



NRDC's Response to CEC's Invitation to Participate in the Development of Appliance Energy Efficiency Measures

2013 Appliance Efficiency Pre-Rulemaking on Appliance Efficiency Regulations: Docket Number 12-AAER-2A - Consumer Electronics – Game Consoles

May 9, 2013

Submitted by:

Pierre Delforge, Natural Resources Defense Council

On behalf of the Natural Resources Defense Council and our more than 250,000 members and online activists in California, we respectfully submit this response to the Energy Commission's Invitation to Participate in the Development of Appliance Energy Efficiency Measures, posted on March 25, 2013. This response addresses the Commission's questions on game consoles.

I. Market Characteristics

Video game consoles have become a staple in the majority of California homes with an average of one console per household in the state. Sales are expected to increase over the next few years as the introduction of next generation consoles in 2013 triggers a refresh of existing stock. Some of the most common game consoles on the market today consume a similar amount of annual energy to a mainstream desktop computer. In aggregate, California game consoles consume roughly 1,100 GWh annually, equivalent to half the output of a medium-sized 500 MW power plant, and as much electricity as is consumed annually by all the households in the city of Oakland.

II. Basic Information

Existing programs - The only existing energy efficiency standard for game consoles in the US is the newly announced EPA recognition program, which is voluntary. As of today, none of the game consoles on the market have sought recognition under this program although the Nintendo Wii U appears to meet the program's requirements. The EPA program is voluntary, providing no guarantee that manufacturers will produce qualifying products or participate. A mandatory standard will ensure that game consoles meet minimal efficiency requirements whether they participate or not in the EPA program.

EPA’s specification includes power limits for the following modes of operation: Active Navigation Menu, Active Streaming Media and Standby. It does not include limits for Active Game Play.

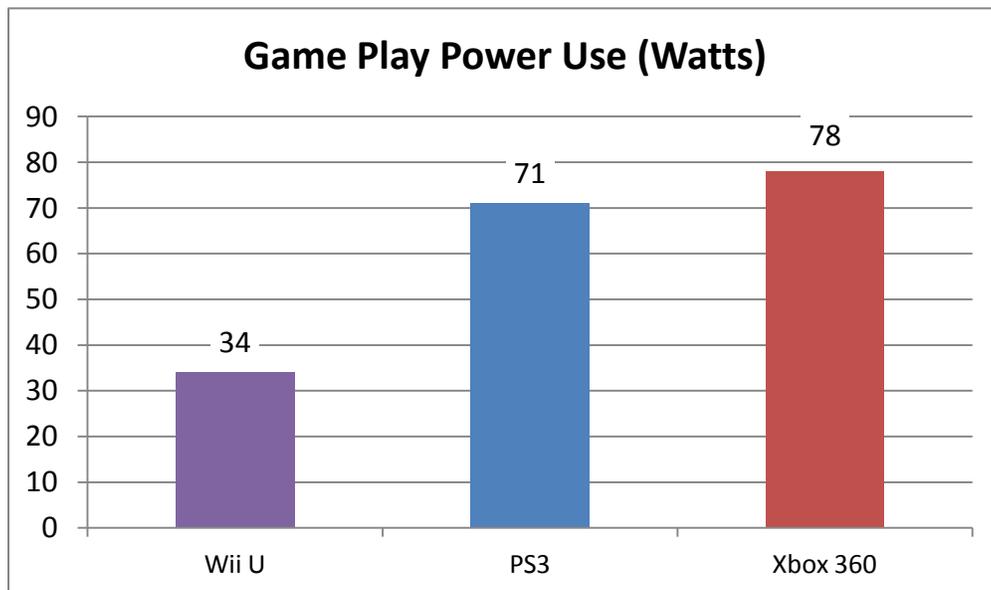
Test methods - The EPA program provides a test method for all key operating modes except for Game Play. NRDC proposes a test method for active Game Play in Appendix 1. A Game Play test method is important in order to 1) inform users of the power draw of their console in active gaming mode, 2) enable CEC and stakeholders to monitor Game Play power use and reassess the energy use of consoles in that mode and the opportunity for policy intervention, and 3) encourage manufacturers to voluntarily reduce active gaming power use.

Standard framework - The ENERGY STAR program provides a robust framework for a CEC standard, which does not limit power use in Game Play, the primary function of game consoles. The program only sets power limits for secondary modes such as Streaming Media Play, Navigation Menu and Standby. CEC can use a similar framework with standard levels adjusted to account for the mandatory nature of Title 20 standards. This will not limit console performance when playing games, and will ensure that consoles are designed to use energy efficiency best-practices to perform secondary functions where higher efficiency alternatives are available.

III. Operations, Functions and Modes

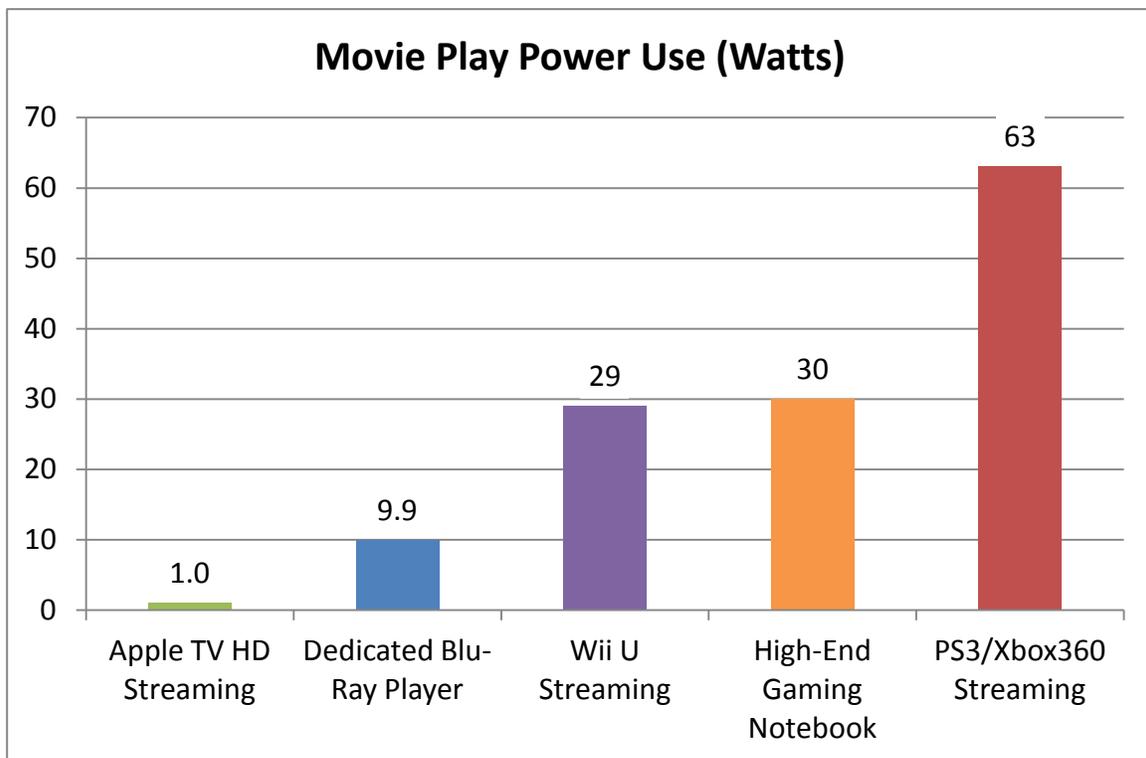
Range of power use – There is a wide range of power use among consoles on the market to perform similar tasks. For example, the PS3 and Xbox 360 draw twice as much power as the Wii U to play a typical game in HD:

Figure 1: Range of Power use to Play a Game in High Definition



Game consoles are also being used increasingly for non-gaming functions such as watching streaming media. Microsoft claims that “Xbox users now spend more time consuming media than playing games”¹. Unfortunately game consoles draw much higher power than other devices to play the same video with the same resolution. There is a very large range of energy use between different types of devices to play the same video with the same resolution. This reflects different architectures and capabilities as integrated game consoles are designed to play games which dedicated steaming players cannot, however there are significant differences even between multi-function devices of equivalent capabilities such as between the higher-consuming consoles and high-end gaming notebooks. As playing movies and videos becomes one of the most popular uses of game consoles, the energy used in media play could increase substantially when much more efficient alternatives are available.

Figure 2: Comparison of HD Movie Play Power Use on a Range of Devices



¹ <http://allthingsd.com/20130104/game-on-xbox-bosses-mehdi-tellem-come-to-dive-into-media/>

Power data - The power use of game consoles in key operating modes is easily measured. NRDC tested recent models of the 4 main consoles on the market and obtained the following data:

Power use of recent consoles (all measurements in watts)

	Standby	Networked Standby	Active Navigation Menu	Active Streaming Media	Active Game Play
Microsoft Xbox 360 (2013)	0.4	N/A	65	63	78
Nintendo Wii (2010)	1.3	10 (6 in 2012)	12	14	14
Nintendo Wii U (2012)	0.5	0.5/11 ²	32	29	35
Sony PS3 (2013)	0.3	11	68	63	71

Modes are defined as follows:

- Standby: Off, cannot be reactivated from the network, per EU Ecodesign definition.
- Networked Standby: Off with active network link, the console can be reactivated from the network, per EU Ecodesign definition.
- Active Navigation Menu: Home menu, equivalent to Idle on a computer.
- Active Streaming Media: Actively playing a movie or video.
- Active Game Play: Actively playing a game.

There are a number of new consoles announced for introduction in the coming months, including next generations of existing consoles such as the PlayStation 4, and new market entrants such as the Ouya³ and Xi3 Piston⁴ consoles. Preliminary reports indicate power use in game play of the order of 5W for the Ouya console⁵ and 40W for the Piston console⁶. We will refine these numbers as soon as possible based on each console's launch schedule. This should be in time for consideration as part of subsequent phases of the rulemaking for some of the new consoles. Microsoft is also expected to make announcements this Spring on the successor to the Xbox 360.

² Per an April 2013 system update, the Wii U is now capable of downloading content while in standby and uses 11 watts to do so. However the Wii U appears to go back to a low-power standby mode once it has completed the download. We are investigating this behavior further.

³ <http://www.ouya.tv/>

⁴ http://xi3.com/buy_now-piston.php

⁵ <http://www.engadget.com/2013/04/03/ouya-review-founding-backer-edition/>

⁶ <http://www.eurogamer.net/articles/df-hardware-what-is-inside-piston>

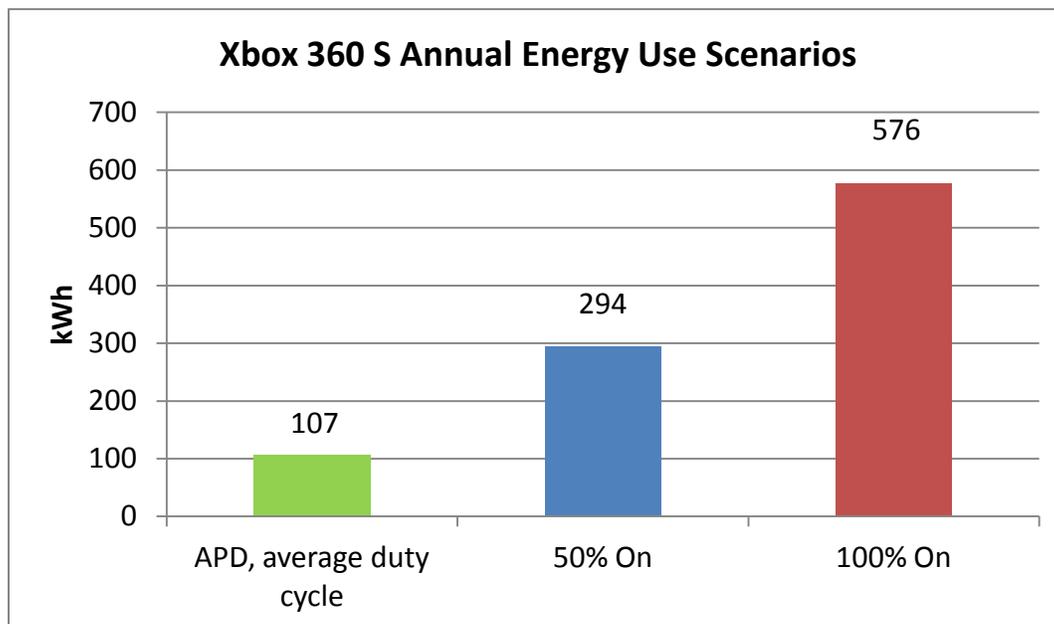
Duty cycle data - There is little publicly available data on the average time spent by users in the various modes of the console, however manufacturers have data on the usage patterns of their own consoles and have shared some of it informally with advocates. We provide below our best-estimate duty cycle derived from discussions with industry and non-publicly available surveys and data shared by manufacturers.

% of Time	PS3	Wii	Wii U	Xbox 360
Game Play	7.0%	7.0%	7.0%	7.0%
Media	5.0%	5.0%	5.0%	5.0%
Navigation	5.0%	5.0%	5.0%	5.0%
Standby	78%	41.5%	83%	83%
Networked Standby	5% ⁷	41.5% ⁸	0% ⁹	0%

These are average numbers across the entire stock, including some consoles which are left on all/most of the time, some which are switched off manually or use auto-power down (APD), and some which are rarely or never used.

The energy use of game consoles is highly dependent on how much time they are used and whether they are switched off when not in use. Figure 3 illustrates the annual energy consumption of an Xbox 360 under three scenarios.

Figure 3: Annual Energy Consumption of the Xbox 360 Under Three Usage Scenarios



⁷ In the absence of publicly available data, and based on manufacturer feedback supported by anecdotal evidence that the Remote Play mode is not commonly used, we provide this number as an assumption.

⁸ In the absence of more specific data, we propose to use the assumption that Wii standby mode is evenly divided between passive and networked standby.

⁹ The Wii U has just released a system update enabling software download in standby mode, and has announced a future update to extend this functionality to applications under the “SpotPass” name. It is too early to estimate the percent of time spent in this mode. We will use 0 and will update this assumption as soon as possible.

Figure 3 shows the importance of auto-power down in reducing annual energy use. To be effective, APD needs to remain enabled in the vast majority of consoles over their life. The challenge of keeping APD enabled is illustrated by a 2010 study on residential desktops which found that 80 percent of desktop computers in US homes do not have sleep/hibernate enabled¹⁰.

IV. Hardware Technology

Power supply efficiency – NRDC commissioned Ecova to measure the efficiency of power supplies used in PS3 and Xbox 360 models purchased in March 2013.

PS3 - The PS3 uses an internal power supply, which was tested using the Generalized Internal Power Supply Efficiency Test Protocol¹¹.

Load	20%	50%	100%	Average
PS3-CECH 4001B	74.82%	81.58%	80.98%	79.13%

This corresponds to the following load point and efficiency in active game play:

Game play power use (PS input)	71 W
Game play power supply load point	37%
Power supply efficiency at game play (interpolation)	78.5%

A power supply with an efficiency equivalent to 80 PLUS Bronze (82% at 20% load, 85% at 50% load) would save over 5% of game play power.

Xbox 360 - The Xbox 360 uses an external multi-voltage power supply, which was tested using DOE's test procedure for EPS (June 2011):

Load	25%	50%	75%	100%	Average
Xbox 360 - Model 1439	81.61%	83.50%	81.20%	83.87%	82.55%

This corresponds to the following load point and efficiency in active game play:

Game play power use (PS input)	78 W
Game play power supply load point	56%
Power supply efficiency at game play (interpolation)	83%

A power supply with a 87% efficiency (DOE proposed 86% average efficiency in its March 2012 proposal) would save 4.6% of game play power.

¹⁰ Pigg and Bensch, Minnesota plug load study, 2010

¹¹ Tested with power supply removed from the console, with cooling from a fan powered by a source other than the power supply unit

V. Conclusion

NRDC thanks the Energy Commission for its leadership in establishing cost effective appliance efficiency standards that reduce electricity bills as well as climate and other harmful emissions for all Californians.

NRDC strongly encourages the Commission to move forward with minimum efficiency standards for game consoles.

Thank you for your consideration of NRDC's input.

Respectfully submitted,

A handwritten signature in blue ink, appearing to read 'Delforge', is positioned above the typed name.

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Appendix I - Active Gaming Test Method for Video Game Consoles

By Pierre Delforge, NRDC

Date: May 2013

I. Purpose

Active gaming continues to represent one of the highest energy uses in game consoles despite the increased use of video playback and other non-gaming uses. While NRDC does not advocate for limits on active gaming energy use in order not to interfere with console performance in gaming mode, we believe it is important to be able to measure and report average power use of video consoles in gaming mode. This will help inform users of the power draw of their console in active gaming mode, it will support potential energy labeling programs such as FTC's Energy Guide, and will encourage manufacturers to reduce active gaming power use voluntarily.

The purpose of this paper is to investigate the feasibility of a test method for video game consoles active gaming mode, and propose a draft of this test method.

The investigation attempts to address the following key challenges with active gaming power measurement:

1. **Reproducibility:** How to ensure that measurements can be reproduced consistently, despite the fact that active gaming power use varies depending on user actions during a gaming session and across gaming sessions and users.
2. **Representativeness:** How to ensure that the test method yields a reasonable proxy for active gaming energy use in the field. Active gaming power varies across game titles for a given console.
3. **Identify any other factors** that need to be taken into account by the test method, such as use of pause mode, idle time, and cut scenes.

Note that Mexico already requires reporting of console Game Play power use, but without defining a test procedure. This proposal has the benefit to enable such reporting in a reproducible and representative manner.

II. Summary of Findings

NRDC's testing shows that while instantaneous power use in game play mode is highly variable depending on place in the game and user behavior, most of this variability averages out over time. When measurements are taken over a sufficiently long period of time (such as 20 minutes or longer) and selecting a test game or test sequence that does not include cut scenes, the variability between different measurement sessions for a given game and user is less than 2%.

User variability can be minimized by ensuring that the person playing the game during testing has minimal familiarity with the game controls and principles. If the tester is not familiar with the game, for example in a 3rd-party test lab, we suggest the user familiarizes him or herself with the game for at least 1 hr prior to testing, which should be sufficient to minimize variability with novice users.

Power use varies by game title, with the majority of game title average power use in a narrow 5% band, with a few outliers outside that band. We suggest a pre-test benchmarking process to select a reference test title close to the median of that band, and using that reference test title in the rest of the test method for a given console model, as representative of typical game play power use for that model.

The largest variability we identified came from different units of the same console model, likely due to component variations and manufacturing variability in IC components. We suggest an approach of selecting a unit that is typical of the highest power consuming unit among the key component combinations, or alternatively an approach reporting a range of the highest and lowest power consuming units among key component combinations.

Other factors can influence test results including console temperature driving variable fan activity, cut scenes which introduce non-negligible variability in natural game play, and the use of Pause or Idle in game play. We suggest a test method that avoid or minimizes variability from these factors.

We conclude that it is feasible to define a test method that yields reasonably reproducible results (within a 5-10% range depending on testing conditions), is representative of actual game play power use in the field and does not impose an undue testing burden and therefore cost on manufacturers.

This analysis is based on Sony PlayStation 3 platform only. Its findings need to be validated on the Microsoft Xbox 360 and the Nintendo Wii platforms.

III. Study Approach

The objectives of this study were to identify the main factors that contribute to the variability of power use in game play, and to determine the feasibility of measuring game play power use in a reproducible and representative manner. To this effect, extensive measurements were performed across a variety of PS3 models, units, game titles and users. We selected 12 PS3 game titles covering different types of games (1st/3rd person shooter, fighting, driving, Sports, Action adventure, Casual). We metered console power use while players were actively playing these game titles. Game play was natural, not scripted. We then downloaded and analyzed the data, and present the results in this paper.

Console models and meters summary:

Tester	Meter	PS3 model	PS3 Release Date
Sony	Xitron 2802 Xitron 2801	CECH-3001A	Aug-11
Sony	Xitron 2802	CECH-2101A	May-10
NRDC	Watts Up Pro – NRDC Xitron 2801	CECH-3001A	Aug-11
Ecova	Yokagawa Watts Up Pro - Ecova	CECH-2101A	May-10

Summary of Testing Performed:

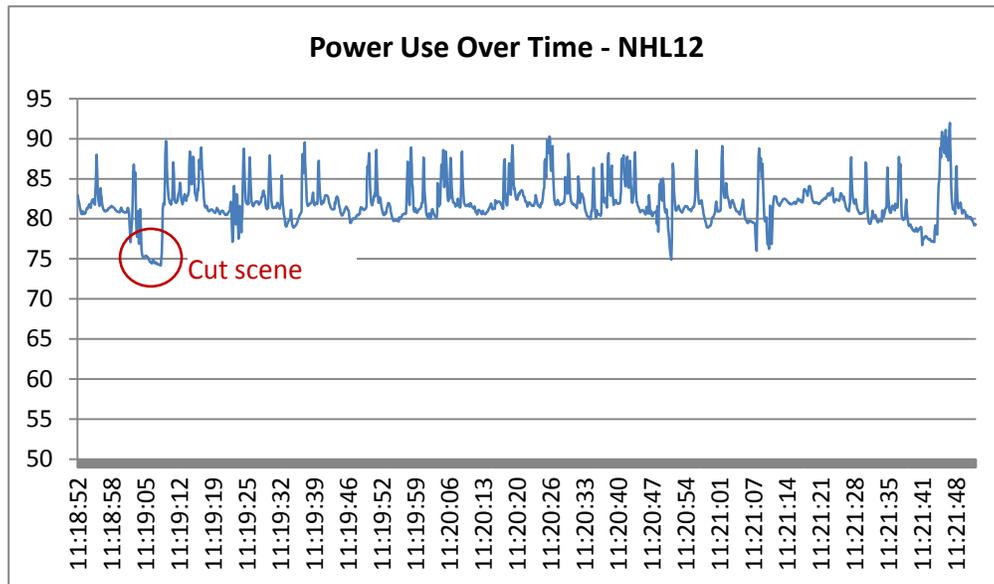
PS3 Model	Unit	Game Title	Sessions	Total Time (hh:mm)
CECH-3001	Sony1	Call of Duty, Modern Warfare 3	2	0:06
		God of War	2	0:06
		NHL12	2	0:05
		Tekken Hybrid	2	0:06
	Sony2	Call of Duty, Modern Warfare 3	3	1:42
		NHL12	2	1:01
	CF413676151-Sony3	Sonic Generations	3	0:20
		God of War III	1	0:10
		Lord of the Rings: War in the North	1	0:10
	CF414506426-Sony4	Call of Duty, Modern Warfare 3	1	0:06
		Call of Duty, Modern Warfare 3	1	0:19
		God of War	1	0:10
	CF416803486-	Sonic Generations	1	0:09
		Saint's Row	3	3:42

PS3 Model	Unit	Game Title	Sessions	Total Time (hh:mm)
	NRDC	Lord of the Rings: War in the North	2	2:18
		Sonic Generations	3	1:57
		Lego - Harry Potter	2	1:03
		God of War	2	0:39
		NHL12	3	0:39
		Jimmy Johnson's - Anything with an Engine	1	0:21
		Call of Duty, Modern Warfare 3	1	0:10
		Bejeweled - Fish Frenzy	1	0:20
		Motor Storm - Pacific Rift	1	0:14
		Back to the Future	1	0:09
		CECH-2101	Ecova	God of War
NHL12	1			0:10
Sony	NHL12		2	0:20
	God of War III		2	0:20
Grand Total			48	17:12

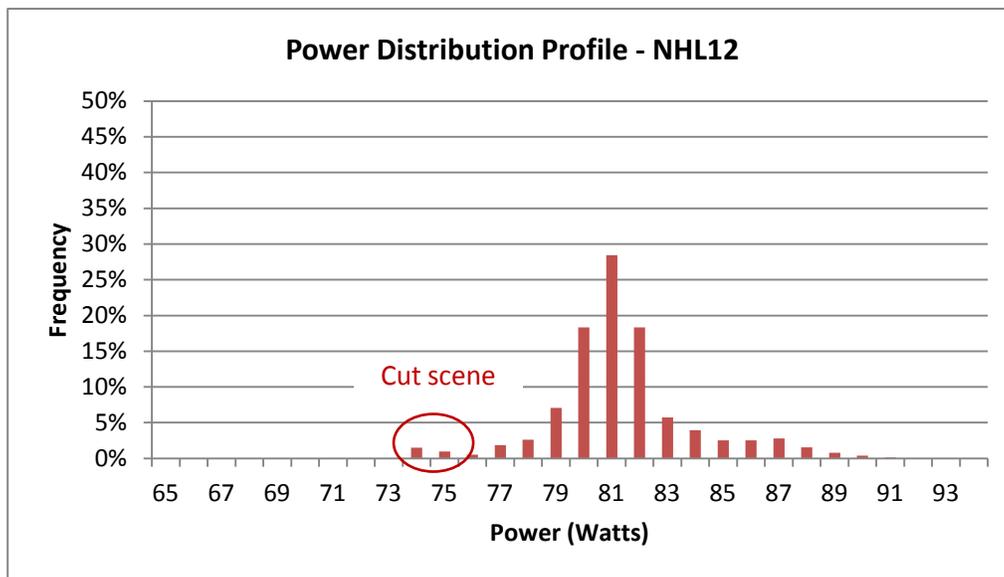
IV. Results Overview

The following data is for one specific game and measurement session, but is typical of other measurements, albeit with different averages and power signatures.

Instantaneous console power during active gaming is highly variable, as illustrated by the following chart:



Active gaming power use follows a fairly normal distribution:

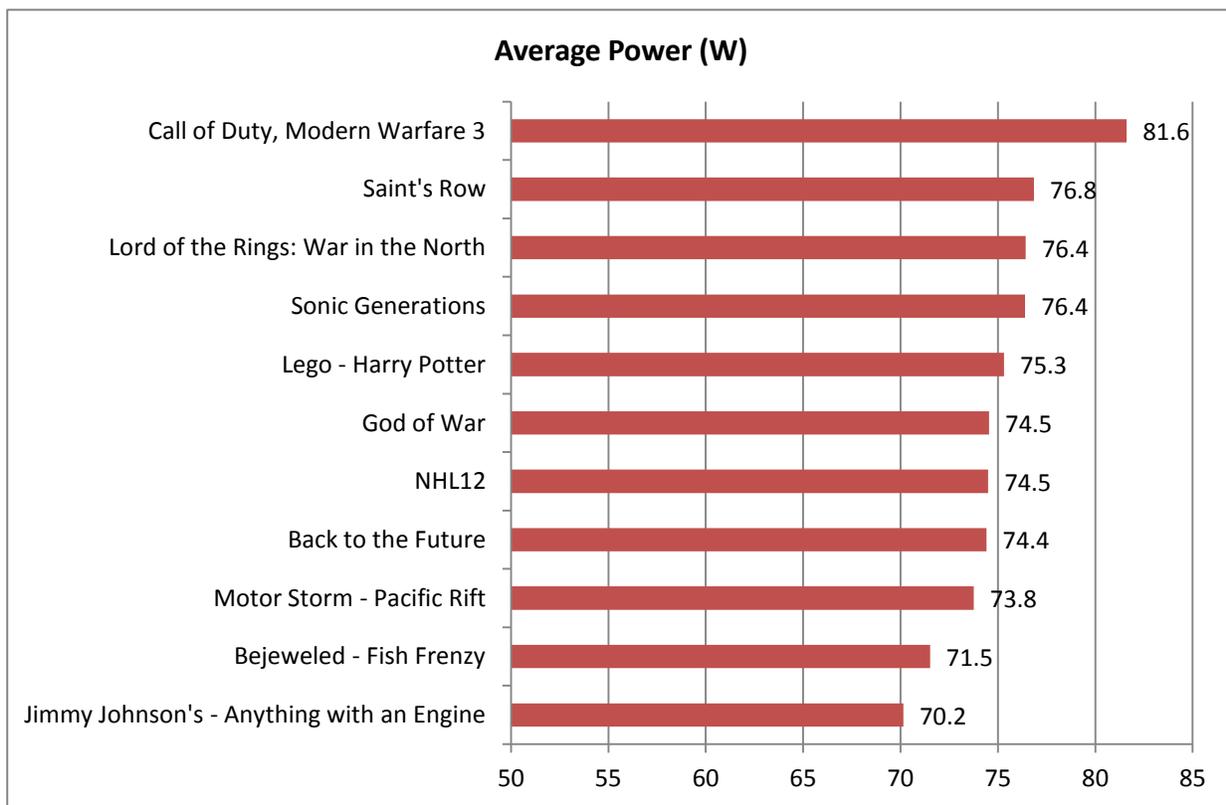


Power profile - NHL12:

Min	74.2 W
25%	80.7 W
50%	81.7 W
75%	82.7 W
Max	91.9 W
Average	81.9 W
Std Dev	2.6 W
Range	17.8 W

Average power use by game title:

The following chart shows average power use by game title for one of the PS3 units tested:



The difference between the lowest and highest consuming game is 16%, with most of the titles in a 5% band around the median.

V. Analysis

We analyzed the following sources of variability in the results, in order to determine which sources were significant and how to address them in the test method:

1. Session variability (variability within a test session and between test sessions, everything else being the same)
2. User Variability (variability due to user behavior)
3. Game title variability
4. Unit variability (differences between several units of the same console model)
5. Other factors

1. Session Variability

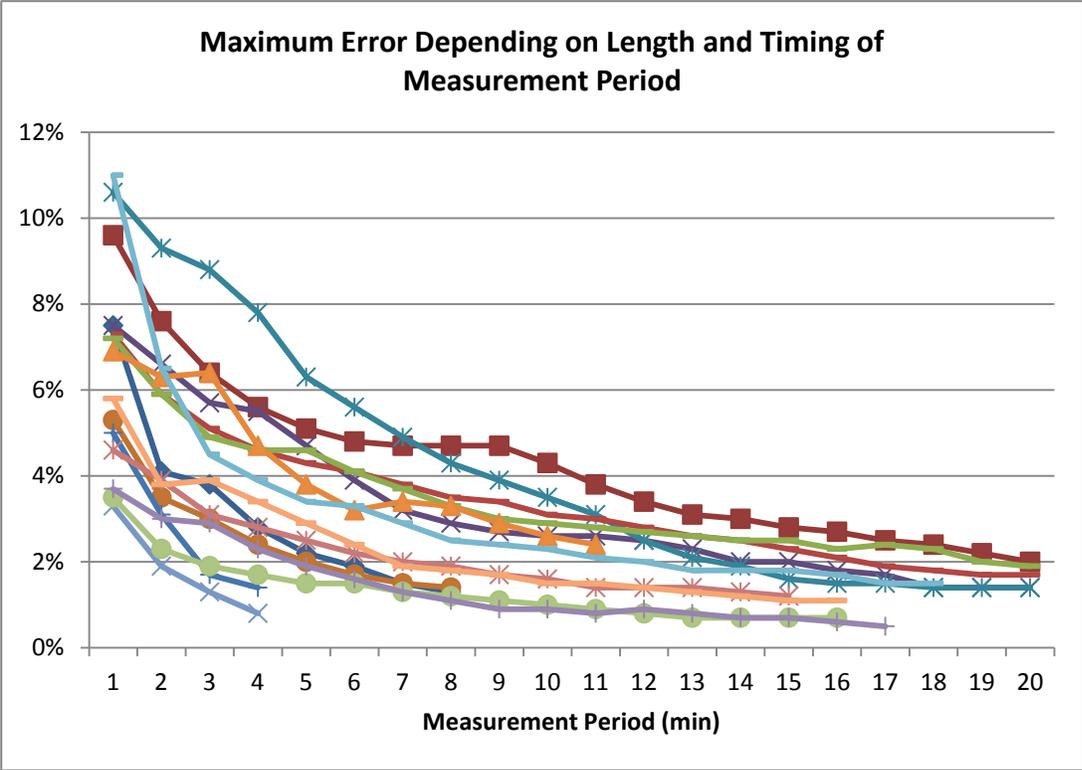
One of the main issues raised by EPA and DOE regarding a test method for active gaming was that active gaming power use varies depending on user actions, such as what the gamer is shooting at, what moves they do, where they go etc. The concern is that measurements would be inconsistent between testing sessions, either due to the high variability of power use over time, or to the differences in user behavior.

Automated Scripting

One approach to address this concern would be scripting. However this would require a degree of scripting minutia which is essentially impossible to conduct manually. For example, it would be impossible to specify the timing and target of shots, or the trajectory and speed of a vehicle in a repeatable manner. This might be possible through recording of inputs and automated playback, although this would require not just automated playback of user inputs, but also predictability of the environment response to user actions (e.g. behavior of other drivers in car race). The feasibility of game play automation remains questionable and was not pursued in this study.

Natural Game Play

Instead, we explored an approach based on natural game play, where console power use is recorded while the tester plays the game normally over a certain period of time. Our testing indicates that the variability of average power measurements reduces as the measurement period increases. In other words, variations get smoothed out over a sufficiently long measurement period. The following chart shows how variability reduces over time for a number of testing sessions (multiple users, titles and consoles):



Maximum error in the above chart is defined as the difference between the highest and the lowest average over a measurement period. For example, given a 30-minute test, the maximum error for 5-minute measurement periods is the highest minus the lowest 5-minute interval average over that 30-minute test period. It indicates how variable the test result would be depending on how long the measurement period is, and when it starts. We suggest a 20-min measurement period in order to minimize variability to less than 2%. Note that this time-dependent variability can be further reduced by avoiding or eliminating cut scenes and pause periods in the measurement period, as described further down.

2. User Variability

The previous section addresses variability over time for the same user. This section addresses the differences in user behaviors for a given game. The table below shows differences in average power use between different users of the same game title and on the same hardware unit:

Variability across users (session averages):

Game	Unit	Users	Min	Max	Difference
Saint's Row	CECH-3001-CF416803486-NRDC	2	75.7	76.1	0.5%
Call of Duty, Modern Warfare 3		3	86.5	87.2	0.7%
NHL12 (CECH-3001)	CECH-3001-CF416803486-NRDC	2	80.7	81.6	1.1%
Lego - Harry Potter	CECH-3001-CF416803486-NRDC	2	74.0	75.2	1.6%

NHL12	CECH-2101-Ecova	2	82.9	84.3	1.7%
Sonic Generations	CECH-3001-CF416803486-NRDC	2	74.9	77.4	3.3%
NHL12 (CECH-3001)	CECH-3001-CF416803486-NRDC	2	72.3	76.4	5.5%

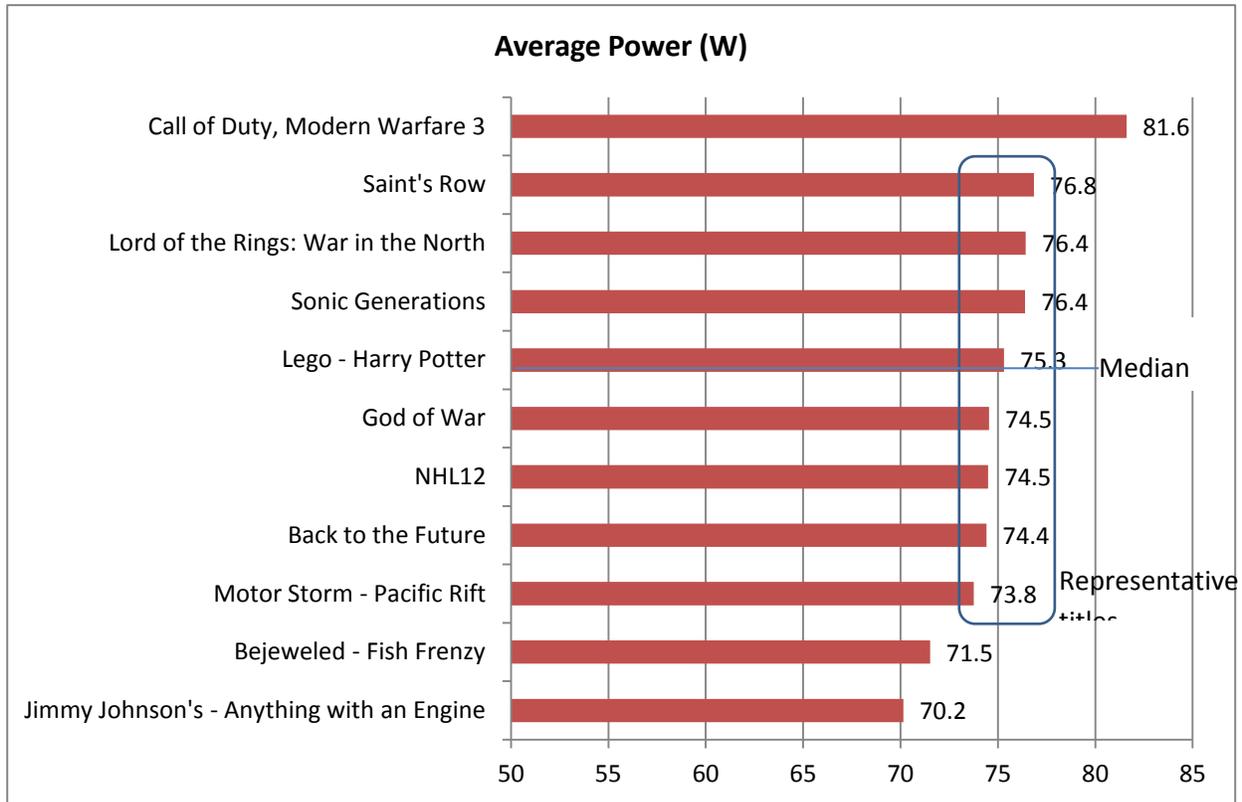
The last 2 rows show differences between minimum and maximum power draw in excess of 3%. In contrast to the other samples, these two points both represent the difference between a novice user discovering the game and therefore playing at a relatively slow pace, and an experienced user playing at a normal pace. This suggests that it is possible to minimize user variability by ensuring that tester has sufficient familiarity with the game controls and principles in order to play at a pace typical of that of average gamers.

The difference in game power use is most significant when a novice user does not know which controls to use, and does not understand the basic principles of the game. In most games, this can be learnt in just a few minutes. We believe that asking testers who are not familiar with the game to play it for at least 1 hour before the test would resolve that problem.

When users have sufficient familiarity with the game, user variability is less than 2%, which is within the range of timing variability discussed above and could be caused as much by timing variability as by user variability.

3. Game Title Variability

The graph below shows the variability of average power use by game title for one of the units tested:



The game titles in the rectangle are within 1% of the median of the dataset and would be appropriate candidates to provide representative measurements of the console's active power use.

Reference Game Title Selection

We suggest the following process for selecting a reference game title in an objective and transparent manner:

1. Perform a benchmark of active gaming power use on the top 10 best-selling titles for the console over the past 12 months (Frequency to be determined: could be as required by manufacturer depending on new model releases).
2. Select the game title that is the closest to the median of the sample.
3. Share benchmark results and selected reference game title with energy efficiency stakeholders to ensure an objective and transparent process.

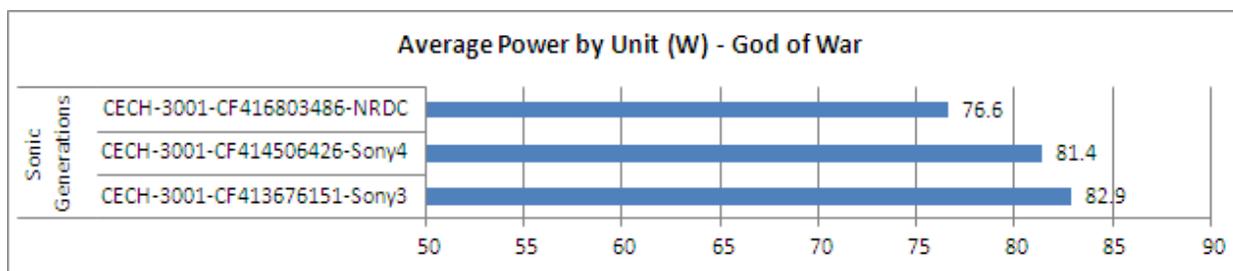
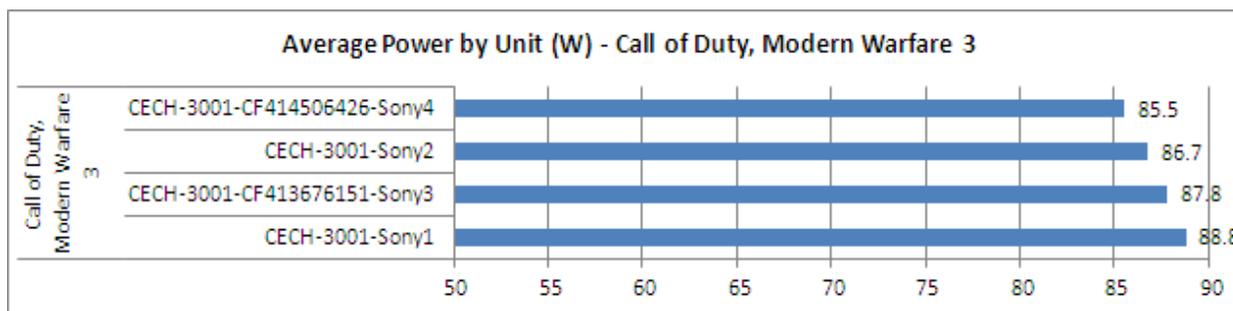
Note that the reference test game may be different for different consoles, but we think that the different games will support a fair active power test method if the same selection process is followed.

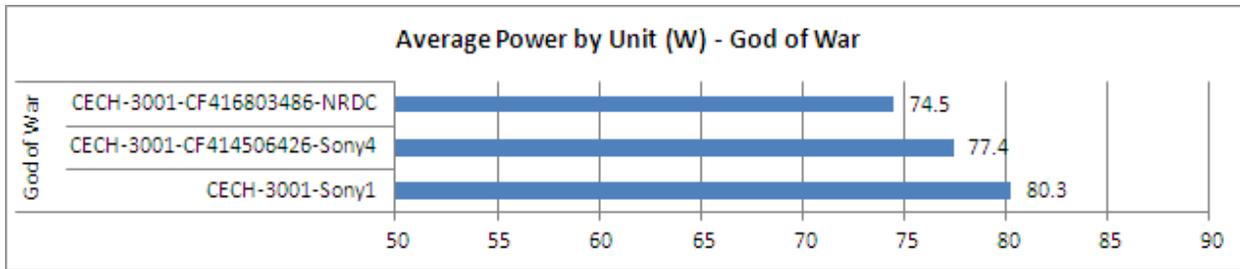
Technology Evolution

It is possible that technology evolution changes a console power profile, and that a game title that is representative for a console model is no longer as representative for a new model. In that case, the manufacturer could choose to perform a new benchmark of 10 titles and select a new reference title that is more representative of active power use for the new model.

4. Unit Variability

We found significant variations between different units of the same PS3 model. We tested 4 units of the CECH-3001A model of the PS3 and found the following variations in average active gaming power use for given game titles:





The lowest consuming CECH-3001A unit gives results up to 9% lower than the highest consuming one. As this difference is larger than we expected, we double-checked other potential factors (meter calibration, game title versions) and validated this difference. We hypothesize that this difference is due to both manufacturing variability on chips, and probably more significantly to component variations within console models, such as power supply, hard drive, fan assembly etc. Sony-PlayStation confirmed the use of 2 different power supplies, hard drives and fan assemblies for the PS3 CECH-3001A model.

Unit variability is a concern because measurements taken with one console may not be representative of many of the consoles in use in the field, or available to consumers to purchase. We suggest the following possible approach for addressing unit variability and are open to other suggestions.

Method to Deal With Variability Across Units of a Given Console Model

Assuming manufacturers know which components are sourced from multiple suppliers for a given model, and can identify units that represent variations in the components most likely to affect power use in game play, such as the power supply and fan assembly (assuming there is no variation in CPU and GPU), we suggest one of the following approaches:

1. **Highest power unit:** select the test unit that has the highest game play power use in a sample of manufacturing variations. The objective is not to identify the absolute highest power console which could require testing an unnecessarily large sample. A simple method would be to select a the 2 or 3 component combinations that get shipped the most, measure their average game play power use per this test method, and retain the highest power one.
2. **High-Low range:** similar approach with selecting and reporting both the highest and lowest power use in the component combinations sample, as a High-Low range.

5. Other Factors

Console power use in active gaming can vary depending on a number of other factors. This section identifies a number of factors and proposes ways to minimize variability for these factors.

6. Fans

Fans seem to come on or off, or vary their speed, depending on the temperature in the console. Console temperature depends on lab temperature conditions, as well as console usage prior to the testing period: a console which has already been subject to a series of tests will be warmer than a console starting cold.

In order to reduce fan power variability due to fan power, we propose the following test conditions:

1. Energy Star recommended temperature conditions in lab
2. Leave the console idle in Navigation mode for 10 minutes prior to the start of each test run, to allow the console to warm up from cold or cool down from active gaming.

7. Cut Scenes

Cut scenes occur at varying times during games. Power use during cut scenes tends to be significantly lower than active gaming power. In order to minimize variability due to cut scenes, we propose that cut scenes are either avoided if possible, e.g. by selecting a game, or a sequence in the game without cut scenes, or edited out of the test data if they cannot be avoided in the reference test game title.

8. Pause Mode and Gaming Inactive

Gaming Pause mode, or Gaming Inactive (leaving the game in active mode without actively playing it) introduce non-typical power signatures and can yield atypical power measurements. We recommended that Pause and Gaming Inactive are not used during testing.

9. Meter Variability

Tests were performed in different labs using different meters depending on local equipment availability. Most meters were Energy Star certified (Xitron, Yokagawa), the 2 Watts Up Pro meters were not. In order to ensure that differences in calibration between meters did not affect the results, we validated the accuracy of the Watts Up Pro meters by putting them in series with the certified meters for some tests and found that while they had a lower resolution (ability to capture rapid swings in power use), they reported the correct average. One of the Watts Up Pro meters had a systematic error of 1 Watt which was corrected in the data.

VI. Test Method Outline

1. Test game title selection:

- Stakeholders (NRDC is willing to lead this effort) perform benchmark of top 10 selling titles over previous year. Select title that is close to median (within 2%) and has no or few cut scenes or offers the ability to by-pass them, and has a fairly stable power signature over different phases of play.
- Stakeholders provide test data to CEC and recommend representative test game.
- CEC selects test title for Game Play test procedure.

2. Console test unit(s) selection: Manufacturers identify key manufacturing configurations, select the unit(s) that have the highest (and optionally lowest if reporting a range) power consumption in active game play per the test method below.

3. Lab equipment and conditions

- Per testing conditions in EPA's test method.
- Sampling frequency: 1 second. This seems to be sufficient from an accuracy perspective while minimizing the burden of editing out cut scenes if necessary.
- Tester needs to have minimal familiarity with the game title, in order to avoid prolonged inactivity or over weighted learning situations. If the tester is not familiar with the game, tester needs to play the game for at least 1 hour prior to the test session in order to learn the basic controls and principles of the game.

4. Measurements:

1. Let console warm up/cool down in navigation mode for 10 minutes.
2. Launch game.
3. Start metering after game loading and initial cut scenes are finished.
4. Play game normally (with the objective to advance in the game).
5. Skip all cut scenes (when possible), or edit them out of measurements.
6. Do not pause game, or leave it inactive during measurement period.
7. Measure active gaming for 20 minutes, not including cut scenes.

5. Results analysis and reporting

- Calculation methodology: Calculate the average of sample power readings. The average allows editing out of cut scenes if necessary, which is not possible with a cumulative measurement.