



# 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](http://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](http://www.energystar.gov/testingandverification).

### 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](http://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.

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24 Partner shall adhere to the following product-specific commitments regarding use of the ENERGY  
25 STAR certification mark on qualified products:

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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](http://www.energystar.gov/partners).

40 **Verifying Ongoing Product Qualification**

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

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46 **Providing Information to EPA**

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

49 7.1. Partner must submit the total number of ENERGY STAR qualified Data Center Storage shipped  
50 in the calendar year or an equivalent measurement as agreed to in advance by EPA and  
51 Partner. Partner shall exclude shipments to organizations that rebrand and resell the shipments  
52 (unaffiliated private labelers).

53 7.2. Partner must provide unit shipment data segmented by meaningful product characteristics (e.g.,  
54 type, capacity, presence of additional functions) as prescribed by EPA.

55 7.3. Partner must submit unit shipment data for each calendar year to EPA or an EPA-authorized  
56 third party, preferably in electronic format, no later than March 1 of the following year.

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

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

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

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67 **Performance for Special Distinction**

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

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

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

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

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

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

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- Provide general information about the ENERGY STAR program to employees whose jobs are relevant to the development, marketing, sales, and service of current ENERGY STAR qualified products.
  - Provide a simple plan to EPA outlining specific measures Partner plans to undertake beyond the program requirements listed above. By doing so, EPA may be able to coordinate, and communicate Partner's activities, provide an EPA representative, or include news about the event in the ENERGY STAR newsletter, on the ENERGY STAR website, etc. The plan may be as simple as providing a list of planned activities or milestones of which Partner would like EPA to be aware. For example, activities may include: (1) increasing the availability of ENERGY STAR qualified products by converting the entire product line within two years to meet ENERGY STAR guidelines; (2) demonstrating the economic and environmental benefits of energy efficiency through special in-store displays twice a year; (3) providing information to users (via the website and user's manual) about energy-saving features and operating characteristics of ENERGY STAR qualified products; and (4) building awareness of the ENERGY STAR Partnership and brand identity by collaborating with EPA on one print advertorial and one live press event.
  - Join EPA's SmartWay Transport Partnership to improve the environmental performance of the company's shipping operations. The SmartWay Transport Partnership works with freight carriers, shippers, and other stakeholders in the goods movement industry to reduce fuel consumption, greenhouse gases, and air pollution. For more information on SmartWay, visit [www.epa.gov/smartway](http://www.epa.gov/smartway).
  - Join EPA's Green Power Partnership. EPA's Green Power Partnership encourages organizations to buy green power as a way to reduce the environmental impacts associated with traditional fossil fuel-based electricity use. The partnership includes a diverse set of organizations including Fortune 500 companies, small and medium businesses, government institutions as well as a growing number of colleges and universities. For more information on Green Power, visit [www.epa.gov/greenpower](http://www.epa.gov/greenpower).



# ENERGY STAR® Program Requirements for Data Center Storage

## Eligibility Criteria Draft 2 Version 1.0

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

### 14 1 DEFINITIONS

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

#### 121 A. Product Types:

- 122 1) Storage Product: A fully-functional storage system that supplies data storage services to  
123 clients and devices attached directly or through a network. Components and subsystems that  
124 are an integral part of the storage product architecture (e.g., to provide internal  
125 communications between controllers and disks) are considered to be part of the storage  
126 product. In contrast, components that are normally associated with a storage environment at  
127 the data center level (e.g., devices required for operation of an external SAN) are not  
128 considered to be part of the storage product. A storage product may be composed of  
129 integrated storage controllers, storage media, embedded network elements, software, and  
130 other devices. For purposes of this specification, a storage product is a unique configuration  
131 of one or more SKUs prepared for sale to an end user.
- 132 2) Storage Device: A collective term for disk drives, tapes cartridges, and any other mechanisms  
133 providing non-volatile data storage. This definition is specifically intended to exclude  
134 aggregating storage elements such as RAID array subsystems, robotic tape libraries, filers,  
135 and file servers. Also excluded are storage devices which are not directly accessible by end-  
136 user application programs, and are instead employed as a form of internal cache.
- 137 3) Storage Controller: A device for handling storage request via a processor or sequencer  
138 programmed to autonomously process a substantial portion of I/O requests directed to  
139 storage devices (e.g., RAID controllers, filers).

#### 140 B. Storage System Connectivity:

- 141 1) Direct-attached Storage (DAS): One or more dedicated storage devices that are physically  
142 connected to one or more servers.
- 143 2) Network Attached Storage (NAS): One or more dedicated storage devices that connect to a  
144 network and provide file access services to remote computer systems.

145 3) Storage Area Network (SAN): 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. Capacity Optimizing Methods (COMs): The reduction of actual data stored on storage devices  
151 through a combination of hardware and / or software. Common COMs include:

152 1) Thin Provisioning: 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) Data Deduplication: 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) Compression: 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) Delta Snapshots: 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) Parity RAID: A collective term used in this specification to refer to any RAID system that  
166 achieves better efficiency than RAID 1.

167 D. Storage Taxonomy<sup>1</sup>: 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) Online Storage: 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  $\leq 80$  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) Near-online Storage: 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  $\leq 80$   
178 milliseconds, while other data may be accessible in  $> 80$  milliseconds.

179 3) Virtual Media Library: 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  $\leq 80$  ms, unless the storage product is in a Deep Idle state.  
183 Virtual Media Libraries are intended primarily for moderate and long term data storage.

184 4) Removable Media Library: 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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<sup>1</sup> 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 [www.snia.org/green](http://www.snia.org/green).

- 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).

- 234 1) Assigned Capacity: The amount of space on a system or data container which has been  
235 allotted to be written by an end user or application. (Note: For capacity-optimizing systems,  
236 an assigned capacity number represents a promise that that amount of space will be provided  
237 on demand; usable capacity is allocated as the container is written too. For fully-provisioned  
238 systems, usable capacity must be committed at the same time the container is allocated.)
- 239 2) Effective Capacity: The amount of data stored on a storage system, plus the amount of  
240 unused formatted capacity in the system.
- 241 3) Formatted (Usable) Capacity: The total amount of bytes available to be written after a system  
242 or device has been formatted for use (e.g., by an object store, file system or block services  
243 manager). Formatted capacity is less than or equal to raw capacity. It does not include areas  
244 set aside for system use, spares, RAID parity areas, checksum space, host- or file system-  
245 level remapping, "right sizing" of disks, disk labeling and so on. However, formatted capacity  
246 may include areas that are normally reserved – such as snapshot set-asides – if these areas  
247 may be configured for ordinary data storage.
- 248 4) Free Space: The amount of unused, formatted capacity as reported by the storage product.
- 249 5) Raw (Addressable) Capacity: The sum total amount of addressable capacity of the storage  
250 devices in a storage product. The raw capacity of a storage device is commonly understood  
251 to be the number of bytes available to be written via SCSI or equivalent protocol. It does not  
252 include unaddressable space, ECC (error correcting code) data, remap areas, inter-sector  
253 gaps, etc.

254 G. Operational States:

- 255 1) Active State: The state in which a storage product is processing external I/O requests.
- 256 2) Idle State: An operational state in which the Storage Product is capable of completing I/O  
257 transactions, but no active I/Os are requested or pending. The system may, however, be  
258 servicing self-initiated I/Os from background data protection and cleansing, and other  
259 operations.
- 260 i) Ready Idle: The state in which a storage product is able to respond to arbitrary I/O  
261 requests within the MaxTTFD limits for its taxonomy category, but is not receiving  
262 external I/O requests. The storage product may perform routine housekeeping tasks  
263 during Ready Idle, provided such operations do not compromise the product's ability to  
264 meet MaxTTFD requirements.
- 265 ii) Deep Idle: A state in which one or more storage product components or subsystems have  
266 been placed into a low-power state for purpose of conserving energy. A storage product  
267 in Deep Idle may not be able to respond to I/O requests within the MaxTTFD limits for its  
268 taxonomy category, and may need to perform a managed 'wake-up' function in order to  
269 return to a Ready Idle or Active state. Deep Idle capability must be a user-selected,  
270 optional feature of the Storage Product.

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

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

- 283 3) Single-output Power Supply: A PSU that is designed to deliver the majority of its rated output  
284 power to one primary dc output. Single-output PSUs may offer one or more standby outputs  
285 that remain active whenever connected to an input power source. For purposes of this  
286 specification, the total rated power output from all additional PSU outputs that are not primary  
287 and standby outputs shall be less than 20 watts. PSUs that offer multiple outputs at the same  
288 voltage as the primary output are considered single-output PSUs unless those outputs (1) are  
289 generated from separate converters or have separate output rectification stages, or (2) have  
290 independent current limits.
- 291 4) Multi-output Power Supply: A PSU that is designed to deliver the majority of its rated output  
292 power to more than one primary dc output for the purpose of powering a storage product.  
293 Multi-output PSUs may offer one or more standby outputs that remain active whenever  
294 connected to an input power source. For purposes of this specification, the total rated power  
295 output from all additional PSU outputs that are not primary and standby outputs must be  
296 greater than or equal to 20 watts.
- 297 5) Redundant Power Supplies: Two or more PSUs that are configured to maintain uninterrupted  
298 output load in the event of failure of one PSU.
- 299 I. Product Family: A group of models/configurations that share a set of common attributes that are  
300 variations on a basic design.
- 301 1) Common Product Family Attributes: A set of features common to all models/configurations  
302 within a product family that constitute a common basic design. All models/configurations  
303 within a product family must share the following:
- 304 i) made by the same manufacturer;
- 305 ii) subject to the same ENERGY STAR qualification criteria; and
- 306 iii) TBD.

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

- 310 2) Maximum Configuration: A product configuration that includes the combination of base  
311 components that generates the maximum possible power consumption within a product  
312 family. [TBD]
- 313 3) Minimum Configuration: A product configuration that includes the combination of base  
314 components that generates the least possible power consumption within a product family.  
315 [TBD]
- 316 4) Typical Configuration: A product configuration that lies between the minimum and maximum  
317 configurations and is representative of a product with high volume sales. [TBD]

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

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



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J. Other Definitions:

- 1) Field-replaceable Unit (FRU): A unit, or component of a system that is designed to be replaced “in the field;” i.e., without returning the system to a factory or repair depot. Field replaceable units may either be customer-replaceable, or their replacement may require trained service personnel.
- 2) High-availability (HA): The ability of a system to perform its function continuously (without interruption) for a significantly longer period of time than the reliabilities of its individual components would suggest. High availability is most often achieved through failure tolerance.
- 3) Maximum Sustainable Performance: Maximum I/O per second (IOPS) or GiB/s that the UUT is able to deliver under a specified workload. For purposes of this specification, it is suggested that “sustainable” performance is that which ensures the maximum achievable data rate, excludes any transient system caching effects, and can be maintained to within ±5% for the duration of the measurement phase.
- 4) Maximum Time to First Data (MaxTTFD): The maximum time required to start receiving data from a storage system to satisfy a read request for arbitrary data.
- 5) RAS Features: An acronym for reliability, availability, and serviceability features. RAS is sometimes also expanded to RASM, which adds “Manageability” criteria. The three primary components of RAS as related to storage products are defined as follows:
  - i) Reliability Features: Features supporting a storage product’s ability to perform its intended function without interruption due to component failures. Technologies applied to increase reliability include: component selection (MTBF), redundancy (both at a micro and macro levels), temperature and/or voltage de-rating, error detection and correction technologies.
  - ii) Availability Features: Features that support a storage product’s ability to maximize normal operating time and minimize planned and unplanned down time.
  - iii) Serviceability Features: Features that support a storage product’s ability to be serviced (e.g., hot-plugging).
  - iv) Non-disruptive Serviceability: Support for continued availability of data and response times during all FRU and service operations; including break/fix, code patches, software/firmware upgrades, configuration changes, data migrations, and system expansion.
- 6) Read/Write:
  - i) Random Read: Any I/O load in which consecutively issued read requests do not specify adjacently addressed data. The term random I/O is commonly used to denote any I/O load that is not sequential, whether or not the distribution of data locations is indeed random.
  - ii) Random Write: Any I/O load whose consecutively issued write requests do not specify adjacently addressed data. The term random I/O is commonly used to denote any I/O load that is not sequential, whether or not the distribution of data locations is indeed random.
  - iii) Sequential Read: An I/O load consisting of consecutively issued read requests to adjacently addressed data.
  - iv) Sequential Write: An I/O load consisting of consecutively issued write requests to adjacently addressed data.
- 7) Response Time: The time required for the UUT to complete an I/O request.
- 8) Single Point of Failure (SPOF): One component or path in a system, the failure of which would make the system inoperable.

377 9) Unit Under Test (UUT): The Storage Product being tested.

## 378 2 QUALIFYING PRODUCTS

### 379 2.1 Included Products

380 2.1.1 Products that meet all of the following conditions are eligible for ENERGY STAR qualification,  
381 with the exception of products listed in Section 2.2:

- 382 i. meet the definition of a storage product provided in Section 1 of this document;
- 383 ii. not fall within the exceptions identified in Section 2.2 of this document;
- 384 iii. be comprised of one or more SKUs and be able to be purchased in a single order from a  
385 system vendor;
- 386 iv. be characterized within the SNIA-defined Online 2, 3, or 4 storage taxonomy categories;
- 387 v. Contain a storage controller within the storage device.

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

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

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

### 395 2.2 Excluded Products

396 2.2.1 Products that are covered under other ENERGY STAR product specifications are not eligible  
397 for qualification under the ENERGY STAR Data Center Storage specification. The full list of  
398 specifications currently in effect can be found at [www.energystar.gov/products](http://www.energystar.gov/products). Also excluded  
399 from qualification under this specification are products which are being considered for future  
400 ENERGY STAR programs.

401 2.2.2 The following products are specifically excluded from qualification under this specification:

- 402 i. Personal / Portable Data Storage Products;
- 403 ii. Computer Servers;
- 404 iii. Storage devices in the Near-online, Removable Media Library, Virtual Media Library, Adjunct  
405 Storage Products, and Interconnect Elements;
- 406 iv. Online Storage Devices without an included controller, e.g. a collection of disks which rely on  
407 a PCI add-in card in a server for RAID functions (JBODs).

## 408 3 QUALIFICATION CRITERIA

### 409 3.1 Significant Digits and Rounding

410 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.

## 416 3.2 Power Supply Requirements

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 *EPR/*  
430 *Generalized Internal Power Supply Efficiency Test Protocol, Rev. 6.5* (available at  
431 [www.efficientpowersupplies.org](http://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. Efficiency and Power Factor in Embedded Equipment: 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.

456 **3.3 Active State Efficiency Criteria**

457       3.3.1 Active State Efficiency Disclosure: 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.

475 **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<sub>MIN</sub>), as calculated per Equation 1.

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

TBD

487 **Table 3: Ready Idle Allowances**

Category	Base Ready Idle Allowance, RI <sub>MIN</sub> (GB/watt)
TBD	TBD

488 **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.

504 **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.

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**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

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**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.

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### 3.7 Standard Information Reporting Requirements

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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]).

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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.

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3.7.3 Templates for the PPDS can be found on the ENERGY STAR Web page for Computer Servers at [www.energystar.gov/products](http://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:

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

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- 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.

## 548 3.8 Standard Performance Data Measurement and Output Requirements

549 **Note:** The requirements in this section are similar to those in the Draft 1 Version 2.0 ENERGY STAR  
550 Computer Servers specification and largely maintained from the Draft 1 Data Center Storage  
551 specification.

552 EPA received limited, but substantive, feedback from stakeholders regarding the complexities of, and  
553 alternatives to, requirements for integrated inlet air temperature measurements. EPA plans to hold further  
554 discussions with stakeholders on this topic in order to finalize requirements.

555 After discussion with stakeholders, the sampling requirement for input power measurements has also  
556 been altered to take 1 or more measurements per 10 second interval. EPA welcomes further stakeholder  
557 input on all of the above modifications to the specification.

558 3.8.1 Data Elements: All Data Center Storage products shall be capable of measuring and reporting the  
559 following data elements:

- 560 i. Input Power, in watts. Input power measurements must be reported with accuracy of less  
561 than or equal to 5% of the actual value for measurements greater than 200 W, through the  
562 full range of operation. For measurements less than or equal to 200 W, the accuracy must  
563 be less than or equal to 10 W times the number of installed PSUs; and
- 564 ii. Inlet Air Temperature, in degrees Celsius, with accuracy of  $\pm 3^{\circ}\text{C}$ .

565 3.8.2 Reporting Implementation:

- 566 i. Data shall be made available in a published or user-accessible format that is readable by  
567 third-party, non-proprietary management systems;
- 568 ii. Data shall be made available to end users and third-party management systems over a  
569 standard network connection;
- 570 iii. Data shall be made available via embedded components or add-in devices that are  
571 packaged with the Data Center Storage product (e.g., a service processor, embedded  
572 power or thermal meter or other out-of-band technology, or pre-installed OS);
- 573 iv. When an open and universally available data collection and reporting standard becomes  
574 available, manufacturers should incorporate the universal standard into their products.

575 3.8.3 Sampling Requirements:

- 576 i. *Input power:* Input power and processor utilization measurements must be collected at a  
577 rate of  $\geq 1$  measurement every 10 seconds. A rolling average, encompassing a period of  
578 no more than 30 seconds, must be reported at a frequency of greater than or equal to once  
579 every 10 seconds.
- 580 ii. *Inlet air temperature:* Inlet air temperature measurements must be collected at a rate of  $\geq 1$   
581 measurement every 10 seconds.

582 3.8.4 Documentation Requirements: The following information shall be included on the Power and  
583 Performance Data Sheet:

- 584 i. Guaranteed accuracy levels for power and temperature measurements, and
- 585 ii. The time period used for data averaging.

## 586 4 TESTING

### 587 4.1 Test Methods

588 4.1.1 Test methods identified in Table 5 shall be used to determine qualification for ENERGY STAR.

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**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)

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**4.2 Number of Units Required for Testing**

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

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

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

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

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**4.3 International Market Qualification**

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4.3.1 TBD

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

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**5 EFFECTIVE DATE**

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

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

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**Table 6: Specification Effective Date**

Effective Date
March 2012 (preliminary)

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



621 **6 CONSIDERATIONS FOR FUTURE REVISIONS**

622 **Note:** This section will be updated in further drafts to capture issues that, while excluded from the Version  
623 1.0 specification, may be reevaluated in future versions.

624 TBD