ENERGY STAR® Program Requirements for Data Center Storage

Partner Commitments
Draft 2 Version 1.0

1 Following are the terms of the ENERGY STAR Partnership Agreement as it pertains to the manufacture
2 and labeling of ENERGY STAR qualified products. The ENERGY STAR Partner must adhere to the
3 following partner commitments:

4 **Qualifying Products**

5 1. Comply with current ENERGY STAR Eligibility Criteria, which define performance requirements and
6   test procedures for Data Center Storage. A list of eligible products and their corresponding Eligibility
7   Criteria can be found at www.energystar.gov/specifications.

8 2. **Prior to associating the ENERGY STAR name or mark with any product**, obtain written
9   certification of ENERGY STAR qualification from a Certification Body recognized by EPA for Data
10   Center Storage. As part of this certification process, products must be tested in a laboratory
11   recognized by EPA to perform Data Center Storage testing. A list of EPA-recognized laboratories and
12   certification bodies can be found at www.energystar.gov/testingandverification.

13

14 **Using the ENERGY STAR Name and Marks**

15 3. Comply with current ENERGY STAR Identity Guidelines, which define how the ENERGY STAR name
16   and marks may be used. Partner is responsible for adhering to these guidelines and ensuring that its
17   authorized representatives, such as advertising agencies, dealers, and distributors, are also in
18   compliance. The ENERGY STAR Identity Guidelines are available at www.energystar.gov/logouse.

19 4. Use the ENERGY STAR name and marks only in association with qualified products. Partner may not
20   refer to itself as an ENERGY STAR Partner unless at least one product is qualified and offered for
21   sale in the U.S and/or ENERGY STAR partner countries.

22 5. Provide clear and consistent labeling of ENERGY STAR qualified Data Center Storage.
23
24   Partner shall adhere to the following product-specific commitments regarding use of the ENERGY
25   STAR certification mark on qualified products:
26
27   5.1. Partner must use the ENERGY STAR mark in all of the following ways:
28   5.1.1. the ENERGY STAR mark shall be included on the product specification sheet on the
29   Partner's Web site where product information is displayed. This mark shall serve as a
30   hyperlink from the manufacturer's specification sheet to the ENERGY STAR *Power and
31   Performance Data Sheet* for the qualified storage product or storage product family;
32   5.1.2. the ENERGY STAR mark shall appear on the ENERGY STAR *Power and Performance
33   Data Sheet*; and
34   5.1.3. the ENERGY STAR mark shall be used to identify qualified storage products and storage
35   product families in electronic and printed marketing collateral materials, including but not
36   limited to user manuals, product guides, and marketing brochures.
37   5.2. If additional information about the ENERGY STAR program(s) or other products provided by the
38   Partner on its Web site, Partner must comply with the *ENERGY STAR Web Linking Policy*, which
39   can be found at www.energystar.gov/partners.

Verifying Ongoing Product Qualification

6. Participate in third-party verification testing through a Certification Body recognized by EPA for Data Center Storage, providing full cooperation and timely responses, EPA/DOE may also, at its discretion, conduct tests on products that are referred to as ENERGY STAR qualified. These products may be obtained on the open market, or voluntarily supplied by Partner at the government's request.

Providing Information to EPA

7. Provide unit shipment data or other market indicators to EPA annually to assist with creation of ENERGY STAR market penetration estimates, as follows:

    7.1. Partner must submit the total number of ENERGY STAR qualified Data Center Storage shipped in the calendar year or an equivalent measurement as agreed to in advance by EPA and Partner. Partner shall exclude shipments to organizations that rebrand and resell the shipments (unaffiliated private labelers).

    7.2. Partner must provide unit shipment data segmented by meaningful product characteristics (e.g., type, capacity, presence of additional functions) as prescribed by EPA.

    7.3. Partner must submit unit shipment data for each calendar year to EPA or an EPA-authorized third party, preferably in electronic format, no later than March 1 of the following year.

    Submitted unit shipment data will be used by EPA only for program evaluation purposes and will be closely controlled. If requested under the Freedom of Information Act (FOIA), EPA will argue that the data is exempt. Any information used will be masked by EPA so as to protect the confidentiality of the Partner;

8. Report to EPA any attempts by recognized laboratories or Certification Bodies (CBs) to influence testing or certification results or to engage in discriminatory practices.

9. Notify EPA of a change in the designated responsible party or contacts within 30 days using the My ENERGY STAR Account tool (MESA) available at www.energystar.gov/mesa.

Performance for Special Distinction

In order to receive additional recognition and/or support from EPA for its efforts within the Partnership, the ENERGY STAR Partner may consider the following voluntary measures, and should keep EPA informed on the progress of these efforts:

-   Provide quarterly, written updates to EPA as to the efforts undertaken by Partner to increase availability of ENERGY STAR qualified products, and to promote awareness of ENERGY STAR and its message.

-   Consider energy efficiency improvements in company facilities and pursue benchmarking buildings through the ENERGY STAR Buildings program.

-   Purchase ENERGY STAR qualified products. Revise the company purchasing or procurement specifications to include ENERGY STAR. Provide procurement officials' contact information to EPA for periodic updates and coordination. Circulate general ENERGY STAR qualified product information to employees for use when purchasing products for their homes.

-   Feature the ENERGY STAR mark(s) on Partner website and other promotional materials. If information concerning ENERGY STAR is provided on the Partner website as specified by the ENERGY STAR Web Linking Policy (available in the Partner Resources section of the ENERGY STAR website), EPA may provide links where appropriate to the Partner website.

-   Ensure the power management feature is enabled on all ENERGY STAR qualified displays and computers in use in company facilities, particularly upon installation and after service is performed.

- 87 ▪ Provide general information about the ENERGY STAR program to employees whose jobs are
- 88   relevant to the development, marketing, sales, and service of current ENERGY STAR qualified
- 89   products.

- 90 ▪ Provide a simple plan to EPA outlining specific measures Partner plans to undertake beyond the
- 91   program requirements listed above. By doing so, EPA may be able to coordinate, and communicate
- 92   Partner's activities, provide an EPA representative, or include news about the event in the ENERGY
- 93   STAR newsletter, on the ENERGY STAR website, etc. The plan may be as simple as providing a list
- 94   of planned activities or milestones of which Partner would like EPA to be aware. For example,
- 95   activities may include: (1) increasing the availability of ENERGY STAR qualified products by
- 96   converting the entire product line within two years to meet ENERGY STAR guidelines; (2)
- 97   demonstrating the economic and environmental benefits of energy efficiency through special in-store
- 98   displays twice a year; (3) providing information to users (via the website and user's manual) about
- 99   energy-saving features and operating characteristics of ENERGY STAR qualified products; and (4)
- 100   building awareness of the ENERGY STAR Partnership and brand identity by collaborating with EPA
- 101   on one print advertorial and one live press event.

- 102 ▪ Join EPA's SmartWay Transport Partnership to improve the environmental performance of the
- 103   company's shipping operations. The SmartWay Transport Partnership works with freight carriers,
- 104   shippers, and other stakeholders in the goods movement industry to reduce fuel consumption,
- 105   greenhouse gases, and air pollution. For more information on SmartWay, visit
- 106   www.epa.gov/smartway.

- 107 ▪ Join EPA's Green Power Partnership. EPA's Green Power Partnership encourages organizations to
- 108   buy green power as a way to reduce the environmental impacts associated with traditional fossil fuel-
- 109   based electricity use. The partnership includes a diverse set of organizations including Fortune 500
- 110   companies, small and medium businesses, government institutions as well as a growing number of
- 111   colleges and universities. For more information on Green Power, visit www.epa.gov/greenpower.

**ENERGY STAR® Program Requirements
for Data Center Storage**

**Eligibility Criteria
Draft 2 Version 1.0**

Following is the ENERGY STAR product specification for Data Center Storage. A product shall meet all of the identified criteria if it is to earn the ENERGY STAR.

1   DEFINITIONS

Note: EPA's ENERGY STAR program supports the global harmonization of definitions and test methods as a means to allow comparability of results and realize cost savings for government and industry. To accomplish this objective, many of the definitions in this document have been aligned with definitions in the Spring 2011 edition of the Storage Networking Industry Association's (SNIA) Dictionary and the SNIA Emerald™ Power Efficiency Measurement Specification, Version 1.0 (23 August 2011), while also reflecting industry input.

A.   Product Types:

   1)   Storage Product: A fully-functional storage system that supplies data storage services to clients and devices attached directly or through a network. Components and subsystems that are an integral part of the storage product architecture (e.g., to provide internal communications between controllers and disks) are considered to be part of the storage product. In contrast, components that are normally associated with a storage environment at the data center level (e.g., devices required for operation of an external SAN) are not considered to be part of the storage product. A storage product may be composed of integrated storage controllers, storage media, embedded network elements, software, and other devices. For purposes of this specification, a storage product is a unique configuration of one or more SKUs prepared for sale to an end user.

   2)   Storage Device: A collective term for disk drives, tapes cartridges, and any other mechanisms providing non-volatile data storage. This definition is specifically intended to exclude aggregating storage elements such as RAID array subsystems, robotic tape libraries, filers, and file servers. Also excluded are storage devices which are not directly accessible by end-user application programs, and are instead employed as a form of internal cache.

   3)   Storage Controller: A device for handling storage request via a processor or sequencer programmed to autonomously process a substantial portion of I/O requests directed to storage devices (e.g., RAID controllers, filers).

B.   Storage System Connectivity:

   1)   Direct-attached Storage (DAS): One or more dedicated storage devices that are physically connected to one or more servers.

   2)   Network Attached Storage (NAS): One or more dedicated storage devices that connect to a network and provide file access services to remote computer systems.

145   3) <u>Storage Area Network (SAN)</u>: A network whose primary purpose is the transfer of data
146   between computer systems and storage elements and among storage elements. A SAN
147   consists of a communication infrastructure, which provides physical connections, and a
148   management layer, which organizes the connections, storage elements, and computer
149   systems so that data transfer is secure and robust.

150 C. <u>Capacity Optimizing Methods (COMs)</u>: The reduction of actual data stored on storage devices
151   through a combination of hardware and / or software. Common COMs include:

152   1) <u>Thin Provisioning</u>: A technology that allocates the physical capacity of a volume or file system
153   as applications write data, rather than reallocating all the physical capacity at the time of
154   provisioning.

155   2) <u>Data Deduplication</u>: The replacement of multiple copies of data – at variable levels of
156   granularity – with references to a shared copy in order to save storage space and/or
157   bandwidth.

158   3) <u>Compression</u>: The process of encoding data to reduce its size. For the purpose of this
159   specification, only lossless compression (i.e., compression using a technique that preserves
160   the entire content of the original data, and from which the original data can be reconstructed
161   exactly) is recognized.

162   4) <u>Delta Snapshots</u>: A type of point-in-time copy that preserves the state of data at an instant in
163   time by storing only those blocks that are different from an already existing full copy of the
164   data.

165   5) <u>Parity RAID</u>: A collective term used in this specification to refer to any RAID system that
166   achieves better efficiency than RAID 1.

167 D. <u>Storage Taxonomy</u>[1]: A categorization scheme for use in segmenting the data center storage
168   market by end-use application and key product characteristics. The major categories of the
169   taxonomy that are referenced in this document are as follows:

170   1) <u>Online Storage</u>: Storage products that are intended to service a mixture of Random and
171   Sequential I/O requests with a short response time. All data stored in Online storage must be
172   accessible in ≤ 80 ms, unless the storage product is in a Deep Idle state. Online storage is
173   typically comprised of one or more HDDs or SSDs and a storage controller, and provides
174   primary data storage to supplement a Computer Server's internal memory.

175   2) <u>Near-online Storage</u>: Storage products that are intended to service a mixture of Random and
176   Sequential I/O requests with a short to moderate response time. Near-online storage
177   products offer an asymmetrical response; a portion of data may be accessible in ≤ 80
178   milliseconds, while other data may be accessible in > 80 milliseconds.

179   3) <u>Virtual Media Library</u>: Storage products that are intended to service primarily Sequential I/O,
180   with a short response time. The media in a Virtual Media Library (e.g., HDD, optical disk) is
181   not designed to be physically removed from the system. All data stored in the Virtual Media
182   Library must be assessable in ≤ 80 ms, unless the storage product is in a Deep Idle state.
183   Virtual Medial Libraries are intended primarily for moderate and long term data storage.

184   4) <u>Removable Media Library</u>: Storage products that are intended to service primarily Sequential
185   I/O, with a moderate to long response time. The media (e.g., tape cartridge, optical disk) in a
186   Removable Media Library is designed to be physically removed from the storage product.
187   Removable Media Libraries are intended primarily for long term data archiving.

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[1] The ENERGY STAR storage taxonomy is consistent with the taxonomy developed by the Storage
Networking Industry Association Green Storage Initiative as defined in "SNIA Emerald™ Power Efficiency
Measurement Specification" Version 1.0 released 23 August 2011. Further detail may be found at
<u>www.snia.org/green</u>.

188   5) Adjunct Storage Products: Products which closely support storage devices by adding in real
189   time value or additional control capabilities not present in the storage device(s) itself.
190   Examples include SAN based virtualization controllers, NAS gateways, or other storage
191   services. A key feature of these products is that no end user data is primarily stored on
192   Adjunct Storage products, though data may be held in cache or other working buffers.

193   6) Interconnect Element: Devices which provide for interconnection functionality within a storage
194   area network. Examples include SAN Switches, etc.

195 E. Other Data Center Equipment:

196   1) Computer Server: A computer that provides services and manages networked resources for
197   client devices (e.g., desktop computers, notebook computers, thin clients, wireless devices,
198   PDAs, IP telephones, other computer servers and other network devices). Computer servers
199   are sold through enterprise channels for use in data centers and office/corporate
200   environments. Computer servers are primarily accessed via network connections, versus
201   directly-connected user input devices such as a keyboard or mouse. For purposes of this
202   specification, a computer server must meet all of the following criteria:

203   i)   is marketed and sold as a computer server;

204   ii) is designed for and listed as supporting computer server operating systems (OS) and/or
205   hypervisors, and is targeted to run user-installed enterprise applications;

206   iii) provides support for error-correcting code (ECC) and/or buffered memory (including both
207   buffered DIMMs and buffered on board (BOB) configurations);

208   iv) is packaged and sold with one or more ac-dc or dc-dc power supplies; and

209   v)   is designed such that all processors have access to shared system memory and are
210   independently visible to a single OS or hypervisor.

211 **Note**: The Computer Server definition presented here is from the Version 1 ENERGY STAR Computer
212 Server specification. It will be updated in the final Data Center Storage specification to reference any
213 revisions made in the Version 2.0 ENERGY STAR Computer Server specification revision effort, currently
214 in process.

215   2) Network Equipment: A device whose primary function is to provide data connectivity among
216   an arbitrary combination of devices connected to its several ports. Data connectivity is
217   achieved via the routing of data packets encapsulated according to Internet Protocol, Fibre
218   Channel, InfiniBand or other standard protocol. Examples of network equipment commonly
219   found in data centers are routers and switches.

220   3) Power Distribution Unit (PDU): A single- or three-phase power strip designed for data center
221   use. A PDU may include instrumentation for metering power input and output, switched
222   outlets for control of individual receptacles, or other advanced features.

223   4) Blade System: A system comprised of a blade chassis and one or more removable blade
224   servers and/or other units (e.g., blade storage, blade network equipment). Blade systems
225   provide a scalable means for combining multiple blade server or storage units in a single
226   enclosure, and are designed to allow service technicians to easily add or replace (hot-swap)
227   blades in the field.

228 **Note:** The Blade System definition has been revised to match the definition included in the Draft 1
229 Version 2.0 ENERGY STAR Computer Server specification. It will be updated in the final Data Center
230 Storage specification to reference any revisions made in the Version 2.0 ENERGY STAR Computer
231 Server specification revision effort, currently in process.

232 F. Capacity: Capacity is reported in units of either binary bytes (1 MiB = 1,048,576 Byte) or decimal
233   bytes (1 MB = 1,000,000 Byte).

1) <u>Assigned Capacity</u>: The amount of space on a system or data container which has been allotted to be written by an end user or application. (Note: For capacity-optimizing systems, an assigned capacity number represents a promise that that amount of space will be provided on demand; usable capacity is allocated as the container is written too. For fully-provisioned systems, usable capacity must be committed at the same time the container is allocated.)

2) <u>Effective Capacity</u>: The amount of data stored on a storage system, plus the amount of unused formatted capacity in the system.

3) <u>Formatted (Usable) Capacity</u>: The total amount of bytes available to be written after a system or device has been formatted for use (e.g., by an object store, file system or block services manager). Formatted capacity is less than or equal to raw capacity. It does not include areas set aside for system use, spares, RAID parity areas, checksum space, host- or file system-level remapping, "right sizing" of disks, disk labeling and so on. However, formatted capacity may include areas that are normally reserved – such as snapshot set-asides – if these areas may be configured for ordinary data storage.

4) <u>Free Space</u>: The amount of unused, formatted capacity as reported by the storage product.

5) <u>Raw (Addressable) Capacity</u>: The sum total amount of addressable capacity of the storage devices in a storage product. The raw capacity of a storage device is commonly understood to be the number of bytes available to be written via SCSI or equivalent protocol. It does not include unaddressable space, ECC (error correcting code) data, remap areas, inter-sector gaps, etc.

G. <u>Operational States</u>:

1) <u>Active State</u>: The state in which a storage product is processing external I/O requests.

2) <u>Idle State</u>: An operational state in which the Storage Product is capable of completing I/O transactions, but no active I/Os are requested or pending. The system may, however, be servicing self-initiated I/Os from background data protection and cleansing, and other operations.

   i) <u>Ready Idle</u>: The state in which a storage product is able to respond to arbitrary I/O requests within the MaxTTFD limits for its taxonomy category, but is not receiving external I/O requests. The storage product may perform routine housekeeping tasks during Ready Idle, provided such operations do not compromise the product's ability to meet MaxTTFD requirements.

   ii) <u>Deep Idle</u>: A state in which one or more storage product components or subsystems have been placed into a low-power state for purpose of conserving energy. A storage product in Deep Idle may not be able to respond to I/O requests within the MaxTTFD limits for its taxonomy category, and may need to perform a managed 'wake-up' function in order to return to a Ready Idle or Active state. Deep Idle capability must be a user-selected, optional feature of the Storage Product.

H. <u>Power Supply Unit (PSU)</u>: A device that converts ac or dc input power to one or more dc power outputs for the purpose of powering a storage product. A storage PSU must be self-contained and physically separable from the system and must connect to the system via a removable or hard-wired electrical connection. Note: Storage PSUs may be Field Replaceable Units (FRUs), but in some cases may be further integrated with the storage product.

1) <u>Ac-dc Power Supply</u>: A PSU that converts line-voltage ac input power into one or more dc power outputs.

2) <u>Dc-dc Power Supply</u>: A PSU that converts line-voltage dc input power to one or more dc power outputs. For purposes of this specification, a dc-dc converter (also known as a voltage regulator) that is internal to a storage product and is used to convert a low voltage dc (e.g., 12 V dc) into other dc power outputs for use by storage product components is not considered a dc-dc power supply.

3) <u>Single-output Power Supply</u>: A PSU that is designed to deliver the majority of its rated output power to one primary dc output. Single-output PSUs may offer one or more standby outputs that remain active whenever connected to an input power source. For purposes of this specification, the total rated power output from all additional PSU outputs that are not primary and standby outputs shall be less than 20 watts. PSUs that offer multiple outputs at the same voltage as the primary output are considered single-output PSUs unless those outputs (1) are generated from separate converters or have separate output rectification stages, or (2) have independent current limits.

4) <u>Multi-output Power Supply</u>: A PSU that is designed to deliver the majority of its rated output power to more than one primary dc output for the purpose of powering a storage product. Multi-output PSUs may offer one or more standby outputs that remain active whenever connected to an input power source. For purposes of this specification, the total rated power output from all additional PSU outputs that are not primary and standby outputs must be greater than or equal to 20 watts.

5) <u>Redundant Power Supplies</u>: Two or more PSUs that are configured to maintain uninterrupted output load in the event of failure of one PSU.

I. <u>Product Family</u>: A group of models/configurations that share a set of common attributes that are variations on a basic design.

1) <u>Common Product Family Attributes</u>: A set of features common to all models/configurations within a product family that constitute a common basic design. All models/configurations within a product family must share the following:

   i) made by the same manufacturer;

   ii) subject to the same ENERGY STAR qualification criteria; and

   iii) TBD.

Note: EPA welcomes stakeholder input on a comprehensive and meaningful list of Common Product Family Attributes. EPA will further define these attributes in response to stakeholder comments submitted in response to this draft.

2) <u>Maximum Configuration</u>: A product configuration that includes the combination of base components that generates the maximum possible power consumption within a product family. [TBD]

3) <u>Minimum Configuration</u>: A product configuration that includes the combination of base components that generates the least possible power consumption within a product family. [TBD]

4) <u>Typical Configuration</u>: A product configuration that lies between the minimum and maximum configurations and is representative of a product with high volume sales. [TBD]

Note: Based on discussions to date and the data available, EPA proposes to proceed with a Product Family structure that "bookends" the systems intended for ENERGY STAR qualification. The "Maximum" and "Minimum" in such an approach refer to the maximum and minimum configurations that the manufacturer intends to sell as ENERGY STAR qualified, not necessarily the maximum or minimum of available configuration options.

EPA has discussed this bookending approach as well as alternative options for family structures with stakeholders over the months preceding this draft release. The bookending approach provides EPA with well-defined boundaries that delineate product families and assure that energy performance within a family is characterized across a range of system sizes. In addition, the bookending approach supports the assembly of active mode test measurement data, which would provide useful information to the product end-user. EPA continues to welcome stakeholder input on this approach as well as comments and discussions on the merits of alternative approaches.

330   J.   Other Definitions:

331   1)   Field-replaceable Unit (FRU): A unit, or component of a system that is designed to be
332   replaced "in the field;" i.e., without returning the system to a factory or repair depot. Field
333   replaceable units may either be customer-replaceable, or their replacement may require
334   trained service personnel.

335   2)   High-availability (HA): The ability of a system to perform its function continuously (without
336   interruption) for a significantly longer period of time than the reliabilities of its individual
337   components would suggest. High availability is most often achieved through failure tolerance.

338   3)   Maximum Sustainable Performance: Maximum I/O per second (IOPS) or GiB/s that the UUT
339   is able to deliver under a specified workload. For purposes of this specification, it is
340   suggested that "sustainable" performance is that which ensures the maximum achievable
341   data rate, excludes any transient system caching effects, and can be maintained to within
342   ±5% for the duration of the measurement phase.

343   4)   Maximum Time to First Data (MaxTTFD): The maximum time required to start receiving data
344   from a storage system to satisfy a read request for arbitrary data.

345   5)   RAS Features: An acronym for reliability, availability, and serviceability features. RAS is
346   sometimes also expanded to RASM, which adds "Manageability" criteria. The three primary
347   components of RAS as related to storage products are defined as follows:

348   i)   Reliability Features: Features supporting a storage product's ability to perform its
349   intended function without interruption due to component failures. Technologies applied to
350   increase reliability include: component selection (MTBF), redundancy (both at a micro
351   and macro levels), temperature and/or voltage de-rating, error detection and correction
352   technologies.

353   ii) Availability Features: Features that support a storage product's ability to maximize normal
354   operating time and minimize planned and unplanned down time.

355   iii) Serviceability Features: Features that support a storage product's ability to be serviced
356   (e.g., hot-plugging).

357   iv) Non-disruptive Serviceability: Support for continued availability of data and response
358   times during all FRU and service operations; including break/fix, code patches,
359   software/firmware upgrades, configuration changes, data migrations, and system
360   expansion.

361   6)   Read/Write:

362   i)   Random Read: Any I/O load in which consecutively issued read requests do not specify
363   adjacently addressed data. The term random I/O is commonly used to denote any I/O
364   load that is not sequential, whether or not the distribution of data locations is indeed
365   random.

366   ii) Random Write: Any I/O load whose consecutively issued write requests do not specify
367   adjacently addressed data. The term random I/O is commonly used to denote any I/O
368   load that is not sequential, whether or not the distribution of data locations is indeed
369   random.

370   iii) Sequential Read: An I/O load consisting of consecutively issued read requests to
371   adjacently addressed data.

372   iv) Sequential Write: An I/O load consisting of consecutively issued write requests to
373   adjacently addressed data.

374   7)   Response Time: The time required for the UUT to complete an I/O request.

375   8)   Single Point of Failure (SPOF): One component or path in a system, the failure of which
376   would make the system inoperable.

| 377 | 9) <u>Unit Under Test (UUT)</u>: The Storage Product being tested. |

2 QUALIFYING PRODUCTS

2.1 Included Products

2.1.1 Products that meet all of the following conditions are eligible for ENERGY STAR qualification, with the exception of products listed in Section 2.2:

    i.   meet the definition of a storage product provided in Section 1 of this document;

    ii.   not fall within the exceptions identified in Section 2.2 of this document;

    iii. be comprised of one or more SKUs and be able to be purchased in a single order from a system vendor;

    iv. be characterized within the SNIA-defined Online 2, 3, or 4 storage taxonomy categories;

    v.   Contain a storage controller within the storage device.

Note: After considering stakeholder feedback on product coverage under the first version of the program, EPA has limited the scope of Version 1.0 to Data Center Storage products falling under the SNIA-defined Online-2, Online-3, and Online-4 storage taxonomy categories.

Some stakeholders raised the prospect of covering Network Attached Storage (NAS) in the scope of the program during development of this Draft 2 document. EPA seeks further stakeholder input on test methodologies appropriate to NAS and how such product fit the requirements structure in this draft.

Other product areas will be considered for future versions of the program.

2.2 Excluded Products

2.2.1 Products that are covered under other ENERGY STAR product specifications are not eligible for qualification under the ENERGY STAR Data Center Storage specification. The full list of specifications currently in effect can be found at www.energystar.gov/products. Also excluded from qualification under this specification are products which are being considered for future ENERGY STAR programs.

2.2.2 The following products are specifically excluded from qualification under this specification:

    i.   Personal / Portable Data Storage Products;

    ii.   Computer Servers;

    iii. Storage devices in the Near-online, Removable Media Library, Virtual Media Library, Adjunct Storage Products, and Interconnect Elements;

    iv. Online Storage Devices without an included controller, e.g. a collection of disks which rely on a PCI add-in card in a server for RAID functions (JBODs).

3 QUALIFICATION CRITERIA

3.1 Significant Digits and Rounding

3.1.1 All calculations shall be carried out with directly measured (unrounded) values.

411　3.1.2　Unless otherwise specified, compliance with specification limits shall be evaluated using
412　　　　　directly measured or calculated values without any benefit from rounding.

413　3.1.3　Directly measured or calculated values that are submitted for reporting on the ENERGY STAR
414　　　　　website shall be rounded to the nearest significant digit as expressed in the corresponding
415　　　　　specification limit.

3.2　Power Supply Requirements

416

417 **Note**: EPA has discussed power supply requirements with a variety of stakeholders and has used this
418 feedback in formulating the requirements in Tables 1 and 2 below. Many stakeholders indicated that
419 levels aligned with those of CSCI Silver would be appropriate, while some asked for reduced efficiency
420 level requirements for redundant capable internal power supplies. The requirements below have been
421 revised to align with CSCI Silver for all power supplies. EPA welcomes continued discussion on the
422 subject of internal power supply efficiency.

423 During the development of Draft 2, stakeholders expressed interest in further investigating power supply
424 efficiency via a market study and focused testing effort. EPA understands that this effort is now ongoing
425 and will review and reconsider these requirements if warranted by the collected data.

426 Additionally, EPA seeks stakeholder input on expected loading patterns on storage PSUs to support
427 further refinement of ENERGY STAR requirements in this section.

428　3.2.1　Internal Power Supplies (IPSs): Internal Power Supplies used in Data Center Storage eligible
429　　　　　under this specification must meet the following requirements when tested using the *EPRI*
430　　　　　*Generalized Internal Power Supply Efficiency Test Protocol, Rev. 6.5* (available at
431　　　　　www.efficientpowersupplies.org).

432　　　i.　Efficiency: Data Center Storage IPS shall meet efficiency requirements as specified in Table
433　　　　　1.

434 **Table 1: Efficiency Requirements for PSUs**

PSU Type	Rated Output Power	10% Load	20% Load	50% Load	100% Load
Non-Redundant Capable IPS	All Output Levels	n/a	85%	88%	85%
Redundant Capable IPS	All Output Levels	75%	85%	89%	85%

435　　　ii.　Power Factor: Data Center Storage IPS shall meet power factor requirements as specified in
436　　　　　Table 2.

437 **Table 2: Power Factor Requirements for PSUs**

PSU Type	Rated Output Power	10% Load	20% Load	50% Load	100% Load
Non-Redundant Capable IPS	All Output Levels	n/a	0.80	0.90	0.95
Redundant Capable IPS	≤ 500 watts	n/a	0.80	0.90	0.95
	500 watts < Output ≤ 1000 watts	0.65	0.80	0.90	0.95
	> 1000 Watts	0.65	0.80	0.90	0.95

438   iii. <u>Efficiency and Power Factor in Embedded Equipment</u>: TBD

439 **Note**: Stakeholders raised the topic of "embedded," non-storage equipment, often built by third-parties,
440 included as part of the storage product; examples include embedded notebook computers, displays, and
441 network switches. Since the power supplies in such embedded products are neither chosen by the Data
442 Center Storage manufacturer nor subject to their modification, EPA may be open to targeted exemption
443 for such power supplies from the efficiency and power factor requirements in this section, provided it
444 cannot be used to exclude power supplies servicing the primary components of the Data Center Storage
445 product (e.g., controller, drawers). EPA welcomes proposals from stakeholders on language to this effect.

446 In proposing this possible exemption, EPA recognizes that the size, complexity, and design time of data
447 center storage products makes it very difficult to track and account for the efficiency of every power
448 supply that enters the system. An exemption to the above PSU requirements may be warranted for this
449 non-storage equipment.

450 Additionally, EPA is also considering a requirement that all equipment in a storage system that falls under
451 the scope of another applicable ENERGY STAR specification (e.g. computers, servers, networking
452 equipment) also be ENERGY STAR qualified. A system's non-storage components would only have to be
453 ENERGY STAR qualified according to the specification in effect at the time of the system's design and
454 would not have to change to track revisions to ENERGY STAR specifications during the system's sales
455 lifetime.

3.3   Active State Efficiency Criteria

457   3.3.1   <u>Active State Efficiency Disclosure</u>: To qualify for ENERGY STAR, a Data Center Storage
458   product or family must be submitted for qualification with the following information disclosed in
459   full:

460   i.   TBD

461 **Note**: This approach mirrors the proposed approach to active power measurement in the ENERGY STAR
462 Computer Server v2.0 development process and requires (1) that a Data Center Storage product be
463 evaluated using a predetermined active state testing methodology, with results to be publically disclosed
464 via the ENERGY STAR program as part of the Power and Performance Datasheet, and (2) that a Data
465 Center Storage product also provide an energy-efficient platform by meeting or exceeding pass/fail levels
466 and requirements in other areas.

467 EPA is pursuing this approach to active state evaluation to encourage further testing for energy efficiency
468 of Data Center Storage products. Data generated through this testing will allow EPA to set efficiency
469 levels for active state energy consumption in future versions of the specification. This reporting approach
470 also assists manufacturers in differentiating their products via energy efficiency. Efficiency data is
471 measured and disclosed in a consistent manner and is provided along with the hardware and software
472 characteristics of each system.

473 As referenced in Section 4.1, EPA proposed use of the *SNIA Emerald™ Power Efficiency Measurement*
474 *Specification, Version 1.0 (23 August 2011)*, as the basis of Active State evaluation and data disclosure.

3.4   Idle State Efficiency Criteria

476 **Note**: In conjunction with the Active State disclosure criteria presented above, EPA intends to pursue
477 Ready Idle limits. An initial structure for such requirements is listed in Section 3.4.1. In other ICT
478 specifications, EPA has used a "base plus adder" approach, where a base level of performance is set for
479 series or categories of products covered by the specification, with a set of allowances to accommodate
480 key features that extend non-energy benefits to the user at a limited cost of efficiency. EPA encourages
481 stakeholder feedback on the appropriateness of this structure for storage equipment and any alternatives
482 stakeholders wish to propose.

483   3.4.1   Ready Idle (GB/Watt) shall be greater than or equal to the Minimum Ready Idle Requirement
484   (RI_{MIN}), as calculated per Equation 1.

485
486   **Equation 1: Calculation of Maximum Idle State Power**

TBD

487   **Table 3: Ready Idle Allowances**

Category	Base Ready Idle Allowance, RI_{MIN} (GB/watt)
TBD	TBD

3.5   Power Management Requirements

489   3.5.1   Data Center Storage products shall be configured with power management described and
490   implemented as follows:

491   i.   Techniques: TBD.

492   ii.   Power management techniques that are enabled by default shall be reported on the Power
493   and Performance Data Sheet, per the requirements in Section 0 of this specification.

494   3.5.2   Power Modeling Presale tool: To qualify for ENERGY STAR, a power modeling tool
495   characterizing the Data Center Storage product must be publicly available. The power modeler
496   must meet the following minimum guidelines:

497   i.   Provide an estimated power usage of a deployed configuration based on user-selected
498   configuration characteristics.

499   ii.   Partner shall warrant delivered hardware to consume equal or less power than predicted by
500   modeler under conditions specified at the time of prediction.

501 **Note**: To promote consideration of energy efficiency issues among the other purchase decision points,
502 and encourage existing stakeholder efforts, EPA has added the Power Modeling Presale tool
503 requirement.

3.6   Energy Efficiency Feature Requirements

505   3.6.1   To qualify for ENERGY STAR, a Data Center Storage product must contain the following
506   features, implemented as specified:

507   i.   *Parity RAID*: To qualify for ENERGY STAR, a storage product must offer a form of Parity
508   RAID in addition to other RAID levels it may support.

509   ii.   *Adaptive Cooling*: To qualify for ENERGY STAR, a storage product must utilize adaptive
510   cooling technologies that reduce the energy consumed by the cooling technology in
511   proportion to ambient air temperature conditions in proximity to the Data Center Storage
512   product (e.g., reduction of variable speed fan or blower speed at lower ambient air
513   temperature).

514   3.6.2   To qualify for ENERGY STAR, a Data Center Storage product must be shipped with [TBD—a
515   designated number] of the following end user configurable / selectable features listed in Table
516   4. For consideration, the feature must be enabled by default upon shipment.

Table 4: Configurable Energy Efficiency Features

Feature	Implementation
Deep Sleep Mode	TBD
Allow for unallocated storage elements to be placed into a power-down state.	TBD
COM: Thin Provisioning	TBD
COM: Data Deduplication	TBD
COM: Compression	TBD
COM: Delta Snapshots	TBD

Note: EPA is interested developing the energy savings associated with COMs and proposes to include them as part of the qualification criteria. EPA seeks stakeholder feedback on how often these COMs are deployed to consumers and the impacts on manufacturers associated with providing these features.

3.7   Standard Information Reporting Requirements

3.7.1   A standardized Power and Performance Data Sheet (PPDS) shall be completed for each ENERGY STAR qualified Data Center Storage product and posted with other product configuration information on the Partner's website. Partners are encouraged to provide one data sheet per qualified configuration, but may also provide one data sheet per Product Family (as defined in Section 1 with data on the power and performance in [TBD].

3.7.2   If one PPDS is used to represent a Product Family, Partners are encouraged to provide a link to a more detailed power calculator where information on the power consumption of specific system configurations can be found.

3.7.3   Templates for the PPDS can be found on the ENERGY STAR Web page for Computer Servers at www.energystar.gov/products. Partners are encouraged to use the template provided by EPA, but may also create their own template provided that it has been approved by EPA and contains the following information, at a minimum:

Note: The following list is for reference only. EPA welcomes stakeholder input and further discussion to finalize this list.

   i.   product model name, model number, and SKU or other configuration identification number;

   ii.   a list of important product characteristics, including [TBD];

   iii.   a list of qualified system configurations, including maximum, minimum and typical configurations of qualified product families;

   iv.   power consumption and performance data, along with guaranteed accuracy levels for all power and temperature measurements, disclosure of the time period used for data averaging, and a hyperlink to a detailed power calculator, as available;

   v.   a list of power management and other power saving features available and enabled by default;

   vi.   information on product power measurement and reporting capabilities;

   vii.   a list of selected data from the ASHRAE Thermal Report; and

   viii.   for product families, a list of qualified storage products within the family.

3.8 Standard Performance Data Measurement and Output Requirements

> **Note:** The requirements in this section are similar to those in the Draft 1 Version 2.0 ENERGY STAR Computer Servers specification and largely maintained from the Draft 1 Data Center Storage specification.
>
> EPA received limited, but substantive, feedback from stakeholders regarding the complexities of, and alternatives to, requirements for integrated inlet air temperature measurements. EPA plans to hold further discussions with stakeholders on this topic in order to finalize requirements.
>
> After discussion with stakeholders, the sampling requirement for input power measurements has also been altered to take 1 or more measurements per 10 second interval. EPA welcomes further stakeholder input on all of the above modifications to the specification.

3.8.1 <u>Data Elements</u>: All Data Center Storage products shall be capable of measuring and reporting the following data elements:

    i.   <u>Input Power</u>, in watts. Input power measurements must be reported with accuracy of less than or equal to 5% of the actual value for measurements greater than 200 W, through the full range of operation. For measurements less than or equal to 200 W, the accuracy must be less than or equal to 10 W times the number of installed PSUs; and

    ii.   <u>Inlet Air Temperature</u>, in degrees Celsius, with accuracy of ± 3°C.

3.8.2 <u>Reporting Implementation</u>:

    i.   Data shall be made available in a published or user-accessible format that is readable by third-party, non-proprietary management systems;

    ii.   Data shall be made available to end users and third-party management systems over a standard network connection;

    iii.   Data shall be made available via embedded components or add-in devices that are packaged with the Data Center Storage product (e.g., a service processor, embedded power or thermal meter or other out-of-band technology, or pre-installed OS);

    iv.   When an open and universally available data collection and reporting standard becomes available, manufacturers should incorporate the universal standard into their products.

3.8.3 <u>Sampling Requirements</u>:

    i.   *Input power*: Input power and processor utilization measurements must be collected at a rate of ≥ 1 measurement every 10 seconds. A rolling average, encompassing a period of no more than 30 seconds, must be reported at a frequency of greater than or equal to once every 10 seconds.

    ii.   *Inlet air temperature*: Inlet air temperature measurements must be collected at a rate of ≥ 1 measurement every 10 seconds.

3.8.4 <u>Documentation Requirements</u>: The following information shall be included on the Power and Performance Data Sheet:

    i.   Guaranteed accuracy levels for power and temperature measurements, and

    ii.   The time period used for data averaging.

4 TESTING

4.1 Test Methods

    4.1.1   Test methods identified in Table 5 shall be used to determine qualification for ENERGY STAR.

589

Table 5: Test Methods for ENERGY STAR Qualification

Product Type	Test Method
All	SNIA Emerald Power Efficiency Measurement Specification, Version 1.0 (23 August 2011)

4.2   Number of Units Required for Testing

590

591   4.2.1   Representative Models shall be selected for testing per the following requirements:

592   i.   For qualification of an individual product model, a product configuration equivalent to that
593   which is intended to be marketed and labeled as ENERGY STAR is considered the
594   Representative Model;

595   ii.   For qualification of a product family, there are three Representative Models: the Maximum
596   Configuration, Minimum Configuration, and an intermediate or Typical Configuration with
597   power consumption between the other two configurations. When submitting product families,
598   manufacturers continue to be held accountable for any efficiency claims made about their
599   products, including those not tested or for which data was not reported.

600   4.2.2   A single unit of each Representative Model shall be selected for testing.

4.3   International Market Qualification

601

602   4.3.1   TBD

603   **Note**: EPA welcomes stakeholder comments on any concerns they have about special provisions for
604   qualification of products intended for sale as ENERGY STAR in international markets. This section is
605   included as a placeholder for future revisions.

5 EFFECTIVE DATE

606

607   5.1.1   Effective Date: The Version 1.0 ENERGY STAR Data Center Storage specification shall take
608   effect on the dates specified in Table 6. To qualify for ENERGY STAR, a product model shall
609   meet the ENERGY STAR specification in effect on its date of manufacture. The date of
610   manufacture is specific to each unit and is the date (e.g., month and year) on which a unit is
611   considered to be completely assembled.

612   5.1.2   Future Specification Revisions: EPA reserves the right to change this specification should
613   technological and/or market changes affect its usefulness to consumers, industry, or the
614   environment. In keeping with current policy, revisions to the specification are arrived at through
615   stakeholder discussions. In the event of a specification revision, please note that the ENERGY
616   STAR qualification is not automatically granted for the life of a product model.

617

Table 6: Specification Effective Date

Effective Date
March 2012 (preliminary)

618   **Note**: EPA is proceeding with a goal to complete development of the Version 1.0 Data Center Storage
619   program by early 2012. As a reminder, the Data Center Storage program, as a new ENERGY STAR
620   program area, would go into effect immediately upon finalization of specification development.

6 CONSIDERATIONS FOR FUTURE REVISIONS

621

622
623

Note: This section will be updated in further drafts to capture issues that, while excluded from the Version 1.0 specification, may be reevaluated in future versions.

624   TBD