



# SPC Benchmark 1/Energy™ (SPC-1/E™)

*SPC Benchmark 1™ with Energy Use Extension*

*<http://www.StoragePerformance.org>*

*[SPCadmin@StoragePerformance.org](mailto:SPCadmin@StoragePerformance.org)*



## SPC Benchmark 1/Energy™

---

- SPC Benchmark 1/Energy™ (*SPC-1/E™*) is an extension to the first industry standard storage benchmark, SPC Benchmark 1™ (*SPC-1™*).
- SPC-1/E was publicly announced on October 13, 2009. Xiotech Corporation was the first SPC member company to submit results at that time.
- SPC-1/E consists of the complete set of SPC-1 performance measurements and reporting, combined with the measurement and reporting of energy use.



## SPC Benchmark 1/Energy™

---

- SPC Benchmark 1/Energy (*SPC-1/E*) is the second SPC benchmark to include measurement and reporting of energy use in addition to storage performance.
- SPC Benchmark 1C/Energy (*SPC-1C/E*) was the first SPC benchmark to include measurement and reporting of energy use in addition to storage performance



## SPC Benchmark 1/Energy™

---

- SPC-1/E expands measurement to larger, more complex storage configurations.
- SPC-1/E is applicable to any SPC-1 storage configuration that can be measured with a single SPC approved power meter/analyzer.
- SPC-1C/E is only applicable to Small Storage Subsystems
  - A maximum of forty-eight (48) storage devices in no larger than a 4U enclosure profile (*1 – 4U, 2 – 2U, 4 – 1U, etc.*)



## SPC Benchmark 1/Energy™

---

- In addition to the “core” SPC-1 performance measurement and reporting requirements, SPC-1/E defines:
  - Configuration and instrumentation requirements for energy usage measurement
  - Execution requirements for application idle state measurements and the transition into active (*performance*) state measurements
  - Data collection requirements for energy use measurements
  - Expanded disclosure and audit requirements



## SPC Benchmark 1/Energy™

---

- The storage configuration's energy use is measured and reported.
  - Measurements are taken during both application idle and active states of the benchmark execution.
  - Multiple application idle phases are allowed.
  - The active (*performance*) state consists of the SPC-1 Tests.
- SPC-1/E energy use results cannot be reported without the corresponding SPC-1/E performance results.



# SPC Benchmark 1/Energy™

---

## □ SPC-1/E execution profile:

- A 10 minute “precondition” phase at 100% of the specified performance offered load.
- An application idle phase lasting at least 30 minutes with one or more distinct phases.
- Each application idle phase may be preceded by an optional transition period not to exceed 3 minutes.
- A second 10 minute “precondition” phase at 10% of the specified performance offered load.
- Execution of the current SPC-1 Tests:  
*Metrics (Sustainability, IOPS, Response Time Ramp),  
Repeatability, and Persistence (energy use measurements are  
not taken during the Persistence Test)*



# SPC Benchmark 1/Energy™

---

## □ SPC-1/E application idle phases:

- More than one idle phase is allowed as long as transitions between idle phases do not require manual intervention.  
*Idle Phase 0, Idle Phase 1...Idle Phase L-1, Idle Phase L*
- Idle Phase 0 thru Idle Phase L-1 must have the same duration, selected by the Test Sponsor, up to a maximum of 10 minutes.
- Idle Phase L (“deepest” idle state) duration is selected by the Test Sponsor with a minimum of 30 minutes.
- The simplest Idle Test consists of a single idle phase with a duration of 30 minutes.





## SPC Benchmark 1/Energy™

---

- SPC-1/E Reported Data includes multiple energy use metrics:
  - Across several selected environments
  - Taking into account hourly variations in I/O load
- This reported data will allow an estimate of average annual energy use.
- The SPC-1/E required table and graph lists and illustrates storage performance and energy use for each performance test.



# SPC Benchmark 1/Energy™

- An example of SPC-1/E Reported Data:
  - Items highlighted in red have been added to the reporting requirements since the initial release of SPC-1C/E.

<b>Power Environment</b>		<b>Average RMS Voltage:</b> <span style="border: 1px solid black; padding: 2px;">206.64</span>		<b>Average Power Factor:</b> <span style="border: 1px solid black; padding: 2px;">0.832</span>			
<b>Usage Profile</b>							
	Hours of Use per Day			Nominal	Nominal	Nominal	Nominal
	Heavy	Moderate	Idle	Power, W	Traffic, IOPS	IOPS/W	Heat, BTU/hr
Low Daily Usage:	0	8	16	164.58	1165.93	7.08	561.56
Medium Daily Usage:	4	14	6	342.46	2968.61	8.67	1,168.51
High Daily Usage:	18	6	0	453.15	5051.52	11.15	1,546.18
<b>Composite Metrics:</b>				<span style="border: 1px solid black; padding: 2px;">320.06</span>	<span style="border: 1px solid black; padding: 2px;">3,062.02</span>		
Annual Energy Use, kWh:	<span style="border: 1px solid black; padding: 2px;">2,803.75</span>						
Energy Cost, \$/kWh:	<span style="border: 1px solid black; padding: 2px;">\$ 0.12</span>			Annual Energy Cost, \$: <span style="border: 1px solid black; padding: 2px;">\$ 336.45</span>			

**AVERAGE RMS VOLTAGE:** The average supply voltage applied to the Tested Storage Product (TSP) as measured during the Measurement Intervals of the SPC-1/E Tests.

**AVERAGE POWER FACTOR:** The ratio of average real power, in watts, to the average apparent power, in volt-amps flowing into the Tested Storage Product (TSP) during the Measurement Intervals of the SPC-1/E Tests.

**NOMINAL HEAT, BTU/HR:** The average amount of heat required to be dissipated over the course of a day (24 hours), taking into account hourly load variations. (1 watt = 3.412 BTU/hr)



# SPC Benchmark 1/Energy™

□ An example of SPC-1/E Reported Data (*continued*):

<b>Power Environment</b>		<b>Average RMS Voltage:</b> <input type="text" value="206.64"/>		<b>Average Power Factor:</b> <input type="text" value="0.832"/>		
<b>Usage Profile</b>						
	Hours of Use per Day			Nominal	Nominal	Nominal
	Heavy	Moderate	Idle	Power, W	Traffic, IOPS	IOPS/W
Low Daily Usage:	0	8	16	164.58	1165.93	7.08
Medium Daily Usage:	4	14	6	342.46	2968.61	8.67
High Daily Usage:	18	6	0	453.15	5051.52	11.15
						<b>Nominal Heat, BTU/hr</b>
						561.56
						1,168.51
						1,546.18
<b>Composite Metrics:</b>				<input type="text" value="320.06"/>	<input type="text" value="3,062.02"/>	<input type="text" value="9.57"/>
<b>Annual Energy Use, kWh:</b>		<input type="text" value="2,803.75"/>				
<b>Energy Cost, \$/kWh:</b>		<input type="text" value="\$ 0.12"/>				
				<b>Annual Energy Cost, \$:</b> <input type="text" value="\$ 336.45"/>		

## SPC-1/E Reported Data

The above usage profile describes conditions in environments that respectively impose light ("low"), moderate ("medium"), and extensive ("high") demands on the Tested Storage Configuration (TSC).

**HEAVY SPC-1 Workload:** 455.19W at 80% of maximum reported performance (*5,569.43 SPC-1 IOPS*).

**MODERATE SPC-1 Workload:** 447.01W at 50% of maximum reported performance (*3,497.79 SPC-1 IOPS*).

**IDLE SPC-1 Workload:** 23.37W at 0% of maximum reported performance (*0.00 SPC-1 IOPS*).

**LOW DAILY USAGE:** Zero (0) hours of **HEAVY** SPC-1 Workload, eight (8) hours of **MODERATE** SPC-1 Workload, and sixteen (16) hours of **IDLE** SPC-1 Workload.

**MEDIUM DAILY USAGE:** Four (4) hours of **HEAVY** SPC-1 Workload, fourteen (14) hours of **MODERATE** SPC-1 Workload, and six (6) hours of **IDLE** SPC-1 Workload.

**HIGH DAILY USAGE:** Eighteen (18) hours of **HEAVY** SPC-1 Workload, six (6) hours of **MODERATE** SPC-1 Workload, and zero (0) hours of **IDLE** SPC-1 Workload.



# SPC Benchmark 1/Energy™

□ An example of SPC-1/E Reported Data (*continued*):

<b>Power Environment</b>				<b>Usage Profile</b>			
Average RMS Voltage: <b>206.64</b>				Average Power Factor: <b>0.832</b>			
	Hours of Use per Day			Nominal Power, W	Nominal Traffic, IOPS	Nominal IOPS/W	Nominal Heat, BTU/hr
	Heavy	Moderate	Idle				
Low Daily Usage:	0	8	16	164.58	1165.93	7.08	561.56
Medium Daily Usage:	4	14	6	342.46	2968.61	8.67	1,168.51
High Daily Usage:	18	6	0	453.15	5051.52	11.15	1,546.18
<b>Composite Metrics:</b>				<b>320.06</b>	<b>3,062.02</b>	<b>9.57</b>	
Annual Energy Use, kWh:	<b>2,803.75</b>						
Energy Cost, \$/kWh:	<b>\$ 0.12</b>			Annual Energy Cost, \$: <b>\$ 336.45</b>			

**NOMINAL POWER, W:** The average power consumption over the course of a day (24 hours), taking into account hourly load variations.

**NOMINAL TRAFFIC, IOPS:** The average level of I/O requests over the course of a day (24 hours), taking into account hourly load variations.

**NOMINAL IOPS/W:** The overall efficiency with which I/O requests can be supported, reflected by the ratio of **NOMINAL TRAFFIC** versus the **NOMINAL POWER**.

**COMPOSITE METRICS:** The aggregated **NOMINAL POWER**, **NOMINAL TRAFFIC**, and **NOMINAL IOPS/W** for all three environments: **LOW**, **MEDIUM**, and **HIGH DAILY USAGE**.

**ANNUAL ENERGY USE, KWH:** An estimate of the average energy use across the three environments over the course of a year and computed as (**NOMINAL POWER** \* 24 \* 0.365).

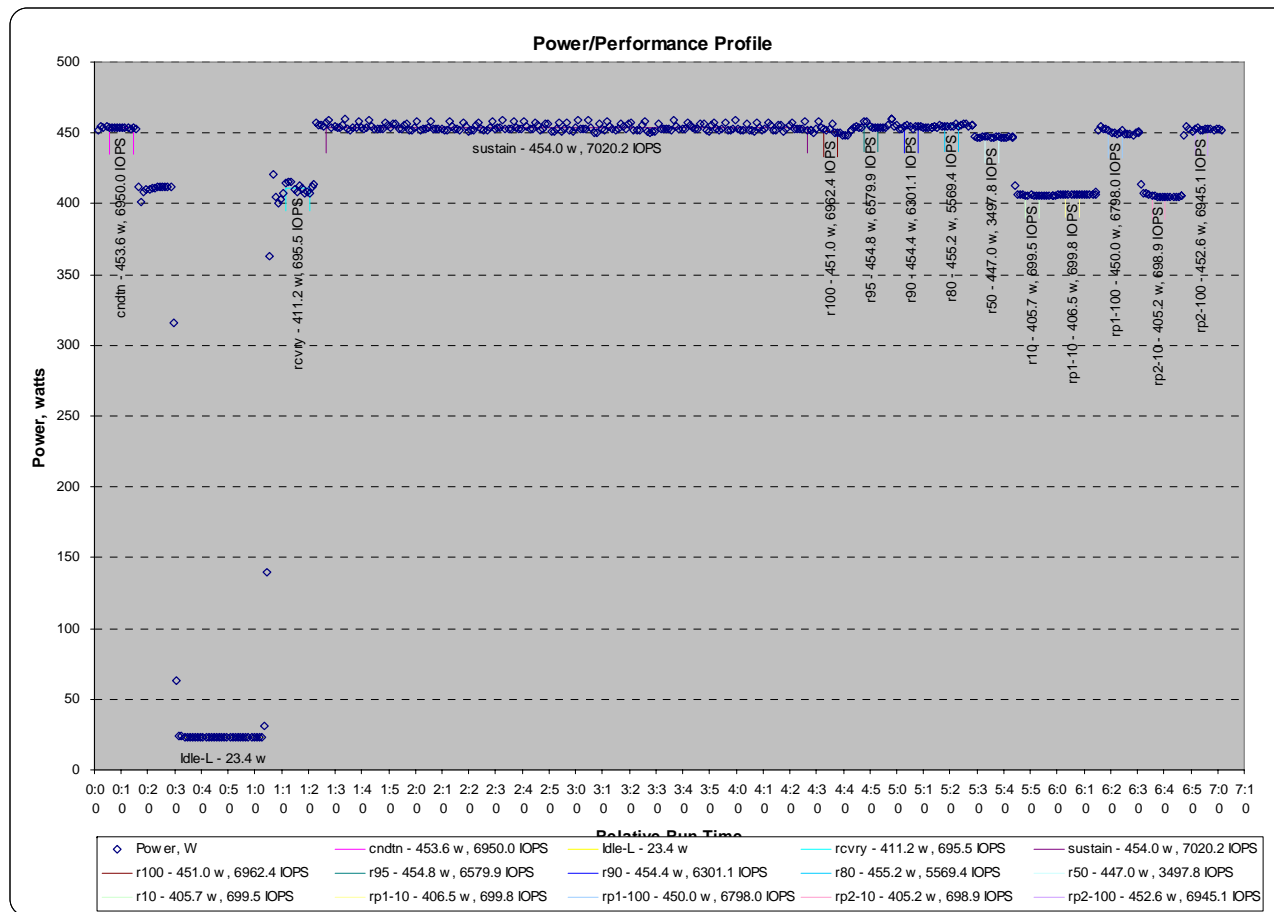
**ENERGY COST, \$/KWH:** A standardized energy cost per kilowatt hour.

**ANNUAL ENERGY COST:** An estimate of the annual energy use across the three environments over the course of a year and computed as (**ANNUAL ENERGY USE** \* **ENERGY COST**).



# SPC Benchmark 1/Energy™

- Example of SPC-1/E required graph (corresponds to the earlier Reported Data example):





## SPC Benchmark 1/Energy™

---

- SPC-1/E Reported Data allows comparison of performance, price-performance, and energy use data singularly or in combinations.
  - A more informed purchase decision by end-users.
  - Expanded insight for vendors during the development and testing of new/updated products.
  
- The two Xiotech SPC-1/E Results are excellent examples.



## SPC Benchmark 1/Energy™

---

- Xiotech Emprise Performance 5000:
  - 146 GB, 15K RPM, 3.5” disk drives
- Xiotech Emprise Capacity 5000:
  - 600 GB, 10K RPM, 3.5” disk drives
- 600 GB configuration provides 88% of 146 GB configuration’s performance with a 20% energy savings.



## SPC Benchmark 1/Energy™

---

- First industry standard measurement of a power saving/management feature:
  - Xiotech PowerNAP: Low power standby mode during idle periods
- Xiotech Emprise Performance 5000:
  - 413.44W to 23.37W, 94.35% reduction
- Xiotech Emprise Capacity 5000:
  - 331.98W to 23.45W, 92.94% reduction





# SPC Benchmark 1/Energy™

---

## □ SPC-1/E future investigations/development:

- Expanding SPC-1/E to use multiple power meters/analyzers.
  - Will begin testing later in the year with two power meters/analyzers with larger, more complex storage configurations.
  - Investigate the use of multiple power meters/analyzers to measure specific components as well the complete configuration.



## SPC Benchmark 1/Energy™

---

### □ SPC-1/E future investigations/development:

- Energy use extension for SPC-2/SPC-2C
  - Will begin testing later this year or early 2010 to determine which of the three SPC-2/SPC-2C workloads (Large File Processing, Large Database Query, and Video on Demand) would be appropriate for inclusion in an energy use extension..



## SPC-1/E – SPC-1C/E End-User Tool

---

- An end-user tool for SPC-1/E and SPC-1C/E is under investigation, which would allow “customization/localization” of benchmark extension’s Reported Data by:
  - Allowing the end-user to change values in the “Hours of Use per Day” matrix to reflect actual or projected values..
  - Use local energy cost for calculating “Annual Energy Use (*kWh*).



# SPC-1/E – SPC-1C/E End-User Tool

- The end-user may only change the values highlighted in **red**, which will reflect actual or projected usage values. All other values are either calculated by the tool or extracted by the tool from the SPC-1/E – SPC-1C/E Result of interest.

Power Environment				Usage Profile			
Average RMS Voltage:		206.64		Average Power Factor:		0.832	
	Hours of Use per Day			Nominal	Nominal	Nominal	Nominal
	Heavy	Moderate	Idle	Power, W	Traffic, IOPS	IOPS/W	Heat, BTU/hr
Low Daily Usage:	0	8	16	164.58	1165.93	7.08	561.56
Medium Daily Usage:	4	14	6	342.46	2968.61	8.67	1,168.51
High Daily Usage:	18	6	0	453.15	5051.52	11.15	1,546.18
Composite Metrics:				320.06	3,062.02	9.57	
Annual Energy Use, kWh:		2,803.75					
Energy Cost, \$/kWh:		\$ 0.12		Annual Energy Cost, \$:		\$ 336.45	