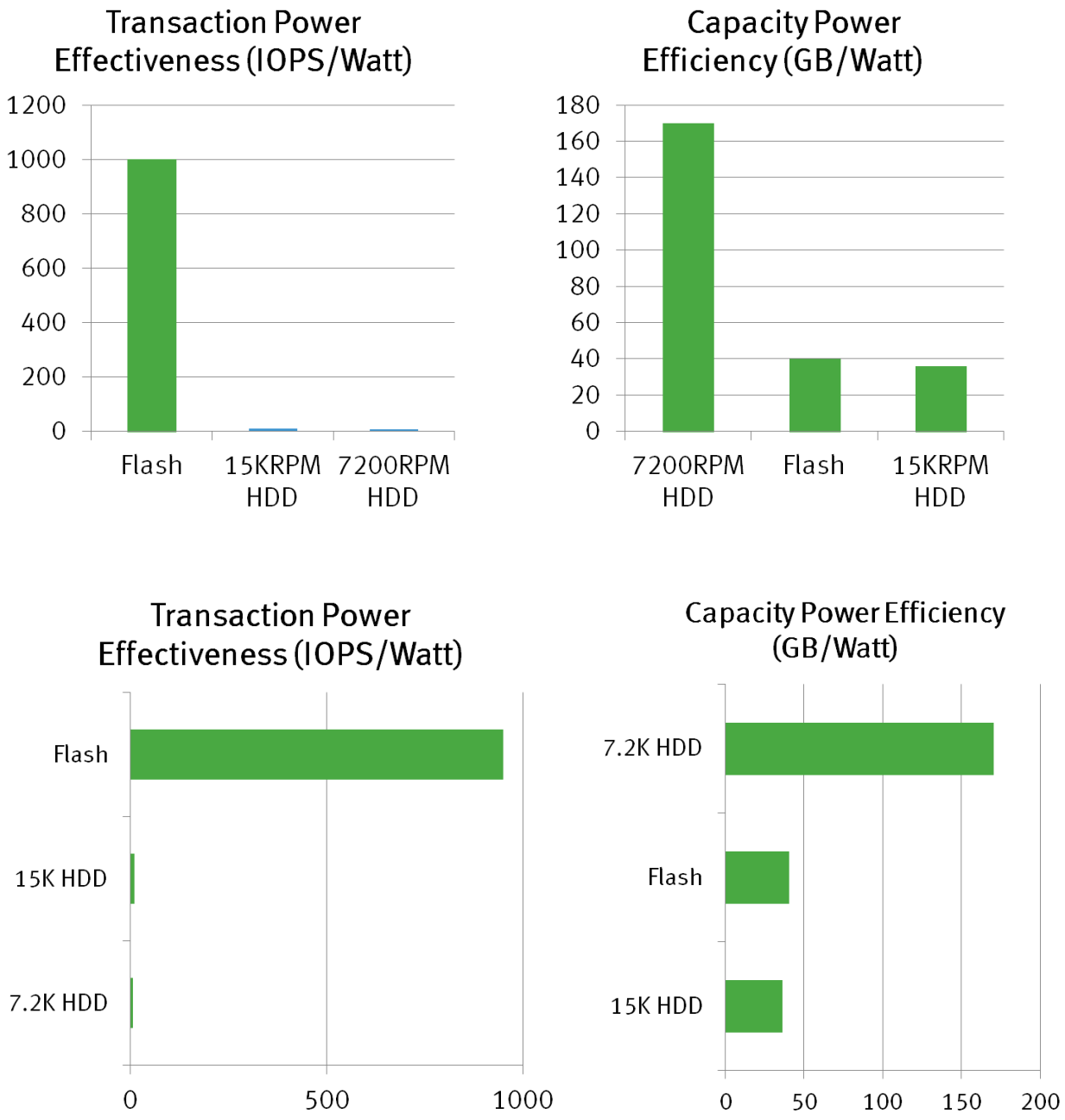

Figure 1 Drive Efficiency

High capacity HDD technology

As will be seen in the following description of EMC's industry-leading FAST technology, the use of very high density, low RPM Nearline SAS HDDs can also have a significant impact on storage-system power. Such drives have very low Watts/TB characteristics, on the order of 5 times less than higher RPM SAS drives. Significant power savings are realized by using system intelligence to place less-frequently accessed data on such drives.

High efficiency power supplies

EMC's use of high efficiency power supplies reduces total equipment power while simultaneously minimizing waste heat. Reductions in energy consumed by the IT equipment can yield significant savings in the facility cooling and power distribution infrastructure.

EMC was an early implementer of power supplies designed to meet or exceed the levels set by the 80 Plus® and Climate Savers Computing Initiative℠ gold-level specifications. In addition, EMC equipment uses high-quality, low-voltage switching power converters to generate the low voltage levels required for today's high performance processors, memory, and other integrated circuits. This attention to detail yields significant, measureable improvements in data center energy consumption.

Adaptive cooling

To maximize the lifetime of the hardware, each component must be monitored to ensure that certain temperatures are not exceeded. The amount of cooling required is a function of the ambient environment as well as various internal factors including configuration, workload, and fault status.

EMC's long standing adaptive cooling technology achieves significant power savings by monitoring the external environment as well as several internal factors. It adjusts the operation of the fans to minimize the power consumed by the system while maintaining reliability.

VNX energy efficient technologies - software

While hardware-oriented efficiencies go a long way toward reduced energy consumption in storage systems, it is possible to achieve even more significant savings and a lower TCO through effective capacity utilization for both overall system management and data capacity. EMC VNX products implement numerous software strategies and tools that provide this optimization and help predict system-level energy consumption.

FAST VP

Fully Automated Storage Tiering (FAST) for Virtual Pools (VP) is an EMC industry-first method whereby stored file and block data is kept in pools while being intelligently and transparently moved to the most appropriate storage medium (tier) based on its access needs and real-time analysis.

Frequently-accessed data with lower latency requirements is placed on tier 0-1 fast access storage devices (such as SSDs that provide I/O rates and latencies up to two orders of magnitude better than the fastest HDDs). Less-frequently-accessed data is placed on lower-power, higher-capacity HDDs. Due to data access skew (a where a relatively small number of files experience the most I/O activity), the capacity requirements of the former are typically much less than the latter.

Therefore, a relatively low number of very high IOPs/Watt SSDs for example can be combined with an appropriate number of higher capacity, lower Watts/TB HDDs to realize the same or better performance and overall capacity requirements, using less power and smaller footprint, than systems previously constructed of many more higher performance and lower capacity HDDs organized in a single tier. Figure 2 shows an example of the benefits of FAST technology.

- 45% Improvement in Performance
- 65% Reduction in Latency
- 57% Less Footprint
  - Before: 90 X 300GB SAS drives
  - After: 39 drives
    - 4x200GB Flash drives in Cache
    - 5 X 200GB Flash drives in Pool
    - 30 X 300 GB SAS drives

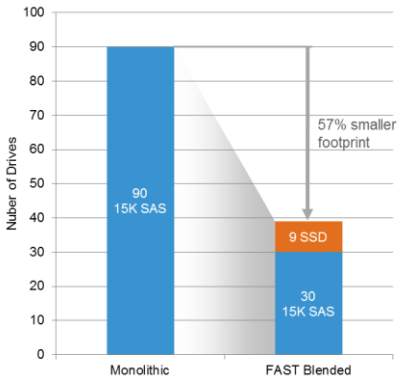

Figure 2: SAP benefits from FAST

Virtual provisioning

Virtual Provisioning is EMC's version of what is known in the industry as *thin provisioning*. With this technique, block and file storage space is allocated on an as-needed (or on-demand) basis rather than in initially set amounts. The latter can in many cases result in over-allocation and *stranded capacity* that cannot be utilized by any other applications. Such under-utilized capacity is still drawing power in the form of spinning HDDs. Virtual Provisioning mitigates this effect resulting in a more effective use of user capacity. Figure 3 demonstrates Virtual Provisioning.

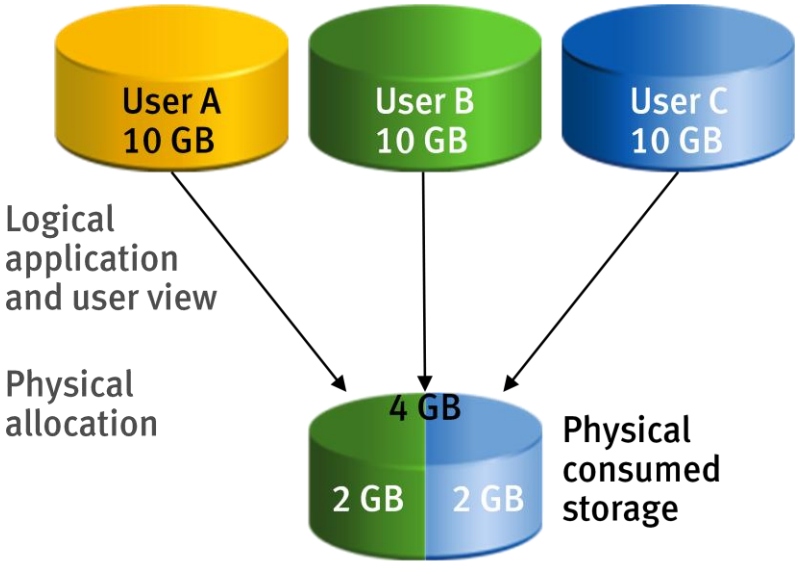

Figure 3 Virtual Provisioning

Compression and deduplication

Both of these methods have the potential for significant capacity savings. In each case, the original user data is *compressed* so that it takes less storage space. Compression utilizes "loss-less" mathematical algorithms that tend to work best on certain data types with space savings up to 50%.

Deduplication searches for repeated patterns in user-block or file data, stores the original patterns once, and then stores unique pointers to the original patterns. VNX deduplication is a file-based functionality that operates as a background task designed to avoid impact on client services. Actual stored capacity reductions of up to 50% are possible. Figure 4 shows the merits of both Compression and deduplication.

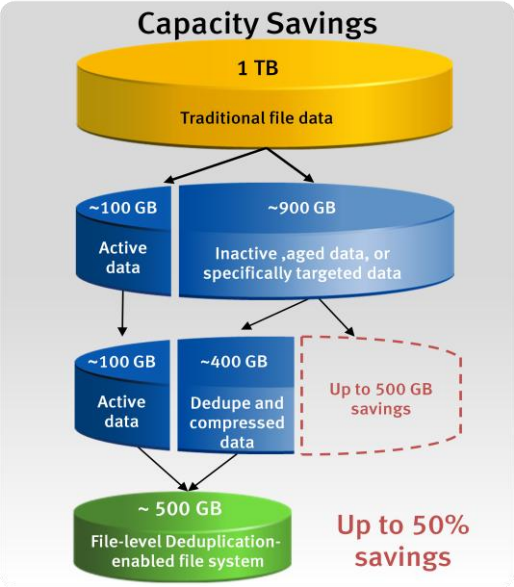

Figure 4 Compression and Deduplication

Snapshots

Snapshot technology creates logical point-in-time copies for various use cases including fast back-ups and application test areas. Early versions would allocate space for the entire snapshot. A method called *copy-on-first-write* (sometimes called a *delta snapshot*) uses added space only as needed for modified data and hence is more effective in capacity use. Figures 5 and 6 demonstrate the benefits of EMC's Snapshot technologies.

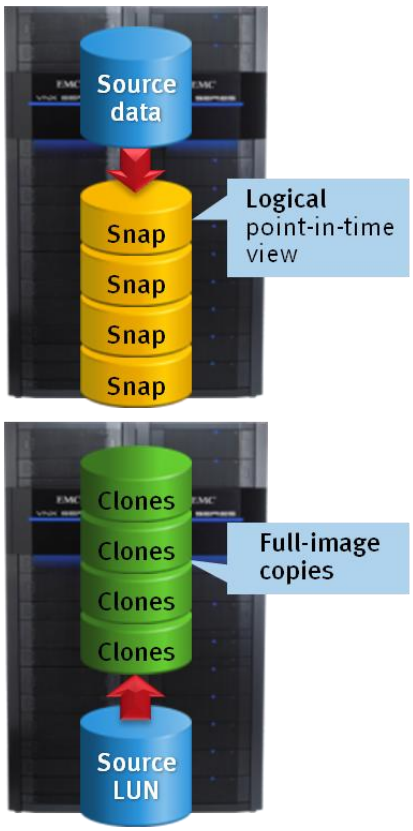

Figure 5 Point in time copies

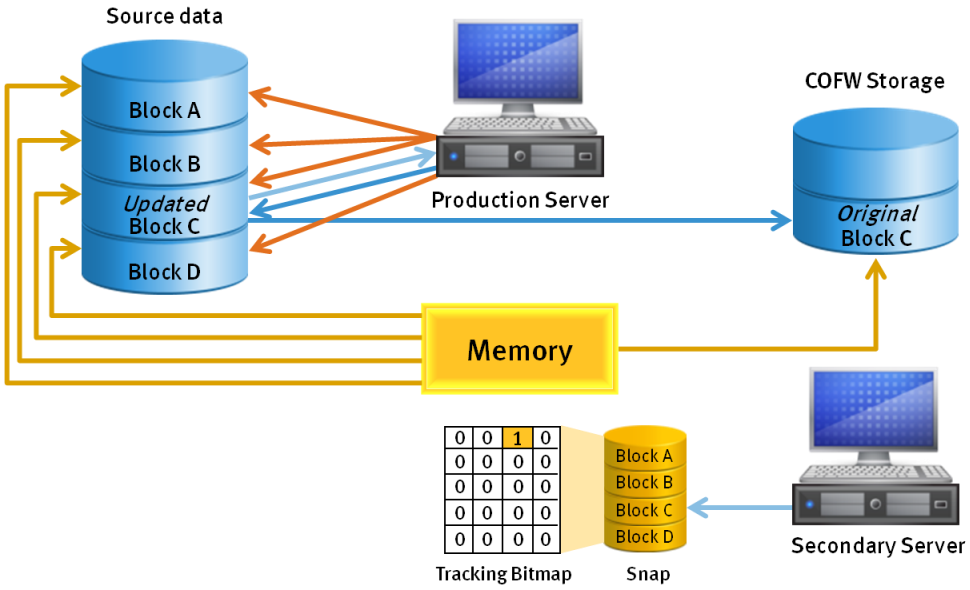

Figure 6 Copy on first write (COFW)

HDD spindown

At times, storage systems may contain data that will not be accessed for long periods but still requires access times less than classic archival storage such as tape. As a pure power-saving feature, EMC VNX storage arrays support selected HDD spin-down.

Tools

Environmental measurement

Data center operators are increasingly pressured to improve efficiency and reduce operational costs. EMC is committed to providing operators with the tools required to understand and address the operating costs of our equipment.

Figure 7 shows EMC's Unisphere unified storage management platform. Unisphere fosters simplicity, flexibility, self help and automation – all key requirements for efficient management of the data center.

Each system element has an 'Environment' tab that can be queried to understand the current operating environment as well as how much power the particular element is dissipating. In addition, power dissipation information can be aggregated for an entire system.

This instrumentation is key to understanding and then optimizing the operation of the data center.

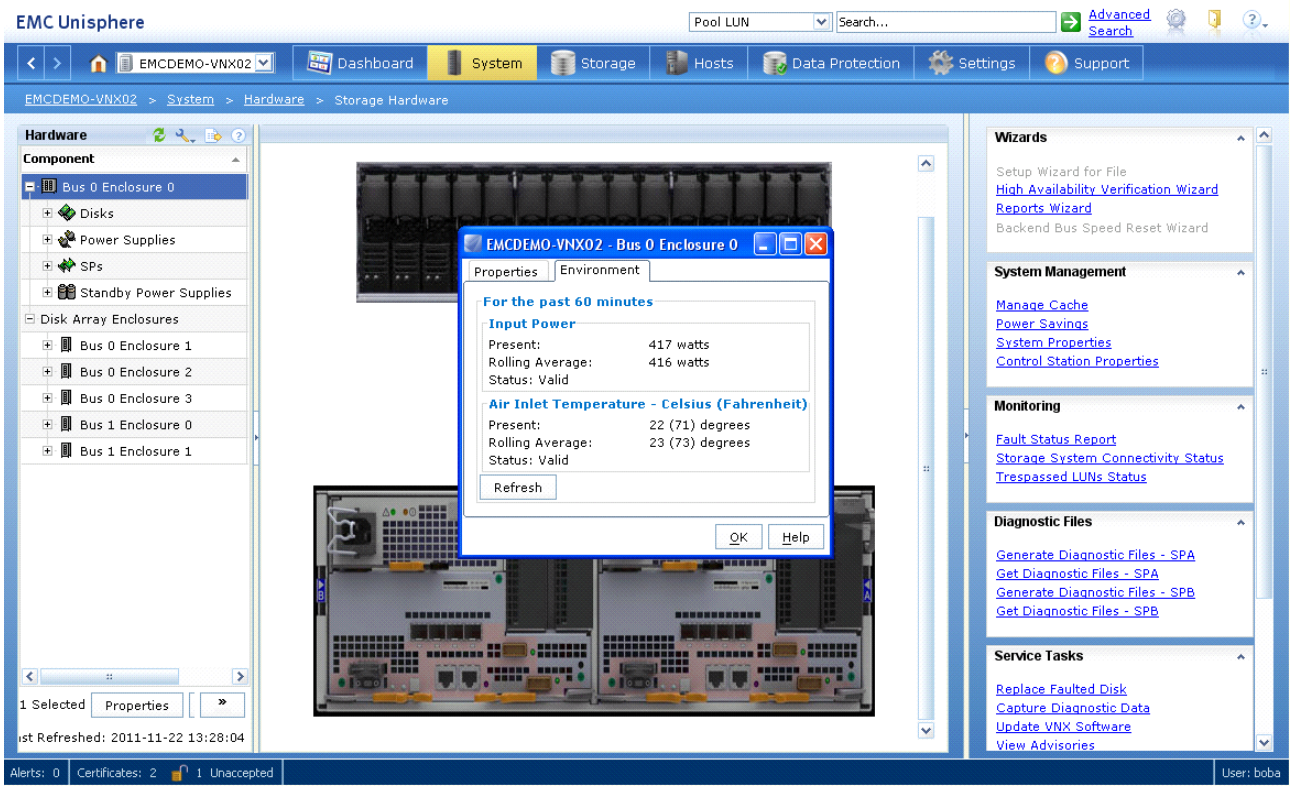

Figure 7 System view of power and temperature

Power calculator

The EMC Power Calculator is an online utility that calculates power consumption and cooling requirements for specific configurations of EMC storage platforms. It also provides a summary report of operational cost, weight, sound levels, and floor space. The calculator has several ease-of-use features, such as the ability to save configurations and reports.

Figure 8 provides an example system calculation and shows the breadth of available information.

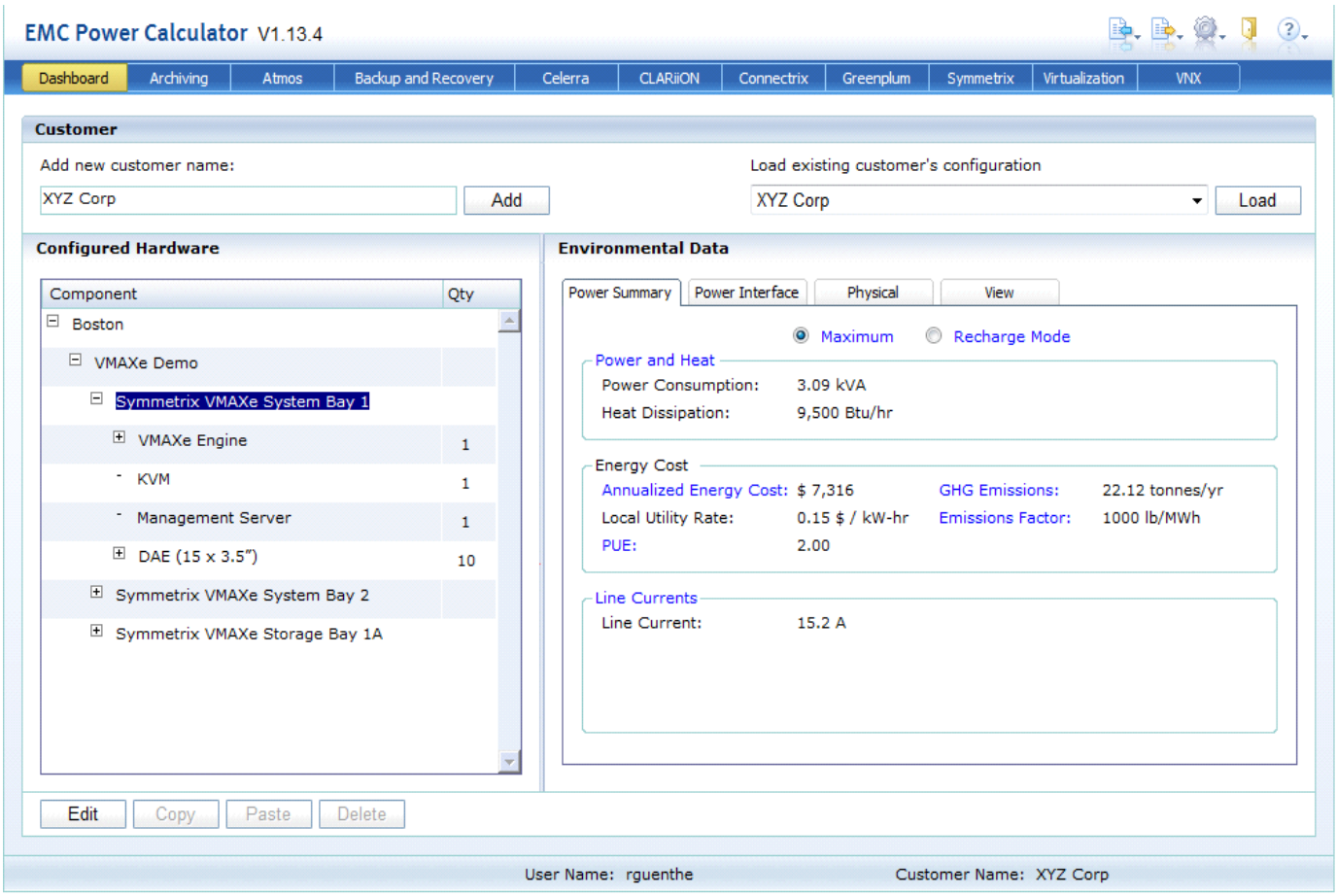

Figure 8 EMC power calculator

Compliance

EMC has long been a strong advocate and participant in the creation and development of both public and ad-hoc standards efforts. To that end, EMC has been a significant contributor to the following initiatives focused on energy efficiency:

1. SNIA Power Efficiency Measurement Specification/SNIA Emerald™
2. EPA ENERGY STAR Specification for Storage Servers
3. The following Green Grid Technical Committee groups
    a. Data Center Design Guide
    b. Data Center Metrics and Measurement
        i. Data Center Storage Efficiency task force of DCMM
    c. Data Center Maturity Model
    d. ENERGY STAR for Data Center Storage Task Force

As a member of Storage Networking Industry Association (SNIA™), EMC has been a significant contributor to the development of the SNIA Power Efficiency Measurement Specification. This Specification defines metrics and forms the basis for conducting energy efficiency measurements to be submitted to the SNIA Emerald™ program, a non-exclusionary and open repository for vendor product energy efficiency information.

While still under development, EMC continues to be a strongly active and willing participant in the development of the EPA's ENERGY STAR Specification for Storage Servers. While the specification itself is not yet final, EMC has been one of many leading storage/information companies helping to guide the development of the specification in order for it to be as useful as possible for customers.

EMC office of sustainability

EMC's Office of Sustainability works to integrate sustainability efforts within EMC. Through this approach, the Office and its champions inside the company focus on areas identified by our stakeholders as important to them and to EMC. Product energy efficiency is one area that our customers consistently ask for, and on which EMC is actively focused.

Energy efficiency makes sound financial sense. By increasing operational and manufacturing energy efficiency, cost savings and scope 3 greenhouse gas reductions can be realized and passed down to customers. Operational and manufacturing energy efficiencies continue to be an organizational priority. From process improvements to reduce the need of additional equipment and power consumption, to system upgrades to increase efficiency, to shared best practices among manufacturing facilities, EMC continues to look at ways of reducing internal consumption.

EMC's Office of Sustainability in partnership with Engineering have completed full cradle to grave lifecycle assessments (LCAs). Results show that energy consumption during the product use phase far outweighs the other phases of manufacturing, sourcing, transport, operations, and so on. Through such analysis, engineering continues to define areas of approach on both component and system levels to help drive down energy consumption.

Supply chain efficiencies are viewed in the same light as operational and manufacturing efficiencies. By increasing supply chain efficiencies, reduced costs and emissions are realized and passed on to customers. EMC collaborates with our suppliers to drive sustainability into the supply chain network. Supplier sustainability agreements, emissions reporting, product design, sustainable packaging, and other means of engaging suppliers help to drive down consumption and increase lifecycle efficiency.

Product materials and end-of-life material reclamation are also investigated as a means to drive efficiencies. EMC has implemented practices related to product return, design for easy disassembly to increase reclamation of materials, recycling of materials for reclamation, and material reuse. All such practices result in less energy consumption and lower costs than building components from scratch. By employing these techniques, not only are they environmentally beneficial, but they reduce the cost and energy impact, driving further gains.

Finally, packaging engineering has programs in place to review packaging solutions currently employed and make improvements related to materials, reuse, and recyclability. Significant progress has been made on returnable and reusable packaging, resulting in cost, energy and greenhouse gas improvements. Moving forward, further reuse and recovery of packaging materials will continue to provide beneficial gains for cost as well as reclamation of materials from customer sites.

EMC continues to drive integrated sustainability across the company, and working with our internal colleagues, to drive positive change across the company, the supply chain, and the industry. Significant benefits are seen in adopting sustainability across the company, and energy efficiency will continue to be a primary focus of the company.

Conclusion

EMC VNX and VNXe systems provide customers with leading edge energy efficiency technology and the means to predict and monitor ongoing operations. These products reflect the beginning of a journey that enables customers to have more insight into their operations and optimize their energy costs.

In addition to ongoing product specific efforts, EMC provides tools that enable potential customers the ability to estimate the power profile of EMC storage systems under consideration.

Finally, EMC is committed to adopting and managing its own “carbon footprint” through the efforts of the Office of Sustainability.