Video Game Consoles: Energy Efficiency Options

Prepared for

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EnergyConsult PTY LTD
655 Jacksons Track
Jindivick, Victoria 3818
Australia
ABN: 18 090 579 365
Tel: +613 5628 5449
Fax: +613 9923 6175
Email: info@energyconsult.com.au

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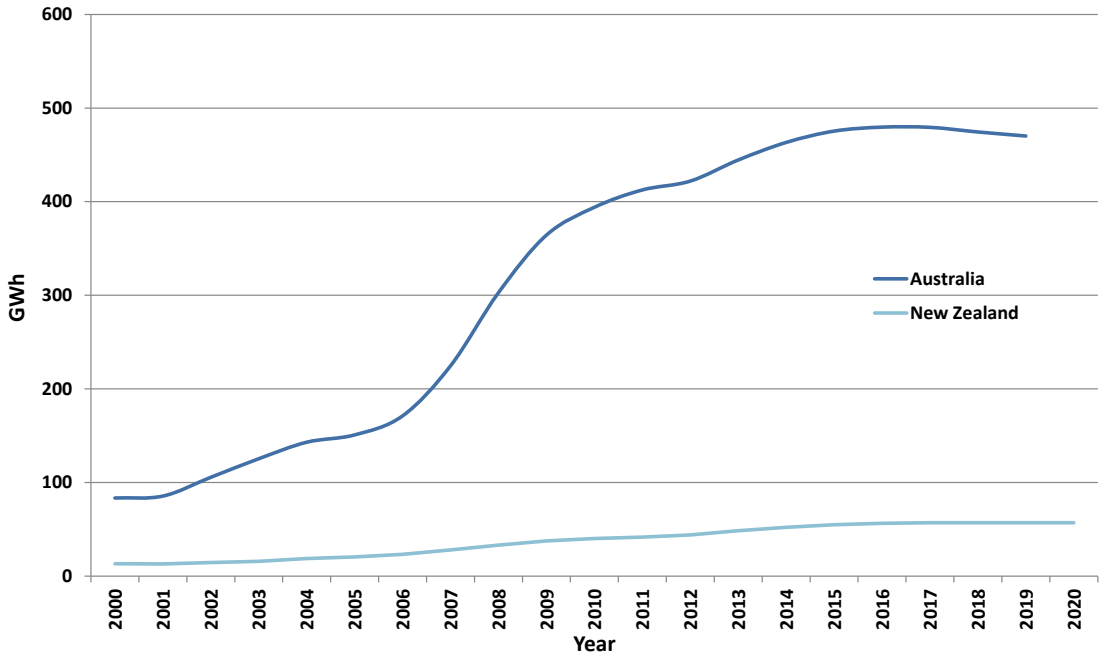
Introduction

Video game consoles were identified as a category of energy use products (besides the TV) in the home entertainment area of households in 2010 that deserved attention. Video game consoles total estimated energy consumption was 395 GWh pa in Australia in 2010, representing over 15% of the total energy consumption by devices associated with household home entertainment. Energy consumption from game consoles is forecast to increase 19%, from 395 GWh pa to 470 GWh pa in 2020 in Australia and by 42% from 40 GWh pa to 57 GWh pa in 2020 in New Zealand.

Estimated Energy Consumption of Game Consoles in Australia & New Zealand 2000 – 2020



It is estimated that 6 million video game consoles were in use in Australian households and almost 800,000 in New Zealand households in 2011. They are increasingly being used as media playing devices, especially in the last year with the introduction of video/music content services by both Microsoft and Sony. In 2012, the new Nintendo Wii U will be released and this will also feature new media content. In the USA, a recent Nielsen survey found that streaming now represents a reported 14% of Xbox 360 time, 15% of PS3 time and 33% of Wii time. With the content increasing, greater usage of media streaming will increase the overall energy consumption of game consoles.

Although the PS3 and Xbox360 have decreased their in-use power consumption by up to 64% since first released there are a number of energy efficiency options available to improve the energy performance of game consoles, including automatic power down, power scaling and low power network standby. These efficiency measures would not necessarily impact the performance of game consoles designed for high resolution graphics.

The purpose of this paper is to explore the market for the modern video game console, their power and energy consumption, and options for efficiency improvement. The paper also discusses the potential policy instruments available to the government for encouraging efficiency improvements in mains connected video game consoles.

Consultation

The Department of Climate Change and Energy Efficiency convened a working group of stakeholders. The aim of this working group is to assist in reviewing the contents of this paper and provide information and advice on the potential for a voluntary agreement to improve the energy efficiency of game consoles. Representatives of the three major game console manufacturers, Sony, Microsoft and Nintendo, met with Australia and New Zealand government officers to discuss the potential options for improving the efficiency of games consoles. The meeting, held in Melbourne on 1st and 2nd of February 2012, followed a series of teleconference meetings since October 2011 to determine if manufacturers can agree to further improvements in the energy efficiency of game consoles sold in Australia and New Zealand. In addition the Interactive Games & Entertainment Association (iGEA) were invited to participate and also provided data to assist with the market characteristics.

The representatives at the meeting discussed current energy efficiency plans and how to ensure that future changes to the game console hardware and software can reduce energy consumption. Options canvased included automatically putting the game console into standby mode when it is left accidentally operating, reducing the power consumption of game consoles when playing videos or streaming from the internet, and reducing the power use of game consoles in network available standby state. It is hoped that an agreement in principle will be reached with the manufactures and the government during 2012.

Although the game console manufacturers have provided feedback on the content of the paper, they do not endorse the report or findings. This paper makes a number of assumptions about the energy characteristics of future game console products, which are not based on any information supplied by the game console manufacturers.

Product Description

Video game consoles are special purpose computer systems that are designed to play video games and output video to an external display, typically a TV monitor. Consoles generally contain a central processing unit, a separate or integrated graphic processor, memory (both internal and optional external) and various controllers to allow user interaction. Although several companies have produced video game consoles over the last three decades, there are now only three major providers; Nintendo, Microsoft and Sony.

Current Models

The modern game console is a multi-function media device. Depending on the model, they are able to play video games, connect to the internet for gameplay, media and chat, and play DVD/Blu-ray discs and stream media from other home network locations. The games are typically loaded into the console as discs or (in the past as) cartridges, with more games being now made available to be downloaded from the supplier over the internet. All game consoles have a user control interface which allows the user to select and interact with the console games and operating system. The user can also save games to the internal memory, or external memory, of the console and access them at a later time.

The current models of the three major game consoles suppliers are listed below, along with some of the key characteristics and features are shown in Table 1.

Table 1: Current Video Game Console Models and Key Specifications

Feature	Nintendo	Microsoft	Sony
Current Model	**Wii**	**Xbox 360 S**	**PS3**
1st Release Date	2006 (AU)	2006 (AU)	2007 (AU)
Media	Wii Optical Disc	DVD	Blu-ray/DVD
CPU	729 MHz PowerPC based IBM	3.2 GHz IBM PowerPC tri-core	Cell Broadband Engine (3.2 GHz POWER-based)
GPU	243 MHz ATI	500 MHz ATI custom design	550 MHz RSX 'Reality Synthesizer
Memory	24 MB integrated into graphics package + 64 MB GDDR3 SDRAM	512 MB	256 MB + 256 MB
Video Resolution	576i	HD capable, up to 1080p	HD capable, up to 1080p
Storage	512 MB built in flash + SD card (32 GB)	Up 250 GB HD internal + USB + Xbox memory card	Up 320 GB HD internal + USB + SD/Memory stick
Network/internet	Wi-Fi or optional USB Ethernet	Ethernet + Optional Wi-Fi	Ethernet + Wi-Fi

Wii features and specifications are from unofficial sources and have not been verified by Nintendo

Nintendo Wii

Source: Nintendo

The Nintendo Wii's primary selling point is its usability and its broad target demographic, which includes many who do not usually play games. The Wii does not feature a HDMI port, nor can it support HD output. The console is controlled using a combination of the 'Wii Remote' and the 'Nunchuk' controllers. The Wii Remote operates on AA batteries which powers the Nunchuk through the cable that connects them. The Wii Remote features a speaker and a rumble vibration device. The console supports an internet connection and through this, games from many previous Nintendo consoles can be purchased, downloaded and played on the machine. An extra 'Classic Controller' can be purchased as an optional extra to allow for improved compatibility with the older games. The internet connection also allows some web services such as weather forecasts and news updates. An optional Opera web browser can be downloaded to add browsing capabilities. An internet connected console can also be used to compete with other players online.

A 'WiiConnect24' feature allows the console to "communicate with the Internet even when the power is turned off"[1], which is used for features such as updates.

The Wii also has the ability to connect wirelessly with the Nintendo DS which adds to the functionality of both devices. Various attachments for the Wii Remote and the Nunchuk can be purchased through Nintendo which add ergonomic functionality

The optical media used is the 'Wii Optical Disc' which is DVD based. The Wii (except for the Wii Family Edition) can also support 'Nintendo GameCube Game Discs' (mini-DVD based). Photos loaded onto an SD card can be inserted into the Wii and manipulated and viewed through the device.

Wii features and specifications are from unofficial sources and have not been verified by Nintendo

[1] http://www.nintendo.com.au/index.php?sectionID=32&pageID=64

Microsoft Xbox 360

Source: Microsoft

The Xbox 360 main functions are as both a games device and a home media centre. Connecting an Xbox 360 to the internet gives access to the Xbox LIVE service which in addition to allowing the playing of games online, allows the purchase and download of movies and games, support for the Foxtel Pay TV service (no extra hardware required), Facebook, twitter, access to the ABC's iView service (in development) and SBS's ON DEMAND service, as well as the online video service YouTube.

The Xbox 360 can also be used to play media stored on the HDD. A now discontinued HD DVD drive could be used for the playing of HD DVD movies. Games typically use the DVD optical media but may also be downloaded. The Console supports DVD and CD playback. The standard controller may be wired or wireless, the wireless version being powered by AA batteries as default with a rechargeable power pack an optional extra. The 'Kinect' controller is an optional device which allows control of the console through hand and body movements and voice control. A 2010 hardware upgrade resulted in the current 'Xbox 360 S' product line-up.

Sony PS3

Source: Sony

The PlayStation 3 (PS3), in addition to primarily functioning as a gaming device, is also a Blu-ray player, set top box (with an additional hardware turner device) and a home media streamer. In addition to storing media on the HDD, the console can also play back media

if connected to a home network. 'PlayTV allows the viewing pausing and recording of free to air TV. It is a device that includes two HD tuners and connects to the console.

The console supports a number of controller inputs, including controllers with motion sensors and vibration feedback. Sony also has officially released a recharger. Sony's PSP can also wirelessly connect with the PlayStation 3.

An internet connected PS3 allows access to the PlayStation Network (PSN) which caters for online gameplay, software updates, and the purchase and download of games. Game media is the Blu-ray disc format and the device also supports playback of Blu-ray, DVD and CD discs.

Although the PS3 is continuously updated, the most significant hardware change came with the release of the 'slim' model in 2009..

Historical Models

In the late 70s console games became popular and more widely used. The main console of this era was the Atria 2600. The main method of input during this time was the joystick. This era (also known as the "8-bit era) ended with the video gaming crash of 1983 when PCs/Mac began to take interest away. The next generation of gaming consoles originated from Japan and used 16-bit processors instead of 8-bit. About this time, Nintendo released a very popular console called the NES (Nintendo entertainment system).

From 1983 to 1996 Nintendo and Sega dominated the market. Nintendo was popular in the U.S but Sega had a larger market share in Europe. In 1994 Sony released the Play Station. Nintendo soon followed with the release of the Nintendo 64. Sega released a new console, but sales were not sufficient and the company influence declined. The consoles of the early 2000's were largely dominated by the Play Station 2, which is the best-selling game console in history with over 140M sold worldwide. In late 2001 Microsoft released the Xbox, and Nintendo released the GameCube. These models are called the sixth generation while the current consoles are now from the seventh generation. It should be noted that the Play Station 2 is still being manufactured and achieves significant sales today, even though it is not the latest generation console.

From the sixth generation up until now, the games console market has been supplied by three companies, Microsoft, Sony and Nintendo. Microsoft has only released 2 games consoles, the Xbox and the Xbox 360, Sony has released 3 games consoles, the Play Station, Play Station 2 and Play Station 3, while Nintendo has released 6 gaming consoles, excluding different versions of each console.

Potential Next Generation Consoles

The Wii U is Nintendo's next generation console after the Wii. It keeps some of the game play techniques used in the Wii, such as motion control however the Wii U will also

add new ways to interact with the games with the integration of the new controller. The new Wii U controller is one of the key new features of the console, which includes a 6.2" touch screen, gyroscope and accelerometer, microphone and a front facing camera.

The Wii U console will also have a significant upgrade in specifications, however the details yet to be published. The Wii U will also support 1080p graphics. Potentially all these features could add to the overall energy use of the console.

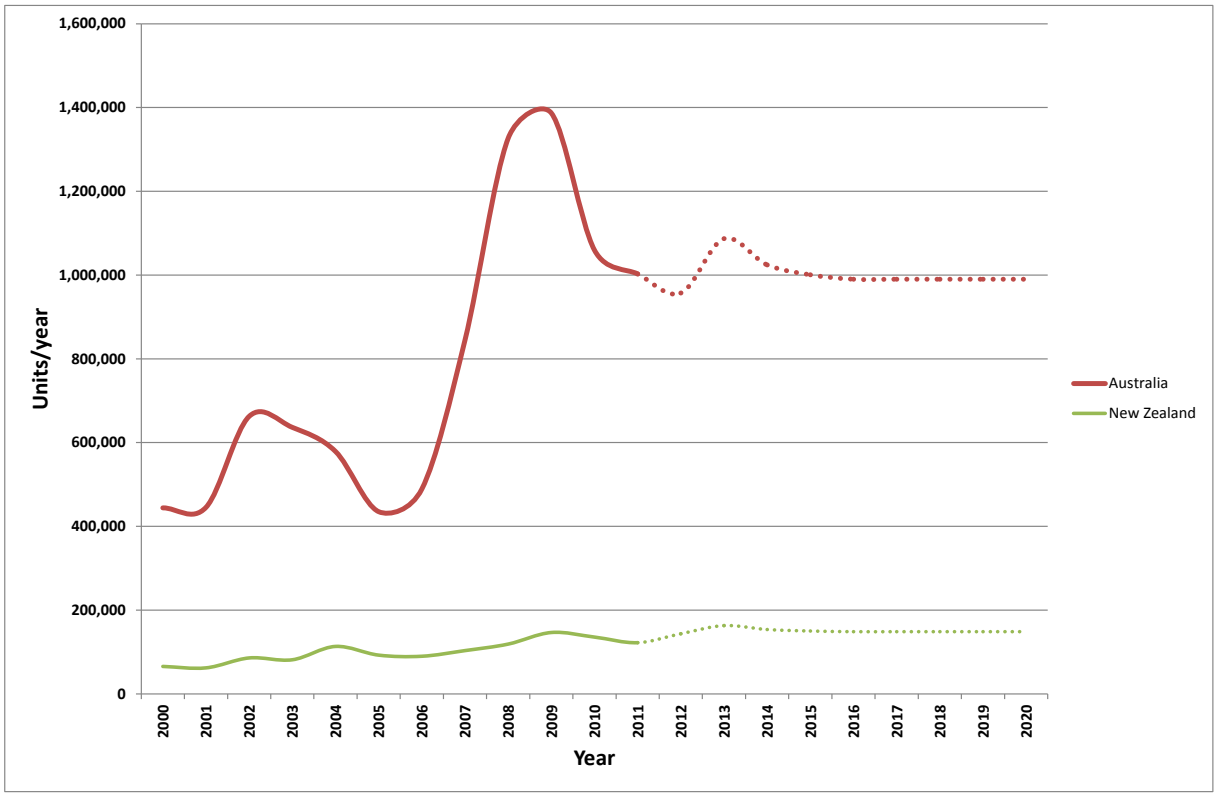
There are no official information releases from either of Microsoft or Sony regarding their next generation consoles.

Market Characteristics

Sales and Stock

The estimated sales of mains connected video game consoles are shown in Figure 1. This estimate was based primarily on data collected by the Interactive Games & Entertainment Association (iGEA) specific to Australia and New Zealand. The forecast sales from 2012 were estimated on historical cyclically trend however these are highly variable and will depend on the release of new generation consoles and major updates by the hardware suppliers.

Figure 1: Estimated Sales 2000 -2010 and Forecast Sales to 2020 of Games Consoles in Australia



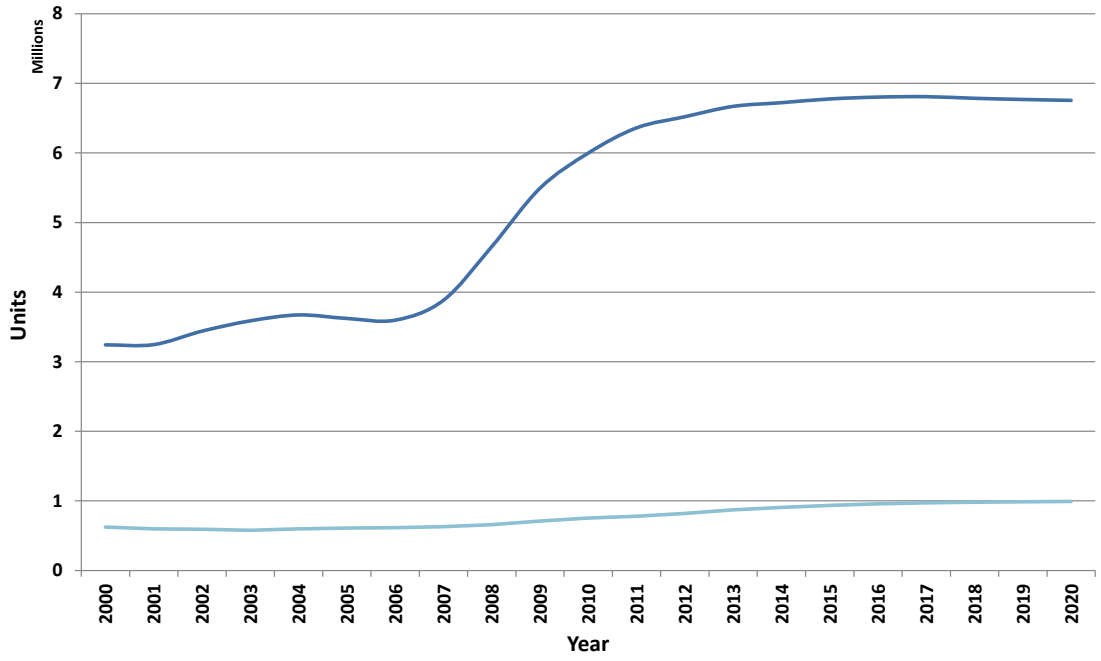
Source: IGEA – historical, EnergyConsult analysis – forecast

The total stock of video game console in Australia is shown in Figure 2, and based on a stock model of new additions and retirements. Based on this stock model, it is estimated that 6 million video game consoles were in use in Australian households in 2011. This translates to an ownership (number of stock divided by the total households) of 0.70. The *Third Survey of Residential Standby Power Consumption of Australian Homes* – 2010 (EES 2011) found an average ownership of 0.81; however the authors acknowledge that the sample may have a possible bias.

The latest ABS publication (ABS 4602) reports that 35.2% of Australian homes have a mains connected video game console in March 2011. Also, according to the ABS, the total number of video game consoles reported to be used in Australian households is 3.2 million. This figure seems to understate the total number of game consoles based on the sales up to the end of 2011. The iGEA study (Bond University 2011a) suggests that 63% of households use a game console, which is consistent with the stock model when you take into account there are multiple consoles in some households. In New Zealand, the iGEA study (Bond University 2011b) suggests that 50% of households have a games console.

According to iGEA sales data, the total number of Wii, PS3 and Xbox360 sold into Australia is 5.2 million. When added to the 2.6 million PS2 and 840,000 Xbox units also sold into Australia, there would be a total of 8.6 million game consoles sold into Australia in the last decade (excluding older legacy consoles). Therefore, considering the number of retirements and lower usage of earlier generation game consoles, a figure of around 6 million is considered to be appropriate. In New Zealand, there are estimated to be 780,000 consoles currently in use in 2011. This stock figure is consistent with the iGEA study.

Figure 2: Estimated Stock of Games Consoles in Australia & New Zealand 2000 – 2020



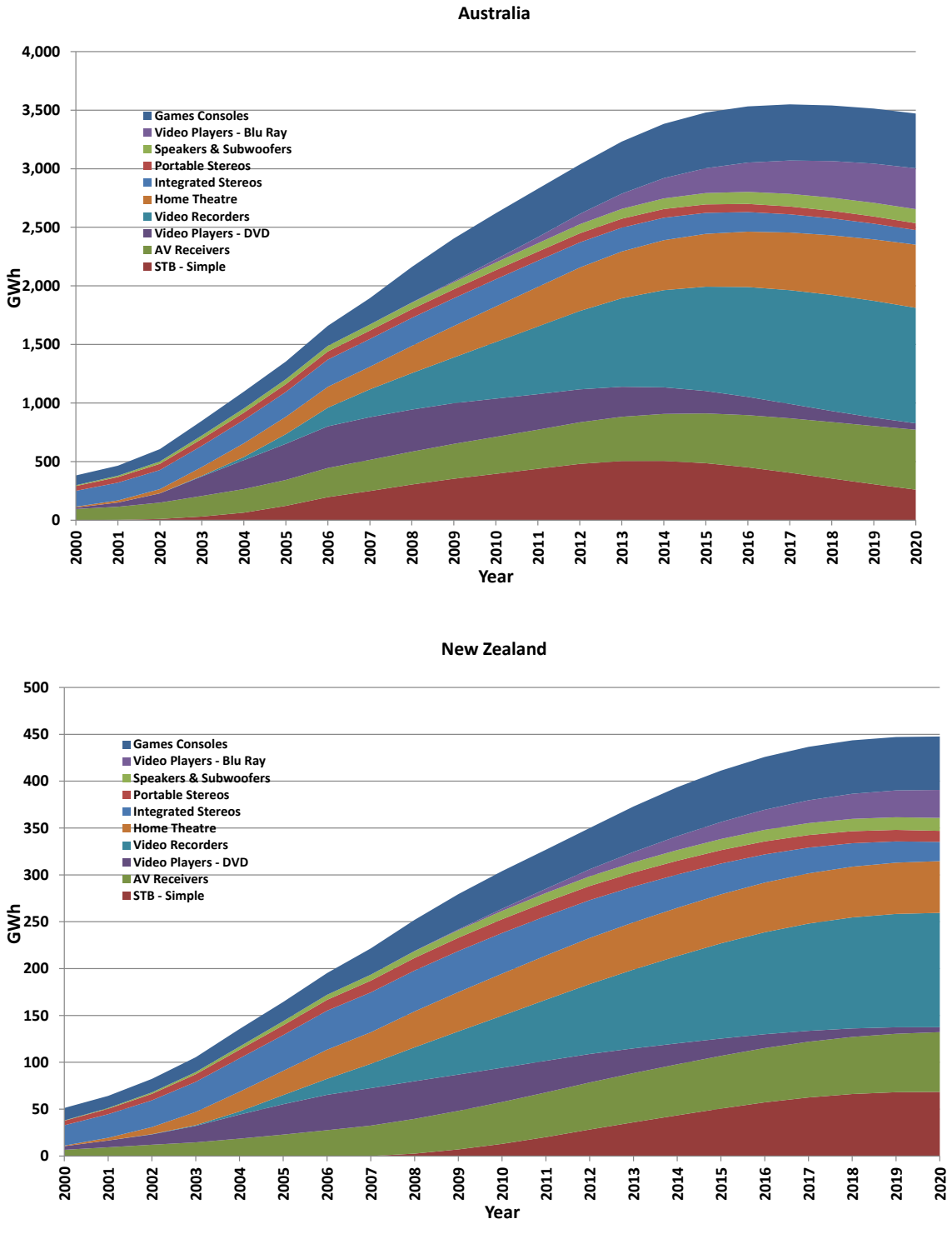
Source: IGEA, EnergyConsult modelling 2012

Energy Consumption

Energy Consumption in Australia

The overall energy consumption of mains powered video game consoles was examined in the *Home Entertainment Products: Product Profile* (EnergyConsult 2010). These products were identified as a category of energy use products in the home entertainment area of households in 2010 that deserved attention. This paper has revised the total energy consumption based on updated sales, power consumption and usage assumptions. Game console total estimated energy consumption was 395 GWh pa in Australia in 2010, representing over 15% of the total energy consumption by devices associated with home entertainment in the household. In New Zealand, the total estimated energy consumption was 40 GWh pa in 2010, representing over 13% of the total energy consumption by devices associated with home entertainment in the household. Figure 3 shows the total energy consumption of video game consoles and other home entertainment products from 2000 and forecast to 2020.

Figure 3: Estimated Energy Consumption of Home Entertainment Products in Australia & New Zealand 2000 – 2020



Source: EnergyConsult 2010, revised with updated data on Game Consoles

The energy consumption of games consoles is forecast to increase 19%, from 395 GWh pa to 470 GWh pa in 2020 in Australia and by 42% from 40 GWh pa to 57 GWh pa in 2020 in New Zealand, as shown in Figure 4. This estimate of energy consumption is

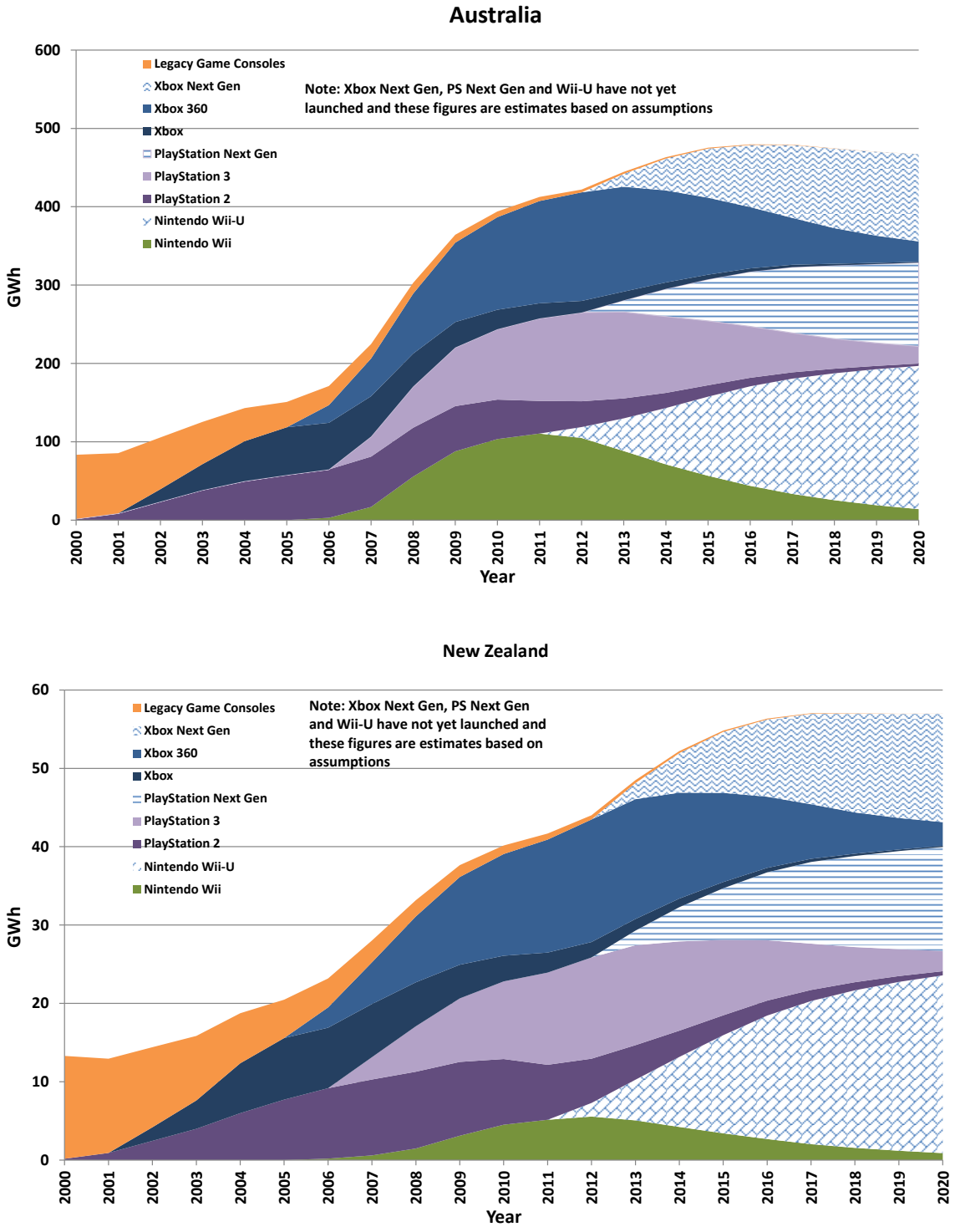
based on sales data, power consumption and estimated usage of consoles in Australia and New Zealand, and assumptions about the power consumption and usage of consoles over the next decade. The following assumptions were made regarding the characteristics of new game consoles from 2012:

- Average power consumption of existing generation consoles is stable at 2011 values.
- Average power consumption of the next new generation consoles follows the same trend of decreasing power consumption as observed for the previous generation of HD game consoles (i.e., power consumption of first release devices are in the 160 -200 W range and decrease as the hardware changes).
- Standby remains below 1 Watt.
- Average household usage is based on the EU study (AEA 2010):
  - gameplay - 1 hrs/day,
  - media playing (0.3 hrs), inactive use (0.6 hrs), and other use (0.4 hrs) – for total of 1.3 hrs/day
  - off/passive standby – 21.7 hrs/day.
- Auto Power Down is implemented for all of the installed PS3 and Xbox 360 by software updates from 2012, and in all sales of new products from 2012. APD reduces the inactive use (idle) by 30 mins/day.
- Sales of current and next generation consoles are estimated to be approximately 1M in Australia and 150,000 in New Zealand over the next decade. The sales are evenly split between Sony, Microsoft and Nintendo.

These assumptions are considered to be conservative as the usage of consoles may increase over the next decade. As the service offerings from the game console suppliers change and more video is offered to consumers, there may be an increase in the overall use. However, the use of the console to play games may decrease as media play increases, but this is considered unlikely.

Another assumption which favours lower energy consumption is that standby power remains below 1 W. The next generation of consoles will be more likely to have a network standby mode and be connected to the internet, which if included in the calculations would increase the overall energy consumption. If network standby is 4 Watts, energy consumption would be 23% higher or an extra 108 GWh pa in 2020.

Figure 4: Estimated Energy Consumption of Game Consoles in Australia & New Zealand 2000 – 2020

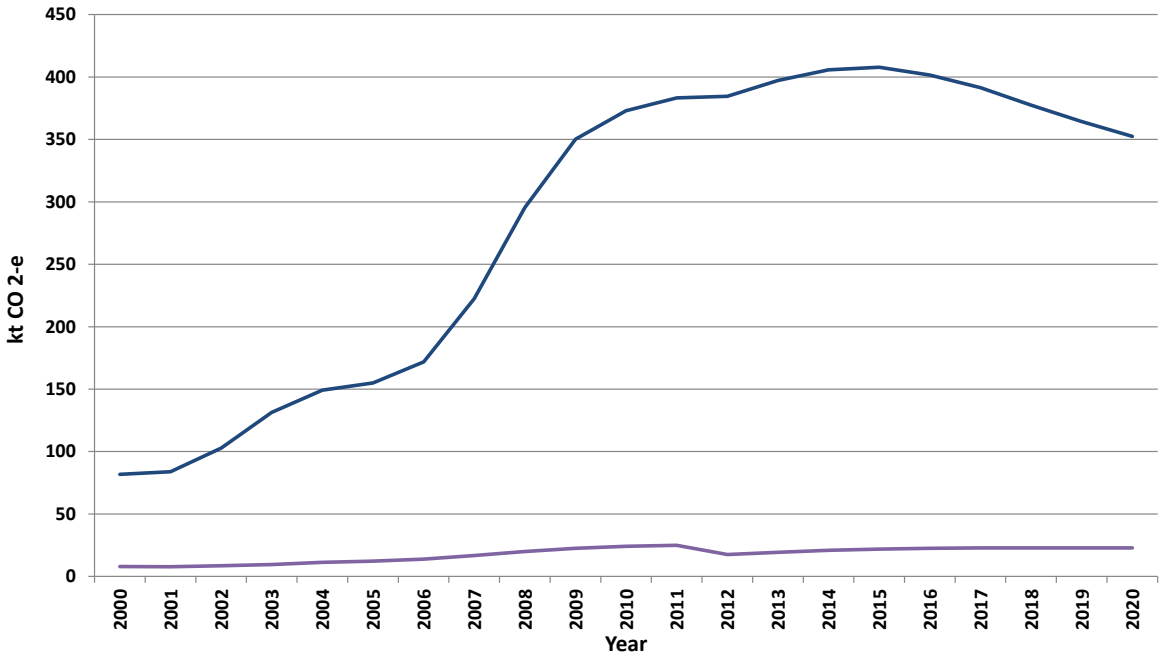


Source: EnergyConsult 2010, revised with updated data on Game Consoles

Games console greenhouse gas emissions are forecast to decrease from 370 kt CO2-e in 2010 to 350 kt CO2-e in 2020 in Australia, due to the decreasing emission intensity of the

electricity system as a result of the government carbon policies. Similar results apply in New Zealand as shown in Figure 5.

Figure 5: Estimated Greenhouse Gas Emission of Game Consoles in Australia & New Zealand 2000 – 2020



Source: EnergyConsult 2010, revised with updated data on Game Consoles

Trends in Energy Consumption

Mode of Use

The game console has now four broad categories of use, as follows:

Gameplay – where the user is interacting with a game and actively playing

Media play– where the user is streaming video/audio media from the internet or home network (including pay TV), playing DVD or Blu-ray optical discs or playing recorded media from the hard drive (recorded TV or other media)

Navigation mode – where the user is interacting with the user interface to change settings, or interacting with applications such as audio/text chat, web browsing etc.

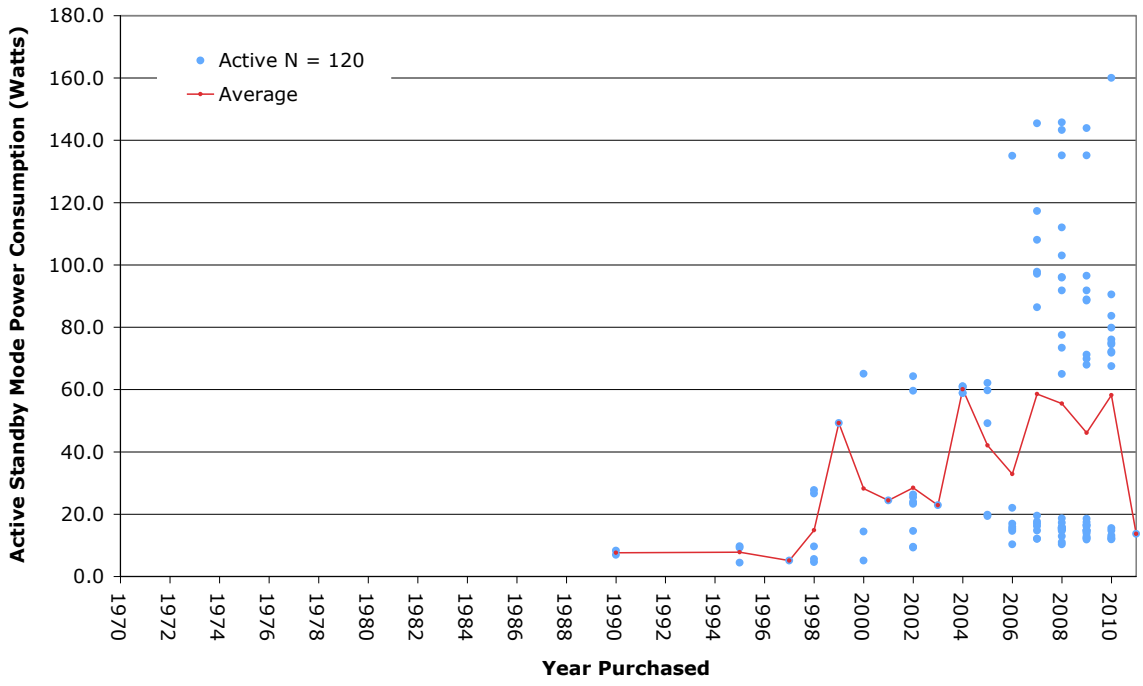
Off/standby/network standby – these modes occur when the user turns off the game console or engages sleep mode. The game console can also have network connections applicable in this mode and may be waiting to undertake recording or other timer set activities.

Most modes of use will fall into these categories. It is useful to examine the power consumption of the games consoles in these modes as console use and performance will vary. Also, over the last 5 years, games consoles have expanded their functionality and power consumption and usage patterns will have a large impact on the total device energy consumption.

Historical Trends

Figure 6 below shows the active standby consumption of games consoles when compared to year of purchase surveyed in Australian homes in 2010[2]. This active standby was measured when the user control interface (UCI) was active on the screen and for most of these consoles, the power consumption in this mode was very similar to the Gameplay and media play mode. It can be observed that the consoles released up till 2006 consumed from 10 to 70 W, however with the release in 2005/06 of the first versions Xbox 360 and PS 3, the power consumption increased to 165W to 200 W.

Figure 6: Games Consoles measured in UCI mode and year purchased

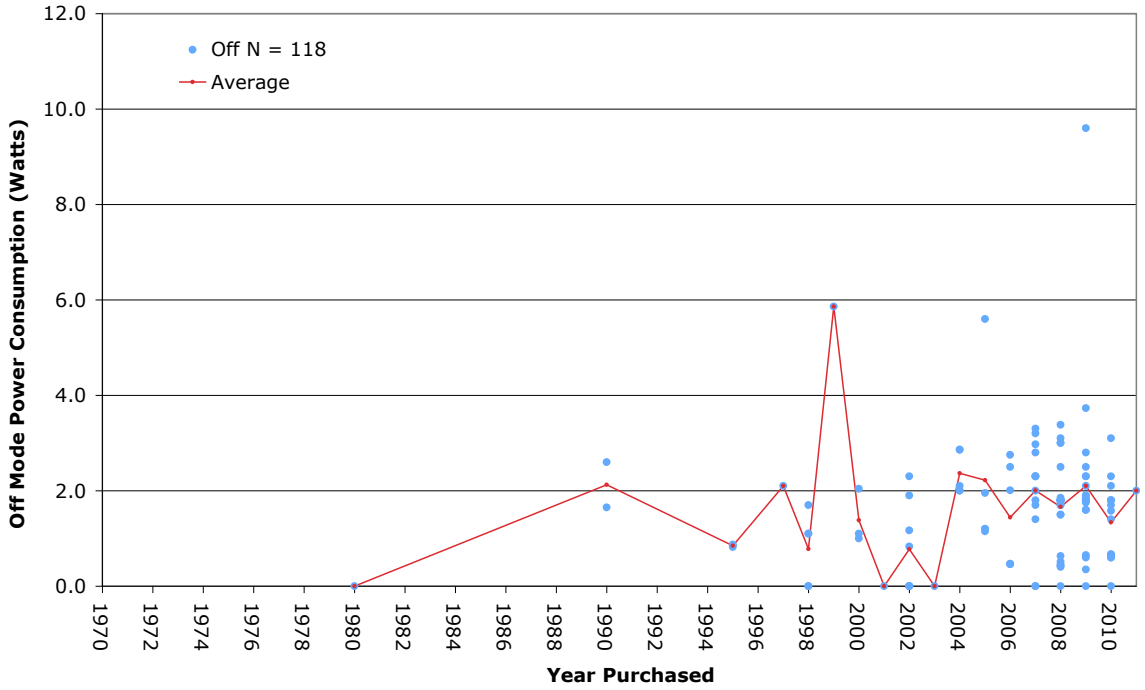


Source: Third Survey of Residential Standby Power Consumption of Australian Homes - 2010, EES 2011

Figure 7 below shows the off mode consumption of games consoles when compared to year of purchase. It can be seen from the trendline that the average off mode games consoles has remained relatively stable over time at around 2 W.

[2] http://www.energyrating.gov.au/wp-content/uploads/Energy_Rating_Documents/Library/Standby_Power/Standby_Power/E3-2010-Intrusive-Survey-FINAL-Report.pdf

Figure 7: Games Consoles measured in off mode and year purchased



Source: Third Survey of Residential Standby Power Consumption of Australian Homes - 2010, EES 2011

Detailed statistics from the survey of residential standby 2010 survey are presented in Table 2. Some of the key findings from this survey are that approximately 50% of the game consoles are now connected to the internet, although this will vary depending on the brand/model. This connected mode typically increases the power consumption when consumers consider they have turned the console to standby/off. As evidenced in testing the average power consumption of these game consoles in connected standby mode[3] was 5.4 W.

[3] The average power consumption when connected to a network would have included some game consoles in network standby mode, such as the PlayStation 3, and game consoles that do not have a network standby mode, such as the Wii Connect 24, although when enabled, the Wii Connect 24 is the lowest power state for this device.

Table 2: Game Console Characteristics from 2010 Survey

Games Consoles	Statistic	Number of Readings
Ownership	0.81	121
Average Age	5.2 years	121
Average Actual Standby	1.00 Watts (1.23%)	82
Internet Connection Capable	56%	68
Connected – Mobile	1.5%	1
Connected – Wired	20.5%	14
Connected – Wireless	23.5%	16
Not connected	54.5%	37
Average Active* Standby	44.9 Watts	120
Minimum Active* Standby	4.4 Watts	120
Maximum Active*Standby	160.0 Watts	120
Average Passive Standby	5.4 Watts	31
Minimum Passive Standby	0.5 Watts	31
Maximum Passive Standby	13.5 Watts	31
Average Off Mode	1.7 Watts	118
Minimum Off Mode	0.0 Watts	118
Maximum Off Mode	9.6 Watts	118

Source: Third Survey of Residential Standby Power Consumption of Australian Homes - 2010, EES 2011.
NOTE: * Active standby was measured as the UCI home screen

Current Model Power Consumption

The power consumption of current 2010 versions of the three game consoles were measured in Australia and USA in late 2010 and early 2011. The results of these measurements are shown in Table 3.

Table 3: Video Game Console Power Consumption by Mode (Watts)

Mode	MS Xbox 360	Sony PS3	Nintendo Wii	Source
Off	0.67	0.05	10/0.8*	ADT 2011/Nintendo
Idle (UCI Home Screen)	76.9	67.6	13.0	ADT 2011
Gameplay	81.3	76.6	14.4	ADT 2011
Video Streaming	73.8	61.9	13.3	EPA 2010
Video - DVD	58.9	73.5	n/a	EPA 2010

*Wii power use in standby mode WiiConnect24 enabled/disabled

These power measurements confirm that the current models of the Xbox 360 and the PS3 have similar power consumption in gameplay, but the Nintendo Wii is significantly lower when playing games. The major difference in power consumption is attributed to the greater processing power and video quality of the Xbox 360/PS3 compared to the Wii. The Wii does not play DVDs, however video streaming is also significantly lower.

Measurements were also undertaken on the 2009 models of game consoles and these measurements show that the power consumption of the Xbox 360 has decreased by about 15% and for the PS3 by almost 45%. Overall, both Sony and Microsoft have decreased the power consumption of their latest generation game consoles by up to 64% since first released. Nintendo has decreased by 22% the power consumption of the Wii from 18W when released to 14W in late 2009. These changes in the power consumption over time can also be seen in the earlier historical measurements of power consumption in homes shown in Figure 6.

Therefore these measurements suggest that over time, the power consumption of game consoles have improved with the recent hardware changes to the latest models. Similar improvements in the standby power can also be observed, with the Wii, Xbox 360 and the PS3 now measuring under 1 Watt in off mode. In fact the PS3 has the lowest standby power of all three consoles at 0.05 Watts[4].

Usage of Consoles

Data on measuring the usage of game consoles is varied. However, recent surveys in Australia suggest that gameplay is about 1 hour per day per user on average. This appears consistent with USA surveys of game console use by Nielsen nevertheless, the overall usage of consoles is likely to increase as the functionality increases. The most recent survey by Nielsen[5] in October 2011 showed that streaming and video-on-demand represent a larger weekly share of usage on Microsoft Xbox 360, Sony PlayStation 3 and Nintendo Wii compared to 2010. Streaming now represents a reported 14% of Xbox 360 time, 15% of PS3 time and 33% of Wii time. Overall the total share of gameplay is now 67% for the Xbox 360, 54% for the PS3 and 63% for the Wii.

[4] Sony report that PlayStation(r)3 power use is around 0.5W in standby and have questioned this result.
[5] http://blog.nielsen.com/nielsenwire/online_mobile/video-streaming-on-game-consoles-on-the-rise/

The increase in usage of media streaming could increase the overall energy consumption of game consoles. A user may not need to purchase a separate device for these media playing functions, however the power consumption of the HD game console when playing media is at least three times higher than a dedicated media playing device (of around 20 W or less).

As the media streaming services for various game consoles increase there is likely to be large changes in the usage patterns of these and related home entertainment equipment. In fact, with the introduction of Foxtel Pay TV for the Xbox 360, and forthcoming movie streaming for the PS3[6], as well as the launch of the HD capable Nintendo Wii U, game consoles could become the key media playing device in the home. The change in usage of consoles may also increase the likelihood of inadvertent use or when the console is left on and the user leaves the room. Therefore, as consoles gain more media functions and the usage characteristics of these devices change there is a likelihood of greater energy consumption both in terms of active and inactive/inadvertent usage.

[6] http://www.theaustralian.com.au/media/iptv/games-consoles-critical-to-iptvs-future/story-fnb1s6g6-1226198939041

Energy Efficiency Developments

International Programs and Policies

Game Consoles have been considered in a number of international programs relating to energy efficiency. The major programs include:

ENERGY STAR

The United States Environment Protection Agency (EPA) is currently developing a recognition program for game consoles. As with other ENERGY STAR programs this would be voluntary. There was a proposal by ENERGY STAR to include games consoles in the Computer Specification (V5) in 2009, however this effort was subsequently placed on hold and development work has continued. In late 2011, the EPA distributed a Draft 1 Recognition Criteria for Game Consoles, and consulted with the stakeholders on the possible test method and criteria for recognition. Further drafts were distributed in March 2012 and discussions are not yet concluded[7].

While EPA has previously proposed ENERGY STAR labelling for game consoles, they understand that with only 3 game consoles on the US market it presents a challenge to the ENERGY STAR principle of recognising the top quartile of products based on efficiency. As there are major performance and platform differences between products, the traditional approach would call for separate product categories. However, separating 3 products into product categories would result in a category with 1 product, therefore removing competition. Hence the idea of recognition is proposed, where the EPA and game console manufacturer sign an agreement. The agreement would reflect a company-wide commitment to meeting the final efficiency criteria with current or next generation boxes. The EPA recognises game consoles that meet the energy efficiency criteria, measured by the ENERGY STAR test method. The EPA proposes recognising companies that pledge to meet these requirements, and hence reduced energy use of participating companies' game consoles.

USA Department of Energy

The USA Department of Energy (DOE) is working with the EPA in the development of efficiency criteria and the potential test method for the ENERGY STAR recognition program. However, the Department of Energy is scheduled to begin a rulemaking for '*Computers, Computer Equipment and Certain Computer Components*' in February 2012 which could cover game consoles. However its scope is uncertain and this rulemaking is in its very early stages with significant uncertainty in the schedule. At the very earliest, the effective date would be in 2018.

[7] See http://www.energystar.gov/index.cfm?c=revisions.game_console_spec for updated information

California Energy Commission

The California Energy Commission (CEC) requested proposals for consideration of new appliance energy efficiency standards in California in October 2012. The CEC have received a proposal from the state Investor Owned Utilities (including Pacific Gas and Electric Company, Southern California Edison, Southern California Gas, San Diego Gas & Electric) for Video Game Consoles. The proposal was prepared by the NRDC (NRDC 2011) and proposes that California adopt a two-tier standard (2014 and 2016) for video game consoles, including auto-power down requirements and power limits in significant modes other than active gameplay. The proposed limits are shown in Table 4

Table 4: Proposed Tier 1 and Tier 2 Measures by NRDC for the CEC New Appliance Regulations

Function	Tier 1 – Jan 2014	Tier 2 – Jan 2016	Rationale
Auto Power Down (APD)	Enabled by default	Enabled by default	See detailed APD proposal in Appendix A Savings estimate: 50% reduction in idle time.
Active Gameplay	N/A	N/A	No limit on active gaming for fairness with gaming PCs and in order not to impact performance.
Inactive - Gaming (Pause)	70 W	60 W	Console needs to scale power down when not fully utilizing the capabilities of the device.
Navigation	70 W	60 W	Modest reductions from current levels, recognizing that this is a transitory mode with a limited impact on annual energy use.
Media (movies, music, internet)	50 W	25 W	Benchmarks: - Most efficient standalone Blu-Ray player: 9.9W - Wii movie streaming: 14 W
Other modes (internet browsing, photos, music, set-top…)	70 W	60 W	Same as Navigation. If any of the other mode emerges as one of the primary uses of consoles, specific limits would need to be set.
Standby/Off	0.5 W	0.5 W	Same as EU Ecodesign 1275/2008
Networked Standby	4.0 W	2.0 W	Same as proposed EU Ecodesign Lot 26

The NRDC proposal notes that these levels are preliminary and need to be discussed with stakeholders for technical feasibility and cost-effectiveness. Comments have been submitted by various stakeholders and the CEC are yet to make a decision on what product categories will be investigated in the pre-rule making workshops. The association representing the game consoles industry have made comments on the NRDC proposal, stating that they do not believe the proposal is technically feasible. It is anticipated that these workshops will be held in the first half of 2012.

Europe

In the European Union, The Ecodesign Directive aims at setting mandatory minimum requirements for individual product groups. Ecodesign Lot 3 includes Game Consoles and Lot 26 covers Networked Standby which impacts game consoles. Both these standards are under development.

Ecodesign Lot 3 final report for the preparatory study Sound and imaging equipment: DVD/video players and recorders, video projectors, and video games consoles. The work was carried out by AEA Group and Intertek between January 2009 and November 2010 (AEA 2010). The document considers power limits for idle modes and the implementation of an Auto Power Down (APD) requirement from 2014. Currently only computers and monitors have progressed to the next stage of the Ecodesign process with the publication of working documents. It is understood that further research and consultation is being undertaken relating to Game Consoles by the European Commission, however details are not yet available.

The Ecodesign Lot 26 has progressed to working documents in July 2011, with global limits of 4 W (low network standby) and 12 W (high network standby) for network connected products from 2014 and limit of 2 W (low network standby) and 8 W (high network standby) for network connected products from 2016. These proposed limits will affect video game consoles that are connected to the network and have a reactivation function while in standby.

The Ecodesign Lot 18, covering complex set top boxes specifically excludes game consoles with a TV tuner. A Voluntary industry agreement has been developed for the products under the scope of Lot 18.

Power Management

Appropriate power management of a game console would involve the following key principles:

- **Auto power down (APD) options enabled by default**. That is defined as automatically setting the device into it lowest power mode after a set period of inaction or time when the console is not being used. This presents significant savings in the energy use of the console as users can leave consoles in an active mode which uses similar power to that of gameplay or media playing. Recently, both Microsoft and Sony have implemented a form of APD in their current generation consoles, while Nintendo have indicated that the Wii U will also have APD.

- **Power Scaling,** where the power use is scaled down and up according the use/function of the device. The amount of power used by the current generation of consoles only decreases by 10% to 20% when playing a video or streaming media. Other media devices and PCs can reduce power consumption significantly when lower levels of processing power are engaged.

- **Low power use when in network standby mode**. The connection of the network for media streaming or gameplay can be important when the device is actively used or to provide software updates or other services when the device is unattended. It is important to ensure that the console is in a low power standby

state from which it can be awoken remotely by a network signal. This will mean a product does not need to be in ON mode to maintain an active network state. Power consumption can be very low in this network standby mode and should be encouraged.

While these concepts are simple, to effectively implement in products it requires careful design and coordination of hardware and software. The advantage of the game console industry is that both the hardware and to a certain extent, the software are under the influence of the same company, unlike the PC industry where the hardware and software from several suppliers interact. Although 3rd parties develop and distribute the vast majority of the software for game consoles, it is the game console suppliers who provide the platform and can influence aspects of the use and development of software for game consoles.

Auto Power Down

The auto power down (APD) function enables a device to power down to a low power mode after a set time and the user has not interacted with the device. The purpose of the APD function is to minimise unintended use of the device. There are examples of equipment that utilise this function including DVD players, PCs and other home entertainment products. The potential savings associated with the implementation of this function in home entertainment products is very large (EnergyConsult 2010). Some of the current versions of video game consoles have implemented or attempted to implement an APD function (ADT 2011).

The NRDC proposal to the CEC (NRDC 2011) included a draft set of requirements that were developed with input from the major game console suppliers. The latest requirements have been updated by the game console suppliers *(Industry communication August 2012)* and are shown below:

Auto Power Down Requirements for Games Consoles

The following requirements, which will be introduced region by region to determine acceptance by users, form the basis of an advanced auto-power down proposal (APD) for games consoles. These requirements combine best practices across several categories of Energy related Products:

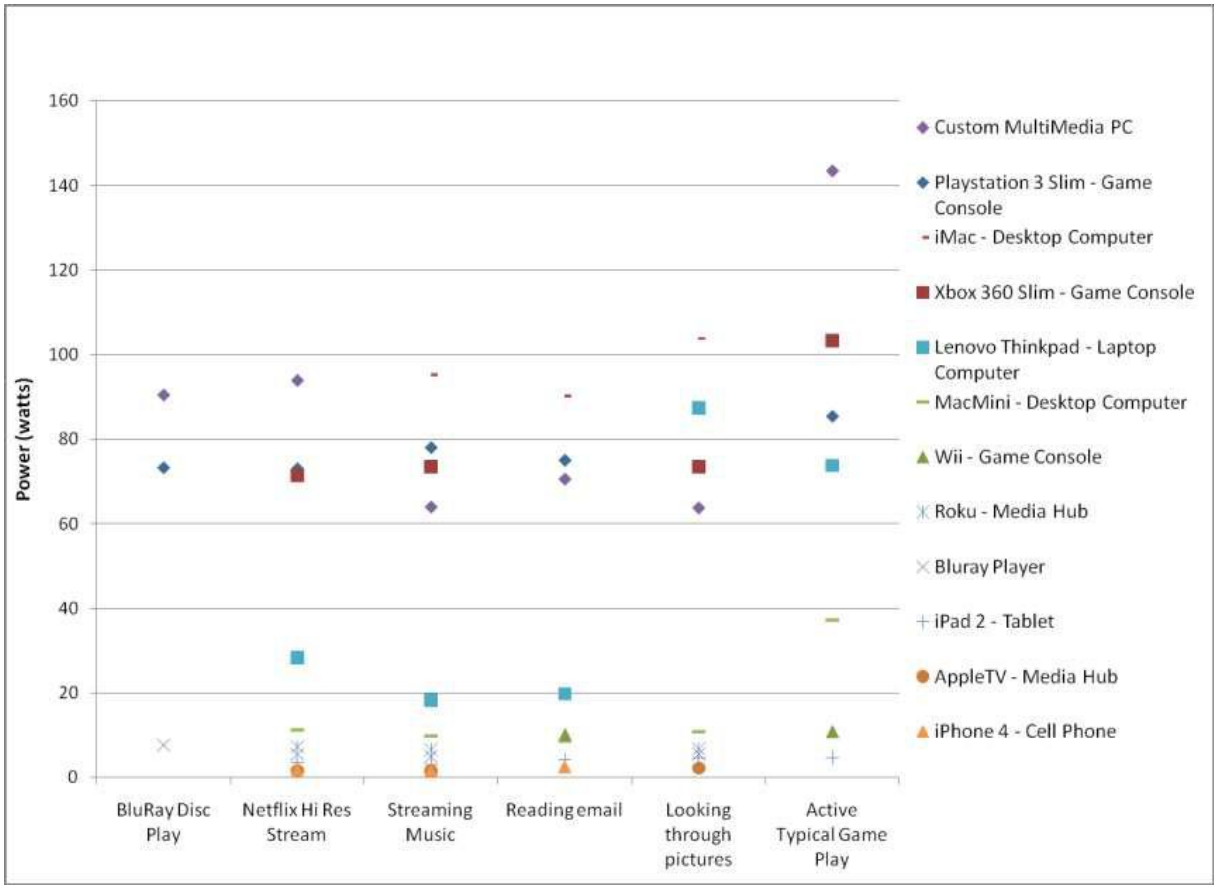
- Games consoles with forced menu on initial activation of the games console shall provide auto-power-down as the default choice on initial activation of the console. If the user selects a mode other than auto-power-down on initial activation of the console, a second selection process shall be prompted to confirm this choice.
- When auto-powering down consoles shall auto-power down to Standby mode, Network Standby mode or another condition that does not exceed the maximum power consumption permitted for Standby mode.
- Consoles shall be shipped with activation of an auto-power down mode that complies with applicable laws.
- The user shall have the option to disable APD for all modes. Consoles may present the option of disabling APD for Active Game mode only first so as to encourage users to leave APD enabled for other modes.
- The user may have the option to change the time settings for the auto-power down function from within the equivalent system settings menu options e.g. for retail display purposes or for heavy game users.
- For Operational modes other than Media Playback, the period of inactivity required to trigger auto-power down shall be set at 1 hour or less from the time of the last user input. In Media Playback mode, auto-power down shall be triggered after 4 hours or less of audio or video media playback (including video files, streaming audio-visual content, IPTV or Digital TV) or triggered by user inactivity of 1 hour or less after termination of video media content.
- In limited circumstances users may be prompted to suspend APD temporarily to allow certain types of games or software applications to run without user input e.g. simulation games and video streaming which run without user input for periods longer than 1 hour. Once selected, the temporary suspension may remain enabled for replay of such game or media content upon restart of the console.
- APD shall be suspended temporarily to allow for the uninterrupted performance of any system update, system maintenance, software installation or content download and shall not occur during the display of an error message to users in the event of a system error.
- After an automatic wake event, consoles shall power down within 5 minutes after performing required system maintenance and downloads, or other functions that may require an automatic wake-up.
- Accessories bundled with the console and using the console as a direct power source shall also power down and shall be included in auto-power down power measurements.
- Console operating systems shall communicate an imminent auto-power down event through an application programmable interface (API) or other means.
- Some software published for current or previous-generation consoles may not necessarily be compatible with the APD functions described in this proposal. Console manufacturers will use best efforts to work with the video game software industry with a view to incorporating these APD functions when publishing software for consoles covered by this proposal.
- Individual console producers may introduce new and innovative approaches to APD as and when the same or better energy saving are possible along with improved consumer experiences. As possible this guideline will be updated to reflect any such significant innovations.

The draft agreement contemplates that these APD requirements would apply only to consoles that use more than 20 watts in Active game mode.

Power Scaling

To illustrate the range of tasks that a game console performs and the related power consumption of various similar devices, a study by Ecos Consulting (Ecos 2011) was undertaken for the Asia Pacific Partnership Standby project. Figure 8 shows that many of the functions performed by the game console can also be performed by media hubs, PCs and Laptops. The large reduction in power consumption by the laptop when playing media or music compared to game playing shows the effectiveness of the concept of power scaling.

Figure 8: Popular universal tasks performed on a variety of devices and associated power consumption



Source: Ecos 2011

Perhaps the most striking difference in power consumption is between the game consoles and the laptop computer. These devices share many of the same fundamental components however when streaming high resolution video or playing music, the laptop uses between one quarter and one half of the power. This example shows the ability of current silicon technology to intelligently use power scaling and reduce the power requirements according to the task. The current high definition game console has significantly more processing power than older laptops, however with the release of new integrated GPU/CPU chips by both Intel and AMD, current laptop PCs can easily play

high definition video. There are reasons why the comparison of a game console with a laptop PC may not be reasonable, as the laptop is a portable device, with different performance levels, architectures and functions to a game console. However, the purpose of the comparison is to highlight the significant reductions in power use due to power scaling strategies in currently available technology. There might be potential for these strategies to be transferred to the next generation of game consoles.

Low Network Standby Power Use

The connection of the game console to the network is becoming common for most installations. All three major suppliers offer valuable services via a network connection, including video/audio media streaming, gameplay and software updates or downloaded games. The value of the internet connection for increasing services to users is significant and one of the major marketing pushes by Sony, Microsoft and Nintendo. Examples of their services include

- Sony Entertainment Network – 30 day free trial to unlimited music streaming (over 7 million songs).
- Microsoft – 40 million of the 66 million Xbox users subscribe to Xbox Live, with users in Australia now able to play ABC/SBS and other TV catch up services. Within 2012, subscribers to Xbox live will be offered MLB Advanced Media, which offers more than 45,000 blockbusters, Hollywood classics, independent films and TV shows.
- Nintendo – the Wii has a Wi-Fi connection that is always connected to the internet where users have selected Wi-Fi connection 'On'. This is used for gameplay and updates to the Wii. When the new Wii U is released, there are likely to be high definition video streaming services.

The requirement for low network standby power consumption will increase in importance as network connected game console devices are used for more and more purposes. The power consumption when connected to the network and not performing network activities should be managed to a low power state. There are limited measurements of the current generation game consoles power consumption when connected to networks and cycled through various modes, however the in-home measurements of connected game consoles show that power consumption does not reduce significantly when networks are not used. The main focus of the current network standby policy efforts appears to apply to devices that have a reactivation function while in standby and are connected to the network. This mode may not be highly relevant to game consoles as only the PS3 currently supports this feature.

Scope of Energy Efficiency Improvements

The major modes of use of game consoles were described in the section Mode of Use on page 14. These include:

- Gameplay

- Media play/recording
- Navigation
- Off/standby/network standby

The scope of energy savings for game consoles in all modes except gameplay may be significant, but are still to be fully evaluated. For instance, power scaling could provide substantial reductions in power use when a game console is playing media, or in navigation mode. Standby power when connected to the network could be minimised and will become more relevant as devices are continuously connected to the internet. Currently, network standby policies applies only when the device has a reactivation function available. Although it is not fair comparison to suggest a game console should be compared with a standalone media player (DVD, Blu-Ray or media streamer), the power consumption of high definition game consoles and the comparable power consumption of a media playing device show reductions in power use of over 70% (~70 W for Game Console and 15 W for media player).

These comparisons highlight the potential power savings from improving the efficiency of game consoles in various modes. If we consider the potential 10 year energy cost savings from using a HD video playing alone (say 1 hour of use per day), compared to a HD game console, it amounts to $60 to consumers using current electricity rates.

Savings from auto power down and network standby are also very significant. Assuming that the APD saves about 50% of the idle time (NRDC 2011), this equates to 10 year energy cost savings of over $30 (about 0.5 hours of reduced time per day) for the HD game consoles. Network standby allowances would apply when the device has a reactivation function available.

The savings predicted from the implementation of an APD function in game consoles is a reduction of 56 GWh pa by 2020 in Australia (derived from EnergyConsult 2010). This assumes that 30 mins per day of inactive use is reduced. A total cumulative energy saving of 330 GWh or 0.3 million tonne CO_2-e is estimated by 2020 from this function alone. These savings are assumed to be already included in the business as usual energy consumption forecast provided earlier. This demonstrates the significant potential savings from efficiency improvements in game consoles.

In summary – these energy savings are significant and require action by the game console suppliers to implement. There is certainly software and hardware changes required that may prove difficult for the suppliers in their current generation systems, however there is significant potential for the next generation game consoles. The current generation consoles do not seem to power scale easily, but over the last 3 years, the power consumption of the main HD consoles have decreased with each iteration of hardware. This shows that the suppliers have accepted the challenges of reducing power consumption however there is certainly more that can be done. The auto-power down function is appearing in the latest consoles, and will need to be carefully implemented to ensure this feature is not disabled by users. In fact the APD has been included in the latest software update provided to the Xbox 360 and hence will be implemented in many

of the installed consoles and PlayStation(r)3. There are issues with certain games when implementing APD as the user may not require the game to be saved before powering down (such as simulation or fighting games).

Policy Options for Consideration

The approach of the Australia Energy Efficiency and Equipment (E3) Program has included a number of policy options to encourage energy efficiency improvements in appliances and products. The main approach by the E3 program has been to introduce Energy Rating Labels (ERL) and/or mandatory Minimum Energy Performance Standards (MEPS).

MEPS and ERLs already apply to a large range of equipment, appliances and lighting products including refrigerators, clothes washers, televisions, compact fluorescent lamps and industrial motors. When offered for sale, appliances regulated for ERL must display a label that shows the star rating and other useful information about energy consumption. The label gives the appliances a star rating between one and ten stars. The greater the number of stars translates to higher efficiency. It enables consumers to compare the energy efficiency of domestic appliances on a fair and equitable basis. It also provides incentive for manufacturers to improve the energy performance of appliances.

MEPS aim to prevent poorly performing products from entering the marketplace, rather than promoting the best. By removing the worst performing products, MEPS aims to create a level playing field for suppliers and protect consumers from higher running costs associated with poor performing products.

Voluntary approaches have also been used in the E3 program, including an agreement with the Subscription TV (Pay TV) set top box (STB) providers. This agreement was negotiation with the main suppliers in Australian and the Australian Subscription Television and Radio Association (ASTRA) which is the peak body that represents the subscription television industry in Australia. The aim of the Code is to:

- Voluntarily minimise the overall energy consumption (kWh) used by set top boxes without limiting or impeding functionality and user convenience
- Set voluntary maximum energy consumption targets for set top boxes and associated testing procedures that endeavour to meet or exceed international best practise for equivalent equipment, and
- Advise the public of the existence and benefits of the Code and the commitments of Signatories to the Code.

The specific market conditions and business models for video game consoles present different opportunities and challenges to the application of the various policy options. The policy options have been assessed with regard to the game console market and how effective they may be in encouraging an increase in efficiency of game consoles. The assessment is as follows.

MEPS

MEPS aims to prevent poorly performing products from entering the market, however as there are only three main consoles from the suppliers currently being sold, a MEPS may

prevent one or more suppliers from offering their product in Australia. If this occurs, the overall efficiency may increase, however the reduction in product availability may have a detrimental effect on consumer choice. This may not occur, if all the suppliers meet the MEPS levels, but the risk is that suppliers may not choose to enter the Australian market if the product changes required to meet the MEPS are too costly or difficult to achieve over a short time frame.

The product life cycle for a game console is reasonable long for a home entertainment product – the Wii, PS3 and Xbox 360 have been in the market since 2006/7, and indications are that manufacturers require around 5 to 10 years before major new product is released. Many of the products in the home entertainment category have shorter life cycles of 6 months to 2 years. The long product life cycle means that major changes to the design of the console to improve operational efficiency are harder to implement. Certainly, incremental changes to the consoles have been implemented since their entry to the market and overall power consumption has reduced by up to 64%, but further efficiency gains may be difficult without a change in the architecture of the products. Further incremental changes could be made to allow for APD or low network standby, but power scaling could be difficult without changes to the overall design of the console.

MEPS may work effectively if long timeframes are chosen and the suppliers have sufficient time to implement the changes to meet the required levels.

Energy Rating Labels

Energy Rating Labels (ERLs) provide the consumer with information on the overall comparative energy use of the products and the efficiency. They have been proven to be very effective in markets in Australia and could be applied to game consoles without any detrimental effect on product availability or competition, as the products are still able to be sold. However, it would be difficult to create a fair system of comparison as the game consoles have various functions, performance and usage characteristics.

The main issue to be considered for ERL is the assessment of comparative energy consumption and efficiency. This is commonly termed the efficiency metric and used to calculate the number of stars. A metric uses a test procedure to measure the performance of the game consoles under similar conditions and outputs/performance. At the moment the performance of the three major consoles differs with regard to their ability to play high definition graphics and video, as well as various differences in media sources. The PS3 and Xbox360 both are able to play HD video and games while the Wii outputs lower resolution and hence uses less powerful processors. Therefore, the development of a comparative ERL would be challenging, however, with the release of the Nintendo Wii U in 2012, all consoles will output HD graphics and video. Future releases of products from Sony and Microsoft may raise the output video resolution higher or offer a range of features that increase the energy consumption while providing greater levels of service. The issues are further complicated as the suppliers do not share what potential features are provided in future products and hence the development of a comparable metric would be difficult in advance.

An alternative to assessing the performance of the game consoles within a comparable output or performance would be to simply disregard the performance and assess the console power input. This would simplify the rating approach, but a lower performing product may obtain higher number of stars, compared to a higher performance console. The consumer would then have to assess the performance and other features offered by the console supplier when comparing different products, but the star rating may differ substantially. They would then be able to make their own judgement on the relative trade-off between energy use and performance.

In addition, the users may want to compare the performance of a game console with a gaming PC, and this creates problems for the design of ERL scheme as game consoles are specific function devices while gaming PCs can have many uses. Including gaming PCs in the scope of an ERL for game consoles may not be possible.

Voluntary Agreement

The main focus for consideration in this paper is voluntary actions – such as an agreement similar to the STV STB agreement (ASTRA 2000). An agreement would be negotiated between the game console industry stakeholders and Government to specify increases in efficiency and reduction in energy consumption relative to the business as usual (BAU) over a set time frame. This agreement could be centred on a Code of Conduct that is not a commercial agreement and does not in itself create any contractual relationship between signatories. The participants in the Code would be aware of their obligations under the Competition and Consumer Act 2010, and if the Code is breached, the Australian Competition and Consumer Commission (ACCC) may take legal action to address these breaches. Voluntary agreements or codes of conduct have been used as suitable policy instruments for similar product categories in other jurisdictions, including the European Union and USA.

A code of conduct would specify either power or total energy consumption (TEC) limits for particular modes of use and could vary depending on the level of performance or features provided by the console. For example, the code could specify the maximum power (watts) per mode of operation to be achieved in a particular timeframe or in a series of Tiers (different levels at say 2 years and 4 years hence) or as a percent reduction from the baseline energy or power consumption from the start of each generation of new console. Depending on the model chosen for development, such as power use per mode or TEC, the code would specify a base power/energy consumption and additional functionalities allowance to be added for each feature or increase in output performance (i.e., DVR function adds 32 kWh pa to the base allowance under the STV Code of Conduct).

A number of principles could also be introduced into the code, such as the auto-power down requirements and low network standby modes. The addition of each new remote feature or controllers could also be optimised for efficiency (such as battery charging efficiency).

The software development industry may also wish to participate in aspects of the code or develop their own code of conduct to enhance the efforts made by the hardware suppliers. At present the intention is to work initially with the hardware supply industry as they have the most influence on the power consumption of game consoles.

The test method can also be specified in the code, and this could be examined in detail when the ENERGY STAR specification is published in 2012. In addition, the code or agreement could be developed in close cooperation with USA government agencies (EPA, CEC) or the EU, to ensure that policy measures taken are harmonised with major international actions. The Australian government has a history of supporting international harmonisations of test methodologies, such as the Standby Power, air conditioners, TVs, etc., or marking schemes, such as the efficiency mark or external power supplies. The Australian government will endeavour to work with other overseas government agencies to ensure that policy instruments are internationally acceptable where appropriate, and especially with products that are common within similar regional markets.

Finally, the code can allow for independent monitoring and reporting, to ensure that participant obligations are being addressed. A third party can arranged for the reporting of sales and power use of newly introduced game consoles – so that only aggregated data is reported to the parties and made publicly available. This would also enable the public to be informed of the code success.

Conclusions

Video games consoles represent the epitome of globally traded equipment, ubiquitously available in many countries around the world and sold by three multinational corporations. The overall energy consumption of video game consoles continues to increase (based on sales estimates tested with industry sources and the results of various console testing programs) and is therefore the legitimate target of government action.

Although the suppliers have continuously improved the power consumption of game consoles from initial hardware release, the overall energy consumption is likely to increase as game console platforms also perform media streaming functions in many households. The game console is changing from just one type of home entertainment equipment to become the centre of the home entertainment system. This trend is being strengthened by media content agreements and by the increasing functionality of this type of equipment.

Games consoles (not including Nintendo Wii) now use more than twice as much power as other home entrainment devices already regulated or subject to efficiency-improvement schemes sponsored by governments around the world (such as DVRs, Optical Disc Players and STBs).

For these reasons, Australian and New Zealand energy efficiency agencies want to work with the global suppliers to improve games console efficiency for the future. At present, though discussions are occurring elsewhere, no program or agreement operates with complete industry support to improve console efficiency.

The three very differing platforms of each of the major suppliers have meant that the suppliers themselves have found it difficult to unilaterally focus on improving energy efficiency in competitive markets. The Australian and New Zealand governments have a role to play in encouraging efficiency as a design consideration and can support the game console industry with fair market-based interventions.

The past work in other locals also provides a solid foundation for a regional agreement in Australasia. The US ENERGY STAR program is developing a method of test while the European Commission and Californian regulators are debating possible regulatory formats for the future. The E3 committee commissioned EnergyConsult to explore a voluntary agreement with three games console suppliers who are all interested in this approach. This agreement should improve the efficiency of current and future consoles more expeditiously than regulation.

Suppliers have agreed to participate in a dialogue about the form of a voluntary arrangement. They have already participated in meetings and teleconferences in late 2011 and early 2012. The initial priority will be the non-game playing modes of games consoles because testing in-game play mode is still problematic. The parties to the potential voluntary agreement have agreed to examine holistic arrangements that will improve

existing products to the extent practicable and to work on ensuring efficiency becomes a key design consideration of all future console models.

Following government endorsement and stakeholder comment on the proposed direction of the voluntary arrangement, the parties have committed to preparing arrangements that should specify the method of test, develop an appropriate approach (i.e., power limits or Typical Energy Consumption), specify limits and/or allowances and otherwise establish the form of the agreement between the parties. The work to establish the framework should be completed during the remainder of 2012.

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