ENERGY STAR
Data Center Storage
Version 1.0 Certification Body (CB) Training

RJ Meyers

John Clinger

Agenda

1	ENERGY STAR Overview
2	Version 1.0 Storage Specification Overview
3	Overview of CB Details
4	Open Questions & Comments

Agenda

1	**ENERGY STAR Overview**
2	**Version 1.0 Storage Specification Overview**
3	**Overview of CB Details**
4	**Open Questions & Comments**

ENERGY STAR Overview

- Federal government product and building labeling program
  - Established in 1992
  - EPA and DOE
  - Voluntary participation by private sector
  - Federal agencies required to buy ENERGY STAR products
- Label awarded for superior energy efficiency.
- Also promotes better practices.
  - Power management
  - Efficiency of buildings
- Save money, reduce greenhouse gases and protect environment, add value to products.
- Influential brand recognized by over 85% of Americans

ENERGY STAR Programs

- Products
- Commercial & Industrial Buildings
- ENERGY STAR Homes
- Low Carbon IT Initiative
- "Top 12" Data Center Efficiency Strategies
- ENERGY STAR Utilities
- Retailer outreach

What does the ENERGY STAR Label Mean?

- A labeled product is:
  - More energy efficient than a conventional one
  - Cost effective
    - Payback in energy saved
  - Capable of delivering same or better performance compared to non-labeled products.
  - <u>Better for the climate</u>.

Timeline of Data Center Specification Completion

- 2009:
  - Computer Servers Version 1.0
- 2011:
  - Data Center Buildings program launched
- 2012:
  - UPS Version 1.0
- 2013:
  - Computer Servers Version 2.0 (finalized March 2013)
  - Storage Version 1.0
- 2014:
  - Large Network Equipment Version 1.0
- 2015:
  - Data Center Cooling Version 1.0 (tentative)

Benefits of the ENERGY STAR Label

- Guarantees energy efficiency with same or better performance
- Standard test procedures applied to all products
  - Apples to apples comparison
  - UPS: IEC 62040-3, ATIS-0600015
  - Storage: SNIA Emerald™ Specification
  - Servers: SPEC Server Efficiency Rating Tool (SERT)
- Detailed, publicly available data
  - Ex: UPS products provide efficiency at 25, 50, 75, 100% load points
  - Soon to be available in XML, other machine readable formats
- Unbiased, 3rd party source for energy efficiency information.

Efficiency Measurements

- ## UPS
  - Measure power in vs. out at a variety of load points for AC, DC systems. Straightforward efficiency calculation.

- ## Servers
  - Idle power, direct measurement in watts.
  - Active power: SERT applies a variety of worklets, simulates common usage scenarios. Various performance per watt metrics.
  - http://www.spec.org/sert/

- ## Storage
  - Idle power, direct measurement in watts.
  - Active power: SNIA Emerald applies representative workloads.
    - Transaction (high I/O), sequential (large, continuous files), capacity (GB per watt)
  - http://snia.org/emerald/download

EPA and SNIA

- Collaboration over last 4 – 5 years
- SNIA developed Emerald^{TM} Specification
  - Test procedure adopted by EPA for ENERGY STAR Storage v1.0
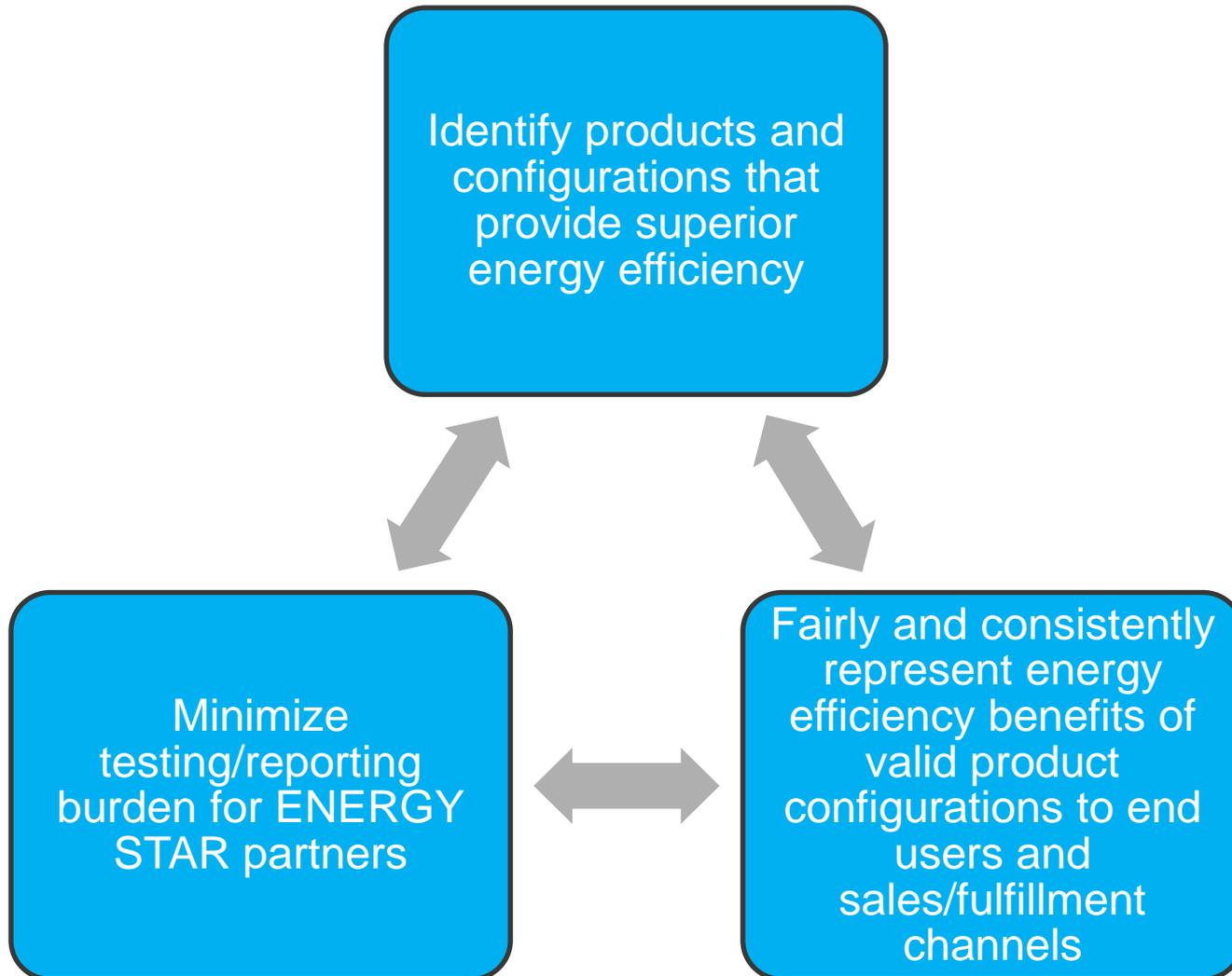 - Planned to continue for future Storage revisions

EPA and SNIA

- Current ENERGY STAR Storage spec result of years of discussions between EPA, SNIA
  - How to use Emerald Specification in ENERGY STAR
- SNIA and its members have provided major contributions to the development of this specification.
  - Feedback on drafts, hosting face-to-face talks, system test data, conference calls, training, and more.
- EPA looks forward to continuing to work with SNIA.

Agenda

1	ENERGY STAR Overview
2	**Version 1.0 Storage Specification Overview**
3	Overview of CB Details
4	Open Questions & Comments

Review of ENERGY STAR Goals

Identify products and configurations that provide superior energy efficiency

Minimize testing/reporting burden for ENERGY STAR partners

Fairly and consistently represent energy efficiency benefits of valid product configurations to end users and sales/fulfillment channels

Adoption of Version 2.0.2 SNIA Emerald™ Specification

- EPA adopted V2.0.0 Emerald specification in the ENERGY STAR Final Draft Storage specification and test method.

- EPA is looking forward to the upcoming release of the V2.0.2 Emerald specification which provides additional guidance for testing storage products with automated storage tiering technology. This version will be referenced in the final ENERGY STAR Storage program requirements.

Definitions

- Align with the SNIA dictionary whenever possible

- Product family is defined in Section I, and provides guidance on:
  - Defining the range of system sizes that fall within a product family
  - How to create configurations for certification using multiple storage device types and/or workload types

Definitions

- Other important concepts covered in the definition section include:
  - Product Types
  - Storage Taxonomy
  - Capacity Optimizing Methods (COMs)
  - Scale-up and Scale-out Storage
  - Automated Storage Tiering
  - Advanced Data Recovery Capability

Storage Taxonomy Review

Attribute	Classification					
	Online 1	Online 2	Online 3	Online 4	Online 5	Online 6
Access Pattern	Random/ Sequential	Random/ Sequential	Random/ Sequential	Random/ Sequential	Random/ Sequential	Random/ Sequential
MaxTTFD (t)	t < 80 ms	t < 80 ms	t < 80 ms	t < 80 ms	t < 80 ms	t < 80 ms
User-Accessible Data	Required	Required	Required	Required	Required	Required
Connectivity	Not specified	Connected to single or multiple hosts	Network-connected	Network-connected	Network-connected	Network-connected
Consumer/ Component	Yes	No	No	No	No	No
Integrated Storage Controller	Optional	Optional	Required	Required	Required	Required
Storage Protection	Optional	Optional	Required	Required	Required	Required
No SPOF	Optional	Optional	Optional	Required	Required	Required
Non-Disruptive Serviceability	Optional	Optional	Optional	Optional	Required	Required
FBA/CKD Support	Optional	Optional	Optional	Optional	Optional	Required
Maximum Supported Configuration	≥1	≥ 4	≥ 12	> 100	>400	>400

In Scope

- Characterized within the Online 2, 3, or 4 Storage Taxonomy with the following additional criteria:

  1. Contain a controller with advanced data recovery capability (no JBODs allowed)
  2. Support Block I/O storage functionality
  3. Implement either scale-up or scale-out storage

Out of Scope

- Storage devices in the following categories of the Storage Taxonomy:
    - Near-online
    - Removable Media Library
    - Virtual Media Library
    - Adjunct Storage Products
    - Interconnect Elements

Out of Scope

- Personal / Portable Data Storage Products
- Computer Servers
- Blade Storage Products
- Direct Attached Storage Products
- Network Attached Storage products that cannot perform Block I/O
- Storage Products capable of object based storage

Power Supply Requirements

- 80 Plus Silver
  - PSUs for primary components
  - i.e. PSUs for controllers, drawers
- All other power supplies excluded from this requirement

Power Modeling Requirements

- Use of a power/performance modeler is allowed for certification
  - Subject to criteria outlined later
- If modeled data is used for certification:
  - Partner is expected to make power modeling tools, that can characterize the system, available to purchasers of the storage product
  - Should provide performance/watt data for user-selected configuration characteristics

Energy Efficiency Feature Requirements

- Adaptive Active Cooling:
  - Must utilize adaptive cooling tech that scales cooling to the current needs of the product.

- COMs:
  - Make available in quantities greater or equal to those listed in Table 4.

Energy Efficiency Feature Requirements - COMs

Table 3: Recognized COM Features

Feature	Verification Requirement
COM: Thin Provisioning	SNIA verification test
COM: Data Deduplication	SNIA verification test
COM: Compression	SNIA verification test
COM: Delta Snapshots	SNIA verification test[3]

Table 4: COM Requirements for Online 2, 3, and 4 Systems

Storage Product Category	Minimum number of COMs required to be made available
Online 2	0
Online 3	1
Online 4	1

Information Reporting Requirements

- For every required testing point in system size, submit:

Workload Test
Hot Band
Random Read
Random Write
Sequential Read
Sequential Write
Ready Idle

Workload Weighting Requirements

- Manufacturers will optimize storage products for specific types of optimization based on the individual workloads specified in Table 6:

Table 6: Workload Weighting Requirements

Workload Test	Transaction Optimization	Streaming Optimization	Capacity Optimization
Hot Band	100%	0%	0%
Sequential Read	0%	70%	0%
Sequential Write	0%	30%	0%
Ready Idle	0%	0%	100%

Testing Data Requirements

- Strongly encourage review of Sections:
  - 3.5.3
  - 3.5.4
  - 3.5.5
- Contain detailed recipe for designing, testing product families plus data points recorded

Test Data for Scale-up, Physical Data only

- For a given workload type (e.g. transaction):
  - Physically test the optimal configuration point and applicable qualification range endpoints for the most commonly sold storage device
  - For additional storage devices in this workload type, only the optimal configuration points for those storage devices are required to be physically tested

Test Data for Scale-up, both Modeled and Physical Data

- For a given workload type (e.g. transaction):
  - Physically test the optimal configuration point and applicable qualification range endpoints for the most commonly sold storage device
  - Verify that modeled data for that configuration (using the same storage device) is within ±5% of the physical data collected above
    - If within 5%, additional storage devices for the same workload type may submit modeled data for the optimal configuration point and additional points
    - If not, follow Physical Data Only instructions on last slide

Test Data for Scale-out Storage Products

- Same as for scale-up systems, but with following change to qualification range:
  - Only test the smallest marketed quantity of storage controllers / nodes available
  - Additional systems with a larger quantity of storage controllers may be optionally submitted

Testing Data General Rules

- Section 3.5.3.vii
- Configurations consisting of exclusively SSDs are not required to submit physical data, unless the SSD device is representative of the most commonly sold drive for that workload type.
- Verification of COM features is only required on one storage device
- If automated storage tiering is enabled during testing, multi-storage device groups necessary for tiering may be counted as single storage devices when determining testing and qualification ranges, so long as the ratio of each device within a group remains as constant as possible.

Testing Data General Rules

- If a product is not marketed with a storage device configurability or scalability that can achieve either the smaller or larger test points in system size required, then these points are not required.

- Product families may not be based solely on Capacity workloads
  - Capacity must be submitted in addition to one or more other optimizations (transaction and/or streaming)

Data Displayed on ENERGY STAR Website

- Product model name, model number, and SKU or other configuration identification number;
- A list of important product characteristics, including;
  - System configuration;
  - Storage controller details (e.g. model name and number);
  - Software configuration;
  - Storage controller power supply information;
  - Storage device drawer power supply information;
  - Storage devices used per optimization points
  - Input power and environmental characteristics during testing;
  - System power optimization capabilities;
  - Inlet air temperature and power consumption reporting capabilities.

Data Displayed on ENERGY STAR Website

- A list of qualified configurations within a family, including performance/watt data for the applicable workloads in Table 7:

Table 7: Active and Idle State Efficiency Test Results Displayed on the ENERGY STAR Website

Workload Test	Transaction Optimization	Streaming Optimization	Capacity Optimization
Hot Band	Yes	No	No
Random Read	Yes	No	No
Random Write	Yes	No	No
Sequential Read	No	Yes	No
Sequential Write	No	Yes	No
Ready Idle	Yes	Yes	Yes

Storage Product Variation Allowances

- Once a product is qualified, system performance/watt may not change by more than 20% as defined in Table 6 (with the exception of Ready Idle)
- If >20%, must test new optimal configuration
  - Added to the existing product family
  - Expands scope of product family

Storage Product Variation Allowances

- To replace storage devices in a storage product without retesting, the following rules apply:
  - No change in:
    - Interface type, quantity, and transfer speed
  - Only an increase in the following:
    - Data capabilities, power management features, capacity, and cache size
  - Limited ±% variations of change in the following:
    - Average seek time, average latency, average power consumption, rotational speed and sustained transfer rate

Standard Performance Data Measurement and Output Requirements

- Report input power at system level
  - Online 3 and Online 4 only
  - Optionally report inlet air temperature too
- Implementation shall follow the reporting and sampling requirements in Sections 3.7.2 and 3.7.3 of the specification.
- iPDUs may be used to fulfill these requirements if the storage product cannot
  - iPDUs must be <u>made available</u> for purchase with the storage product

Test Method

- Provides guidance on input power and frequency requirements for the following product types:
  - Products with Ac-dc single output PSUs
  - Products with Ac-dc multi-output PSUs
  - Products with Ac-dc for Japanese markets
  - Three-phase products for North American market
  - Three-phase products for European market

Test Method

- Guidance on environmental test variables including:
  - Ambient temperature
  - Relative humidity

- Guidance on power meter and temperature sensor accuracy requirements

Test Method – Deviations from SNIA Emerald™ Specification

- Online 2 storage products must contain a controller with advanced data recovery capability

- Storage products shipped with COMs must disable all COMs that are capable of being disabled during the following tests:
  - SUT Pre-fill Test
  - SUT Conditioning Test
  - Active State Test
  - Ready State Idle Test

Test Method – Deviations from SNIA Emerald™ Specification

- Network Attached Storage (NAS) products that ship with Block I/O capability shall be tested under the following additional requirements:

  1. All usable storage devices not needed for minimal NAS capability shall be allocated to Block I/O for all testing

  2. NAS functionality shall be enabled for all testing

  3. No external NAS storage requests shall be presented to a product during testing

Agenda

1	ENERGY STAR Overview
2	Version 1.0 Storage Specification Overview
3	Overview of CB Details
4	Open Questions & Comments

Certification Timeline

August 14th:
Training Webinar

October 2013:
EPA announces recognized CBs

CBs submit applications to EPA

CBs certify products and submit data via QPX

Late August 2013:
Specification and test method published

Early December 2013
EPA posts QPL for all products in Version 1.0 scope

Application Process

- After the specification and test method are finalized, EPA will begin accepting applications for recognition
- Please send a signed application and evidence that you have contacted your accreditation body requesting a scope expansion for the Data Center Storage program to certification@energystar.gov:
- A successful QPX test submission using the Data Center Storage web service will also be a pre-requisite for recognition.
- Submission deadline for those CBs that want to be among the first batch recognized will be early October. EPA will continue to accept applications at any time, but cannot guarantee prompt recognition for those that apply after the submission deadline.

Submission Deadline
Early October 2013

Scope Evaluation

- How to determine if a product is in scope:

Product Attribute	✔ In Scope	🚫 Out of Scope
Power Type	AC single phase, AC three phase	DC
Taxonomy	• Online 2, 3, 4	• Online 1, 5, 6 • Near-online • Removable Media Library • Virtual Media Library • Adjunct Storage Products • Interconnect Elements
Controller with Advanced Data Recovery Capability?	Yes	No
Block I/O capable?	Yes	No

Reporting Requirements

A successful QPX test submission using the Data Center Storage web service will be a pre-requisite for CB recognition.

CBs shall report the following data to EPA which includes both tested and verified data and manufacturer provided information:

- General characteristics
- Electrical characteristics
- Active and idle power consumption and performance values for all tested configurations
- Available and enabled power savings features
- Thermal characteristics and air inlet temperature measurements
- List of qualified configurations, including SKUs or configuration IDs

Fields are specified in the data reporting template (QPX). This template was released for CB and stakeholder review in the July. Comments on this document were due August 15th.

Using the QPX

- Single configurations shall have data from one configuration provided in the QPX

- Each product family shall have data for at least one storage device for each workload type certified in the product family:

Transaction Optimization	Streaming Optimization	Capacity Optimization

- For product families with multiple configurations, all required testing configurations are reported in the same data submission

ENERGY STAR Data Submission

- Qualified Product Exchange (QPX) EPA-recognized certification bodies submit data

- System characteristics and power/performance data information displayed on ENERGY STAR website

CB 1

CB 2

CB 3 …

QPX

CBs coordinate with manufacturers to obtain necessary data.

New Qualified Product Lists

- Enormous data set
  - One of the largest in the world
  - Lists all ENERGY STAR qualified products for the US market
  - All 65+ products types
- Transition in process to new system
  - Target completion date mid-2013
- "ENERGY STAR Product Finder"
  - Basic View
    - Compare Feature
    - Product Details
  - Advanced View
    - Export Options
    - Filter Options
  - Direct access to all datasets
  - Machine readable data export formats (XML, etc.)
- Automated updates Monday, Wednesday and Friday of each week

Remaining Version 1.0 Timeline

- June 20: Final Draft specification and test method released
- June 24 – 26:
  - SNIA Emerald test training for CBs, labs.
  - ENERGY STAR specification training for CBs, labs
- July 9: Final Draft stakeholder webinar
- July 15: Final Draft written comments due
- Late July:
  - Draft QPX form released for stakeholder review
  - Comments due +3 weeks later
- End of August:
  - Final Storage Program Requirements released
- Mid-September:
  - QPX system finalized
  - CB can start submitting applications
  - Submit test QPX data
- Early October: Deadline for first batch of CB applications
- Mid-October: EPA announces recognized CBs
- Late November/Early December: Version 1.0 Storage is effective
  - Note this is a three month delay until effective date
  - Due to unique complexity of this product category

Agenda

1	ENERGY STAR Overview
2	Version 1.0 Storage Specification Overview
3	Overview of CB Details
4	Open Questions & Comments

References and Resources

Questions?
Please send any technical questions to: storage@energystar.gov
Please send any certification questions to: certification@energystar.gov
Please find CB Resources at: www.energystar.gov/CBresources

Thank You!

RJ Meyers
EPA, ENERGY STAR
(202) 343-9923
Meyers.Robert@epa.gov

John Clinger
ICF International
(215) 967-9407
John.Clinger@icfi.com