AEA

Building on the Eco-design Directive, EuP Group Analysis (I)

ENTR Lot 3 Sound and Imaging Equipment

Task 1–7 Report

Report to the European Commission DG ENTR

ED 45386
Issue Number 1
Date November 2010

Intertek

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The sections of this report have been completed at different stages throughout the progress of this study. As a consequence of this, some of the information provided in the earlier sections may be out of date. Task 7 contains the most up to date information at the time of completion of this report.

Abbreviations

A/V	Audio/video
BD	Blu Ray Disc
CD	Compact disc
CoC	Code of Conduct
CPU	Central Processing Unit
CRT	Cathode Ray Tube
DDR	Double Data Rate
DECT	Digital Enhanced Cordless Telecommunications
D-ILA	Direct Drive Image Light Amplifier
DLNA	Digital Living Network Alliance
DLP	Digital Light Processing
DPF	Digital Photo Frame
DTV	Digital Television
DVB-T	Digital Video Broadcasting Terrestrial
DVD	Digital Versatile Disc
DVI	Digital Visual Interface
DVR	Digital Video Recorder
EPG	Electronic Programme Guide
EPS	External Power Supply
GPU	Graphic Processor Unit
GSM	Global System for Mobile communications: originally from Groupe Spécial Mobile
HD	High definition
HDCP	High-bandwidth Digital Content Protection
HDD	Hard Disc Drive
HDMI	High Definition Multimedia Interface
I/O	Input/Output
IP	Internet Protocol
IPTV	Internet Protocol Television
LAN	Local Area Network
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LSI	Large Scale Integration
METI	(Japanese) Ministry for Enterprise Trade and Industry
MPEG	Moving Pictures Expert Group
MTP	Market Transformation Programme

OS	Operating System
OTA	Over the Air
PC	Personal Computer
PDA	Personal Digital Assistant
PDP	Plasma Display Panel
RF	Radio Frequency
SACD	Super Audio Compact Disc
SDIO	Secure Digital Input Output
SoC/SOC	System on a Chip/System on Chip
SPI	Serial Peripheral Interface Bus
SSD	Solid State Drive
STB	Set Top Box
SXRD	Silicon X-tal Reflective Display
UART	Universal Asynchronous Receiver/Transmitter
USB	Universal Serial Bus
USB-OTG	USB On the Go
VCR	Video Cassette Recorder
VGA	Video Graphics Array
VR	Video player/recorder
WLAN	Wireless Local Area Network

Executive Summary

This is the final report for the preparatory study for ENTR Lot 3: 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. The study has followed the European Commission's MEEuP methodology, and our findings to date (in Task order) have shown that:

Task 1 - Definition

There is a wide range of products available for the presentation of video images. To facilitate manageability of this study, three product types have been investigated[1] covering video players / recorders, video projectors, and video games consoles. This is a product area which is undergoing rapid technological change. Newer products are being developed continually that offer more functionality and sophistication to enhance the consumer's visual appreciation. Consequently, the time scale from new to obsolescence is very short. Many of the products are very new to the European market or reflect a step change in functionality and storage technology (e.g. Blu-Ray Disc playing and recording equipment).

The first task in the MEEuP methodology and consequently to our study is to develop a product definition to be used throughout the work and to identify the existing legislation and standards that are pertinent to these products.

The definition discussion for these products starts with a review of existing definitions found in various publicly available sources, continues with a risk assessment of those definitions in order to assess their robustness and flexibility, and concludes with a suggested preliminary definition for each product type.

The following three preliminary definitions have been established:

Table 1: Definitions established

Video Player/Recorder
A video player/recorder is a stand alone device whose primary function: • Decodes video to an output audio/video signal   o from recorded or recordable media via a powered or integrated media interface such as an optical drive, USB or HDD interface • Has no tuner unless it records on a removable media in a standard library format • Is mains powered • Does not have a display for viewing video • Is not designed for a broad range of home or office applications
Projector
A projector is a mains powered, optical device, for processing analogue or digital video image information, in any, broadcasting, storage or networking format to modulate a light source and project the resulting image onto an external screen. Audio information, in analogue or digital format, may be processed as an optional function of the projector.
Games console
A "Games console" is a mains powered stand alone device which is marketed as a product providing video game playing as its primary function through an external screen and which has the following features: <u>Hardware Architecture</u> • CPU • System memory • Video architecture • Network architecture • Optical drives (to be defined) • Hard drives or other internal memory (optional)

[1] Note: An initial assessment of Digital Picture Frames was also carried out for Tasks 1, 2 and 3 only. This has been published as a separate report.

- Mains connected internal or external power supply unit

Input devices
- Typically hand held controllers or other interactive controllers rather than keyboards or mice

Optional Secondary functions
- Optical disk playback
- Digital picture viewing (via an external screen)
- Digital music playback

Excluded components or functionalities:
- Integrated screens
- Conventional Personal Computing (PC) operating systems
- Internal batteries for powering products over extended periods of time

Some specific products types have been excluded from the work including those:

- that are designed for use using a battery power supply,
- that are niche market products (e.g. professional cinema projectors)

In addition to the preliminary definitions, Task 1 identifies and comments on standards, existing legislation, voluntary agreements, and labelling initiatives that affect the products of this study and can be found at the European Union (EU), in the Member States and outside Europe.

Standards:

Harmonised standards, within the European Union, are developed by European standardisation bodies based on essential requirements defined in European legislation. Standards are also developed by internationally recognised standardisation bodies and often share ratification and published as European standards.

European and international standards relevant to video players / recorders, video projectors, and video games consoles pertain to power consumption, environmental impact, health and safety requirements and electromagnetic compatibility.

Directives and Regulations

The key European Community Directives and Regulations affecting these products are Waste Electrical and Electronic Equipment (WEEE) (2002/96/EC), Restriction on hazardous substances (ROHS) (2002/95/EC), Low Voltage Directive (2006/95/EC), Electromagnetic compatibility (EMC) Directive (2004/108/EC), Regulation 1275/2008 (Ecodesign requirements for standby power), and Regulation 278/2009 (Ecodesign requirements for external power supplies (EPS)).

Voluntary measures/agreements

In total 13 voluntary agreements have been identified that relate to video players / recorders, projectors, and games consoles. Five of them within the European geographical area and the remaining in countries outside EU.

Table 2: Voluntary measures at European and International level

EU	International
EICAT – self commitment to improve energy efficiency	Energy Star (US)
Group of Energy Efficiency Appliances (GEEA)[2]	The Korean Eco Label (Korea)
The Nordic Ecolabel (Scandinavia)	Green Mark (Taiwan)
The Blue Angel (Germany)	California Energy Efficiency Regulations
TCO Label	Top Runner Program (Japan)
Code of Conduct on Energy Consumption of Broadband Equipment	The IEA '1 Watt Plan' Japanese Eco Mark Product Category No. 145 - Projectors

Task 2 – Economic and Market Analysis

The main manufacturing and assembly bases for these product groups are situated outside the EU in East Asia, including Malaysia and China. However, small amounts are manufactured in Eastern Europe. Thus, amounts imported to the EU-27 are high compared with amounts produced in the EU-27.

Whilst annual sales of video players/recorders are declining slightly (~1% per year) and sales of projectors are currently flat, annual sales of games consoles are growing.

The video recorder market has peaked at approximately 40 million devices sold per year. It is expected to decline at approx 1% a year. Substitution of DVD with Blu-ray is also expected and DVD will become obsolete between 2015-2020.

For projectors and games consoles, commercial market research data is more difficult to obtain and assess. For projectors, this can be partly explained by the complicated cross-over of internet based direct sales and sales of school projectors that are usually obtained through bulk procurement contracts and are not necessarily registered in commercial market research databases. Games consoles, on the other hand, face high market competition with publications of sales data being subject to increased market pressure and thus are not always available.

Overall annual sales for projectors are expected to saturate by 2015, with forecast of annual sales at around 1.7M to 2.2 M units. For games consoles, the market is dominated by three main manufacturers all of whom are competing for share of a growing games market. Due to the nature of the market there is a great uncertainty around the product both in terms of future sales and timing and type of new products to be launched into the market. Based on assumptions and scenarios developed by the project team, sales of games consoles are projected to fluctuate over the years.

Current stock of actively used video players/recorders is expected to be approximately 180 million with a maximum figure of 350 million. For projectors the figure is much smaller, at around 8 million. However, this figure could be much higher if internet based sales and school projectors were included. Games consoles are assumed to peak at approximately 87 million units. All product types exhibit significantly higher numbers than the indicative threshold number of 200,000 units required for consideration under the Ecodesign Directive.

For video players/recorders there is a competitive market including most major Consumer Electronic Manufacturers, each offering a range of different models covering price points from around 30 Euros to over 1000 Euros. New models are released on a 6-12 month lifecycle and usually are available for retail sales for between 12-24 months.

The video projector market is now quite mature as there is over a decade of established core technology. Development of alternative lamp technology is a priority for all key current manufacturers but it is considered unlikely that this will be a catalyst for new players entering the market. High end products with only minor changes to the main specification tend to have a comparatively long retail

[2] No longer in operation. Products that got the label in the past are allowed to retain the label.

shelf life - over periods of up to five years. New models with no significant production changes are released on a nine to twelve month manufacturing cycle.

For games consoles, competition can be distinguished between those competing for the gaming enthusiast market (demand for enhanced graphics and more advanced game playing) and those competing for lower specification products. The current products on the market are designed and developed over long periods of time and are usually launched with state of the art components.

The replacement cost of many consumer electronic products is currently significantly less than, or equal to, the basic inspection charge levied by electronic product repair workshops. Diagnosing faults other than those associated with the power supply can be time consuming and repairs at chip level can be very complex. For these reasons, it is unlikely that an electronic device costing up to 150 Euros will be repaired in its lifetime.

Task 3 – User Behaviour

The use pattern of video players/recorders is assumed to depend on its features. The video recorders/players with the lowest use are most likely to be those that provide playback only. Recorders have longer use periods, and if the device is used in the same way as a set-top box (STB), i.e. for pausing live TV, use is at least as long as the TV on-time.

Other factors that could influence power consumption are auto power down and standby modes. For video players, auto power down and switch to stand by mode is a common feature but recorders are less likely to offer this feature and thus on-time use can be significantly longer.

The market segmentation of projectors, i.e. home cinema, office and schools, generates very different usage patterns. For a home cinema, the average usage can vary from 0.5 hours per day in on-mode operation to 23.5 hours per day in standby mode, while that could change to 6 hours/day and 4 hours/day respectively for a school projector (the rest of the day it is switched off).

Games consoles have increased their usage pattern through the launch of the seventh generation products. Current estimates suggest that the most prolific gamers (accounting for 75% of all gaming time) use their games consoles for over 5 hours each day that they play. Average use hours across each product in stock are expected to be significantly lower than this. Use is predicted to increase further as more games become available for download.

These multimedia items have a typical lifetime of around 6 years. The EC WEEE Directive sets an overall collection target for all WEEE and also sets specific targets for the recovery and the reuse and recycling of consumer equipment (Category 4 appliances). Further to this, following a 2008 review of the WEEE Directive, in December 2008, the European Commission issued proposals to increase these targets including setting a collection target founded on a different basis (proportion of what is placed on the market). Product replacement is driven by fashion and new technology trends. In addition, the very low cost products may be designed for shorter lifespans and faster replacement cycles. Data on waste arisings of these products are very limited and estimates based on stock/lifetime calculations are very approximate.

Task 4 – Assessment of Base-Case

Generally, items in this product group comprise of about 20-40% by weight of plastics (various types) and about 15-30% metals (assembly). Cardboard packaging accounts for about 30% of the weight as purchased. For the purposes of this assessment, compliance with the WEEE Directive has been assumed for the 'end-of-life' phase of these products.

	Video player/recorder	Projector	Games console
Materials	**%**	**%**	**%**
Bulk Plastics	22.5%	14.9%	27.8%
Tech Plastics	-	17.4%	0.3%
Ferro	29.8%	5.1%	8.8%
Non-ferro	2.6%	9.0%	7.6%
Coating	-	0.0%	-
Electronics	11.2%	11.8%	17.0%
Misc.	33.9%	41.7%	38.5%
Total weight	**100.0%**	**100.0%**	**100.0%**

Three base cases were agreed with stakeholders for this study. These were: a typical video player/recorder, projector and games console. The Eco-report outputs on the base cases indicate that the 'use phase' accounted for a large proportion of the impacts (in some impact categories more than 90%) for these products. This was found to be particularly the case for Total Energy consumption, Electricity consumption, greenhouse gas emissions and acidification emissions to air. The total electricity consumption for these multimedia products (8.6 TWh) represents about 83% of the total energy (GER) consumption This amount of electricity consumption is equivalent to slightly less than the total electricity consumption of Lithuania, and is equivalent to about 0.3% of the total electricity consumed in the EU.

In terms of greenhouse gas (GHG) emissions, 6 million tonnes CO2eq is equivalent to around 0.14% of the EU-15 base year emissions of GHG (fixed at 4265.5 mt CO2eq).

In terms of acidification impact, 36 kt SO2eq represents about 0.8% of National Emissions Ceiling Directive target for 2010 for the EU-15.

Total annual consumer expenditure was significant at around 13 billion Euros – mainly on price paid for products.

	Video Player	Video Recorder	Projector	Games console
Product Price	1,300	1,568	1,280	7,416
Installation costs	0	0	800	0
Electricity	481	234	161	393
Repair and maintenance	0	0	567	0
Total	1,781	1,802	2,807	7,809

(Note: Units are billions of Euros)

Task 5 – Technical Analysis BAT and BNAT

Our analysis of best available technology (BAT) identified a range of options for improving the environmental performance and efficiency of these multimedia products. For video players/recorders, we concluded that the two best options for BAT were:

- the use of optimally designed docking station architecture with external HDD, and
- the use of energy optimised chip sets.

For projectors, BAT options include optimisation of:

- the Lamp/light module,
- the lens system,
- the light path beam splitting optics, and
- the elimination of leaded glass from the lens elements.

For games consoles, BAT would include optimisations of

- the inclusion of additional power management functionality,
- using the most efficient power supplies available, and
- maximising processor performance scaling to reduce power consumption when maximum computing performance not required.
- noting the achievements made in the personal computer industry to reduce wider environmental impacts around end of life, material content and upgradability

The pace of development in consumer electronics technology is increasing and the introduction of new innovations is seemingly constant. What might have been considered as BNAT (Best "not yet" Available Technology) can become BAT very quickly. Thus, improvements tend to be accommodated within the design cycle typical for these products. BNAT options for these multimedia products relate

to changes in product type and consumer behaviour and response to innovations on the ways that the consumer's visual experience is enhanced.

Task 6 – Improvement Potential

The purpose of this task was to identify design options, their monetary consequences in terms of Life Cycle Cost for the user, their environmental costs and benefits, their economic and possible social impacts and pinpointing the solution with the Least Life Cycle Costs (LLCC) and the Best Available Technology (BAT). Design options considered included: Auto Power Down (APD) feature, operational mode requirements (efficiency improvement of active/idle/quick start mode), hard On/Off switch, product lightweighting, PVC-free products, BFR-free products, improved recyclability, increased product durability (lifetime), reusable components, and minimum recycled content requirement for plastics.

In all of the product types assessed in this task, there was a common theme of improvement suggestions that appear to offer the LLCC point. These are:

- Operational mode requirements
- Product lightweighting
- APD feature
- Reusable components

Combination of two or more of these above improvement options leads to the LLCC point for these products. This provided the basis upon which recommendations for policy actions were made (see Task 7). Note that although the incorporation of APD (option 1) showed little improvement for projectors, this does not mean that its use as an improvement option should be ignored. A power down feature is already utilised in conventional projectors as part of the lamp cooling regime for protecting the lamp life. With technology trends towards the use of LED/laser lamp combinations in projectors, lamp life protection is no longer an issue. Therefore it is important to ensure that APD is retained and not dispensed with (see Task 7).

Sensitivity analysis showed that product price has a major effect in the life cycle cost of all products and can particular affect the LCC-curve for the product lightweighting option. The effect is less significant with changes in electricity prices or discount rates. In addition, analysis showed that the use pattern plays a critical role. The level of variation in the total environmental impact score due to changes in usage pattern is about the same order of magnitude as the level of benefits derivable from the improvement options assessed earlier.

Task 7 – Policy and Impact Analysis

Task 7 looked at suitable policy measures to achieve potential power consumption improvements for the three product groups (Video Players / Recorders, Projectors, Games consoles). There are a number of other environmental impacts associated with these products, however, given that no ecodesign measures for other electronics products have included wide ranging requirements on non-energy in use impacts it would be unsuitable to suggest these type of requirements for the products of this study in isolation.

Video players/recorders

Following the definition risk assessment of Task 1, the definition of video players/recorders is given in the box below:

A video player/recorder is a stand alone device whose primary function:

- **Decodes video to a output audio/video signal**
- **from recorded or recordable media via a powered or integrated media interface such as an optical drive, USB or HDD interface**
- **Has no tuner unless it records on a removable media in a standard library format**
- **Is primarily mains powered**
- **Does not have a display for viewing video**
- **Video recorders additionally provide the option to record video and audio on a data storage medium**

For video players/recorder it is suggested that the preliminary definition changes to 'is primarily mains powered' to prevent a potential loophole for products that might use auxiliary battery power.

The advances in technology expected in future years could increase the consumption that video player/recorders have in on-power and stand-by mode. However it is difficult to predict the exact future power consumption levels of these products as the technology is rapidly evolving.

For video players/recorders two overall operational modes are recognised. These are the idle modes (further broken down to off/stand-by, network stand by and fast start) and active modes (broken down to secondary functions, video playback and recording).

A first tier is assumed to apply in 2012 setting the following power limits as ecodesign requirements:

- On-play HD = 15W
- On-play SD = 8W
- Live pause SD/HD = 20W/30W

The second tier is assumed to apply in 2014 setting the power limits as ecodesign requirements for

- Live pause HD = 25W

Standby and off mode power consumption of video players/recorders is already appropriately covered by ecodesign Commission Regulation No 1275/2008.The potential for power management lies within the Auto Power Down function and should apply to the fast start, content navigation and live pause operating modes. It should activate after no user input in less than 30 minutes for video players and three hours for video recorders.

The majority of savings result from the reduction in use time, particularly from reducing fast start. Disabling fast start by default for BD players is responsible for approx 2/3 of all the savings in 2015. Most of the remaining savings from reducing fast start use in BD recorders, however, some projections sales and stock of BD and DVD recorders in 2015 are over five times smaller. This could reduce the energy savings attributable to the policy recommendations for recorders to less than 0.2 TWh.

A number of voluntary eco labelling schemes which support public procurement already exist internationally. Currently, ENERGY STAR is considered to set the most effective ecodesign requirements. Another potential eco label option is to apply the EPEAT standards development process[3], which has been successfully used to develop specifications for desktop and computer laptops and being developed for televisions and other products.

For the small niche segment of High End devices that use innovative technologies and provide superior AV-quality using discrete electronic designs highly integrated silicon as it is used in mass-

[3] http://www.epeat.net/StandardsDevelopment.aspx

market products is not available. To limit the environmental impact given by such product and reduce the burden for the mainly SME in this sector a specific registration/vignette system is proposed.

Projectors

Following the definition risk assessment of Task 1, the definition of projectors is given in the box below:

A projector is a primarily mains powered, optical device, for processing analogue or digital video image information, in any, broadcasting, storage or networking format to modulate a light source and project the resulting image onto an external screen. Audio information, in analogue or digital format, may be processed as an optional function of the projector.

For projectors, professional products are excluded from the scope of this study and the task 1 definition statement 'is mains powered' is qualified to 'is primarily mains powered' to prevent a potential loophole for these portable and personal projector products.

Two overall operational modes are defined low power and on (projecting an image) which are broken down, as applicable, into sub-modes.

As on (video projection) mode completely dominates the in-use power requirement of a projector, in this assessment two tiers of minimum energy performance standard were initially recommended to apply. The first in 2012 based on an average minimum luminous efficiency of 0.09 W/Lumen while the second is proposed for 2015 on the prediction that the light output efficiency could be increased to 0.05 W/lumen by solid state illumination technology. However no evidence to support this second tier proposal has been made available to the study team by the projector Industry or other Industries developing solid state lighting. To the delivery date of this study, it still remains only as a claimed potential efficiency standard, from one of the projector manufacturers developing solid state illumination. However the study team recommends that the Commission should continue to closely monitor light source developments in projectors since predicted step improvements in efficiency may be confirmed in months rather than years. For the present, the study team recommends that a minimum efficiency, as detailed in the following table, applies to standard projectors from 2012. Coefficients to qualify the negative impact on efficiency of special lenses and special light path processing (home cinema projectors) are also recommended.

Effective Flux (Total Projected Light output) X lm	Efficiency Limit W/lm
X < 2,500	0.105
2,500 ≥ X < 4,000	0.095
4,000 ≥ X < 5,000	0.085
X ≥ 5,000	0.080

Recommended correction coefficients relaxing the efficiency limit:

- Short throw projector, *1.3
- Wide projector, *1.1
- Home cinema projector, *1.4

The study team consider that standby and off mode power consumption of projectors is already appropriately covered by ecodesign Commission Regulation No 1275/2008, and more stringent product- specific limits are not proposed.

Auto Power Down function is currently a normal projector design criterion as the protection of the lamp life is still a design priority. A trend towards long life lamp solutions could turn this functionality into an unnecessary design criterion; however it is proposed that it should still apply to projectors so as to ensure that some power is saved from the lamp when there is no user requirement to project video data in a usage cycle.

Based on the above energy efficiency requirements the savings compared with the baseline could be 0.55 TWh in 2015 and 0.58 TWh in 2020. The 2020 saving would increase to 1.3 TWh if the claimed step change in light source efficiency occurred.

The implementing measure could be complemented by an industry voluntary agreement to eliminate mercury from all projector lamps and lead from light path glass. In addition, an eco labelling could be introduced to support public procurement and target Schools Projectors as this is the largest market in the EU-27.

Games consoles

Following the definition risk assessment of Task 1, the definition of games consoles is given in the box below:

A "Games console" is a mains powered stand alone device which is marketed as a product providing video game playing as its primary function through an external screen and which has the following features:

Hardware Architecture

- CPU
- System memory
- Video architecture
- Network architecture
- Optical drives (optional)
- Hard drives or other internal memory (optional)
- Mains connected internal or external power supply unit

Input devices

- Typically hand held controllers or other interactive controllers rather than keyboards or mice

Optional Secondary functions

- Optical disk playback
- Digital picture viewing (via an external screen)
- Digital music playback
- General internet connectivity

Excluded components or functionalities:

- Integrated screens
- Conventional Personal Computing (PC) operating systems
- Internal batteries for powering products over extended periods of time

In task 7, the definition of a game console has slightly changed to include the term 'general internet connectivity'. That is to reflect the fact that games consoles are being also increasingly used for general internet based applications.

Looking towards computers it seems that similar measures and approaches can be also adopted for games consoles, albeit at different levels. An example is the scalable chip that many desktop and notebook PCs are now incorporating that can increase or decrease CPUs power demand depending on processing demands.

It is shown that many of the power saving technologies employed in personal computers (PCs), such as dynamic voltage scaling, dynamic frequency scaling and clock gating, have yet to be fully implemented in games consoles. The inclusion of these power saving technologies in games consoles is discussed in terms of potential future improvements.

Most of the power modes, except the active mode, present a good potential for reducing power consumption.

A TEC approach is proposed, which aims to circumvent the difficulties associated with developing ecodesign requirements for future products where specification levels, and therefore power demands, are unknown. The approach is based on computational efficiencies in the active mode (measured in FLOPS/W) and idle mode power demand based on feasible reductions from the active mode power. Other power modes such as sleep and standby mode power are also addressed in the proposed TEC approach with an emphasis on encouraging the lowest possible power demand. It is recognised that for this approach to work it will be necessary to confirm a suitable use profile and develop a methodology to measure computational performance in he active mode.

Absolute power demand limits are suggested as an alternative to the TEC approach. It is suggested that idle and sleep mode power demand could be reduced to similar levels found in a draft ENERGY STAR specification. However, it is also recognised that the suitability of future idle mode power levels is heavily dependent on the functionality and specification found in future games consoles. As such it is also suggested that idle mode power levels could be based on pre-defined reductions from the active mode power of any new games console.

In terms of power management requirements, it is suggested that the requirements listed in a joint industry and non-governmental organisation (NGO) auto-power down (APD) proposal are adopted (after minor amendments and clarifications are made to the text). The APD requirements would come into force 6 months after the implementation of an ecodesign requirement for games consoles using more than 20W in active mode. All games consoles would be covered from 2014 onwards. The APD requirements address high definition consoles and includes a period of 30 minutes of inactivity in most power mode other than y before the game console auto-powers down.

For any power management functionality to ensure that works effectively and is accepted by users it is essential to ensure that game publishers are also involved to ensure that power management has no impact on the gaming experience.

Given the above policy measures if these were to be implemented the savings would range from 0.7 TWh in 2016 for applying Idle Mode limits to all modes to 2.1 TWh in 2020. While the savings would have been greater if power down after 30 minutes and idle mode limits were to apply – 2.1 TWh in 2016 to 3.7 TWh in 2020.

In addition to minimum ecodesign requirements an EU ecolabel could be extended to cover games consoles. The EU ecolabel could be developed to reflect the best performance of the games consoles on the market and automatically apply to the one product that met the specification. This process could be useful where one manufacturer has not taken the same steps as a competitor to reduce environmental impacts such as in use energy or reductions in material usage.

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1 Task 1: Definition

1.1 Introduction

The European Union (EU) has established competitiveness and sustainable development as two priority policies. Considering these, DG Enterprise and Industry promotes the integration of sustainable development with other policies fostering the EU's competitiveness including those connected with entrepreneurship and innovation and the Lisbon Agenda.

Within this a key area is sustainable industrial policy that aims to foster environmental and energy efficient products within the internal market. The Ecodesign Directive (2009/125/EC) is central to the approach. It sets out a coherent, consultative mechanism by which requirements can be set for energy-related products whilst ensuring the free movement of such products within the market.

Energy-related products have been recognised as important because they are responsible for a significant fraction of the energy and other resources consumed by the EU. There is also considerable potential for reducing the associated environmental impacts by adopting ecodesign measures at the product design stage because at this point up to 80% of a product's life cycle impacts are determined whether these be emissions to air and water, water use or waste generation. Hence if eco-design is to reflect holistic thinking then it is appropriate to take account of the whole life cycle at the design stage.

The adoption of the Ecodesign Directive paves the way for the development of implementing measures to regulate the environmental characteristics of ErPs whilst fully respecting the economic factors associated with making change. The Directive itself requires the Commission to ensure that related activities involve:

- The balanced participation of all member States,
- The participation of all relevant stakeholders for a particular product group including producers, traders, retailers, importers, NGOs and consumer groups.

The Commission established in 2004/05 a well-defined approach to the development of implementing measures – the Methodology for the Eco-design of Energy Using Products (MEEuP). This sets out a common method to gather information to help define implementing measures. The method involves the use of a simplified life cycle tool (EcoReport).

The first step of the MEEuP method is to undertake a preparatory study. These are undertaken for a particular product group with the express purpose of providing the necessary information to prepare the Commission for subsequent activities including consultation with the Forum, an impact assessment and defining draft implementing measures.

The work required by DG Enterprise and Industry will, using the established MEEuP methodology, gather information regarding market characteristics, trends, environmental impacts, consumer behaviour, standards and test methods, stakeholder opinion and scope for improvement and the associated costs. In doing so it will provide information that helps policy makers develop minimum requirements for energy-related products, complemented with, where appropriate, voluntary "lead" standards, benchmarks, labelling and incentives to drive performance upwards. A public access website is kept up to date with the most significant developments within the study.

In particular the study will:

- Develop a product definition to be used throughout the work;
- Identify relevant existing legislation and standards;
- Develop an economic and market analysis for the product, including market structure and trends;
- Evaluate the significant environmental impacts of the product using the EcoReport tool;

- Assess the investment, design and production costs, least life cycle costs and other necessary economic conditions for cost-effective ecodesign requirements;
- Form an assessment of the impact of specific measures on the competitive situation of market players and employment conditions;
- Identify the needs and generic requirements for standards to be developed;
- Identify via consultation self-regulation initiatives by industry;
- Develop dynamic labelling and benchmark categories linked to possible incentives, such as public procurement or fiscal instruments;
- Determine the impact of incentives.

1.2 Product Definition

The generic products in this preparatory study are:

A) Video players/recorders (VRs)

B) Projectors/Beamers (The product name “Beamer” is commonly used for Projector in some parts of Europe but for the purposes of this report the name “Projector” will be used. This product, is, by current market categorisation, sub qualified as Professional Cinema / E-Cinema / Digital Cinema Projector, Domestic , Home-Cinema projector and Office Projector – further categorised as Portable or Permanently Installed)

C) Games consoles (consumer gaming consoles such as available as Microsoft Xbox, Nintendo Wii or Sony Playstation)

For those product groups the product definition approach is a three step process (figure 1). First, a review of the existing definitions displayed by various studies, government sources and/or international standards (see section 1.3for more details). Second, a risk assessment to assess the robustness and flexibility of the definitions identified. And third, based on the outcome of the risk assessment, a preliminary definition is defined. That preliminary definition will be in turn reviewed in task 7 to conclude with a final definition.

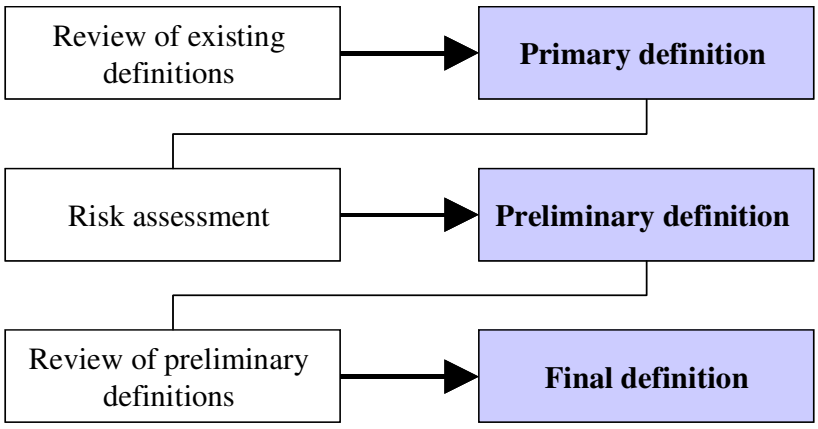


Figure 1: Product Definition Process

1.2.1 Existing Product Definitions

To define these products, trade categorisations, tax categories, voluntary and mandatory initiatives, and relevant test standards were studied. For the definition of some of the products covered by this study the following sources are considered the most appropriate: the US Environmental Protection Agency (EPA) for Energy Star and definitions given in International measurement and testing

Standards for a product genre. Products not defined by these sources include those categorised under the groupings, B) and D) that follow. The definition discussion for these products concludes with a suggested primary definition.

A) What is a Video player/recorder and what specifications are used?

Video recorders first entered the domestic mass market in the 1970s with the video cassette recorder (VCR). This enabled owners at home to play back pre-recorded video on their TV from an easily handled, removable tape. In addition, it was possible to record from the TV. In doing so, consumers were able to store videos to be watched at their convenience and as often as they liked. The cheap media format also allowed premium content to be distributed, such as movies. By the 1990's, VCRs were very commonly found in many households.

Newer removable optical formats were then developed, most significantly the digital versatile disc (DVD) in the 1990s. This is a digital format with higher capacity, enabling higher video and sound quality to be reproduced. While many devices can only play video, a minority of products also record to DVD. DVD players are now very cheap and at least as popular as VCRs at their peak.

Since 2000, there have been two major developments, Blu-ray Discs (BD) and hard disc drive recorders. Blu-ray is another optical format with even higher capacity, able to store full high definition (Full HD) content. Hard disc drive (HDD) recorders with digital TV (DTV tuners) have the benefit of being able to record and play simultaneously and continuously, enabling live-TV to be paused. It also stores all the video within the device, reducing the space needed to physically store optical discs and the need to swap them in and out of the device. However, the storage is not considered removable and therefore has a large but limited capacity.

Other innovations include combination devices which include:

- multiple storage options such as both DVD and HDD in one device,
- solid state discs (SSD) which are potentially a direct replacement for HDD
- internet connections for downloading multimedia content and conditional access to device specific media content.

Video players/recorders (VRs) encompass a variety of devices using different data formats and physical forms for storing video. As described, these include Digital versatile disc (DVD), Blu-ray Disc (BD) and hard disc drives (HDD). As a result the definitions tend to define each type of device separately. The **California Energy Commission**[4] uses four definitions:

1) "Digital versatile disc (DVD) player" means a commercially-available electronic product encased in a single housing that includes an integral power supply and for which the sole purpose is the decoding of digitized video signals on a DVD.
2) "Digital versatile disc (DVD) recorder" means a commercially-available electronic product encased in a single housing that includes an integral power supply and for which the sole purpose is the production or recording of digitized video signals on a DVD. "DVD recorder" does not include models that have an EPG function[5].
3) "Digital video recorder (DVR)" means a device which can record video signals onto a hard disk drive or other device that can store the images digitally. "DVR" does not include models that have an EPG function."
4) "Video Cassette Recorder (VCR)" means a commercially-available analogue recording device that includes an integral power supply and which records television signals onto a tape medium for subsequent viewing.

This approach could create a very large number of definitions as new products enter the market with new features or combine existing features.

The ENERGY STAR criteria are currently under revision. This is being broadened to an ENERGY STAR Audio/Video specification:

[4] CEC reference [(2007) 2007 Appliance efficiency regulations (revised) http://www.energy.ca.gov/2007publications/CEC-400-2007-016/CEC-400-2007-016-REV1.PDF
[5] "Electronic programming guide (EPG)" means an application that provides an interactive, onscreen menu of TV listings, and that downloads program information from the vertical blanking interval of a regular TV signal.

Product Classifications:
1) AV Product: For purposes of this specification, all products that offer audio amplification and/or optical disc drive functions and do not meet the definition of a Dedicated Audio DSP Device shall be classified as AV Products and subject to the requirements specified in this document.
2) Consumer AV Product: Consumer AV Products are intended for sale to individual consumers and include the following: cassette decks, CD players/changers, CD recorders/burners, clock radios, DVD & Blu-ray Disc products, equalizers, laserdisc players, mini- and midi-systems, minidisc players, powered speakers, rack systems, stereo amplifiers/pre-amplifiers, stereo receivers, table radios, and tuners.

Excluded Products:
Products that are covered under existing ENERGY STAR product specifications are not eligible for qualification under the Audio/Video specification. The list of specifications currently in effect can be found at www.energystar.gov/products. For example, displays, monitors, lighting, computers, and game consoles cannot qualify as Audio/Video products, since each is subject to qualification criteria under another ENERGY STAR specification.
The following products are excluded from qualification under this specification.
a) Products which meet the definition of a Display, Television, Set-Top Box (STB), Computer, or Game Console per the definitions in ENERGY STAR requirements for those product categories. Also excluded are products that include an IP video tuner and are sold or provided outside of a dedicated service contract.
b) Primarily battery-powered products (i.e. MP3 players, portable DVD players, portable gaming systems, etc.)
c) Products for use in automotive applications
d) Video projectors
e) Home and building automation & control products
f) Whole-house and whole-building audio and/or video systems
g) Videoconferencing systems
h) Wireless microphone systems
i) A/B Selector Switching
j) Media Server

Product Functions:
1) Audio Amplification: A function by which a device increases the amplitude of an audio signal for purposes of sending the signal to a transducer for playback.
2) Audio Signal Processing: A function by which a device modifies an audio signal for a purpose other than amplification.
3) High Resolution Display: A function by which a device converts a video signal into a visual output (e.g. LCD panel, Plasma display panel).
4) Status Display: A function by which a product provides a visual display of less than 480x234 pixel resolution or 5 inches diagonal screen size. A typical status display would be a back-lit alphanumeric clock or channel indicator. Note that single indicator lamps are not included under the definition of status displays and are not provided power allowances under this specification.
5) IP Networking: A function by which a device can connect to an IP-based network for transmission and receipt of data. The connection may be wired or wireless (e.g. WiFi, Ethernet, Bluetooth).
6) Optical Disc Player/Recorder: A function by which a device can read and/or write data to removable disk media (e.g. CD, DVD, Blu-ray Disc, and derivatives).

Significantly, ENERGY STAR 2.0 does not define a video recorder/player instead creating a broader definition for Audio/Video products with only two features, an optical disc drive and/or audio amplification. It then narrows the definition by excluding all other products already covered by other ENERGY STAR specifications as well as an additional list of other devices. A very limited number of additional functions are defined for the purpose of setting power consumption criteria.

The definition from a logical perspective is very complex since the exclusions require that a product must be evaluated against all other ENERGY STAR definitions. However, from a pragmatic point of view it is very effective and recognises the breadth of AV equipment. In the context of a voluntary

agreement, this makes it possible for products to be included in the ENERGY STAR programme where a manufacturer decides this is advantageous.

For the purposes of the Preparatory Study, extracting a definition for video recorder from the ENERGY STAR AV definition is difficult. Since most video recorders do not have audio amplification, this requirement is not considered relevant. This means that optical disk drive is the key criteria, which includes cd players and critically excludes hard disk drive only media players that can consume as much or more power than an optical disk drive.

In conclusion, the existing definitions are unlikely to be able to address the changing technology in video recorders. Instead a broader definition, which captures the basic functions is needed . Based on the existing definitions, the common functions common to all VRs and the initial defining factor appears to be the ability to decode (or play) pre-recorded video from a storage medium. This is distinct from decoding live broadcast video signals via a tuner. A risk assessment and functionality analysis will be carried out in chapter 1.1.2 to evaluate the robustness of this primary definition.

A primary definition for video recorders/players is:

A standalone product with the primary function:

- to decode (or play) pre-recorded video to and output video signal
- from a storage medium which is distinct from decoding live broadcast video signals via a tuner.
- And optionally record input video or broadcast signals.

B) What is a Projector and what specifications are used?

Projectors were developed to fulfil the requirement for a group of viewers to simultaneously view an image originally intended and formatted for personal viewing. To achieve this the image is “projected” on to a large viewing area (the screen) The group presentation can encompass a few to several hundred viewers with a projected screen area of one square metre to more than one thousand square metres. The physical juxtaposition of viewers and projector resulted in two projection formats:

Forward projection – where the projector is located with the viewers and in front of the screen;

Rear projection - where the projector is behind the screen. The latter normally applies to products with a screen and projector system contained in one physical assembly.

This latter format is not now applicable to the genre of projector covered by this report because it comes under ENER Lot 3 and 5 monitors /TVs.

Generically defined, a projector is an OPTICAL device that modulates a high intensity light source and via an optical lens assembly, beams that modulated light onto a remote screen (usually not integral to the projector), to produce visual images framed by the screen.

Since the advent of photography and up to the last decade of the 20th century, the principal modulation system has been a physical image printed onto transparent film and arranged to mechanically interrupt a light source with static or multiple (moving) image frames. These “film” projectors are not considered in this study but the basic principal of modulating a light source by an interrupting medium still applies to the projectors under consideration.

A particular variant of projection technology, based on a pre-modulated light source (cathode ray tube) and now in virtually complete manufacturing decline, is not considered in this study.

In the projectors under consideration, an electronic image source (digital video data stream or analogue base band video) is processed to electronically drive an interrupting medium in the light path. The electro-mechanical assembly that contains the interrupting medium that processes the light source and delivers the modulated light beam to the optical lens assembly, is called a “light engine”. The interruption process is achieved with two distinct technologies, based on a transmissive interruption medium or a reflective interruption medium. These two, basic, light engine systems, share the office projector market however reflective semiconductor projection engines now totally dominate the E-Cinema and Home-Cinema projector product market. They are based on HTPS[6] (transmissive)

[6] High Temperature Poly Silicon

or DMD[7] / LCoS[8] (reflective) semiconductor technology. Limitations in LCD transmissive projection engines in terms of image quality and brightness have now restricted the application of this technology to the low cost office projector market.

All projectors are based on a high intensity light source that totally dominates the energy footprint of the product (typically > 90% of total power requirement of projector). For that reason different environmental related labelling schemes around the world (see section 1.3 for more details) have made their principal eco-design criteria minimum energy consumption requirements in the active and stand by mode, minimum noise levels (from cooling fans), and hazardous material restrictions.

Projectors are not specifically defined in National or International measuring or testing standards. Where projector performance has to be qualified, existing generic standards for safety, electromagnetic compatibility and image characteristics are applied.

Given that the market for Projector products has resulted in the development of three distinct product types, the task of defining the product can be approached by establishing a generic definition qualified by the important characteristics of the three subcategories.

- Generic Projector : A projector is a mains powered optical device for processing an analogue or digital video signal, to modulate a light source, and project the resulting image onto an external screen.
    - Professional / E / Digital - Cinema Projector:: A Professional Cinema projector is a mains powered optical device intended for, but not restricted to professional cinema applications, for processing an analogue or digital video signal, to modulate a light source, and project the resulting image onto an external screen.
    - Home-Cinema Projector: A Home-Cinema projector is a mains powered optical device intended for, but not restricted to home viewing applications, for processing an analogue or digital video signal sourced in TV standards and Computer standards, to modulate a light source, and project the resulting image onto an external screen. Audio signals related to the video signals may also be processed and controlled by the projector.
    - Office Projector: An office Projector is a mains powered optical device intended for, but not restricted to office viewing applications, for processing an analogue or digital video signal sourced in TV standards and or Computer standards to modulate a light source, and project the resulting image onto an external screen.

It may be concluded that a primary definition of a projector is:

A projector is a mains powered, optical device, for processing analogue or digital video image information, in any, broadcasting, storage or networking format to modulate a light source and project the resulting image onto an external screen. Audio information, in analogue or digital format, may be processed as an optional function of the projector. A risk assessment and functionality analysis will be carried out in chapter 1.1.2 to evaluate the robustness of this primary definition.

C) What is a *Games console* and what specifications are used?

Early games consoles designed for home use first came onto the market in the early 1970's. Like most electronic devices the sophistication of games consoles has increased over the years. The historical timeline of games consoles is often separated into "generations" with the current games consoles on the market being described as "seventh generation". The seventh generation games console market is currently dominated by three main games consoles, from three manufacturers, for which worldwide sales reached 100 million units by 2008.

A "Games console" (otherwise known as a "Game(s) Machine") is an entertainment computer or electronic device that displays a video game on an external screen (e.g. a computer monitor or television). The term "Games console" is used to identify an electronic device that is designed primarily for playing video games. The term "Games console" is not usually applied to personal computers (which offer many additional functions to game playing) or commercial arcade machines.

As well as through games consoles, video game functionality is offered by a large array of electronic products. For many of these devices, video game playing is offered as a secondary functionality

[7] Digital Micromirror Device
[8] Liquid Crystal on Silicon

alongside the primary functionality of the product (e.g. DVD players used for playing DVD based games). For other products, video game playing might be the primary functionality but the design of the product closely resembles common products on the market for which video game playing is not their primary function (e.g. desktops personal computers (PCs) which are marketed as "Gaming Desktops).

In addition there is a wide range of hand-held battery operated games consoles with integrated screens for which video game playing is the primary function. The major environmental impacts of hand held battery devices are considered to be covered by the EC batteries Directive and will therefore not be subject to further investigation in this preparatory study[9].

Thin Client gaming consoles are also beginning to appear on the market. These Thin Client gaming products are not currently covered by any preceding ecodesign preparatory studies nor are they subject to any other pieces of European legislation which seeks to reduce their energy consumption. Thin Clients however are inherently low power consuming devices since the majority of functionality is provided by remote data centres. For this reason they will not be investigated as part of this ecodesign preparatory study.

The most dominant type of Game Consoles currently on the market are sophisticated computing devices which are stationary mains powered and for which video game playing is their main (and sometimes only) functionality. These Game Consoles are not covered by any previous ecodesign preparatory studies or major pieces of European legislation which address in use energy consumption. Gaming Personal Computers (PCs) are covered in the draft ecodesign implementing measures for computers. Given the sophistication of the most common games consoles, the large numbers sold each year and the fact that no legislation currently addresses energy use during operation, these types of stationary mains powered devices will be the main focus of this preparatory study.

The above sections identify a large number of diverse electronics products on the market, many of which are covered by other ecodesign Preparatory Studies such as in ENER Lot 3 Personal Computers (desktops and laptops) and Computer Monitors. The likelihood of DVD gaming through video player/recorder products is remote. Gaming is more likely through the use of set-top boxes (for example, in the UK, Sky offer such games as a subscription service). To avoid repeating work covered in other ecodesign Preparatory Studies it is necessary to further define the term "Games consoles".

The ENERGY STAR® Program Requirements for Computers Version 5.0 provides a definition for "Games consoles" which relates to stand alone mains powered devices[10].

*"**Game Machine**: A standalone computer-like device whose primary use is to play video games. Game Machines use a hardware architecture based in part on typical computer components (e.g., processors, system memory, video architecture, optical and/or hard drives, etc.). The primary input for game consoles are special hand held controllers rather than the mouse and keyboard used by more conventional computer types. Game machines are also equipped with audio visual outputs for use with televisions as the primary display, rather than (or in addition to) an external or integrated display. These devices do not typically use a conventional PC operating system, but often perform a variety of multimedia functions such as: DVD/CD playback, digital picture viewing, and digital music playback. Handheld gaming devices, typically battery powered and intended for use with an integral display as the primary display, are not covered by this specification".*

The above ENERGY STAR definition offers some clarity on the type of product that can be defined as a "Game Console". However for the purposes of this study some further clarity to the ENERGY STAR definition is required to ensure that the four main types of games consoles currently on the market are covered by the definition. The original ENERGY STAR definition did not include a reference to other forms of internal memory other than hard drives. Other changes have been made to the description of input devices to ensure that all types of games console input devices are covered. A further clarification on the type of operating system used in games consoles has also been included to ensure

[9] Directive 2006/66/EC of the European Parliament and of the Council of 6 September 2006 on batteries and accumulators and waste batteries and accumulators and repealing Directive 91/157/EEC
[10] ENERGY STAR® Program Requirements for Computers Version 5.0 - http://www.eu-energystar.org/downloads/specifications/20081118/final/Computer_Spec_Version%205%200_%20Final%20Nov08.pdf

that gaming PCs are not covered by the definition. The reference to Handheld gaming devices in the original ENERGY STAR definition has also been removed and replaced by a sentence concerning the necessary requirement for games consoles to be mains power devices. This clarification was included to ensure that battery operated handheld gaming devices are not covered by the scope of this preparatory study. Thus it may be concluded that a primary definition for a Game Console is:

*"**Game Console**": A computing device whose primary function is to play video games. Games consoles share many of the hardware architecture features and components found in general personal computers (e.g., central processing unit(s) (CPU), system memory, video architecture, optical drives and/or hard drives or other forms of internal memory). Games consoles typically utilise either dedicated hand hold or other interactive controllers designed for enhancing game playing rather than the mouse and keyboard used by personal computers. Games consoles are also equipped with audio visual outputs for use with televisions or video projectors as the primary display, rather than (or in addition to) an external or integrated display. These devices do not typically use a conventional PC operating system but rather have dedicated console operating systems. Games consoles may also offer DVD/CD playback, digital picture viewing, and digital music playback. Games consoles are mains powered devices provided by either internal or external power supply units".*

For the above primary definition a risk assessment and functionality analysis will be carried out in section 1.1.2 to evaluate its robustness.

1.2.2 Preliminary Definitions of the Study

Risk assessment of the definitions

For a workable definition, a risk assessment of the proposal is needed: e.g. is the definition **robust** on the one hand, and **flexible** enough on the other hand, to be used in an ecodesign measure? The proposition is that a definition is robust if it cannot be (easily) qualified in the context of the wording of that definition. A definition is flexible if it allows future trends in functionality to be included.

For ***robustness*** the qualification is, can manufacturers modify the design of the product in such way that:

1) the product does not meet the accepted product definition on which the specific eco-design criteria is based and therefore need not comply with related regulatory parameters
2) the modification costs are less than the costs needed to meet the regulatory criteria.

A closed definition runs high risks of being circumvented by products that have some functionality that is not included in the definition (loopholes, as they are known, for the circumvention of the standby regulation by adding a RJ 45 socket to the product to create a "networked product").

The ***flexibility*** refers to the question; is the definition flexible enough to cope with functional and technological trends? What is available today can be outdated tomorrow and, in general, regulation cannot be changed overnight and should be stable for a longer period, so that it can be used as a design guidance for developers and manufacturers.

What are the trends expected for the product groups in this study that may qualify the accepted or suggested product definitions. Trends for this product group in terms of technology development and market uptake are under investigation and were discussed at the first stakeholder workshop.

A) Video Players/Recorders

The table below illustrates the main devices generally classed marketed as video players/recorders. These include BD, DVD, HDD and combinations thereof. A HDD player is very likely to be also almost identical to future SSD players. In addition the main functions are listed to compare and check the initial definition adapted from the existing definitions.

A standalone product with the primary function:

- to decode (or play) pre-recorded video to and output video signal

- from a storage medium which is distinct from decoding live broadcast video signals via a tuner.
- And optionally record input video or broadcast signals.

Devices generally marketed as Video Player/Recorders:

		
Blu-ray player	DVD/HDD player/recorder	HDD media player
Optical Drive Blu-ray/DVD decryption and decoding Ethernet Video out	Optical drive Integrated HDD Video encoding and decoding Tuner Video in Video out	WiFi USB Ethernet Interface for internal HDD (HDD not supplied) Decoding support for multiple video codecs and file formats Video out
		
DVD Player	Blu ray recorder	
Optical Drive DVD decryption and decoding Video out		

The definition is flexible enough to adapt to new products such as HDD media players with all devices decoding video and playing from a storage medium (inc. BD, DVD or HDD). However, to check that the definition is robust and distinct, it is instructive to compare the definition with devices generally NOT marketed as VRs.

Devices generally not marketed as a video recorder/player

Set top box	Home cinema system (Home theatre in a box)	Portable DVD player
Tuner HDD Video out	Optical drive DVD decoding Video out Audio amplification Speakers	Optical drive DVD decoding Integrated screen Battery operation

		
External hard drive	External DVD drive	
Storage only device (does not function without master device) Connects via USB/eSATA/Firewire etc	Storage only (does not function without master device) Connects via USB/eSATA/Firewire etc	

Devices with video playback functions:

		
Games console	Handheld game console	Desktop personal computer
Optional: - dvd player - blu ray player - hard drive player - streaming video player - in game video recording - online video store	Optional: -optical disc player -streaming video player -SD card player	Optional: -dvd/bluray player -dvd/blu ray recorder - video streaming player/server - online video store -Hard drive playback and recording - broadcast video recording

		
Laptop personal computer	Ultra mobile personal computer/Mobile Internet Device	Mobile phone
Optional: -dvd/bluray player -dvd/blu ray recorder - video streaming player/server	Optional: -dvd/bluray player -dvd/blu ray recorder - video streaming player	Optional: - video streaming player - video player

- online video store -Hard drive playback and recording - broadcast video recording	- online video store -Hard drive playback and recording - broadcast video recording	

		
MP3/personal media player (shown with dock)	Thin client	Digital photo frame
Optional -video player	Optional: -streaming video player	Optional: -video player

		
Network attached storage	Refrigerator	Wifi/internet enabled consumer electronic device (Chumby shown)
Optional: -video player -streaming video server	Optional: -streaming video player	Optional: -streaming video player -video player

		
Television	Video Projector	Video camcorder
Optional:	Optional:	-Video player

- bluray/dvd player - hard disk player/recorder - streaming video player	-dvd player	

		
Digital Camera	In car entertainment (ICE)	Video conferencing/ video phones
Optional: -video player		

		
Patio Heater		
Optional: - hard disk player/recorder - streaming video player		

Because video playback is possible in virtually any internet browser, and the electronic components so cheap and simple, video playback can be integrated into virtually anything – including home appliances, portable devices, children's toys and other consumer electronics.

It is clear that the initial definition is too broad and it is not possible to distinguish between other products; all the products featured above would be classed as a VR under the initial definition. There are also no distinguishing visual features of a video recorder. It is important to determine if these products could be in the scope of the study and if this would impact the subsequent development of relevant and effective policy, or if a more restrictive definition is needed.

An alternative starting point to find the functions that might distinguish between VRs and other consumer electronics is the preliminary list of functions for audio and video equipment suggested by ENERGY STAR Audio/Video specification revision[11].

[11] http://www.energystar.gov/index.cfm?c=revisions.audio_video_spec

- Audio
    - Amplification
    - Signal Processing (Commercial Only)
    - Switching & Distribution
    - Output (Speaker)
    - Input (Microphone)
- Video
    - Switching & Distribution
    - Output (Display)
    - Input (Camera)
- Media Interface
    - Optical Drive (CD, DVD, BD)
    - Digital Drive (USB, Card reader, etc.)
- Signal I/O
    - Network Connectivity (Ethernet, Wi-Fi, etc.)
    - Audio Tuner (OTA, Satellite)
    - Video Tuner (IP)
- Data Storage (HDD, SSD)

In addition, a draft table comparing common audio/video products with the functions associated is presented:

		Amplification	Switching & Distribution	Output (Speaker)	Input (Microphone)	Switching & Distribution	Output (Display)	Input (Camera)	Optical Drive	Digital Drive	Network Connectivity	Audio Tuner	Video Tuner	Storage (HDD/SSD)
		Audio				Video			Media I/F		Signal I/O			
Home / Retail	*AV Receiver*													
	Home Theater Receiver	x	x			x			x	x	x	x	x	x
	Web Video Device (i.e. Vudu, AppleTV)		x			x					x		x	x
	Media Server													
	Digital Music Server System		x								x			x
	Media Player													
	Blu-ray Disc Player					x			x		x			
	DVD Player					x			x		x			
	CD/SACD Player													
	Amplifier													
	Power Amplifier	x												
	Signal Distribution & Switching													
	A/B Selector Switch		x											
	Signal Processor (Analog/Digital)													
	Tuner											x		
	Pre-amp	x												
	Speaker Systems													
	Self-powered Subwoofer	x		x										
	Wireless Speaker System	x		x							x			
	Home Theater in a Box (HTIB)													
	HTIB System	x	x	x		x			x				x	
	Compact & Portable Audio Systems													
	Compact Shelf System	x		x								x		
	Clock Radio	x		x								x		
	Boombox	x		x								x		
	Home Radio	x		x								x		
	Karaoke Machine	x		x	x									x
	Control Systems (whole-house systems)													
	CCTV Camera Security System				x	x	x	x						x
	Touch-panel Home Control System	x	x	x	x		x	x			x			

The table covers the A/V products that are intended to be included. However, this is a prescriptive approach and may not be flexible enough to adapt to new products developments which could be excluded by default. In addition, while it is acknowledged this is a draft example it is not entirely clear, why, e.g. CD/SACD player is not identified as having an Optical Drive. While it has informed the draft AV definition (and exclusions), it is instructive to note that very little of the functional matrix has made its way to the ENERGY STAR draft definition as discussed in Section 1.1.1.

The most immediate restriction is to create a distinction between set top boxes already defined and regulated under the Ecodesign Directive. The current definition for simple set top boxes in Commission Regulation 107/2009 is:

1. ‘Simple set-top box’ (SSTB) means a stand-alone device which, irrespectively of the interfaces used,

> (a) has the primary function of converting standard-definition (SD) or high-definition (HD), free-to-air digital broadcast signals to analogue broadcast signals suitable for analogue television or radio;
>
> (b) has no ‘conditional access’ (CA) function;
>
> (c) offers no recording function based on removable media in a standard library format.
>
> A SSTB can be equipped with the following additional functions and/or components which do not constitute a minimum specification of an SSTB:
>
> (a) time-shift and recording functions using an integrated hard disk;

(b) conversion of HD broadcast signal reception to HD or SD video output;

(c) second tuner.

The voluntary agreement currently under consideration at the time of writing, defines a complex set top box as:

A CSTB is a standalone device equipped to allow conditional access that is capable of receiving, decoding and processing data from digital broadcasting streams and related services, and providing output audio and video signals. It may have either an internal or else a dedicated external power supply.

For the purposes of the Code a device shall not be considered to be a CSTB unless it can fulfil the functions of a CSTB when activated by the operator of the network.

A Simple STB, as defined in Annex F, is outside the scope of this Code. Also excluded from the scope of this Code are devices whose primary function is something other than the reception of television signals, such as but not limited to:

• Computers fitted with digital TV tuners or TV add-in cards;

• Games consoles with digital TV tuners

• Digital receivers with recording function based on removable media in a standard library format (VHS tape, DVD, Blu-ray disk and similar)

• Digital TVs with integrated receiver decoder

• External plug in digital receivers for computers (e.g. USB)

The most important overlap from the primary VR definition and STBs is the presence of a tuner, internal storage and removable storage. Based on this, a product with an integrated hard disc and/or *only playback* of removable media in a standard library format is classed as a set top box. **Therefore, a device with a tuner that *records* to a removable standard library media could be included.**

Referring back to the products not marketed as VRs, home cinema systems (also known also home theatre in a box) can be identified by the ability to be connected directly to speakers because they have an audio amplifier. The amplifier is typically integrated but may be a separate unit sold together with a VR. The amplifier can greatly increase the power consumption and has more in common with other types of audio amplifiers and receivers which are not the focus of this study. Depending on the technology, the increased power consumption could be 100W or more, dominating the power consumed by the player itself, typically around 10W. This results in the home cinema systems having ecodesign and other efficiency characteristics more in common with amplifiers and receivers, rather than standard video recorders.

However, following stakeholder feedback, it has been suggested that home cinema systems be included in the VR study, and that the ecodesign aspects of the amplification circuitry be excluded.

Therefore, home cinema systems are included in the study.

As previously discussed, portable, battery operated DVD players and other similar portable media players (PMP) are designed to be small, lightweight and highly energy efficient to enable ease of carrying, and extended use from the limited energy capacity of a battery. These have a smaller environmental impact than mains powered devices, with the exception of the battery which is not a priority of the Ecodesign Directive. While almost all battery operated devices can also be powered by mains, some are designed to be primarily operated in this way and the battery operation is provided for exceptional use. **Therefore, all battery operated devices should be excluded.**

Professional Products

Professional products, including CCTV security systems are designed to be used in larger professional suites and therefore provide greater control and access to other parts of the suite. The technology required is often not in common with more common household/retail products which may offer very basic networked data streaming and power control between devices. Professional product usage also tends to be different. In addition, security systems may be required to comply with additional standards to demonstrate security levels attained.

Therefore Professional Products are not considered to be standalone devices and therefore not video players/recorders.

Summary

Tabulating the additional products and functions shows the functions and products. However, it is not sufficient to extrapolate the common features that define a video recorder because they are so ubiquitous. Therefore, similar to ENERGY STAR, additional exclusions must be added.

	Audio				Video			Media interface		I/O					
	Amplification	Switching and Distribution	Output (speakers)	Input (microphone)	Switching and distribution	Output (display)	Input (camera)	Optical drive	Digital drive	Network connectivity	Audio tuner	Video tuner	Internal storage	Battery operation	Professional suite integration
Included Products															
DVD player	N					Y		Y						N	
DVD recorders	N					Y		Y				O		N	
DVD recorder with hard disk drives	N					Y		Y				O	Y	N	
Blu-ray player	N					Y		Y		O				N	
Blu-ray recorders	N					Y		Y		O		O		N	
Blu ray recorders with hard disk drives	N					Y		Y		O		O	Y	N	
Home cinema system	Y		Y			Y		Y		O				N	
Hard disk media players						Y			O	O			O	N	
Excluded products:															
Simple set top box						Y						Y		N	
Simple set top box with hard disk drive						Y						Y	Y	N	
Simple set top box with hard disk drive and DVD player						Y		Y				Y	Y	N	
Simple set top box with DVD player						Y		Y				Y		N	
Simple set top box with Blu-ray player						Y		Y		O		Y		N	
Simple set top box with blu ray player and hard disk drive						Y		Y		O		Y	Y	N	

	Audio				Video			Media interface		I/O					
	Amplification	Switching and Distribution	Output (speakers)	Input (microphone)	Switching and distribution	Output (display)	Input (camera)	Optical drive	Digital drive	Network connectivity	Audio tuner	Video tuner	Internal storage	Battery operation	Professional suite integration
Complex set top box						Y						Y		N	
Complex set top box with hard disk drive						Y						Y	Y	N	
Complex set top box with hard disk drive and DVD player						Y		Y				Y	Y	N	
Complex set top box with DVD player						Y		Y				Y		N	
Complex set top box with Blu-ray player						Y		Y		O		Y		N	
Complex set top box with blu ray player and hard disk drive						Y		Y		O		Y	Y	N	
Thin clients/ streaming only devices										Y			N	N	
Security systems							Y							N	
Portable media player			Y			O		O	O				O	Y	
Audio amplifier/receiver	Y		Y					N	N				N	N	
Professional equipment															Y
All VRs						**Y**						**Y***		**N**	**N**

*only if it records to a removable library media

Key: Y: Required function, N:Not available; O:Optional feature

It is clear from the table that a large number of features as identified by Energy Star have no relevance to a video recorder definition. In addition the media interface and internal storage can be combined to create a more flexible definition, which allows for hard drive enclosures which have an internal media interface but no internal storage.

In summary, the full list of features and functions defining a VR is therefore:

- Designed to be primarily mains operated (required)
- Video source (required)

  - Media interface to storage medium (required) to:
    - Standard removable library formats e.g. DVD, BD
    - And/or other formats e.g. hard disk drive, USB, flash memory card reader
  - Integrated storage device e.g. (HDD), (SSD) (optional)
- Video playback (required) – Audio/Video decoding, (decryption) and output
- Video recording (optional) – Audio/video encoding, (encryption) and input
- Network connectivity (optional)
- Amplification (optional)
- Switching and distribution (optional)
- Input (optional)
- *(Tuner to decode broadcast video signals, including IPTV if there is also recording to removable library media)*

A number of functions are also identified that could exclude the product:

- A display for viewing video – this would most likely class the device as a TV based on the definition in EU Regulation 642/2009:

Television set means a product designed primarily for the display and reception of audiovisual signals which is placed on the market under one model or system designation, and which consists of:

- a display;
- one or more tuner(s)/receiver(s) and optional additional functions for data storage and/or display such as digital versatile disc (DVD), hard disk drive (HDD) or videocassette recorder (VCR), either in a single unit combined with the display, or in one or more separate units;

Television monitor means a product designed to display on an integrated screen a video signal from a variety of sources, including television broadcast signals, which optionally controls and reproduces audio signals from an external source device, which is linked through standardised video signal paths including cinch (component, composite), SCART, HDMI, and future wireless standards (but excluding non-standardised video signal paths like DVI and SDI), but cannot receive and process broadcast signals;

It is possible that a non-portable player without a tuner or any other video signal input can be manufactured, and would be classed as neither a video recorder nor TV, but this is considered too unlikely since its market would be extremely limited.

- Is not designed for a broad range of home and office applications – the ability to use word processing and calculations software would class the product as a desktop or notebook computer.

"Computer" means a device which performs logical operations and processes data. Computers are composed of, at a minimum: (1) a central processing unit (CPU) to perform operations; (2) user input devices such as a keyboard, mouse, digitizer or game controller; and (3) a computer monitor screen to output information. For the purposes of this preparatory study, computers include both stationary and portable units, including Desktop computers, integrated Desktop computers, Notebook computers, thin clients, and workstations. Although computers must be capable of using input devices and computer displays, as noted in numbers 2 and 3 above, computer systems do not need to include these devices on shipment to meet this definition.

"Desktop Computer" means a computer where the main unit is intended to be located in a permanent location, often on a desk or on the floor. Desktops are not designed for portability and utilize an external computer display, keyboard, and mouse. Desktops are designed for a broad range of home and office applications.

"Integrated Desktop Computer" means a Desktop system in which the computer and computer display function as a single unit which receives its ac power through a single cable. Integrated Desktop computers come in one of two possible forms: (1) a system where the computer display and computer are physically combined into a single unit; or (2) a system packaged as a single system where the computer display is separate but is connected to the main chassis by a dc power cord and both the computer and computer display are powered from a single power supply. As a subset of Desktop computers, integrated Desktop computers are typically designed to provide similar functionality as Desktop systems.

"Notebook Computer", sometimes referred to as a "laptop", means a computer designed specifically for portability and to be operated for extended periods of time either with or without a direct connection to an ac power source. Notebooks must utilise an integrated computer display and be capable of operation of an integrated battery or other portable power source. In addition, most Notebooks use an external power supply and have an integrated keyboard and pointing device. Notebook computers are typically designed to provide similar functionality to Desktops, including operation of software similar in functionality as that used in Desktops. Tablet PCs, which may use touch-sensitive screens along with or instead of other input devices, are considered Notebook Computers.

"Thin Client" means an independently-powered computer that relies on a connection to remote computing resources to obtain primary functionality. Main computing (e.g., programme execution, data storage, interaction with other Internet resources, etc.) takes place using the remote computing resources. Thin Clients covered by this definition are limited to devices with no rotational storage media integral to the computer. The main unit of a Thin Client covered by this specification must be intended for location in a permanent location (e.g. on a desk) and not for portability.

"Workstation" means a high-performance, single-user computer typically used for graphics, CAD, software development, financial and scientific applications among other computer intensive tasks. To be considered a workstation, a computer must:

- Be marketed as a workstation;
- Have a mean time between failures (MTBF) of at least 15,000 hours based on either Bellcore TR-NWT-000332, issue 6, 12/97 or field collected data; and
- Support error-correcting code (ECC) and/or buffered memory.
- In addition, a workstation must meet three of the following six optional characteristics:
    1. Have supplemental power support for high-end graphics (i.e., PCI-E 6-pin 12V supplemental power feed);
    2. System is wired for greater than x4 PCI-E on the motherboard in addition to the graphics slot(s) and/or PCI-X support;
    3. Does not support Uniform Memory Access (UMA) graphics;
    4. Includes 5 or more PCI, PCIe or PCI-X slots;
    5. Capable of multi-processor support for two or more processors (must support physically separate processor packages/sockets, i.e., not met with support for a single multi core processor); and/or
    6. Be qualified by at least 2 Independent Software Vendor (ISV) product certifications; these certifications can be in process, but must be completed within 3 months of qualification.

- *(Tuner to decode broadcast video signals, including IPTV if there is no recording function to removable library media)*

The presence or absence of a tuner could include or exclude the product depending on the other features present, and is therefore in both lists.

Following the definition risk assessment, a preliminary definition is given in the box below:

Based on the definition risk assessment, a video player/recorder is a stand alone device whose primary function:

- **Decodes video to an output audio/video signal**
- **from recorded or recordable media via a powered or integrated media interface such as an optical drive, USB or HDD interface**
- ***Has no tuner unless it records on a removable media in a standard library format***
- **Is mains powered**
- **Does not have a display for viewing video**
- **Is not designed for a broad range of home or office applications**

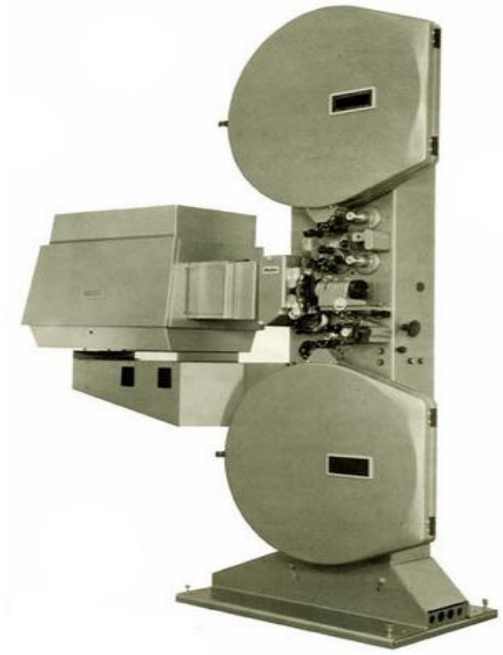
B) Projectors/Beamers

In arriving at the three definitions covering the categories of projector in the world market it is important to keep the video signal source and standard as general as possible. Future trends in office and home-cinema projectors will include a docking interface for personal multimedia products, integral memory card readers, network connectivity through wired / wireless LAN interface and wireless HDMI. In Professional / Digital / E-Cinema projectors, professional video signal standards generally apply, usually based on the Film frame rate of 24 FPS or a multiple of it. The video source is usually large capacity HDD incorporated into the equipment package of the projector and often combined with a network server (multiscreen)and satellite or web linked central programme sources. The functional variants are potentially endless and the robustness and flexibility of the E-projector definition will only be maintained by a generalisation of the video input signal standard and source.

Figure 2: Devices Generally Classed as Projectors

	
HOME CINEMA /OFFICE	PROFESSIONAL / DIGITAL / E-CINEMA
Functional Blocks	Functional Blocks
Video signal interface (multi standard) Input (and output looped) Ethernet Remote Control Interface Optional Low level Audio signal input and output for level control purposes Internal signal source (stored graphics etc). and built in signal source (e.g. DVD/BD player and/or mobile device docking station) Replaceable Light Source (Metal Halide - Halogen, Lamp) Fixed Light Source (LED) Projection Engine (Light Engine) Optional Motorised Lens	Video Signal Interface with standard or non standard interconnection to associated equipment package of professional HDD/ Network Server/ Network broadcast reception platform(satellite/ Internet / Cable) / Audio processing and Amplification system/Local and remote, control interface./High power DC power supply. Equipment Rack and Lamp, cooling plant.

Figure 3: "Projector" Devices Generally Excluded in this Study

	
FILM PROJECTOR Excluded because of complete decline in image storage technology (film) and projector product manufacturing.	REAR PROJECTION TV or TV MONITOR Excluded because product falls under the remit of other ecodesign Studies: ENER Lot 3 Monitors and ENER Lot 5 TVs
FUNCTIONAL BLOCKS RELATED TO PROJECTOR DEFINITION	FUNCTIONAL BLOCKS RELATED TO PROJECTOR DEFINITION
High Power Lamp Audio Amplifier Racks Lamp Cooling Plant	Video Signal Interface (multi-Standard including broadcast tuner when sold as a TV) Audio in and out with remote control. High Power Lamp / LED Light Source Light Engine Screen (Integral)

Following the definition risk assessment, the following key objectives must be covered by the preliminary definition.

- The projector light source should not be qualified
- The projector light engine technology and fundamental characteristic (reflective or transmissive) should not be qualified
- The projector signal source (internal or external) signal characteristics, and signal interfaces should not be qualified
- The projector screen should be defined as external to avoid product definition overlap with TVs, TV monitors, PC monitors and all other integrated screen displays.
- The optional function of processing audio information must be covered by the projector definition

The primary definition of a projector given in section 1.1.1 appears to meet these key objectives.

A projector is a mains powered, optical device, for processing analogue or digital video image information, in any, broadcasting, storage or networking format to modulate a light source and project the resulting image onto an external screen. Audio information, in analogue or digital format, may be processed as an optional function of the projector.

C) Games consoles

The table below illustrates the main devices generally marketed as games consoles and provides functionalities and hardware components common to games consoles.

Devices generally classed as Games consoles

Games consoles		
Hardware Architecture CPU System memory Video architecture Network architecture Optical drives Optional hard drives or other internal memory Mains connected internal or external power supply unit	**Input devices** Typically hand held controllers rather than keyboards or mice	**Secondary functions** Optical disk playback Digital picture viewing (via an external screen) Digital music playback

Devices generally not marketed as Games consoles

The excluded components and functionalities serve to distinguish “games consoles” from other gaming products which are either already covered by ecodesign preparatory studies (as previously listed), or to exclude gaming products where environmental impacts are likely to be significantly smaller than “true” games consoles and where the most significant impacts from those products are covered by other EU legislation (e.g. battery power devices), or which are primarily commercial devices with low sales volumes.

Gaming Desktops	Gaming Laptops	Gaming Thin Clients	Hand-Held Games consoles	Educational Games consoles with integrated screens
CPU System memory Video architecture Optical drives Conventional Personal Computing (PC) operating systems	CPU System memory Integrated screen Video architecture Optical drives Hard drives Personal Computing (PC) operating systems	CPU System memory Video architecture Personal Computing (PC) operating systems	CPU Battery operation Integrated screen System memory Video architecture	CPU Battery operation Integrated screen System memory Video architecture
Covered by ecodesign ENER Lot 3 Personal Computers (desktops and laptops) and Computer Monitors **Gaming Desktop and Laptop PCs are covered by the draft ecodesign Computer measures.**		Majority of environmental impacts occur in remote Data Centres	Battery based products where impacts are covered by other legislation.	Battery based products where impacts are covered by other legislation.

Devices generally not marketed as Games consoles (continued)

			
Portable DVD player	**DVD/HDD player**	**Blu-ray player**	**Arcade Games Machine**
Optical drive DVD decoding Integrated screen Battery operation	Optical drive Integrated HDD Video encoding and decoding Tuner Video in Video out	Optical Drive Blu-ray/DVD decryption/decoding Ethernet Video out	CPU System memory Integrated screen Video architecture Hard drives
Battery based products where impacts are covered by other legislation. Excluded due to reduced sales numbers.	Covered under video players/recorders in ENTR Lot 3 Sound & Imaging Preparatory Study		Excluded due to commercial products with low sales volumes.

Following the definition risk assessment, a preliminary definition is given in the box below:

A "Games console" is a mains powered stand alone device which is marketed as a product providing video game playing as its primary function through an external screen and which

has the following features:

Hardware Architecture

- CPU
- System memory
- Video architecture
- Network architecture
- Optical drives (to be defined)
- Hard drives or other internal memory (optional)
- Mains connected internal or external power supply unit

Input devices

- Typically hand held controllers or other interactive controllers rather than keyboards or mice

Optional Secondary functions

- Optical disk playback
- Digital picture viewing (via an external screen)
- Digital music playback

Excluded components or functionalities:

- Integrated screens
- Conventional Personal Computing (PC) operating systems
- Internal batteries for powering products over extended periods of time

1.2.3 Scope of the Study

The Commission assessed a number of product groups according to the criteria laid down in Article 15 of the Ecodesign Directive, notably

1. the product group represents a significant volume of sales and trade within the Community,
2. the product group has a significant environmental impact within the Community resulting from the energy-using products during their life cycle,
3. the product group presents significant potential for improvement in terms of its environmental impact without entailing excessive costs.

The product groups prioritised by the Commission fulfill the sales and trade criteria of indicatively more than 200,000 units a year within the Community. Energy-related products from the domestic, tertiary and industrial sectors are covered. This criterion is a yes/no question, as the impact of the number of units per product group directly influences the assessment of the second criterion, the environmental impact.

Regarding the third criterion, the significant potential for improvement in terms of the environmental impact of the product groups and the potential for ecodesign measures were considered to set priorities: An important potential for ecodesign measures is given by a high potential for energy savings (indicatively > 20%) or for better energy input (e.g. fossil fuels are more efficient for heating applications than electricity). Further important ecodesign measures may comprise reduced weight/volume of a product, optimised product design for the consumer's use phase, modularisation of a product to ease maintenance and recycling or the extension of the product's lifetime. Existing third country specifications, such as energy labelling, MEPS, Energy Star and/or eco-labels, indicate important potential for improvement and a wide disparity in the environmental performance of the energy-related products with equivalent functionality.

Note for Projectors: From initial stakeholder feedback it is clear that Projectors intended for Digital/E – Cinema use and other professional applications such as flight simulators and 3D projection for computer assisted design analysis should not be included in this study. This decision is based on stakeholder feedback showing that these products have a very small specialist market (less than 0.1% of total EU27 sales) and low or negligible eco design improvement potential. Stakeholder feedback

has also shown that a generic base case for such projectors is hard to define since the installed product is an integral part of a complex installation and will often have associated energy overheads not related to, but hard to separate from, the projection function.

The product groups discussed in the study reflect these criteria.

Table 3: Initial Screening - Estimated Energy Savings Potential

Product	Estimated energy saving potential per product [% in 2015]	Estimated EU-27 savings in TWh/year in 2015	Estimated energy saving potential per product [% in 2020]	Estimated EU-27 savings in TWh/year in 2020
Video Games consoles				
Current Games consoles (Xbox, PS2&3, Wii)	20-30%	0.93	20-30%	0.10
Future Games consoles 2012 Launch	25%	2.07	25%	0.72
Future Games consoles 2017 Launch	25%	0.00	25%	2.80
Projectors				
Digital/E Cinema	0%	0.00	0%	0.00
Schools Projector	36%	0.56	36%	0.56
Office Projector	36%	0.25	36%	0.24
Home Cinema	36%	0.04	36%	0.04
AV Players and Player / Recorders				
DVD player	20%	0.09	20%	0.03
DVD recorders	20%	0.10	20%	0.00
DVD recorder with hard disk drives	20%	0.21	20%	0.00
Blu-ray player	85%	4.01	85%	4.01
Blu-ray recorders	85%	0.61	85%	0.31
Blu ray recorders with hard disk drives	85%	0.66	85%	0.33
Home cinema system	70%	1.09	70%	0.44
Other future video recorders	85%	1.82	85%	5.45
Total Savings:		12.44		15.04

A significant environmental impact area under investigation within this preparatory study will be the product energy efficiency. In particular the preparatory study will investigate power consumption during the in-use phase of the life cycle.

Whilst the energy used during product operation is often described as having the largest share of total lifecycle impacts, “notable” impacts are present in other life cycle stages from manufacture to final disposal. Product design can play a major part in reducing some of these other lifecycle impacts. As such, as part of this ENTR Lot 3: Sound and Imaging Equipment project the project team will investigate the major environmental impacts occurring in each stage of the covered products’ lifecycle stages. These investigations will centre on the following categories:

1. Environmentally sensitive chemicals and materials
2. Materials design
3. Design for recycling
4. Design for upgradability

1.2.4 Technical Parameters

A) Video Players/Recorders

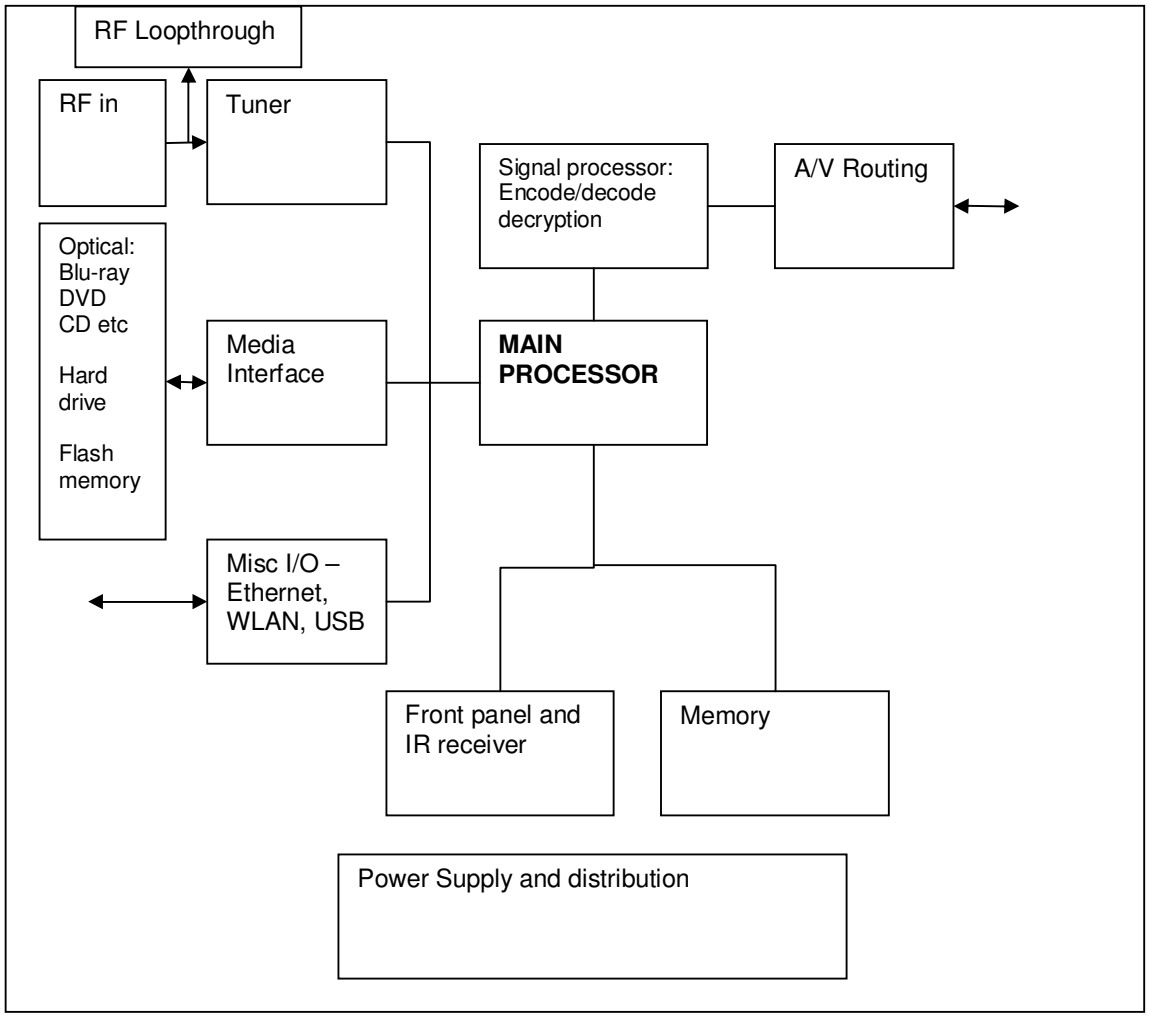
The main components are:

- Media drive, optical or hard drive
- Power supply / power distribution
- Video processing LSI
- Network interfaces such as gigabit Ethernet

Closely inter-linked with power consumption is power management that is able to minimise the time spent in higher power modes when there is no user demand.

The following block diagram shows a simplified generic video recorder and the components which could be influenced by product design.

Figure 4: Generic video recorder block diagram



Function of components of block schematic:

- RF in: This is the connection to a broadcast video signal, most often terrestrial.
- Tuner: Demodulates the broadcast video signal for processing
- Optical disk, hard drive, flash memory: This is the medium on which the video stored
- Media interface: Provides the physical and electronic means to read the video data from the storage medium
- Misc I/O: Provides input/output communication with other, miscellaneous networks such as Ethernet, wireless Ethernet, USB to hard drives etc.
- Main processor: Performs and controls the functions of the video recorder
- Signal processor: Dedicated hardware, which can be integrated in the main processor, that decodes the video data from the storage medium or tuner into video signals for the display device. It can also encode the video from the tuner to record onto the storage medium.
- Memory: Temporary and permanent storage which holds the video data being processed as well as the operating system for the video recorder

- A/V routing: The audio/video routing outputs the audio and video signal via the various video and audio outputs such as component, HDMI, and optical connections, to the display and/or audio amplification device.
- Front panel and IR receiver: Provides information to the user about the status of the video recorder and receives the commands from the remote control
- Power supply and distribution: Provides power to all the electronics and components in the video recorder

Glossary of terms used

BD Blu-ray Disc. A digital optical storage medium for video and other types data. It is designed to have a higher capacity than DVD to store high-definition content with the same physical size. Launched commercially in 2006 to mainstream market.

DVD Digital versatile disc. A digital optical storage medium for video and other types of data. DVD have up to 6 times the capacity of CDs, allowing higher quality audio and video. DVDs were launched around 1997 (depending on geographical region).

SACD Super audio compact disc. An optical audio disc format designed to be superior to audio CDs by enabling surround sound and higher quality audio.

CD Compact disc. A digital optical storage medium launched in 1982 originally to store audio.

HDD Hard disc drive. A storage device that stores data on rotating magnetic platters. HDDs are generally integrated into the device and are not designed to be easily exchanged. HDDs offer much higher storage capacity and data can be written to and read from them simultaneously and at higher data transfer rates.

EPG Electronic programme guide. A digital guide to scheduled broadcast TV, typically displayed on screen.

SSD Solid state drive. A storage device that store data on solid state memory. It is designed to provide similar function and physical format to HDD

HD High definition.

Optical storage A method of storing and retrieving data by using a laser that reads the reflectivity of the disc. For audio/video, optical discs are used which can be read in a compatible optical drive. This allows the discs to be cheaply produced, easily sold, played and transported, with each disc typically holding one music album/movie/television series.

VR video player/recorder. A generic term used to refer to the range of video playback technologies and formats e.g. DVD, VCR.

VCR video cassette recorder. A magnetic tape storage medium used to store video. This was the first mainstream format for playing and recording video but the technology has been superseded and is nearing obsolescence

A/V Audio/Video

USB Universal Serial Bus. A standardized interface to connect computer peripherals such as external HDD, flash drives and printers

I/O Input/Output

WLAN Wireless Local area network. Links computers and other devices together without cables to transfer data.

OTA Over the air. Also known as terrestrial TV which broadcast signals sent via radio transmission to ground based transmitters/receivers.

In addition, the following factors also have an environmental impact that could be addressed:

- Media, including optical discs and disc packaging

- Data centre, servers and ICT infrastructure required to support downloadable consumable media content
- Product casing

Physical media, video recorders and servers will all have associated waste and consume material resources during manufacture. Hazardous materials are restricted by RoHS but products may still include flame retardants that may create an environmental risk. In addition, servers are currently exempted from lead (Pb) restrictions and will consume energy.

B) Projectors

The environmental impact of existing projector products in terms of energy, may be qualified by the following principal components.

- Light source (in all categories) >90% of power requirement
- Power supply (especially for lamp drive) – mainly included in lamp drive power.
- Peripheral Equipment racks (E-Cinema only)
- Cooling Fans
- Video Processing LSI
- Input Video Signal interface, (LAN and HDMI wired /wireless network interfaces
- Projection Engine (motorised colour wheel – low cost office/home-cinema)

In addition, the following factors also have an environmental impact that could be addressed:

- Consumables (Lamps)

Product construction materials, packaging and recycling raise no significant new issues in environmental impact over other Consumer Electronic products.

BLOCK DIAGRAMS (REFLECTIVE AND TRANSMISSIVE ENGINES)

Examples of current popular Projector Light Engines and a Generic Block Schematic Circuit:

Figure 5: Reflective Light Engines using 3 modulating panels

(Liquid Crystal on Silicon - LCoS or Digital Mirror Device - DMD)

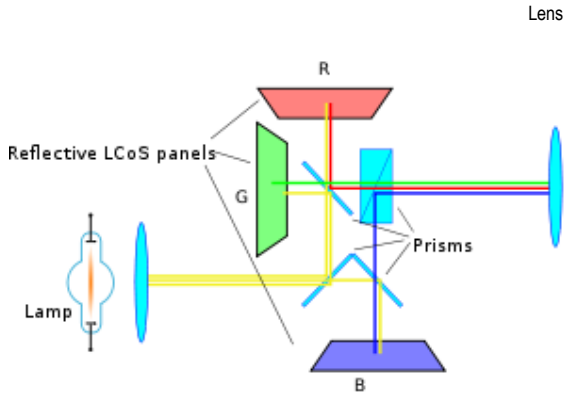


Figure 6: Reflective Light Engine using one modulating panel and a colour wheel

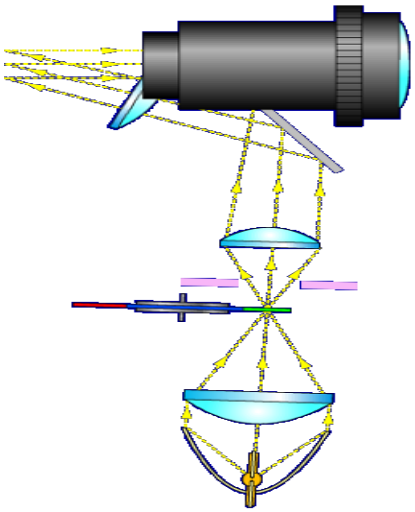
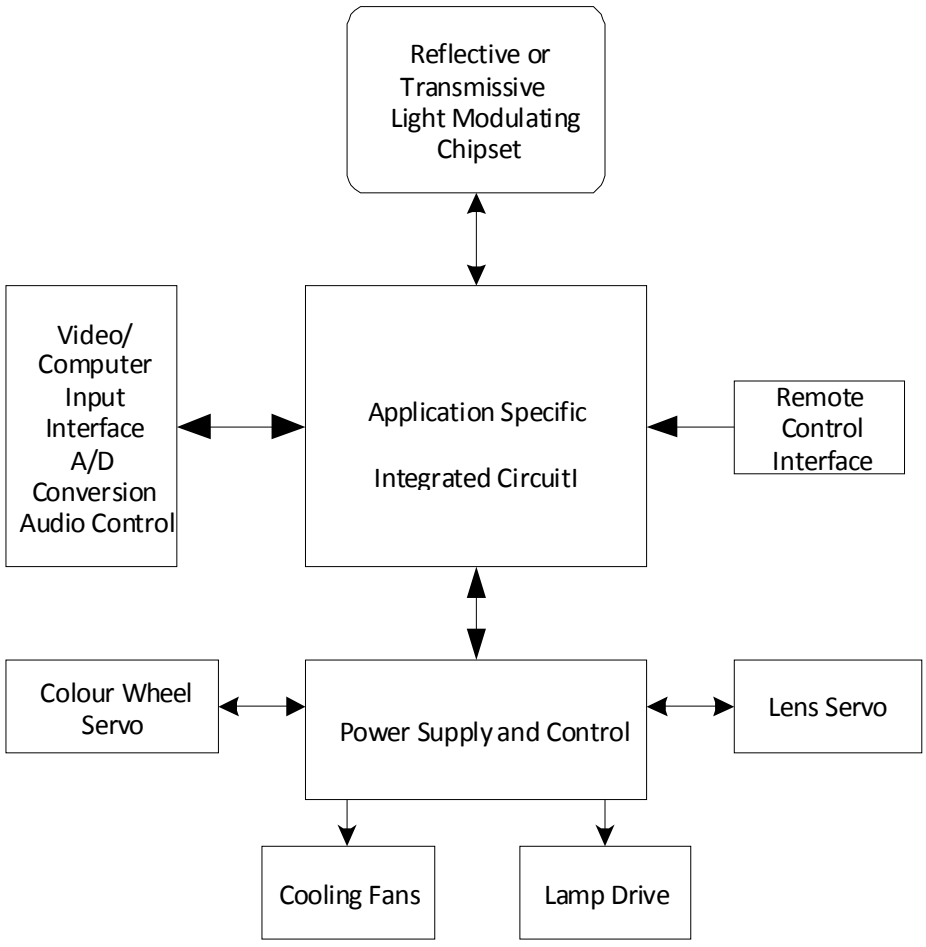


Figure 7: Generic Projector Block Schematic Diagram



Function of components of Block Schematic

- Application Specific Integrated Circuit , Provides all the required electronic processing for the secondary functional blocks shown connected to it..
- Video and Computer Signal Input Interface, Analogue to Digital signal conversion and Audio signal control. One or more dedicated integrated circuits interfacing input and output signals for the projector · Remote control Interface. Electronics to detect and process user input via remote control.
- Reflective or trans missive light modulating chipset. The reflective or transmissive panels in the light engine of the projector that modulate the light components from the lamp (Red Green and Blue light) according to the image requirements of the input video signal. After modulation the light components are combined and projected onto the external screen via the lens assembly of the projector.
- Colour Wheel Servo. Used in single modulating reflective panel light engines to control motorised light source splitting colour wheel.
- Lens Servo. Control and drive circuitry for focusing mechanism of projector lens.
- Power Supply and control. Main power supply for all electronics and control circuits for lamp drive and cooling fans..

C) Games consoles

- the main processor,

Power consumption requirements for the four main games consoles currently on the market, during the active use phase, currently range between approximately 17W to 190W. Power consumption in idle modes currently ranges from approximately 11W to 182W and in off-mode from approximately 1.1W to 3.1W.

The large variation in power consumption during active use amongst the current products on the market is primarily due to the amount of processing power provided by each product. The higher power consuming products offer significantly more processing power and therefore require more power to deliver the higher level of gaming functionality.

Power management functionality has the potential to be able to help reduce overall energy consumption used by games consoles. Some games consoles on the market have basic power management functionality already installed but not always optimised for energy reductions. A significant reason for not implementing power management on games consoles stems from the fact that many games do not support this functionality. Further work is required in this area to ensure that gaming software is compatible with power management functionality enabling major components in the games consoles to power down after a period of inactivity.

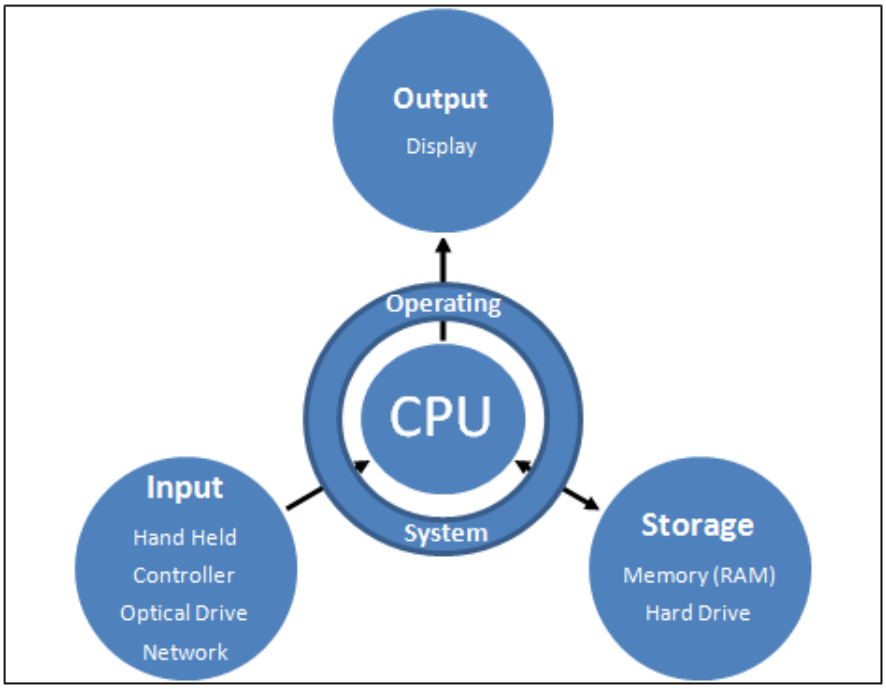


Figure 8: Basic Diagram of Games console Components

There are a number of other environmental impacts associated with games consoles that will be investigated in more detail during the study including:

- Consumables - games are often supplied on optical disks. These disks as well as associated packaging have environmental impacts.
- Hazardous material content – the RoHS Directive places restrictions on some hazardous materials which may have previously been found in games consoles. Other potentially hazardous materials such as flame retardants that are likely to still be present and therefore warrant further investigation.
- Waste – given the large number of games consoles sold throughout the EU-27 significant numbers of products will enter the waste stream at end-of-life.

1.3 Test and other Standards

This section of Task 1 reports on the investigation of those standards, relevant to the measurement of the environmental performance of

A) Video Players/Recorders

B) Projectors/Beamers

C) Games consoles

and are approved by internationally recognised standardisation bodies, or where relevant industry associations. The internationally approved standards often share ratification and are published as European Standard / Norm (EN) and International Electrotechnical Commission Standard (IEC) under a common reference number and title.

Technical harmonisation takes place through a clear separation of responsibilities between the EC legislator and the European standardisation bodies. European Commission through its directives

define the essential requirements that a product must meet when placed on the market and the standardisation bodies have the task to draw up technical specifications to meet the essential requirements of the directives. These specifications are known as 'harmonised standards'. Standards are not mandatory but remain voluntary. Producers, however have an obligation to prove that their products fulfill these essential requirements.

A typical test regime for the devices (covered by the study) to be brought to the European market encompasses various categories of Test Standard including:

- those relating to power consumption
- those relating to health and safety
- those qualifying electromagnetic compatibility
- those relating to environmental considerations

1.3.1 Standards at European Community level

EN/IEC 62301:2005. **"Household Electrical Appliances, Measurement of Standby Power"**

The scope of the standard is not to specify safety and/or minimum performance requirements nor it set maximum limits on power or energy consumption.

The standard provides a method of test to determine (measure) the power consumption of a range of appliances in stand by mode (generally where the product does not perform its main function). It applies to mains powered electrical appliances and defines 'stand by' mode as the lowest power consumption when connected to the mains. It specifies the general conditions for measurements (test room, power supply, supply-voltage waveform and power measurement accuracy) as well as selection and preparation of appliance/equipment for measurement, and test procedure.

The IEC standard is relevant to the stand by/off mode of appliances.

Aside from the stand by mode the test method is also applicable to other low power modes where the mode is a steady state or provides a background or secondary function. The relevant low power modes (in addition to standby mode) to which this test procedure is applied should be defined by performance standards of appropriate appliances. As an example, IEC 62087 (see below) specifies a range of modes for VCRs and similar equipment.

The IEC 62301 standard has been adopted as EN standard and test measurements should follow the guidance given in IEC 62301 "Household Electrical Appliances – Measurement of Standby Power", for both standby passive mode and other low power modes where the mode is steady state or providing a background or secondary function. Particular reference should be made to the guidance given in this standard on power metering methodology and meter specifications for given load stability characteristics.

The standard is currently under revision and will be formally published as an updated standard in late 2010.

IEC 62087:2002 / EN 62087:2003 **"Methods of measurement for the power consumption of audio video and related equipment"**

The standard specifies methods of measurement for the power consumption of equipment, which can be connected to the mains (e.g. TV receiver, VCRs, DVDs, Set Top Boxes (STBs)). It also defines the different modes of operation, which are relevant to power consumption.
The measuring conditions in this standard represent the normal use of the equipment and may differ from specific conditions, for example as specified in safety standards. Corresponds to the International Standard IEC 62087:2002.

IEC 62087 has been under review and its second edition was recently published (IEC 62087:2008 (E)). This second edition cancels and replaces the first edition, published in 2002 and constitutes a technical revision. Among others it now incorporates requirements to report on the power supply voltage and frequency and the ambient temperature and incorporates update requirements regarding the power measurement instrument.

For on mode and standby mode, the conditions and methodology quoted in IEC 62087 should be used. For metering both on mode and standby mode the methodology in IEC 62301 should be used.

The product should be tested at the mains voltage for the European Market (230VAC) under the voltage fluctuation and harmonic content limits given in this standard.

Environmental Characteristics

The tests are carried out for all specimens in the same normal environmental conditions (temperature and medium humidity).

The same test image is used for all specimens.

All specimens are in a steady, stable state (after approximately 10 minutes)

Power

An active power meter is used for the measurement of the power consumption of each specimen in the following modes:

- off mode
- standby mode
- on mode for playback operation

Indication of an automatic shutdown, if any.

Power Switch

Is there a mains switch available that separates the sample completely from the grid?

Where is it placed? Is it easily accessible?

The assumptions for the calculation of the power consumption within the products life cycle are: Operation of 6 hours per day and a life cycle of 6 years (20 Cent/kWh).

1.3.2 Standards at Member State Level

No standards at Member State level were identified by the study team or communicated to the study team.

1.3.3 Third country standards

(Note: Third country = outside EU-27, not adopted as EN already)

IEC 62075 ed1.0 (2008-01) Audio/video, information and communication technology equipment – Environmentally conscious design

The IEC 62075:2008 standard details requirements and recommendations for design aspects of ICT and CE products in order to reduce environmental impacts. The standard covers the following design areas:

- Material efficiency
- Energy efficiency
- Consumables and batteries

- Chemical and Noise emissions
- Product lifetime
- End of life
- Hazardous substances and preparations
- Product packaging

Whilst the standard provides clear guidelines about how design improvements for each of the above categories could be instigated, further work would be required to translate most of these guidelines into ecodesign requirements since not all can be easily measured or verified.

IEC 61947-1 ed1.0 (2002-08) Electronic Projection Measurement and documentation of key performance criteria Part 1 - Fixed resolution projectors.

The standard specifies requirements for measuring and documenting key performance parameters for fixed resolution projectors. It aims to codify the measurements of the performance of variable resolution projectors and does not intend to provide design goals for manufacturers of such equipment.

The standard applies to all aspects of a projector's performance and is important for product scope parameters.

Projectors and projection systems with multiple variable resolutions, such as cathode-ray tubes (CRT) and laser projectors, are not fully addressed by this standard, and reference should be made to IEC 61947-2.

IEC 61947-2 ed1.0 (2001-09) Electronic Projection Measurement and documentation of key performance criteria Part 2 – Variable resolution projectors.

The standard specifies requirements for measuring and documenting key performance parameters for CRT and laser-based projectors and other variable resolution projectors that are capable of multiple variable resolutions and in which the image is raster-scanned.

Similar to part 1 it aims to codify the measurements of the performance of variable resolution projectors and does not intend to provide design goals for manufacturers of such equipment.

ISO/IEC 21118 Ed.1 2005-08-15 Information to be included in data sheets -Data Projectors

This International Standard is applicable for information to be included in specification sheets about front projection type, fixed resolution and light valve system, and data projectors having a computer signal input port capable of projecting the image outputs from a computer, VCR or other devices.

EN/IEC 60065:2001 +A1: 2005 Audio Video and Similar Electronic Apparatus - Safety Requirements.

This safety standard applies to electronic apparatus that are connected to the main either directly or indirectly and intended for reception, generation, recording or reproduction respectively of audio, video and associated signals. It also applies to apparatus designed to be used exclusively in combination with the above-mentioned apparatus.

This standard concerns only safety aspects of the above apparatus; it does not concern other matters, such as style or performance.

It specifies requirements for marking, insulation, components, electrical connections and fixings, protection against ionizing radiation, resistance to heating, mechanical strength and stability, etc., as well as a requirement for splash-proof mains operated electronic equipment.

Does not apply to apparatus designed for rated supply voltage exceeding 433 V (r.m.s.) between phases in the case of three-phase supply and 250 V (r.m.s.) in all other cases.

1.4 Existing Legislation and Voluntary Agreements

1.4.1 Legislation and Agreements at European Community Level

Mandatory Legislation at European Community Level

The key European Community Directives and European Commission Regulations covering relevant aspects to the product groups of this study are:

Directives:

1. Directive 2002/96/EC on waste electrical and electronic equipment (WEEE).

The purpose of this Directive is, as a first priority, the prevention of waste electrical and electronic equipment (WEEE), and, in addition, to promote the reuse, recycling and other forms of recovery of such wastes so as to reduce disposal. It also seeks to improve the environmental performance of all operators involved in the life-cycle of electrical and electronic equipment, e.g. producers, distributors and consumers, and in particular those operators directly involved in the treatment of waste electrical and electronic equipment.

Video players/recorders, projectors and games consoles fall within the scope of this Directive, which sets targets for the separate collection and the recovery, reuse and recycling of these products.

WEEE Directive 2002/96EC has been amended twice. First by Directive 2003/108/EC that revised Article 9 regarding the financing in respect of WEEE from users other than private households. And then by Directive 2008/34/EC that confers powers on the Commission to amend the annexes of the WEEE Directive.

2. Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS).

The purpose of this Directive is to approximate the laws of the Member States on restrictions of the use of hazardous substances in electrical and electronic equipment, and to contribute to the protection of human health and the environmentally sound recovery and disposal of waste electrical and electronic equipment. Exemptions[12] are given for technical applications of the banned substances rather than for electrical or electronic products as such. The onus to determine if a specific application is covered by the exemptions listed in the Annex to the RoHS Directive is on the producer who is the person best placed to assess the characteristics of his product. In case of doubt concerning the scope of the exemption, the producer can check with the Member States authorities that are responsible for the enforcement of the national legislation implementing the provisions of the RoHS Directives.

Directive 2002/95/EC has been amended by Directive 2008/35/EC to confer power on the Commission to amend the annexes of the RoHS Directive.

3. Council Directive 2006/95/EC on the harmonization of the laws of Member States relating to electrical equipment designed for use within certain voltage limits (Low Voltage Directive (LVD) 2006/95/EC)

Sets appropriate measures to ensure that electrical equipment (designed for use with a voltage rating of between 50 and 1 000 v for alternating current and between 75 and 1 500 v for direct current, other than the equipment and phenomena listed in Annex II) may be placed on the market only if, having been constructed in accordance with good engineering practice in safety matters in force in the Community, it does not endanger the safety of persons, domestic animals or property when properly installed and maintained and used in applications for which it was made. Although this Directive allows for exemptions for specialised equipment types (e.g. equipment for use in explosive atmospheres), sound and imaging equipment is covered by this Directive.

[12] http://ec.europa.eu/environment/waste/weee/legis_en.htm

4. Directive 2004/108/EC on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC – EMC Directive

In 1989 the directive 89/336/EEC for regulations concerning electromagnetic compatibility (EMC directive) was adopted to introduce protective measures against the problem of electric and electronic equipment transmitting electromagnetic interference that can disturb other equipment or systems.

The purpose of electromagnetic compatibility (EMC) is to keep all those side effects under reasonable control. EMC designates all the existing and future techniques and technologies for reducing disturbance and enhancing immunity.

The EMC Directive first limits electromagnetic emissions of equipment in order to ensure that, when used as intended, such equipment does not disturb radio and telecommunication as well as other equipment. The Directive also governs the immunity of such equipment to interference and seeks to ensure that this equipment is not disturbed by radio emissions when used as intended.

The equipment considered in this study is covered by this Directive (and therefore must comply with its requirements).

Regulations

1. Commission Regulation 1275/2008 implementing Directive 2005/32/EC. Ecodesign requirements for standby power

This applies to the standby and off mode power consumption of electrical and electronic household and office equipment and as a result applies to all the products under study "unless inappropriate". It sets maximum power consumption allowances depending on the functions enabled while in standby and off-mode which come into effect in 2010. The requirements are then tightened further in 2013.

The Regulation specifically defines standby and off mode which must be available for equipment "unless inappropriate":

'**Off mode'** means a condition in which the equipment is connected to the mains power source and is not providing any function; the following shall also be considered as off mode:

(a) conditions providing only an indication of off-mode condition;

(b) conditions providing only functionalities intended to ensure electromagnetic compatibility pursuant to Directive 2004/108/EC of the European Parliament and of the Council

'**Standby mode(s)'** means a condition where the equipment is connected to the mains power source, depends on energy input from the mains power source to work as intended and provides only the following functions, which may persist for an indefinite time:

- reactivation function, or reactivation function and only an indication of enabled reactivation function,

  and/or

- information or status display;

The requirements are shown in table

Table 4: Ecodesign requirements for standby power

	Off-mode (W)	Standby mode (W)	Standby mode with information display (W)
2010	1	1	2
2013	0.5	0.5	1

In 2013, unless inappropriate, equipment must switch to a standby and/or off mode and/or other low power mode after the shortest appropriate period of time. The mode switched to must not exceed the applicable power consumption requirements for off mode and/or standby mode when the equipment is connected to the mains power source. The power management function shall be activated before delivery.

While the provision "appropriate period of time" should be justified on a product-by-product basis, a discussion of the legal definition is not relevant to this study. Instead rather than pre-empting ecodesign options with Regulation already agreed, the various power modes for the products, which may include an overlap with standby, are better assessed on a case by case basis.

2. Commission Regulation 278/2009 implementing Directive 2005/32/EC. Ecodesign requirements for external power supplies (EPS)

The regulation sets maximum power consumption levels for EPS in no-load condition and an average power conversion efficiency when in active mode. This will apply to any products in this study that are sold with an external power supply. In these cases, because the power efficiency of device includes the EPS, any losses resulting from the EPS must be taken into account during design. The ecodesign requirements come into effect in 2010 and are tightened in 2011.

The definitions used and the ecodesign requirements are too complex to be listed concisely and informatively. However, since the EPS is contained in a physical enclosure separate from the primary load the ecodesign cross-over is relatively simple.

1.4.2 Voluntary Agreements at European Community Level

European Commission Code of Conduct on Energy Consumption of Broadband Equipment

There is a European Commission Code of Conduct in place for Broadband Equipment which includes target power demand values for products providing internet connectivity in domestic premises [13]. **Error! Reference source not found.** below illustrates the low power and on power demand targets for Wi-Fi access points. These values are potentially for any products, such as games consoles, which can act as Wi-Fi access points.

	Tier 2009/2010:		Tier 2011:	
Equipment	**Low-Power-State (W)**	**On - Power-State (W)**	**Low-Power-State (W)**	**On - Power-State (W)**
Wi-Fi Access Points with single band IEEE 802.11b/g or 11a	3.0	4.0	2.3	3.6

Target EC CoC Wi-Fi Equipment Power Demands.

[13] http://ec.europa.eu/information_society/activities/sustainable_growth/docs/broadband_eq_code-conduct.pdf

1. Industry Self Commitment to improve energy performance of Digital Versatile Disc (DVD) equipment sold in the European Union.

On 1 July 2003, EICTA (the European Industry Association for Information Systems, Communication Technologies and Consumer Electronics) submitted to the European Commission a Self Commitment to improve energy performance of household consumer electronics sold in the European Union.

The Self Commitment aims to:

- Improve the energy performance of DVD players by reducing the passive standby energy consumption per appliance.
- Not to stifle technological development in DVDs but to deliver them in an energy-efficient manner.

Members of EICTA that signed the commitment, agreed to achieve 1 W for power consumption in standby passive by 2005 and report on an annual base the market share of DVD players, and the standby power consumption.

2. Group for Energy Efficiency Appliances (GEEA)

The Group for Energy Efficiency Appliances[14], compromising by government agencies and institutions form Denmark, the Netherlands, Sweden, Switzerland and the European Energy Network (EnR), provides tools for promoting the use of energy efficient appliances.

The criteria for receiving the GEEA label are decided by the board based on technical documents submitted by the relevant working groups.

Relevant to the scope of this study two group of products are covered by the GEEA label:

- all video equipment with playback function (e.g. DVD players, video cassette players)
- all video equipment with recording and playback function (e.g. VCR, DVD recorder)

For video equipment with playback function to comply with GEEA criteria, power consumption in standby-passive mode must be 1W or less while power consumption in on mode must be 11W or less.

Video equipment with recording and playback function, on the other hand must have standby-passive power consumption equal or less than 2.5 W while on mode must be 15W or less.

Both groups of products must automatically switch to standby passive after 30 minutes of inactivity.

Table 5 summarises the requirements placed by the voluntary agreements at European community level.

[14] No longer in operation. Products that got the label in the past are allowed to retain the label.

Table 5: Voluntary agreements at European Community level – summary of requirements

Programme	Scope	Summary of requirements			Program type	Date
		On (W)	Standby passive (W)	Other		
Industry Self-Commitment	DVD stand alone players		1	Report on an annual base the market share and the standby power consumption	Industry's voluntary self commitment	1st July 2003
GEEA label	Video equipment with playback function	11	1	Must automatically switch to standby passive after 30 minutes of inactivity.	Voluntary label	2007
	Video equipments with recording and playback function	15	2.5			

Note: The Voluntary Industry Agreement to improve the energy consumption of Complex Set Top Boxes within the European Community (proposed June 2009) proposes the following:

This Code is effective from July 1, 2010.

Tier 1 energy consumption targets shall be effective from the Effective Date.

Tier 2 energy consumption targets will become effective on July 1, 2013.

Table 6: Base Functionality Annual Energy Allowance

Base Functionality	Tier1 Annual Energy Allowance (kWh/year)	Tier2 Annual Energy Allowance (kWh/year)
Cable	45	40
Satellite	45	40
IP	40	35
Terrestrial	40	35
Thin-client/Remote	40	35

3. Joint Industry and NGO Proposal for Auto Power Down (APD) Requirements in Games Consoles

A joint industry/NGO working group has developed a proposal for automatic powering down of games consoles. This auto power down proposal is suggested to be applied to all new game consoles

(exempt for those using less than 20W in active mode) placed on the market from an implementation date. Further discussion about the APD proposal is included in the Task 7 report.

1.4.3 Voluntary agreements at Individual Member State Level

1. The Nordic Ecolabel

The Nordic Ecolabel is a voluntary licence system where any product certified needs to follow certain criteria. These criteria include environmental, quality and health arguments.

The Nordic ecolabel checks that products fulfil certain criteria using methods such as samples from independent laboratories, certificates and control visits. Up till now 66 different product groups, including DVD/Blue-ray players, have been covered by the label.

For such equipment the following criteria have been put together:

- Energy efficiency
- Hazardous material
- Design to ensure economically and environmentally feasible dismantling.
- Costumer information relevant to proper environmental use.
- Code of Conduct – plan for ethical production based on the 10 principles in UNs Global Compact.

For the shake of energy efficiency products shall have a hard or soft on-off-switch that it is clearly visible on. The passive standby mode shall be at maximum 2 Watt, while the on-mode power consumption must not exceed 15 Watt.

The label makes also provisions for heavy metals and flame retardants while a requirement is placed to the manufacturer to demonstrate that the product could be easily dismantled for repairing and/or recycling purposes.

2. The Blue Angel (Der Blaue Engel)

The Blue Angel is the oldest environmental-related label for products and services in the world. It was created in 1978 on the initiative of the Federal Minister of the Interior and it aims to distinguish the positive environmental features of products and services on a voluntary basis.

The Blue Angel label in Germany covers not only DVD-players, but also DVD-recorders and Blu-ray Disc-Players[15]. It sets out requirements for maximum power consumption levels for a range of modes of operation, and requirements for power consumption minimisation including APD function.

For digital projectors the Blue Angle label ensures low energy consumption, low-noise levels, projector lamps with a long service live and no hazardous substances in plastic casings.

More specifically the power consumption in standby mode shall not exceed 2 Watts while the active-mode-power-consumption to luminous-flux ratio may not exceed in any performance class the values shown in Table 7 . Devices that belong to class I must also equipped with an on-off switch for total disconnection from the mains on the side of the mains voltage.

Regarding noise levels the devices certified under the label must not exceed the values listed in Table 7 while the manufacturer based on number of operating hours shall also guarantee the minimum service lives for the projector lamps.

Table 7: The Blue Angel – Energy, Noise, Service life requirements

[15] RAL-UZ 144, January 2010. http://www.blauer-engel.de/en/products_brands/search_products/produkttyp.php?id=500

Class	Luminous Flux (Lumen)	Active mode (W)	Sound power level (dB(A))	Guaranteed service life of the lamps (h)
I	≤ 1750	≤ 0.15 W/Lumens	≤ 33	≤ 2,000
II	> 1,750 to ≤ 2,750	≤ 0.11 W/Lumens	≤ 35	≤ 3,000
III	> 2,750	≤ 0.09 W/Lumens	≤ 37	≤ 3,000

Finally provisions are made for plastics used in casings and casing parts. The plastics used shall not contain halogenated polymers and additions of halogenated organic compounds (e.g. as flame retardants).

3. The TCO Label

TCO development through its voluntary label scheme works to ensure that IT and office equipment products have high degree of usability, while keeping environmental impact to a minimum.

The label is developed through testing procedures conducted by independent test laboratories and the criteria documents are set in consultation with users, manufacturers, researchers and other experts.

Relevant to the scope of this study TCO has developed certification for video and office projectors. Criteria concern picture quality, energy consumption and environmental requirements.

The energy consumption of projectors is highly depended on the amount of light that projected on a maximum screen size (i.e. energy consumed by the projector lamp). Table 8 shows the different energy consumption and sound power levels that TCO has developed for different image sizes and for different operational modes. Except on, off and standby mode, criteria have been also developed for the Eco mode.

Eco mode:
A reduced power state that the projector enters on the user's initiative following the manufacturer's instructions. Eco mode is when the projector consumes less energy than in on mode, the acoustic noise level is reduced and the possible life of lamp is increased.

Table 8: The TCO label – energy and Noise requirements

Projector type	Image size (m2)	Energy consumption (W)				Sound power level (B(A))
		On mode	Eco mode	Stand by mode	Off mode	
Office	≤ 3	≤ 260	≤ 90% of the measured On mode	≤ 1	≤ 1	≤ 4.9
	≤ 6	≤ 310				≤ 5.5
Video	≤ 6.6	≤ 260				≤ 4.9
	≤ 13.3	≤ 310				≤ 5.5

In addition to energy consumption and sound power levels the TCO label makes provisions for:

- Hazardous Substances – heavy metals, flame retardants, plastics.
- Preparation for Recycling – factors to stimulate recycling.
- Product Lifetime – factors to extend the life of the product.
- Packaging – hazardous substance content and recycling

Table 9 summarises the requirements placed by the voluntary agreements at Member State level.

Table 9: Voluntary agreements at Member State level – summary of requirements

Program	Scope	Summary of requirements					Program type	Date
		On (W)	Standby (W)	Eco mode (W)	Off mode (W)	Other		
Nordic Swan (Scandinavia)	Audio visual equipment – VHS, DVD players	15	2	NA	NA	Off switch, materials including plastic additives, dismantling, reparability and operating instructions	Voluntary label	2003-2010
Blue Angel (Germany)	DVD player/recorders, combination DVD/HDD, Blu-ray players	8 (DVD-P) 22 (DVD-R) 25 (DVDHDD) 22 (BD-P)	0.5	NA	NA	Power consumption minimisation, material requirements on plastics used, design for recycling, manufacturer guarantees	Voluntary label	Jan. 2010
	Projectors	Watt/Lumen Metric	2	NA	NA	Noise levels, hazardous substances in plastics, minimum service life for projector lamp		2008
TCO label (Sweden)	Projectors	≤ 260 to ≤ 310 depending on the image size	1	≤ 90% of the measured On mode	1	Hazardous Substances, recycling factors, factors to extend the life of the product.	Voluntary label	2009

1.4.4 Third Country Legislation (countries outside EU-27)

1. ENERGY STAR Program

ENERGY STAR is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy. The program has matured over the years and it is now recognised a high class world-wide energy efficiency program.

Products earning the ENERGY STAR mean that meet strict energy efficiency guidelines set by the US Environmental Protection Agency and the Department of Energy.

On the 16th of November 2009 the version 2.0 ENERGY STAR specification for Audio/Video (AV) products was released. DVD players, blue-ray discs that were also included in ENERGY STAR version 1.0 will now be subject to the new requirements as outlined in version 2.0.

Products must meet all of the requirements specified in version 2.0 to be eligible for ENERGY STAR qualification:

Mandatory Auto Power Down (APD): To qualify for ENERGY STAR, all products must offer APD functionality that is enabled by default. APD timing begins after the last user input has been received (e.g., control signal, volume adjustment) or when the product ceases performance of all primary functions. For devices that process audio or video signals from external sources, the presence of a signal on any active AV input may constitute performance of a primary function, and APD timing begins upon loss of audio or video signal (LOS) on any active AV inputs. Manufacturers may offer users the option (via system menu, DIP-switch, or other means) to modify APD timing in 10 minute intervals or to disable APD entirely. Products may also initiate APD immediately upon receipt of authoritative control instruction via an active Networking / Control Protocol.

APD Timing ≤ 30 minutes: This timing option is acceptable for use as a default setting. If APD timing is set by default to no more than 30 minutes and APD cannot be disabled or increased to greater than 30 minutes, products do not have to meet Idle state power consumption requirements.

30 minutes < APD Timing ≤ 2 hours: This timing option is acceptable for use as a default setting. If APD can be disabled, or if APD timing can be increased to no more than 2 hours, products must meet Idle state power consumption requirements.

APD Timing > 2 hours: This timing option may only be enabled by the end user and is not acceptable for use as a default setting. If APD can be disabled, or if APD timing can be set to greater than 2 hours, products must meet Idle state power consumption requirements.

Exception to Mandatory APD Requirements: Products that are subject to 3rd party performance standards that prohibit APD, including those used for Mass Notification and Emergency Communications Systems and subject to proposed ANSI/UL 2572, are exempt from ENERGY STAR APD requirements.

General qualification criteria

- All products must offer an Auto-Power Down (APD) functionality that is enabled by default. APD starts after the last user input has been received and when the product ceases performance of all primary functions. Manufacturers may offer users the option to modify APD timing in 30 minute interval or to disable APD entirely.

- Products with an External Power Supply (EPS) must ensure that the EPS is also ENERGY STAR certified or an EPS that meets the applicable no-load active mode efficiency levels and power factor requirements provided in the latest version of ENERGY STAR program requirements for single voltage external AC-AC and AC_DC power supplies.

- On and sleep mode limits in a multi-component system must be assessed independently.

Modal qualification criteria

- Standby and sleep mode power consumption must not exceed 1 Watt – Table 10

Table 10: Standby, sleep mode power consumption requirements

	Power consumption (W)	
	Standby mode	**Sleep mode**
DVD, Blu-ray	1	1

The new version includes a wider variety of products All AV products that offer amplification or removable disc playback (e.g. CD, DVD, Blu-ray) are now eligible to earn the ENERGY STAR.

2. The Japanese Eco Mark Product Category 145 "Projectors Version 1.0 June 2010"

The Japanese Eco Mark program is a voluntary certification program developed and controlled by the Japan Environment Association Eco Mark office.

The Eco Mark compliance requirements for projectors are comprehensive and cover:

- Resource Conservation
- Long life design
- Easily recyclable design
- Detailed Power consumption requirements
- Harmful chemical substances
- Information for users
- Noise

An English translation of the product category 145 document is provided in Appendix 5

3. The Korea Eco-label

The Korea Eco-labelling program is a voluntary certification program for products in order to reduce consumption of energy and resources and to minimise generation of pollution substances.

The Eco-labelling program is a responsibility of the Ministry of Environment and the Korea Eco-products Institute (KOECO) and the ultimate goal is to provide consumers with accurate information about eco-products and encourages companies to develop eco-products in line with consumer preferences.

Criteria have been developed for two of the product groups that fall under the scope of this study, video media players (DVD, VCR etc) and projectors.

With respect to the energy consumption of video media players, rated consumption power shall be less than 15W while standby power consumption less than 1W.

The label develops also criteria for the use of chemical substances in the manufacturing process and the recycling capability of the product.

For projectors the criteria apply to LCD and DLP type projectors that displays by magnifying images transmitted in connection with machines transmitting digital image information such as PC, VTR, and DVD player.

The standby energy consumption shall be not more than 5 Watt, while the energy consumption shall satisfy certain requirements in accordance to the brightness of the light source (Table 11). In addition based on the brightness of the light source different sound pressure and sound power level shall occur.

Table 11: Electricity consumption based on the brightness of the light source

Brightness of Light Source	Electric Consumption [W]	Sound pressure level (dB(A))	Sound power level (dB(A))
<1000	'0.025 × brightness of light source + 195' and below	≤30	≤36
1000 to 3000	'0.05 × brightness of light source + 170' and below	≤35	≤42
3000 to 5000	'0.075 × brightness of light source + 95' and below	≤40	≤48
>5000	'0.1 × brightness of light source + 70' and below	≤40	≤48

Similar to video media players, requirements regarding hazardous materials (e.g. lead, cadmium, mercury, hexavalent chromium etc) and recyclability apply.

4. The Green Mark

The Green mark programme of R.O.C (Taiwan) launched in August 1992 under the Environmental Protection Administration of Executive Yuan Taiwan (R.O.C). The aim of this program is to promote the concept of recycling, pollution reduction and resource conservation. As for the objectives of

awarding the Green Mark, it is not only to persuade consumers to purchase environmental friendly products but also to encourage manufacturers to design and supply "green" products.

Criteria have been developed for portable projector products that consist of an imaging instrument and an optical component.

In the standby mode the power consumption shall be less than 5 Watts, while under normal operating conditions, the product shall meet the power requirements shown in Table 12.

Table 12: Power consumption requirements for projectors under normal operating conditions

Specifications (ANSI lux [16])	Standard power consumption
measured value ≦ 1500	< 20W/ 100 ANSI lux
2500 ≧ measured value > 1500	< 15W/ 100 ANSI lux
Measured value > 2500	< 10W/ 100 ANSI lux

Projectors shall include labels on all major plastic components, indicating the composition code to facilitate future recycling. Codes should meet ISO 11469 requirements.

Provisions are made for hazardous material used either in the product or during the manufacturing process, the ease of the dissemblance of the product and on the material used for packaging (i.e. cartons used for packaging should be made of recycling pulp with at least 80% recycled paper).

5. California - Appliance Efficiency Regulations

The California's Appliance Efficiency Regulations were established in 1976 in response to a legislative mandate to reduce California's energy consumption. They are updated regularly to allow incorporation of new technologies and methods and include standards for both federally-regulated appliances and non-federally-regulated appliances. The latest regulations were adopted on July 2009.

Products that fall under the scope of this study and for which standards have been developed are Digital Versatile Disc Players and Digital Versatile Disc Recorders. The power usage of these products in standby mode should not exceed 3 Watts. For equipment that consists of more than one individually powered product, each with a separate main plug, the individually powered products shall each also have a power usage not greater than 3 Watts.

6. Top Runner Programme – Japan

Top Runner Program was introduced in 1999 as a countermeasure to reduce energy consumption. Under the Energy Conversation Law the program applies standards with the aim to advance energy efficiency of machinery and equipment.

The programme has developed standards for energy consumption efficiency for video cassette recorders and DVD recorders with and combination VCR or HDD.

For VCRs energy consumption efficiency is a numeric value obtained as follows. First, the difference in standby power (W) between with (clock, etc.) display ON and OFF is multiplied by 0.2, and then the result is subtracted from standby power with (clock, etc.) display ON to obtain energy consumption efficiency.

For DVD recorders the energy consumption efficiency is annual energy consumption (kWh/year) obtained as follows. First, each of standby power, power consumption when operating DVD, VCR or HDD, and power consumption when acquiring EPG (electronic program guide) is multiplied by

[16] For projectors that have been tested under the methodology established by the American National Standards Institute, the luminousluminusluminusluminous flux may be quoted in 'ANSI Lumens'

respective annual standby/operation hours, and then the resulting values are added together to obtain annual energy consumption.

Standard values for energy consumption efficiency are shown in Table 13.

Table 13: Energy consumption efficiency, VCRs, DVD recorders

Category	Standard energy efficiency consumption
VCRs	**Watts**
VCRs with signal processing power for 400 or more lines of horizontal resolution that have satellite broadcasting receiving functions	2.5
VCRs with signal processing power for 400 or more lines of horizontal resolution that do not have satellite broadcasting receiving functions	2
VCRs without signal processing power for 400 or more lines of horizontal resolution that have satellite broadcasting receiving functions	2.2
VCRs without signal processing power for 400 or more lines of horizontal resolution that do not have satellite broadcasting receiving functions	1.7
DVD recorders with	**kWh/year**
HDD with recording capacity of below 500 GB	58.1, 64.4, 71.2*
HDD with recording capability of 500 GB or greater	65.3, 71.7, 78.4*
HDD and VCR, with HDD recording capacity of below 500 GB	65, 71.9, 79.3*
HDD and VCR, with HDD recording capacity of 500 GB or greater	72.9, 79.8, 87.2*

* the range in values depends on the number of additional functions. Low range: no additional function, Middle range: with one additional function, High range: two or more additional functions

7. International Energy Agency (IEA) "One Watt Plan"

In 1999, the IEA proposed that all countries harmonise energy policies to reduce standby power use to no more than 1 watt per device. The proposal contained 3 elements:

- Participating countries would seek to lower standby to below 1 watt in all products by 2010
- Each country would use measures and policies appropriate to its own circumstances
- All countries would adopt the same definition and test procedure

The so called 'horizontal approach' ensures that all products are included by default, unless specifically excluded. This provides certainty for manufacturers and therefore enables the market for technical solutions to transform faster and at the lowest cost.

Products that are already regulated by an efficient standard that captures standby power and products with special features that make it difficult to comply with the 1 Watt threshold (e.g. medical products) are excluded from the horizontal standard.

Table 14: Summary of Voluntary Measures Outside the EU

Country	Programme	Scope	Summary of requirements				Program type	Date
			On (W)	On-idle (W)	Standby (W)	Other		
USA	ENERGY STAR[17]	DVD player/recorders. Laserdisc. Blu-ray players			1		Voluntary label	2003
Korea	Eco label[18]	DVD player/recorder		15	1	Hazardous substances, recyclability criteria and life cycle considerations	Voluntary label	2005 /6
		VCR		15	1			
		Combination VCR/DVD			1			
		Projectors	Watt/lumen Metric		5			
Japan	Top Runner[19]	VCRs. DVD video recorders with and combination VCR or HDD	Annual typical energy cycle. DVD recorders have 16 categories ranging from 39kWh/yr to 101kWh/yr (with 1TB HDD). Criteria currently under revision				Mandatory fleet average Energy Performance and voluntary label	Target fleet average energy performance in 2008
Japan	Top Runner[20]	DVD video recorders with digital tuner and combination VCR or HDD. Excludes blu-ray and non-combination products	Annual typical energy cycle. Specifies 16 categories with targets ranging from 58.1kWh/yr to 87.2kWh/yr				Mandatory fleet average energy performance and voluntary label	Target fleet average energy performance in 2010
Japan	Eco Mark	Projectors	Comprehensive Eco design requirements with complex minimum energy requirements based on a relatively granular categorisation of total light output, and correction coefficients for special lens characteristics (English Translation Appendix 5)				Voluntary label;	2010
Taiwan	Green	Projectors	Watts/Lumen		Standby	Plastic	Voluntary	

[17] http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=DP
[18] http://www.koeco.or.kr/eng/business/cover_document/EL432.pdf and http://www.koeco.or.kr/eng/business/cover_document/EL146.pdf
[19] http://www.eccj.or.jp/top_runner/pdf/tr_tv_vcr.pdf
[20] http://www.eccj.or.jp/top_runner/pdf/tr_dvd_with_digital_tuner_may2007.pdf

Country	Programme	Scope	Summary of requirements				Program type	Date
			On (W)	On-idle (W)	Standby (W)	Other		
	Mark[21]		metric		5W	composition restrictions ISO 11469 Labelling for re-cycling		
California	Appliance Efficiency Regulations (2009)[22]	Digital Versatile Disc Players and Digital Versatile Disc Recorders			3			Originally established in 1976 but revised periodically. Last update 2009
Taiwan	Standby Power Regulation[23]	DVD Player			1			2009-12
International Energy Agency (IEA)	One Watt Initiative'[24]				1		Proposal to harmonise energy policies to reduce stand by power	

Games consoles

The US Environmental Protection Agency have published a draft ENERGY STAR Program Requirements for Computers Version 5.1 which includes a specification for games consoles [25]. More recently it has become clear that the draft ENERGY STAR specification will not be implemented until further discussions with stakeholders have taken place. The current ENERGY STAR computer specification does include a basic test procedure for measuring the power consumption of games consoles. It is unclear whether or not this test procedure will be adopted for the final games console specification.

The draft ENERGY STAR specification includes three Tiers of requirements dealing with power consumption across different power modes. The second and third Tier requirements also tackle power consumption for different functionalities other than game playing such as DVD playback and set top box functionalities. In addition to restrictions on power consumption the draft ENERGY STAR specifications also includes requirements for power management functionality to be installed and activated on shipment.

Table 15: Draft ENERGY STAR Specifications for Games console System Idle

Tier and Effective Date	System Idle (W)
Tier 2 (Effective July 1, 2011)	≤ 45.0
Tier 3 (Effective July 1, 2012)	≤ 25.0

[21] http://greenliving.epa.gov.tw/GreenLife/greenlife-v2/Criteria-82.html
[22] http://www.energy.ca.gov/appliances/2007regulations/index.html (p.140)
[23] http://www.energyrating.gov.au/pubs/2006-sb-hu.pdf
[24] http://www.iea.org/Textbase/subjectqueries/standby.asp
[25] http://www.energystar.gov/index.cfm?c=revisions.game_console_spec

Table 16: Draft ENERGY STAR Specifications for Games console Media Functions

Tier and Effective Date	Media Functions (W)
Tier 3 (Effective July 1, 2012)	≤ 35.0

Table 17: Draft ENERGY STAR Specifications for Games console Sleep Mode

Tier and Effective Date	Sleep Mode (W)	
	Wireless AP/Router Functions not engaged:	Wireless AP/Router Functions engaged:
Tier 1 (Effective July 1, 2010)	≤ 2.0 plus an additional 0.7 for WOL enabled devices	≤ 10.0
Tier 2 (Effective July 1, 2011)	≤ 1.0 plus an additional 0.7 for WOL enabled devices	≤ 5.0
Tier 3 (Effective July 1, 2012)	≤ 1.0 plus an additional 0.7 for WOL enabled devices	≤ 5.0

There are currently no other major voluntary initiatives centred on games consoles.

1.5 Conclusions

Task 1 identifies a number of products for inclusion within this Preparatory Study:

- Video players/recorders,
- Projectors and beamers,
- Games consoles

Some specific products types will be excluded from the work including those:

- that are designed for use using a battery power supply,
- that are niche market products such as professional cinema projectors.

The initial screening of these products indicates that potential energy savings of 15 TWh per year are possible by 2020.

The product list considered for this study has taken into account qualifications from Stakeholder feedback in the first questionnaire and the First stakeholder meeting. Many of the products are very new to the European market or reflect a step change in functionality and storage technology (e.g. Blu-Ray Disc playback and recording equipment). For many new products, the impact of network connection for supporting software and data contributing to the product function is an important Stakeholder input topic.

2 Task 2: Economic and Market Analysis

2.1 Introduction

Task 2 focuses on an analysis of the market for Video Recorders/Players, Projectors (Beamers) and games consoles.

The analysis for each segment is divided into two topics:

- The actual market situation and market potential
- The market trends

This analysis focuses on DVD and Blu-ray formats which are still in use and have more reliable market data and forecasts available. Professional products are not considered to be video recorders/players and analysis from the Futuresource on professional blu-ray expects the future market to be extremely minimal although Futuresource consider it too early to make a forecast.

Initial stakeholder feedback on the EU27 market for projectors suggested that projectors intended for professional applications such as Digital/E-Cinema, flight simulators and 3D projection for computer assisted design (CAD) should not be included in the scope of this study (see Task1 1.1.3) With the growing popularity and decreasing cost of large screen televisions, the home cinema projector market has reached a plateau in Europe and market saturation for all projector markets in Europe is predicted for 2018 with annual sales from now until 2020 flat at around 1.5 to 1.6 million units.

Games consoles have been on the market since the early 1970's. Despite two periods of decline, the first in the late 1970's and the second in the mid 1980's, games consoles have increased in popularity since their initial launch onto the market. Current annual sales (2008) in the EU-27 are estimated at over 20 million units Three manufacturers currently dominate the games consoles hardware industry.

2.2 Generic Economic Data

This section describes the data derived from official EU statistics regarding the products under investigation and estimates the apparent EU consumption of these products based on the formula:

Sales in EU-27 = Production in EU-27 – export to third countries (from EU-27) + imports from third countries (to EU-27)

Manufactured products are classified under NACE ((in French: Nomenclature statistique des activités économiques dans la Communauté européenne). NACE is the European standard classification of productive economic activities. NACE is part of an integrated system of statistical classifications, developed mainly under the auspices of the United Nations (UN) Statistical Division. From the European point of view, this system can be represented as follows:

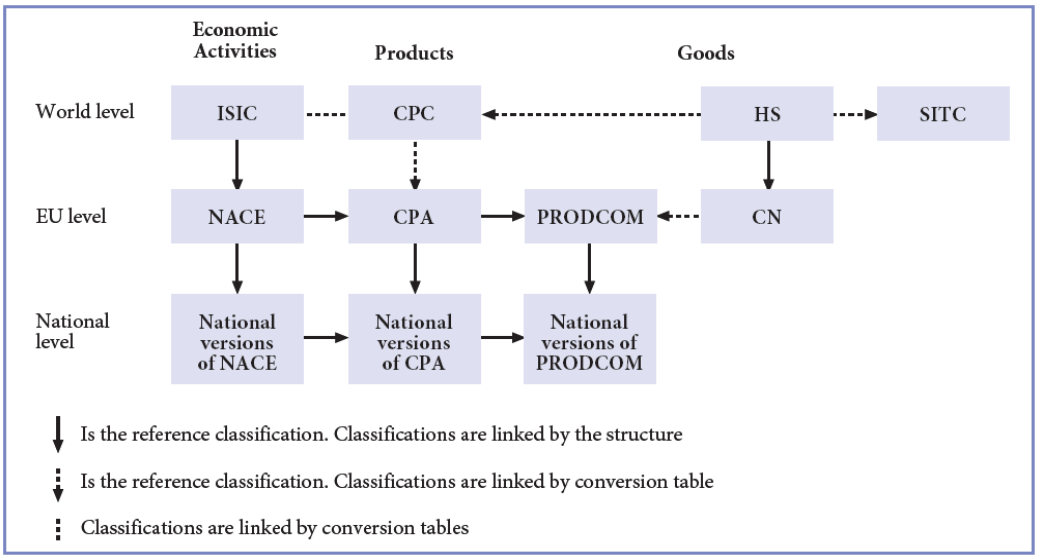


Figure 9: International System of Classifications

Where:

- **ISIC** is the United Nations' International Standard Industrial Classification of all Economic Activities.
- **CPC** is the United Nations' Central Product Classification.
- **HS** is the Harmonized Commodity Description and Coding System, managed by the World Customs Organisation.
- **CPA** is the European Classification of Products by Activity.
- **Prodcom** is the classification of goods used for statistics on industrial production in the EU.
- **CN** stands for the Combined Nomenclature, a European classification of goods used for foreign trade statistics.

A number of revisions to NACE have been made over the years. ProdCom data for 2005, 2006 & 2007 have been reported under NACE Rev. 1.1. However, data for 2008 and onwards are now reported under NACE Rev. 2. Thus, the data for 2008 is not strictly comparable with the data for the previous years, and a judgement has been taken for selecting product codes with comparable descriptions.

2.2.1 EU Production

A number of PRODCOM codes which include several sound and imaging products like video recorders and projectors were identified. However, interpreting the data to give an accurate account of production for all sound and imaging equipment was not possible because of difficulties in interpreting clearly the various coding descriptions. The codes identified alongside with the number of units produced in EU for the years 2005, 2006 and 2007 are shown in the table below.

PRODCOM Codes	Product description	Sold Production (p/st)		
		2005	2006	2007
32.30.33.70	Video recorders or player/recorders (including laser or digital video disc players/recorders) (excluding those combined with a television, for magnetic tape)	N/A	3200000	6470175
32.30.33.39	Video cassette recorders for magnetic tape of width ≤1.3cm and with a tape speed ≤50mm per sec. excluding those combined with television, or a built-in television camera	5206157	5400000	4000000

PRODCOM Codes	Product description	Sold Production (p/st)		
		2005	2006	2007
32.30.33.50	Other video tape recorders excluding those combined with a television - for magnetic tape of width ≤1.3cm and with a tape speed ≤50mm per second	N/A	3200	12
30.02.16.70	Input or output units whether or not containing storage units in the same housing (including mouse) (excluding printers and keyboards)	N/A	13449080	11607252
32.30.20.20	Colour television projection equipment and videoprojectors	3640773	3739033	4055269
33.40.35.50	Slide projectors (excluding for cinematography)	N/A	14000	15000
33.40.35.90	Still image projectors (excluding for cinematography)	159812	93860	46754
36.50.42.00	Video games of a kind used with a television receiver	17941	1400	4978

From 1st January 2008, ProdCom data is reported according to NACE Rev. 2 coding. This makes comparison with previous years data (in NACE Rev. 1.1 coding) difficult. However, the ProdCom data relevant for the following similar product descriptions for 2008 are shown below.

PRODCOM Codes	Product description	Pieces
		2008
26.40.33.00	Video camera recorders and other video recording or reproducing apparatus	9,000,000
26.40.34.20	Video projectors	15,000
26.40.60.00	Video games consoles of a kind used with a TV receiver	800

Video Recorders/Players

The production base for VRs is very similar to other consumer electronics. The main manufacturing and assembly bases are therefore in East Asia, including Malaysia, China and small amounts in Eastern Europe. DVD players are commodity products which can be found at very low price points (under €30) which can only be fulfilled by high volume, low cost production facilities mainly available in China. Similarly, the majority of hard drive only VRs are established in China.

Blu-ray players are currently higher cost as they have lower economies of scale and require higher precision manufacturing. However, the price is dropping which reflects an improvement in manufacturing process and transfer to lower cost production facilities.

The VCR market is not considered since it is obsolete except for specialist demand.

ProdCom code 32.30.33.70 (NACE Rev 1.1) and code 26.40.33.00 (Nace Rev 2) are considered as relevant to video players/recorders.

Projectors

Projectors considered in this study, are specifically covered by ProdCom code 32.20.20.20.Unfortunately there is no differentiation, in this category, between rear projection televisions and video projectors. The data provided by ProdCom has no value in the economic and market analysis for this study.

The rapidly falling EU market for other projector ProdCom categories (33.40.35.50 and 33.40.35.90) indicates that they refer to the soon to be obsolete photographic slide, transparency and document projectors which are not considered in this study.

The main manufacturing bases for the principal components of all projectors sold in the EU27 market are in East Asia with design and development concentrated in Japan and to a certain extent in the USA. Projector lamp technology is heavily based on European research and development but lamp manufacturing is outside Europe. There is little projector assembly in Europe[26] for the EU27 or export market. One manufacturer currently dominates the EU27 market with about a 50% share. Ten other manufacturers share the rest of the market but products are often based on commonly sourced projection engines and optics. The price base for projectors varies widely with application ranging from 300 Euros for an average low end product to 30,000 Euros for a fixed installation large meeting room product.

Games consoles

Games consoles are covered by the ProdCom code "9504.10" (and "26.40.60" under NACE Rev 2) which is classed as "Video games of a kind used with a television receiver".

The games consoles market is currently dominated by three main manufacturers. Manufacturing bases of the final consoles are primarily found in South East Asia with Japan and China being the most common countries. Former games consoles manufacturing in Hungary was relocated to mainland China. There is currently no large scale games consoles production in the EU-27. Whilst, the four main games consoles on the market are all imported into the EU27 due to their Asian manufacturing bases some games consoles consumables such as video games are developed and manufactured within the EU27.

The way in which games software is developed could have an impact on the energy consumption on games consoles by either supporting or not supporting the use of power management functionality. Games consoles manufacturers have some ability to influence software developers to ensure power management functionality is supported by individual games but they do not have absolute control. It will therefore be important to ensure that games developers are aware of the need to support games console power management in the future.

2.2.2 EU Trade Statistics

Extra-EU Trade

In 2008 the EU27 imported approximately Euros 1.3 billion of projectors. There is no verifiable data currently available on the very small export market of European assembled products.

In 2008, the EU27 imported approximately Euros 5.5 billion of video game consoles and video games. In contrast the EU27 exported Euros 0.4 billion of the same product group. The majority of imports (Euros 5.3 billion) came from China. Approximately 90% of the remaining imports came from Japan, Hong Kong or the USA.

The four main games consoles on the market are all imported into the EU as there is currently no large scale EU based manufacturing. In 2008, the EU27 imported approximately Euros 5.5 billion of video game consoles and video games. In contrast the EU27 exported Euros 0.4 billion of the same product group. The majority of imports (Euros 5.3 billion) came from China. Approximately 90% of the remaining imports came from Japan, Hong Kong or the USA[27].

[26] (there is some manufacturing capacity for the high end home cinema sector in Norway /www.projectiondesign.com, If there is any remaining manufacturing base of Barco in Belgium it is not for home cinema, Barco works close together with JVC that was partly owned by Matsushita now Panasonic and is now part of JVC Kenwood Holding)
[27] European Commission, Market Access Database, http://madb.europa.eu/mkaccdb2/indexPubli.htm

PRODCOM Codes	Product description	Imports			Exports		
		2005	2006	2007	2005	2006	2007
32.30.33.70	Video recorders or player/recorders (including laser or digital video disc players/recorders) (excluding those combined with a television, for magnetic tape)	44,282,918	45,064,885	51,084,543	2,114,205	2,133,943	2,848,023
32.30.33.39	Video cassette recorders for magnetic tape of width ≤1.3cm and with a tape speed ≤50mm per sec. excluding those combined with television, or a built-in television camera	2,790,568	1,799,898	1,493,874	58,015	38,269	75,342
32.30.33.50	Other video tape recorders excluding those combined with a television - for magnetic tape of width ≤1.3cm and with a tape speed ≤50mm per second	314,897	139,267	210,836	97,076	43,588	43,588
30.02.16.70	Input or output units whether or not containing storage units in the same housing (including mouse) (excluding printers and keyboards)	121,272,074	129,829,546	120,995,176	15,834,379	16,316,985	22,392,466
32.30.20.20	Colour television projection equipment and videoprojectors	1,750,485	2,317,315	2,198,745	460,436	696,557	466,222
33.40.35.50	Slide projectors (excluding for cinematography)	13,302	22,257	64,202	16,927	42,705	13,332
33.40.35.90	Still image projectors (excluding for cinematography)	316,263	162,781	334,094	147,414	80,621	38,808
36.50.42.00	Video games of a kind used with a television receiver	N/A	N/A	N/A	N/A	N/A	N/A

As described before, ProdCom data for year 2008 onwards is reported according to NACE Rev. 2 coding. This makes comparison with previous years data (in NACE Rev. 1.1 coding) difficult. However, the ProdCom data relevant for the following similar product descriptions for 2008 are shown below.

PRODCOM Codes	Product description	Imports	Exports
		2008	2008
26.40.33.00	Video camera recorders and other video recording or reproducing apparatus	53,846,317	4,892,596
26.40.34.20	Video projectors	2,256,196	352,016
26.40.60.00	Video games consoles of a kind used with a TV receiver	N/A	N/A

Intra-EU Trade

There are no verifiable statistical data currently available to the study group on Intra-EU trade of the products covered by this study.

2.2.3 Apparent EU Consumption

Apparent EU consumption for years 2005 to 2008 has been calculated as follows:

PRODCOM Codes	Product description	Apparent EU Consumption		
		2005	2006	2007
32.30.33.70	Video recorders or player/recorders (including laser or digital video disc players/recorders) (excluding those combined with a television, for magnetic tape)	N/A	46,130,942	54,706,695
32.30.33.39	Video cassette recorders for magnetic tape of width ≤1.3cm and with a tape speed ≤50mm per sec. excluding those combined with television, or a built-in television camera	7,938,710	7,161,629	5,418,532
32.30.33.50	Other video tape recorders excluding those combined with a television - for magnetic tape of width ≤1.3cm and with a tape speed ≤50mm per second	N/A	98,879	167,260
30.02.16.70	Input or output units whether or not containing storage units in the same housing (including mouse) (excluding printers and keyboards)	N/A	126,961,641	110,209,962
32.30.20.20	Colour television projection equipment and videoprojectors	4,930,822	5,359,791	5,787,792
33.40.35.50	Slide projectors (excluding for cinematography)	N/A	- (6,448)*	65,870
33.40.35.90	Still image projectors (excluding for cinematography)	328,661	176,020	342,040
36.50.42.00	Video games of a kind used with a television receiver	N/A	N/A	N/A

*This negative number for apparent EU consumption is due to a higher amount of exports than other years

Again, the 2008 data from ProdCom is reported differently. The following similar product descriptions reveal the apparent EU consumption in 2008.

PRODCOM Codes	Product description	Apparent EU Consumption
		2008
26.40.33.00	Video camera recorders and other video recording or reproducing apparatus	57,953,721
26.40.34.20	Video projectors	1,919,180
26.40.60.00	Video games consoles of a kind used with a TV receiver	N/A

2.3 Market and Stock Data

2.3.1 Study Approach to Gathering Market and Stock Data

Video Recorders/Players

Data was obtained from desk based research as well as supporting industry and expert data from contacts and the first questionnaire.

Projectors

Data was extrapolated from specific manufacturing industry and retail inputs received through Stakeholder Questionnaire 1[28] and detailed follow up enquiries.

Games consoles

The preparatory study team reviewed current major market research firms for games consoles sales data covering the EU-27. As no major reports were found the team reviewed games consoles focussed publications including web based companies such as VG Chartz.

2.3.2 Commercial Market Research Data

Video Recorders/Players

Futuresource[29] appear to be the most quoted source for commercial market research data. The indications are that sales have peaked at about 40 million per year and that sales are declining by about 1% per year. However, forecasts by different organisations vary between 22 million and 37 million overall annual sales by 2020. Substitution of DVD with Blu-ray is also expected and DVD will be obsolete between 2015-2020. In addition new, technologies will enter the market and its environmental impact is not clear.

Projectors

Commercial market research data[30] on projectors appears to underestimate total EU27 sales by 30% in comparison with the 1.7 million products stated as total EU 27 sales by unrelated Stakeholder sources. This may be explained by the complicated cross-over of internet based direct sales of projectors into a mix of CE product sales sites. Further confusion in commercial market data is caused by the large Schools projector market in the EU27 (over 800,000 units sold in 2008) The larger proportion of these are obtained through bulk procurement contracts placed directly with manufacturers and do not necessarily register in commercial market research data.

Games consoles

There are few commercial market research data organisation which offer standard reports covering combined games consoles sales for the EU-27. Sales data for the four main consoles on the market is also confused by the fact that the manufacturers tend to report sales data at the regional level rather than at the individual country level. Sales data for games consoles is also likely subject to increased market pressure as video game developers seek to align with the most popular games consoles on the market. This increased market sensitivity to the numbers of each games consoles being sold could in part explain why complete sets of commercially available data sources for these products covering the whole of the EU-27 are not available.

2.3.3 Data – Assumptions and Qualifications

Video Recorders/Players

Draft MTP projections for UK sales are presented below[31]. This would suggest that EU27 sales are approximately 42 million. This is estimated to fall over time, by approximately 1% a year to around 37 million in 2020.

[28] Available at http://www.ecomultimedia.org/questionnaires/
[29] http://www.futuresource-consulting.com/
[30] http://www.futuresource-consulting.com/
[31] Unpublished, Personal Communication,

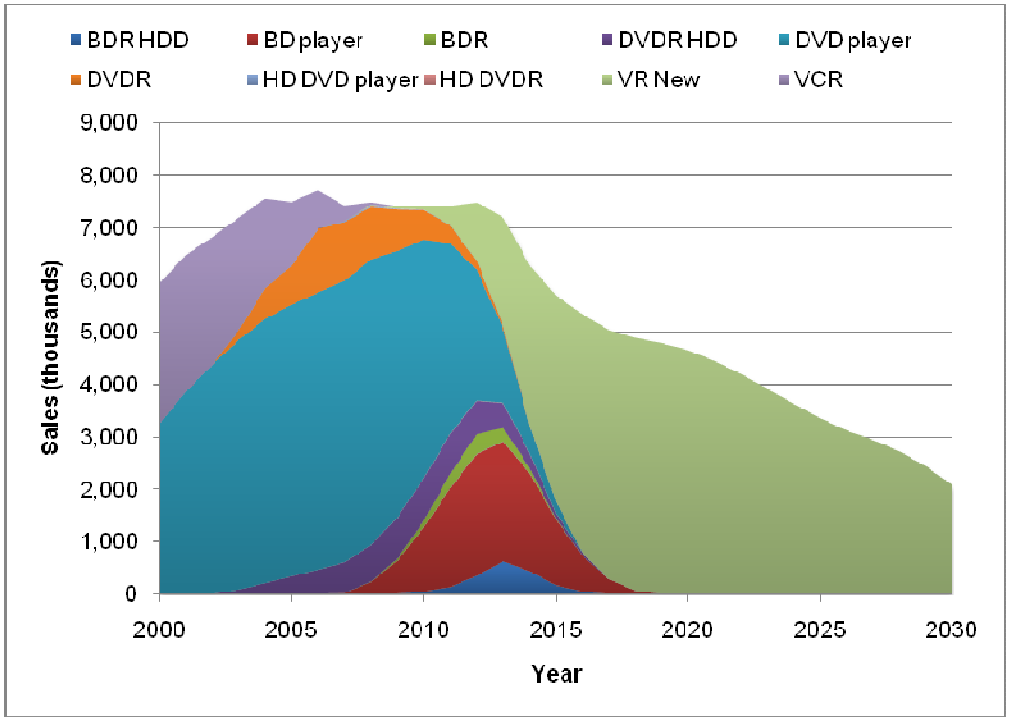


Figure 10: UK MTP UK video recorder sales projection

The Screen Digest (Figure 11) forecast of video hardware sales for Western Europe to 2013 shows a similar trend to MTP forecasts, although they predict a slightly slower decline of DVD hardware. However, Screen Digest does not cover the whole EU27.

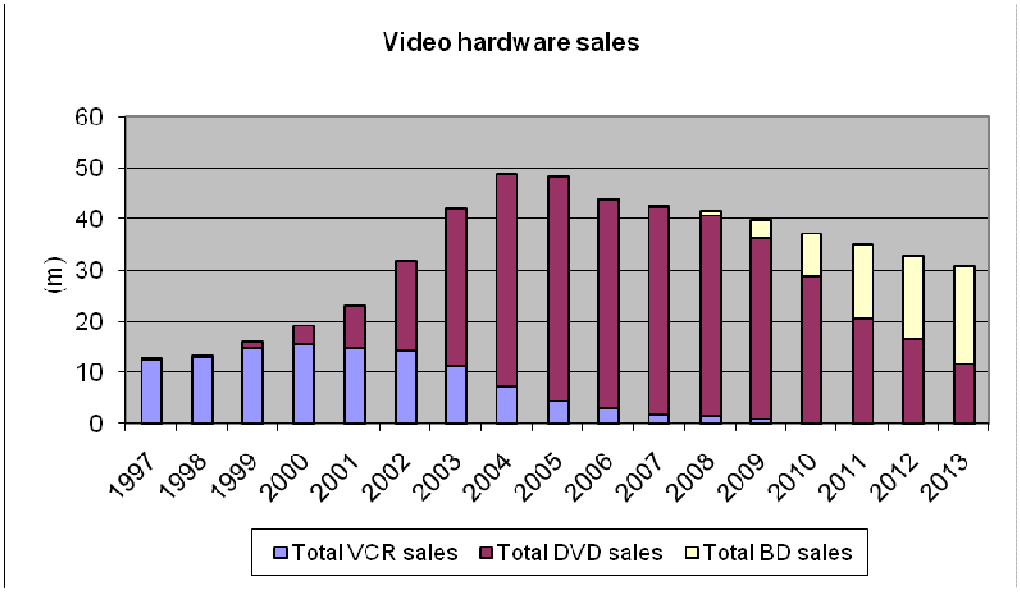


Figure 11: Screen Digest Western Europe VR sales projections

Strategy Analytics present a very different forecast (Table 18). In 2009 and 2012, the DVD player sales by Strategy Analytics for EU27 are substantially lower than MTP and Screen Digest forecasts. The VR sales, however, are generally in line. Beyond 2012 to 2020, Strategy Analytics projects DVD recorder sales continuing to 2020, and blu-ray VR sales at 22.5 million a year. This may reflect the

heterogeneity of markets across Europe or over pessimistic forecasts by MTP for the demand for Blu-ray against competition from other video delivery methods, particularly the internet.

Table 18: Strategy Analytics EU27 VR sales projections (million units)

	2009	2012	2020
DVD Player	11.63	3.57	0.00
DVD Recorder	6.28	6.31	4.63
Blu-ray Player	3.14	15.00	13.75
Blu-ray Recorder	0.00	10.00	8.75
Totals	**21.05**	**34.88**	**27.13**
	2009	**2012**	**2020**
DVD Player	55.2%	10.2%	0.0%
DVD Recorder	29.8%	18.1%	17.1%
Blu-ray Player	14.9%	43.0%	50.7%
Blu-ray Recorder	0.0%	28.7%	32.3%

Projectors

In the interpretation and extrapolation of sales and stock data for the EU27 projector market the basic assumption is made that projector sales will not distort the existing sales ratio to other forms of video monitor (TVs, TV monitors and PC monitors) Developments in large area self-emissive video displays That might compete on a cost basis with the average 2.5M. (90") projection screen are not likely to impinge on the main projector market for more than a decade. These assumptions are supported by the display and projector Industry. (Digital Europe consultation)

Table 19: Estimated Projector sales EU27 (Home Cinema, Office, and Schools)

Year	Sales 2008 and Forecast EU-27	Stock (Estimated)
2008	1,600,000	8,000,000
2012	1,700,000	8,000,000
2020	1,900,000	8,500,000

Individual Industry sources and Manufacturers' Association sources in Europe and Japan predict saturation of the annual sales market for EU27 by 2015, with forecast of annual sales flat at 1.7M to 2.2M units.

Games consoles

There are few single sources of market research data covering games console sales into the EU-27 as a whole. The sales and stock data for games consoles in this preparatory study have been sourced in part from the VG Chartz website[32]. The VG Chartz data is used to support assumptions in this ecodesign preparatory study as there is a lack of formal market research data available for games consoles on the EU-27 market.

VG Chartz provides past and current sales data for the four main games consoles currently on sale within the EU-27. The VG Chartz data is published for Japan, America and Europe. The European dataset is not defined as the EU-27. No further information is available on which European countries are considered in the VG Chartz dataset. In light of further information being unavailable the VG Chartz European dataset is taken to be representative of the EU-27. VG Chartz polls retailers, other publishers and manufacturers to identify sales quantities of the four main games consoles.

All sales and stock data are rounded to the nearest thousand.

[32] VGChartz, 2009, available at <http://vgchartz.com/welcome.php>, last accessed 22nd June 2009

Table 20: Estimated Games consoles Sales EU27 (based on VGChartz data)

Year	PS2	Xbox360	PS3	Wii	New Products 2012 Launch	New Products 2017 Launch	Total
2000	689,000	-	-	-	-	-	689,000
2001	5,122,000	-	-	-	-	-	5,122,000
2002	6,179,000	-	-	-	-	-	6,179,000
2003	6,855,000	-	-	-	-	-	6,855,000
2004	5,801,000	-	-	-	-	-	5,801,000
2005	7,433,000	-	-	-	-	-	7,433,000
2006	4,351,000	-	-	-	-	-	4,351,000
2007	3,295,000	3,245,000	4,114,000	5,411,000	-	-	16,065,000
2008	3,155,000	4,874,000	3,737,000	8,883,000	-	-	20,649,000
2009	1,218,000	3,076,000	2,949,000	5,643,000	-	-	12,886,000
2010	609,000	1,941,000	1,861,000	3,562,000	-	-	7,973,000
2011	-	3,245,000	4,114,000	2,248,000	-	-	9,607,000
2012	-	2,048,000	2,596,000	1,419,000	12,770,000	-	18,834,000
2013	-	1,293,000	1,639,000	895,000	17,493,000	-	21,320,000
2014	-	816,000	1,034,000	-	11,668,000	-	13,518,000
2015	-	515,000	653,000	-	7,364,000	-	8,532,000
2016	-	-	-	-	9,607,000	-	9,607,000
2017	-	-	-	-	6,063,000	12,770,000	18,834,000
2018	-	-	-	-	3,827,000	17,493,000	21,320,000
2019	-	-	-	-	1,850,000	11,668,000	13,518,000
2020	-	-	-	-	1,168,000	7,364,000	8,532,000

A number of assumptions were required for past, current and future sales of the four main games consoles on the market. The assumptions were required to fill gaps in the current published data. The sales data for 2000-2009 shown in Table 20 is sourced from VG Chartz. The 2009 data is estimated from the first five months of sales data published on the VG Chartz website. The 2010 sales data for the PS2 is based on a straight line interpolation between the 2009 sales data and zero assumed sales in 2011. The Xbox 360 and PS3 sales data for 2010 is based on the assumption that sales in this year will be 60% of the sales in 2009. Sales in 2011 for the Xbox and PS3 are assumed to revert to the 2007 level as either improved input devices or revised versions of the console are launched to market. Post 2011 sales volumes of the PS3 and Xbox are assumed to be at 60% of the previous years' figure until zero sales in 2015. Sales of the Wii are expected to be at 60% of the previous years' figures in each year post 2009. Wii sales are listed to 2013 as it assumed that no further sales of these console types will take place after this date. It is assumed that a new generation of games consoles will be launched in 2012 and 2017. Sales of these new games consoles are based on the combined sales of each current games console from 2007 onwards.

Two separate scenarios have also been developed to assess possible future changes in the games console market if manufacturers move towards the development of thin client based gaming. The first scenario assumes that 50% of future games consoles sales from 2014 will be thin client gaming consoles and the second scenario assumed that all new sales from 2014 will be thin clients.

Table 21: Estimated Games consoles Sales EU27 (based on VGChartz data) including an assumed partial future shift to thin client gaming

Year	PS2	Xbox360	PS3	Wii	New Products 2012 Launch	New Products 2017 Launch	50% Thin Client Gaming Consoles	Total
2000	689,000	-	-	-	-	-		689,000
2001	5,122,000	-	-	-	-	-		5,122,000
2002	6,179,000	-	-	-	-	-		6,179,000
2003	6,855,000	-	-	-	-	-		6,855,000
2004	5,801,000	-	-	-	-	-		5,801,000
2005	7,433,000	-	-	-	-	-		7,433,000
2006	4,351,000	-	-	-	-	-		4,351,000
2007	3,295,000	3,245,000	4,114,000	5,411,000	-	-		16,065,000
2008	3,155,000	4,874,000	3,737,000	8,883,000	-	-		20,649,000
2009	1,218,000	3,076,000	2,949,000	5,643,000	-	-		12,886,000
2010	609,000	1,941,000	1,861,000	3,562,000	-	-		7,973,000
2011	-	3,245,000	4,114,000	2,248,000	-	-		9,607,000
2012	-	2,048,000	2,596,000	1,419,000	12,770,000	-		18,834,000
2013	-	1,293,000	1,639,000	895,000	17,493,000	-		21,320,000
2014	-	816,000	1,034,000	-	5,834,000	-	5,834,000	13,518,000
2015	-	515,000	653,000	-	3,682,000	-	3,682,000	8,532,000
2016	-	-	-	-	4,803,500	-	4,803,500	9,607,000
2017	-	-	-	-	3,031,500	6,385,000	9,416,500	18,834,000
2018	-	-	-	-	1,913,500	8,746,500	10,660,000	21,320,000
2019	-	-	-	-	925,000	5,834,000	6,759,000	13,518,000
2020	-	-	-	-	584,000	3,682,000	4,266,000	8,532,000

Table 22: Estimated Games consoles Sales EU27 (based on VGChartz data) including an assumed future shift to thin client gaming

Year	PS2	Xbox360	PS3	Wii	100% Thin Client Gaming Consoles	Total
2000	689,000	-	-	-		689,000
2001	5,122,000	-	-	-		5,122,000
2002	6,179,000	-	-	-		6,179,000
2003	6,855,000	-	-	-		6,855,000
2004	5,801,000	-	-	-		5,801,000
2005	7,433,000	-	-	-		7,433,000
2006	4,351,000	-	-	-		4,351,000
2007	3,295,000	3,245,000	4,114,000	5,411,000		16,065,000
2008	3,155,000	4,874,000	3,737,000	8,883,000		20,649,000
2009	1,218,000	3,076,000	2,949,000	5,643,000		12,886,000
2010	609,000	1,941,000	1,861,000	3,562,000		7,973,000
2011	-	3,245,000	4,114,000	2,248,000		9,607,000
2012	-	2,048,000	2,596,000	1,419,000		18,834,000
2013	-	1,293,000	1,639,000	895,000		21,320,000

Year	PS2	Xbox360	PS3	Wii	100% Thin Client Gaming Consoles	Total
2014	-	816,000	1,034,000	-	11,668,000	13,518,000
2015	-	515,000	653,000	-	7,364,000	8,532,000
2016	-	-	-	-	9,607,000	9,607,000
2017	-	-	-	-	18,833,000	18,834,000
2018	-	-	-	-	21,320,000	21,320,000
2019	-	-	-	-	13,518,000	13,518,000
2020	-	-	-	-	8,532,000	8,532,000

2.3.4 Stock Data

Video Recorders/Players

There are very little reliable, freely available data on video recorder stock. However, based on the extremely low cost of DVD players, and extremely wide use for computer data and other video formats, it is assumed that ownership is at least as high as primary TV ownership.

Therefore as a first assumption, current stock of actively used players is expected to be approximately 180 million with a maximum figure of 350 million. The total stock is expected to be higher since a large number of e.g. obsolete VCRs may have not yet entered the waste stream.

The UK Market Transformation Programme estimates the UK stock is 45 million units in 2008 (below). The UK consumer electronics market is generally 22%[33] of the Western European market, or approximately 18% of EU27. This sets the European market at 250 million units.

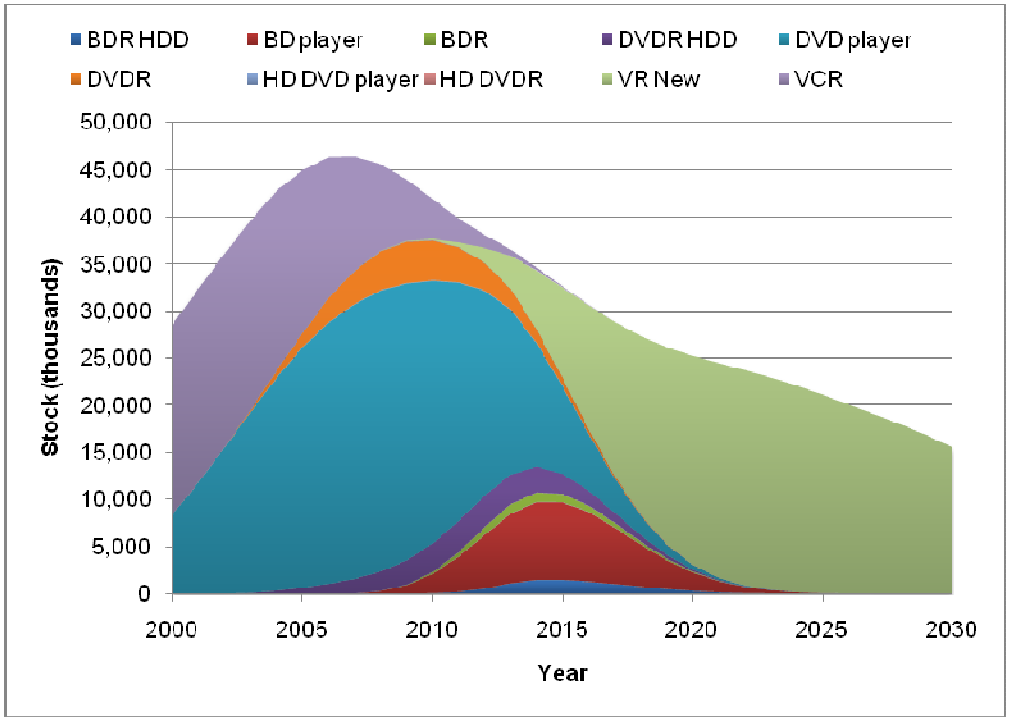


Figure 12: MTP UK Stock Projections (Video players/recorders)

[33] http://www.pcr-online.biz/news/30411/UK-leads-consumer-electronics-spending

The MTP graph shows that in the near future there will be significant substitution of DVD products to Blu-ray and other 'New' technologies, which have not been specified in detail. In the longer term, beyond 2015, these 'New technologies are expected to dominate in a substantially smaller VR market.

Table 23: MTP UK stock proportion

	BDR HDD	BD player	BDR	DVDR HDD	DVD player	DVDR	HD DVD player	HD DVDR	VR New	VCR
2008	0%	1%	0%	5%	66%	9%	0%	0%	0%	20%

Assuming that the proportion of sales is the same as the UK, the EU27 sales for blu-ray is 1.36 million units. This is significantly less than the 10.48 million estimated by Futuresource Consulting.

Table 24: European stock estimate based on MTP (millions)

	BDR HDD	BD player	BDR	DVDR HDD	DVD player	DVDR	HD DVD player	HD DVDR	VR New	VCR
2008	-	5.0	0.03	11.46	166.11	23.03	0.23	0.04	0.11	50.86

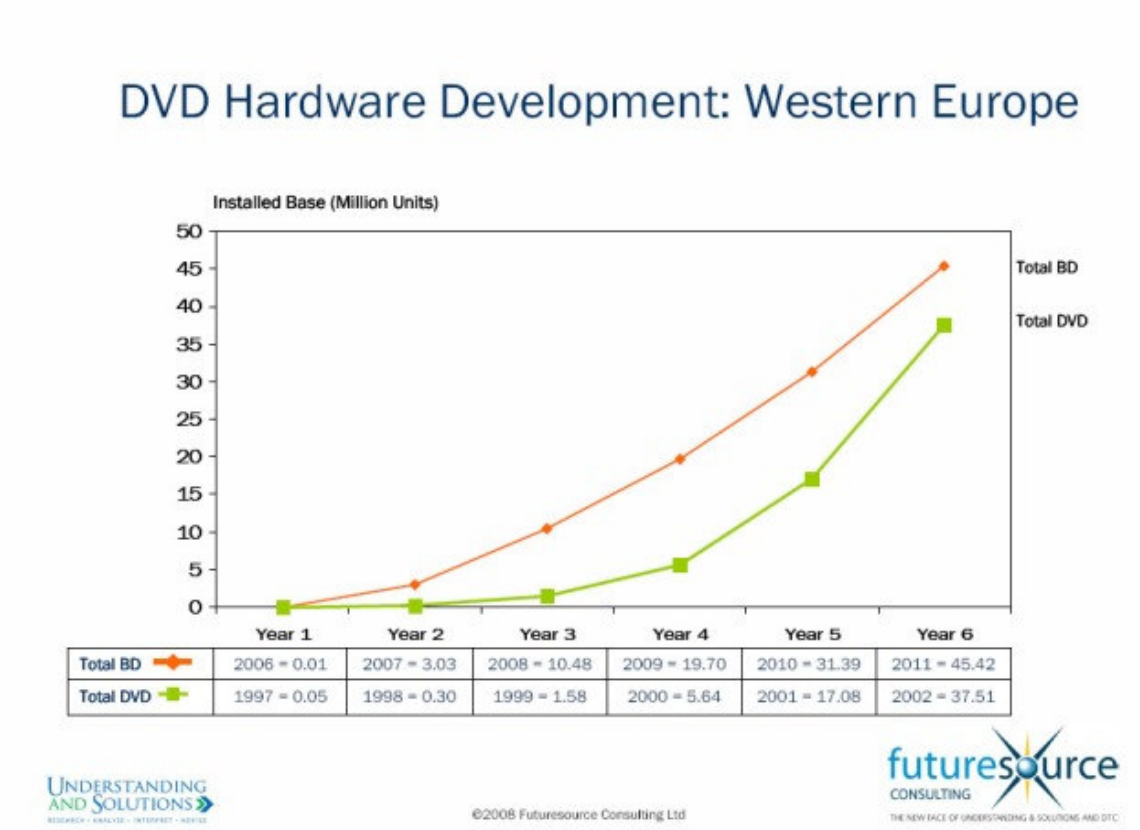


Figure 13: Futuresource forecast Blu-ray sales vs. historic DVD sales

Projectors

Please note: projector stock data has already been discussed in the previous section (ref. Table 23). Stock estimates have been based on a typical lifetime of 6 years.

Games consoles

The games consoles stock data shown in **Error! Reference source not found.**is based on the sales data shown in Table 18 with an assumed lifetime of 5.5 years per console and an assumed rate of decay to account for products falling out of stock.

The stock of games consoles in the EU-27 assumed to peak at approximately 87 million units and therefore also significantly higher than the threshold number of 200,000 units required for consideration under the ecodesign Directive.

Table 25: Estimated Games consoles Stock EU27 (based on VGChartz data)

Year	PS2	Xbox360	PS3	Wii	New Products 2012 Launch	New Products 2017 Launch	Total
2000	689,000	-	-	-	-	-	689,000
2001	5,802,000	-	-	-	-	-	5,802,000
2002	11,899,000	-	-	-	-	-	11,899,000
2003	18,491,000	-	-	-	-	-	18,491,000
2004	23,617,000	-	-	-	-	-	23,617,000
2005	29,642,000	-	-	-	-	-	29,642,000
2006	31,514,000	-	-	-	-	-	31,514,000
2007	31,128,000	3,245,000	4,114,000	5,411,000	-	-	43,898,000
2008	29,538,000	8,079,000	7,801,000	14,227,000	-	-	59,645,000
2009	25,330,000	11,005,000	10,590,000	19,611,000	-	-	66,536,000
2010	20,350,000	12,560,000	12,041,000	22,502,000	-	-	67,453,000
2011	15,079,000	14,984,000	15,307,000	23,312,000	-	-	68,682,000
2012	10,496,000	15,580,000	16,437,000	22,214,000	12,770,000	-	77,497,000
2013	6,807,000	14,766,000	15,986,000	19,493,000	30,107,000	-	87,160,000
2014	4,066,000	12,996,000	14,462,000	15,180,000	41,206,000	-	87,909,000
2015	2,203,000	10,748,000	12,330,000	10,848,000	47,103,000	-	83,232,000
2016	1,065,000	8,096,000	9,549,000	7,107,000	43,996,000	-	69,813,000
2017	451,000	5,752,000	6,958,000	4,269,000	38,679,000	12,770,000	68,879,000
2018	165,000	3,821,000	4,712,000	2,342,000	31,208,000	30,107,000	72,354,000
2019	51,000	2,344,000	2,929,000	1,160,000	22,595,000	41,206,000	70,284,000
2020	13,000	1,311,000	1,650,000	509,000	14,405,000	47,103,000	64,991,000

Two separate scenarios have also been developed to assess possible future changes in the games console market if manufacturers move towards the development of thin client based gaming. The first scenario assumes that 50% of future games consoles stock from 2014 will be thin client gaming consoles and the second scenario assumed that all stock from otherwise newly launched games consoles in 2012 and 2017 will be thin clients by 2014.

Table 26: Estimated Games consoles Stock EU27 (based on VGChartz data) including an assumed partial future shift to thin client gaming by 2014

Year	PS2	Xbox360	PS3	Wii	New Products 2012 Launch	New Products 2017 Launch	50% Thin Client Gaming Consoles	Total
2000	689,000	-	-	-	-	-	-	689,000
2001	5,802,000	-	-	-	-	-	-	5,802,000
2002	11,899,000	-	-	-	-	-	-	11,899,000
2003	18,491,000	-	-	-	-	-	-	18,491,000
2004	23,617,000	-	-	-	-	-	-	23,617,000
2005	29,642,000	-	-	-	-	-	-	29,642,000
2006	31,514,000	-	-	-	-	-	-	31,514,000
2007	31,128,000	3,245,000	4,114,000	5,411,000	-	-	-	43,898,000
2008	29,538,000	8,079,000	7,801,000	14,227,000	-	-	-	59,645,000
2009	25,330,000	11,005,000	10,590,000	19,611,000	-	-	-	66,536,000
2010	20,350,000	12,560,000	12,041,000	22,502,000	-	-	-	67,453,000
2011	15,079,000	14,984,000	15,307,000	23,312,000	-	-	-	68,682,000
2012	10,496,000	15,580,000	16,437,000	22,214,000	12,770,000	-	-	77,497,000
2013	6,807,000	14,766,000	15,986,000	19,493,000	30,107,000	-	-	87,160,000
2014	4,066,000	12,996,000	14,462,000	15,180,000	20,603,000	-	20,603,000	87,909,000
2015	2,203,000	10,748,000	12,330,000	10,848,000	23,551,500	-	23,551,500	83,232,000
2016	1,065,000	8,096,000	9,549,000	7,107,000	21,998,000	-	21,998,000	69,813,000
2017	451,000	5,752,000	6,958,000	4,269,000	19,339,500	6,385,000	25,724,500	68,879,000
2018	165,000	3,821,000	4,712,000	2,342,000	15,604,000	15,053,500	30,657,500	72,354,000
2019	51,000	2,344,000	2,929,000	1,160,000	11,297,500	20,603,000	31,900,500	70,284,000
2020	13,000	1,311,000	1,650,000	509,000	7,202,500	23,551,500	30,754,000	64,991,000

Table 27: Estimated Games consoles Stock EU27 (based on VGChartz data) including an assumed future shift to thin client gaming by 2014

Year	PS2	Xbox360	PS3	Wii	100% Thin Client Gaming Consoles	Total
2000	689,000	-	-	-	-	689,000
2001	5,802,000	-	-	-	-	5,802,000
2002	11,899,000	-	-	-	-	11,899,000
2003	18,491,000	-	-	-	-	18,491,000
2004	23,617,000	-	-	-	-	23,617,000
2005	29,642,000	-	-	-	-	29,642,000
2006	31,514,000	-	-	-	-	31,514,000
2007	31,128,000	3,245,000	4,114,000	5,411,000	-	43,898,000
2008	29,538,000	8,079,000	7,801,000	14,227,000	-	59,645,000
2009	25,330,000	11,005,000	10,590,000	19,611,000	-	66,536,000
2010	20,350,000	12,560,000	12,041,000	22,502,000	-	67,453,000
2011	15,079,000	14,984,000	15,307,000	23,312,000	-	68,682,000

Year	PS2	Xbox360	PS3	Wii	100% Thin Client Gaming Consoles	Total
2012	10,496,000	15,580,000	16,437,000	22,214,000	-	77,497,000
2013	6,807,000	14,766,000	15,986,000	19,493,000	-	87,160,000
2014	4,066,000	12,996,000	14,462,000	15,180,000	41,206,000	87,909,000
2015	2,203,000	10,748,000	12,330,000	10,848,000	47,103,000	83,232,000
2016	1,065,000	8,096,000	9,549,000	7,107,000	43,996,000	69,813,000
2017	451,000	5,752,000	6,958,000	4,269,000	51,449,000	68,879,000
2018	165,000	3,821,000	4,712,000	2,342,000	61,315,000	72,354,000
2019	51,000	2,344,000	2,929,000	1,160,000	63,801,000	70,284,000
2020	13,000	1,311,000	1,650,000	509,000	61,508,000	64,991,000

2.4 Market and Production Structures

2.4.1 General Trends

Video Recorders/Players

The VR market is currently diversifying in terms of recording formats (HDD, optical) and features (recording, high definition, network connection). The increase in consumer choice could be expected to lead to an increasing market.

Alternative Products

However, the ecodesign set top box definition encompasses a lot of the functions previously identified with video recorders. If the only consumer requirement is to record broadcast TV, but not for permanent archiving, a STB will fulfil this role. Home cinema systems which integrate surround sound speakers could also replace VRs at the higher end, assuming only playback is required by the user.

The growth of battery operated portable products which can be docked and connected to TVs, i.e. portable media players (PMPs) such as the iPod could also reduce stock. In addition, secondary TVs may be replaced by computers which provide equivalent video playback functionality.

Game consoles are not assumed to replace video recorders in the short term for a number of reasons:

- The interface is more complex because it needs to offer more functions and as a result can be harder to use, especially without a more familiar remote control
- Game consoles have a higher cost than VRs. This means that it is unlikely that a consumer will buy a console as a direct replacement.

However, as game consoles become more popular, some households may choose not to replace an existing VR if they own a suitable console. In addition, the user interfaces are improving and standardising across manufacturer product ranges.

It is therefore expected that the overall stock of VRs will not increase since the market is already saturated and could potentially decline as video recorders are replaced by other products. The dominant technology is expected to shift from DVD.

High-definition video

The Blu-ray market is already expanding rapidly as the cost of players continue to fall rapidly, much more quickly than DVD players when first introduced. The tipping point is generally understood to be

around €100 whereby mass market adoption occurs. This is expected to occur within the next two years. As well as cost, demand also needs to be balanced against the ownership of HD televisions, since HD video offers little advantage on SD screens. Although all new TVs on sale are HD, existing TV stock must still be replaced. This means that secondary home blu-ray players are much less likely since the cost is more important and image quality less important. Blu-ray must also compete with internet access and streaming media and is expected to have a relatively short life[34] . As a result some users will not switch to Blu-ray and switch directly to internet and HDD devices. Consumer uptake of HD screens may depend on the price development of HD screens.

3D video

Longer term, there is expected to be a market for 3D movies. This is likely only to be possible using blu-ray due to its large disc capacity. It is not clear how large the market will be, with current projections for 3D capable TVs at approximately 3-15% by 2012-2015[35].

Internet access and HDD devices

Competing HDD storage and downloadable content could significantly impact the use of optical disk devices. A similar trend to music players could occur where existing consumer libraries of CD/DVDs are eventually transferred to hard disc and played directly. However, the factors which limit this are the space requirements of video compared with music, amplified by the high compression possible for transferring CDs which cannot be performed for video.

The second analogy to music sales are Internet stores, like iTunes, Xbox store and others which allow videos to be streamed or downloaded directly. The size of files and download speeds is again likely to determine the success of these. To download a Blu-ray disc at the same quality with current internet connection speeds is likely to take a significant amount of time, an inconvenience which must be taken into account by consumers. The current online market tends to offer video at lower image and sound quality, promoting convenience over quality. However, evidence suggests that video quality is not as important as convenience as exemplified by the success of Youtube and other user created content platforms.

Another trend for internet access is BD Live which provides additional exclusive content linked to the BD feature that has been purchased.

Summary

The short term trend suggests that DVD will still be dominant in 2012, with projections of media by value to be approximately 60% DVD. However, since blu-ray is backwards compatible, hardware is expected to be a higher proportion

[34] http://www.pocket-lint.com/news/news.phtml/17399/18423/samsung-blu-ray-5-years-left.phtml
[35] http://www.reghardware.co.uk/2009/04/01/screen_digest_3dtv/

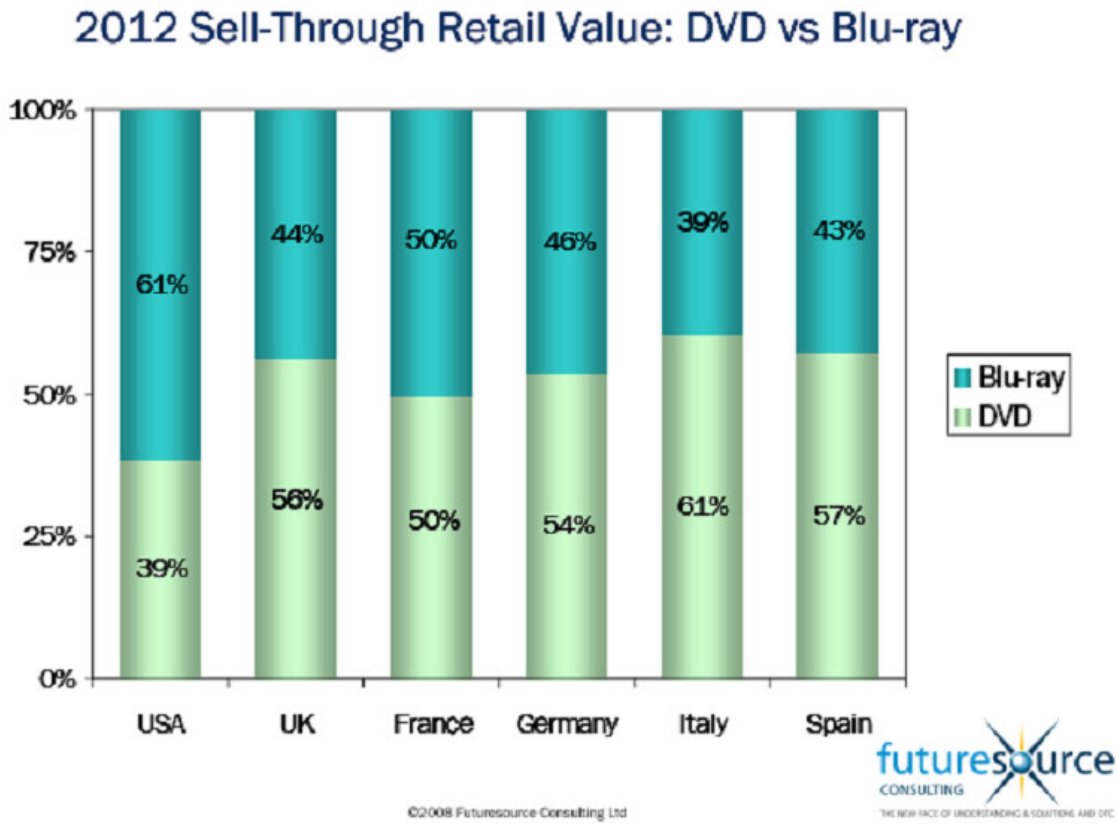


Figure 14: Futuresource 2012 Media sell-through

Projectors

The main competing manufacturers in the EU27 market for projectors tend to cover all product types without "niche" specialisation.

The firm technological trend in all projectors is to a high-resolution product, servicing high definition video projection requirements. Improvements in projected image brightness, colour gamut (colour depth and accuracy) and contrast ratio are marketing imperatives for each new model range. Short throw projectors for schools projection purposes (Interactive Whiteboard/Smartboard). Both of these trends will demand higher efficiency lamps and optics.

The growing personal multimedia product market is dictating other imminent technological trends in projectors. Docking facilities for players and mobile phones capable of streaming video up to high definition standard are already featured on some projectors. Built in DVD/Blu-Ray Disc players are new features that will become a common trend for home cinema and some other projectors and wireless connectivity is common in most manufacturers' product ranges.

Games consoles

The games consoles market is highly competitive with three main manufacturers accounting for the majority of sales. The current games consoles on the market can be sub-divided into high and lower specification devices both with distinct markets.

There is a significant amount of uncertainty surrounding the future of games console sales due to doubt over release dates for new products and whether manufacturers could favour Thin Client gaming options in the future. It is assumed that new generations of games consoles could be launched in 2012 and 2017. Sales of these new games consoles are based on the combined sales of

each current games console on the market from 2007 onwards. Sales of the new games consoles released in 2012 are assumed to reduce at the same rate as sales for current games consoles on the market. In recognition of potential moves to Thin Client games consoles two additional scenarios have been developed. The first additional scenario assumes that by 2014 half of new games consoles could be based on Thin Client architecture. Sales of these Thin Client games consoles are based on 50% of the assumed sales of the new games consoles (from 2014) assumed to arrive on the market in 2012 and 2017. Hence total games consoles numbers remain constant for each year. The second additional scenario assumes that all games console sales from 2014 (based on sales volumes of new generation games consoles) will be Thin Client based.

2.4.2 Structure of the Supply side

Video players/recorders

The casing of HDD based players/recorders including the PCB with the specific electronics are mostly made in Mainland China. The HDDs are made in China or in Thailand. A small amount of HDDs could still be made or assembled in Malaysia. The DVD drive manufacturing is located in China and Korea (Loader manufacturing at DVS Korea Co. Ltd. A spin-off of Hyundai Electronics)

Projectors

The key projector manufacturers for the EU27 market source projection engines and optics from a small number of East Asian specialist manufacturers. The finished projector is assembled in a combination of Brand owner factories (high end products) and OEM factories (low end products) Distribution of the finished projector product to the consumer is commonly through specialist consumer electronic retailers, in their shops or through their internet sites. The projector is not generally retailed through supermarkets since it is a relatively low volume consumer electronic product with a wide retail price range. Direct procurement, in volume, from manufacturers or specialist wholesalers (e.g. office equipment wholesalers) is a common supply chain for the large Schools projector market in EU27 states with centralised education budgets.

Games consoles

The four main games consoles on the market are manufactured in East Asia with Japan and China being the major centres of production. Each of the main games consoles is manufactured through outsourcing agreements with third party manufacturers rather than by the companies who market the games consoles.

2.4.3 Competitive Analysis of the Market

Video players/recorders
There is a competitive market including most major Consumer Electronic Manufacturers, each offering a range of different models covering price points from around 30 Euros to over 1000 Euros. Specialist manufacturers cover a higher cost market segment from around 300-5000 Euros. These offer higher quality image and video quality.

While the DVD market is mature, Blu-ray is still relatively new and prices are now reaching the tipping point for high volume, mass market sales. Other new technologies such as 3D are also being introduced and will continue to disrupt the market. Innovation and reducing costs are the priorities for the key manufacturers.

Projectors
All principal Consumer Electronic manufacturers represented by DIGITALEUROPE produce projectors in a wide range of models. SMEs feature in the small professional projector market not covered by this study. Several specialist Brand names, solely associated with projector products tend to source their main projector components (projection engine and optics) from major manufacturers or OEMs.
The video projector market is now quite mature (over a decade of established core technology) and the basic projection engine types are common to all players in that market. Development of alternative

(efficient) lamp technology is a common priority for all key manufacturers and is unlikely to be the catalyst for new players in the market, given the high R&D or licensing costs potentially involved. Segmentation of the projector market by energy efficiency and other environmental performance parameters is not practicable in a given product market entry point This is because lamp technology is common to most projectors, and the two core projection engines (Digital Mirror Device and LCD) have common optical demands for a given performance level. Higher functionality involving wireless networking, multimedia storage system docking or integration, 3D projection and the continuous drive for higher picture quality may start to segregate manufacturers and their products under an eco-design regime of mandated or voluntary standards.

Games consoles
The games consoles market is very competitive amongst the three main manufacturers. Competition is especially evident amongst the manufacturers of the two higher specification consoles on the market as they compete for the gaming enthusiast market. These gaming enthusiasts demand games consoles which can deliver enhanced graphics and more advanced game playing. The lower specification games consoles on the market are more typically aimed at gamers who perhaps value game play in a social setting above absolute gaming performance.

As previously mentioned not all games support power management functionality. Manufacturers have some control over the way games are developed for their consoles (such as providing guidance documents) but do not have overall control. Manufacturers have expressed a concern that if they are too stringent with software demands then game developers may choose to work with an alternative games console manufacturer.

2.4.4 Average economic Product Life-Cycle

Video recorders

New models are released on a 6-12 month lifecycle. The changes are generally iterative improvements to technology which may provide newer features and also reduce costs of manufacture and retail price. A particular model is generally available for retail sales for between 12-24 months. New features on Blu-ray are introduced in a relatively short timeframe following standardisation. This includes Blu-ray 2.0 which mandated a network connection and Managed Copy is expected to be available in the next 12 months.

Projectors

In the typical manufacturer's range of projectors, high end products tend to have a comparatively long retail shelf life with minor changes to the main specification over periods of up to five years. Optical path design, lamp technology and projection engine technology are well established without the need for significant production changes and new models for the volume mid-range market (500-1200 Euros) with additional user features (personal player docking stations, wireless connectivity, DVD/Blu-Ray Disc integrated player etc.) can be developed and released in a nine to twelve month manufacturing cycle. These additional features usually require little R&D and associated Silicon design and production is usually carried by the projection engine or feature licensees. Pay off and return on investment is readily calculated from the "off the shelf" cost of these building bricks and the market entry point is tailored accordingly. The retail shelf life of a newly introduced model is around 18 months for low to mid market entry point products (350-1200 Euros). The estimated product life is 5.5 to six years for low to mid market entry point products.

Games consoles

The current games consoles on the market are designed and developed over long periods of time. High end gaming consoles are typically launched to market with state of the art components offering high levels of computing power for the day. Overtime, as computing power in general increases, the manufacturers are able to use less expensive components which offer the same level of functionality.

This model allows manufacturers to produce iterations of the same games console which offers the same or similar functionality as the first iteration but at reduced manufacturing costs.

2.5 User Expenditure Base Data

2.5.1 Average Consumer Prices

(incl VAT and in Euro)

Video Recorders/Players

Based on major French, German and UK retailers, the average price for the main products are as follows:

Type	Retail price UK (Euros)[36]	Retail price France (Euros)	Retail price Germany (Euros)
DVD player	40	39	45
DVD recorder	145	170	180
Home cinema system	225	210	225
Blu ray player	190	180	190

Projectors

Based on Internet, shop and manufacturers RRP the spread of prices on the three main genres of projectors supplied to the EU27 market is:

Projector genre	Retail price (Euros)
Home Cinema	350- 2500
Office	250-30,000
Schools	400-2500

Games consoles

The average price of each of the three main games consoles is shown in Table 28. These prices are based on the sales price of a large UK retailer. Prices per console can vary depending on the individual specifications and the number of additional products supplied alongside.

[36] At time of analysis, the exchange rate GBP to EUR was approx 1.25

Table 28: Average Games console consumer prices

Games console	Average Purchase Price (Euros) UK	Average Purchase Price (Euros) Germany
Nintendo Wii	220	179
Microsoft Xbox 360	205	240
Sony Playstation 3	360	(PS3) slim 120GB 279
Sony Playstation 2	145	(PS2) New Edition 99,99

2.5.2 Electricity Rates, Water Rates, Fossil Fuel Rates

Running costs for the products are dictated by the price of the electricity used. To keep the costs for electricity comparable between the different studies we referred to the Eurostat figures published for the second semester of 2007. See Table below.

Table 29: Electricity Prices, Second Semester 2007[37]

Households *(Euro/100KWh)*

	Real Price	Taxes	
	All taxes included	VAT	Other Taxes
EU-27	**16.0**	**2.1**	**2.0**
Belgium	16.8	2.6	1.4
Bulgaria	7.2	1.2	-
Czech Republic	10.6	1.7	-
Denmark	24.0	4.8	8.9
Germany	21.1	3.4	4.9
Estonia	7.9	1.2	0.1
Ireland	19.2	2.3	-
Greece	9.8	0.8	-
Spain	14.0	1.9	0.6
France	12.1	1.7	1.3
Italy	23.8	2.2	4.9
Cyprus	15.7	2.0	0.2
Latvia	7.3	0.4	-
Lithuania	8.7	1.3	-
Luxembourg	15.9	0.9	0.8
Hungary	13.0	2.2	1.2
Malta	9.9	0.5	-
Netherlands	17.2	2.8	1.5
Austria	17.4	2.8	2.1
Poland	13.8	2.5	0.6
Portugal	15.6	0.7	-
Romania	11.4	1.9	-
Slovenia	11.2	1.9	0.7
Slovakia	13.7	2.2	-
Finland	11.5	2.1	0.7
Sweden	16.1	3.2	2.8
United Kingdom	14.8	0.7	-
Norway	15.0	3.0	1.3
Croatia	9.8	1.8	0.1

It can be seen that Denmark has the highest rate with approximately 24 Euro for 100 kWh. In comparison Bulgaria has the lowest electricity rate with 7.2 Euro per 100 kWh. The overall average price rate for EU-27 countries is reported as 16.0 Euro per 100 kWh. Cyprus, Luxemburg, Portugal and Sweden are all close to this figure.

2.5.3 Interest and inflation rates

The following tables show inflation and interest rates for EU-27 countries as published by Eurostat and the ECB. Both data categories only reflect national rates and are not product-specific.

[37] Source: EuroStat.

Table 30: Long term interest rate (10 years' average %)[38]

Country\Year	2006	2007	2008
EU-27	4.08	4.57	4.55
Eurozone (EA11-2000, EA12-2006, EA13-2007, EA15-2008, EA16)	3.84	4.32	4.30
Belgium	3.81	4.33	4.42
Bulgaria	4.18	4.54	5.38
Czech Republic	3.80	4.30	4.63
Denmark	3.81	4.29	4.30
Germany	3.76	4.22	4.00
Estonia	5.01	6.09	8.16
Ireland	3.77	4.31	4.53
Greece	4.07	4.50	4.81
Spain	3.78	4.31	4.37
France	3.80	4.30	4.24
Italy	4.05	4.49	4.69
Cyprus	4.13	4.48	4.60
Latvia	4.13	5.28	6.43
Lithuania	4.08	4.55	5.61
Luxembourg	3.91	4.56	4.61
Hungary	7.12	6.74	8.24
Malta	4.32	4.72	4.81
Netherlands	3.78	4.29	4.23
Austria	3.79	4.29	4.27
Poland	5.23	5.48	6.07
Portugal	3.91	4.43	4.53
Romania	7.23	7.13	7.70
Slovenia	3.85	4.53	4.61
Slovakia	4.41	4.49	4.72
Finland	3.78	4.29	4.30
Sweden	3.70	4.17	3.90
UK	4.38	5.06	4.51

Table 31: HICP - all items - annual average % inflation rate

geo\time	2006	2007	2008
European Union	2.2	2.3	3.7
Euro area	2.2	2.1	3.3
Belgium	2.3	1.8	4.5
Bulgaria	7.4	7.6	12.0
Czech Republic	2.1	3.0	6.3
Denmark	1.9	1.7	3.6
Germany	1.8	2.3	2.8
Estonia	4.4	6.7	10.6
Ireland	2.7	2.9	3.1
Greece	3.3	3.0	4.2
Spain	3.6	2.8	4.1
France	1.9	1.6	3.2
Italy	2.2	2.0	3.5
Cyprus	2.2	2.2	4.4

[38] EuroStat. http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=de&pcode=tec00097. Latest available data : 2008
[39] EuroStat. http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tsieb060. Latest available data 2008

geo\time	2006	2007	2008
Latvia	6.6	10.1	15.3
Lithuania	3.8	5.8	11.1
Luxembourg	3.0	2.7	4.1
Hungary	4.0	7.9	6.0
Malta	2.6	0.7	4.7
Netherlands	1.7	1.6	2.2
Austria	1.7	2.2	3.2
Poland	1.3	2.6	4.2
Portugal	3.0	2.4	2.7
Romania	6.6	4.9	7.9
Slovenia	2.5	3.8	5.5
Slovakia	4.3	1.9	3.9
Finland	1.3	1.6	3.9
Sweden	1.5	1.7	3.3
United Kingdom	2.3	2.3	3.6

2.5.4 Installation Costs

Video players/recorders

Video recorders are generally sold with all the accessories necessary for connection to the TV. This includes the power cable and a basic audio/video cable. Higher quality cables can be purchased for approx 20-30 Euros, however, given this is almost the same cost of a DVD player, are unlikely to be used.

There may also be an additional cost for connecting devices to the network using wired networks. This will depend largely on the length of the Ethernet cable at approx 1euro per metre. Wireless network connections have no additional cost. This assumes the consumer already has an internet connection which is primarily used with computers.

Projectors

Approximately 20% of the projectors deployed in offices and Schools are part of a professional installation providing remote control and remote signal interface to the projector. Such installations, involving extended wiring runs, safe mounting, and often customised interface connection panels can easily double the product cost for typical medium conference room /classroom projectors costing around 2000 Euros. For schools using SMART'/Whiteboard projection, the additional interactive board installation is typically 2500 Euros.

Games consoles

There are no installation costs associated for games consoles which are used as standalone devices. It is increasingly common to connect games consoles to the internet for the purposes of either game playing with others, purchasing games or other software, or for watching television. Most of the current games consoles on the market allow users to connect to the internet to either play games with other gamers or to purchase games. Some games consoles include integrated Wi-FI components allowing users to wirelessly connect to the internet (with the addition of a wireless router and internet connection). For other games consoles Wi-Fi components need to be purchased separately but internet access is still achievable through wired Ethernet connections.

2.5.5 Consumer Prices of Other Consumables

Video recorders

Optical discs are not considered consumables for the purpose of this study because the disc lifetime is similar to the hardware. Instead, it is considered to be infrastructure in the same way as the broadcast and transmission equipment for TVs and the data centres and internet for downloadable content.

Projectors

Although projectors are now sold with long lamp life guarantees (e.g. 4000 hours) non-installed projectors are prone to lamp damage when a projector is moved before the lamp cooling cycle is complete or disconnected from the mains supply when in operation or during the cooling cycle. Lamp replacement is usually a straightforward operation for the average user but the lamp cost is high (90-500 Euros depending on the projector brightness. In a six-year working life, a movable projector could require up to four lamp replacements. For a consumer with a very low cost projector of low picture specification, lamp failure can be a catalyst for purchasing a replacement projector.

Games consoles:

Video games are available in various formats for the four main types of games consoles on the market. Video game prices vary considerably amongst the different games consoles and even for the same games console. Prices in general range from under €10 to a little over €60.

2.5.6 Repair and Maintenance Costs

The replacement cost of many consumer electronic products is currently significantly less than, or equal to, the basic inspection charge levied by electronic product repair workshops. Diagnosing faults other than those associated with the power supply can be time consuming and repairs at chip level very complex. For these reasons, it is unlikely that an electronic device costing up to 150 Euros will be repaired in its lifetime. Instead of a repair, a replacement of failed devices is the common practice with importers of such items. Costs for storage of spare parts needed for repair is far beyond the budget of importers. For guarantee purposes an oversupply of devices at no cost is common.

Video recorders/players

Video recorders in general have a standard 1 year warranty. The very low cost of DVD players means that the repair cost is greater than replacement. There are generally no maintenance costs associated with video recorders. All the parts of VR are well established components with high reliability.

Projectors

The principle maintenance cost for most projectors is in lamp replacement. Mechanical components in the projector such as fans, lens servo motors and colour wheel motors are very reliable and rarely require servicing in the typical average life of a projector (6 years) As discussed above servicing of projector electronics and mechanics is unlikely to be cost effective in low entry point products (<400 Euro) and a replacement product is likely to be provided within the warrantee periods (normally a minimum of two years) For mid to high market entry point projectors, servicing outside the warrantee period is available through specialist suppliers, but in most cases such projectors now have very long warrantees (3-4 years) 100-150 Euros would be the typical inspection cost of a projector prior to repair time and component replacement costs. The latter can be very high if mechanical failure occurs in an optical system since the whole system is normally replaced.

Games consoles

Repair, maintenance and disposal cost issues for games consoles are similar as those for DPFs. There are limited repair solutions for games consoles outside the warranty period since by then the resale value of the games console is quite low compared with potential repair and handling costs. Games consoles in general have a 1 year warranty as standard (2 years in some regions) but manufacturer warranties can be as high as 3 years for known issues. Around 50% of the repair services offered today are subject to a charge. This is considered best practice in the electronics industry and has been highlighted in UK government case studies. A product recycling scheme specifically for games consoles is not known. End-of-life (EOL) games consoles are most likely to report to the 'mixed small WEEE' container if taken to the separate WEEE collection facilities provided. Currently, there are no reliable data detailing the amounts of EOL games consoles separately collected. EOL disposal costs will depend on the recycling arrangements implemented in each Member State.

2.5.7 Disposal Tariffs/Taxes

End of life disposal costs for electronic devices will depend on the recycling procedure to be implemented in each country. When the implementation is fully established in all EU countries and the structures of these recycling procedures are known at Consumer level it will be possible to generate reliable data on this topic in the case of the devices mentioned in the study.

2.6 Conclusions

Video recorders/players

The video recorder market has peaked at approximately 40m devices sold a year. It is expected to decline at approx 1% a year. Substitution of DVD with Blu-ray is also expected and DVD will be obsolete between 2015-2020. In addition new, technologies will enter the market and its environmental impact is not clear. The uncertainty means that improvements in environmental performance is unlikely without flexible eco-design measures.

Projectors

The European market for projectors will quickly plateau at 1.7M to 2.0 M products per annum. Alternative large area emissive display technologies are unlikely to compete with projectors in the next decade on a cost/unit area basis. Core functional blocks in current projectors are based on firmly established technology shared by most manufacturers. Radical segregation of these manufacturers on product, environmental and energy efficiency performance is unlikely to be practicable without mandatory or voluntary eco-design measures.

Games consoles:

The games console market is dominated by three main manufacturers all of whom are competing for share of a growing games market. The stock of the current games consoles on the market is expected to continue to grow in the near future. It is further envisaged that a new generation of games consoles will be placed on the market in the next few years to replace the current generation.

3 Task 3: User Behaviour

3.1 Introduction

Video Recorders/Players are primarily consumer entertainment devices. As their name suggests they have two main functions: playback of pre-recorded media, generally at higher quality and with greater choice than broadcast TV; and recording and subsequent playback of broadcast TV. Greater competition and convergence of devices is expected to increase innovation to create a differentiated market in this sector.

Projectors have two distinct usage roles in clearly segmented market applications. In the EU27 market 10% of the projectors sold are for home entertainment use. Such projectors supplement the audio/visual entertainment of the television receiver by providing a large screen video presentation in a designated viewing and listening area of the home, i.e. “the home cinema” The projector rarely replaces the principle or secondary televisions in a home.

In the other segments of the market, comprised of 50% schools projectors and 40% office projectors, the projector is principally a visual communication support tool where the requirement is the shared presentation of information to a group of observers. The large EU27 school projector market clearly underlines the rate at which the projector has replaced the “blackboard” in the context of classroom teaching and lecturing.

Games consoles are entertainment devices offering a range of functionalities to the user from the primary game playing function to video and music playback and even Internet surfing. Games console usage is expected to increase as game play and other functionalities increase in sophistication.

3.2 User Information

3.2.1 Video Recorders/Players

Purchasing decision for video recorder products is based on a number of factors including cost, features and appearance. Energy consumption is not a consideration and currently would be very difficult to do since, as presented in Task 1, there are very few endorsement labels to inform consumers and power information is not generally displayed.

Since power consumption is generally low, around 10-40W in on-mode it is unlikely that even with information provision, it will be an important determining factor for consumers.

With the rapid pace of innovation expected a standard ecological profile may hinder environmental improvements. It might also act as a lowest common denominator, acting as an implicit approval of lower environmental standards.

3.2.2 Projectors/Beamers

The product specifications that principally influence the purchase of a projector are dictated by the usage roles discussed, entertainment or group communication. For the entertainment, projector picture quality and the audiovisual signal/user-control interface are the dominant influencing specifications. In the communication projector, picture brightness and projection throw dominate the specifications. In both projector types there is little difference in the impact of eco-design characteristics on user choice. This is because projector lamp power and lamp life dominates the operating characteristics of the projector. With the main lamp technology in use today, automatic lamp standby in the absence of display data and automatic cooling cycles apply to the majority of projectors. The sustainable use of the product is generally outside of user control. In the new low brightness projector, principally for small home cinema and small office applications, the advantages of efficient new lamp technology based on LEDs are communicated to the user as eco-design advantages. Lower energy in use and cooler quieter running are the principle user information parameters here.

3.2.3 Games consoles

Games consoles are purchased by a diverse number of people. Consumers currently have a choice between the four main games consoles on the market. Two of the games consoles are aimed at gamers who demand better graphics and more advanced game play whilst the third has traditionally been aimed at a gaming audience demanding standard game play. The remaining major games console was a high specification gaming console when first introduced but due to the length of time it has been on the market it is now considered a standard gaming console. Games consoles are becoming increasing common in homes throughout the EU27 as witnessed by the large stock figures illustrated in task 2.

3.3 User Behaviour in the Use Phase

3.3.1 Video Recorders/Players

The use pattern of video recorders is assumed to depend on its features. From the range of average daily use figures based on questionnaire responses and personal communications. It is clear that a wide range of values are used for the same function, e.g. video playback from an optical drive varies from 0.5 to 4 hours.

The video recorders/players with the lowest use are expected to only provide playback. Recorders have longer use periods, and if the device is used in the same way as a set-top box (STB), i.e. for pausing live TV, use is at least as long as the TV on-time.

Other factors which could strongly influence power consumption are auto power down and standby modes. For video players, auto power down is a common feature and can switch to standby after very short periods on-idle since it provides no other function and start-up is generally fast. Recorders are less likely to offer this feature and therefore on-time can be significantly longer than intended use as consumers forget to power down the device.

Another, newer trend is “fast-start” standby modes. These are a higher power standby mode which offers faster response time from activation to disc playback compared with passive standby. The most common implementation of this is through HDMI-CEC which places the video recorder/player into fast start when the TV is switched on.

While some consumers will unplug the device, it is generally assumed that any remaining time is spent in standby or off-mode.

Table 32: TIAX (2007) estimates for video recorder use based on CEA data (Hours/day)

	Active	Idle	Off/standby
Stand alone	0.74	2.47	20.8
Stand alone with record	0.74	2.47	20.8
DVD/VCR	1.15	2.47	20.4

Table 33: METI assumptions for use (Hours/day)

	Standby	HDD record	HDD play	DVD operating	VCR	EPG
DVD recorder no digital tuner	20.5	2.0	1.0	0.5		
VCR	21			2	1	variable
DVD recorder with digital tuner	20.5	2	1	.5		variable

The METI and TIAX profiles only cover a limited range of products. In addition, newer features such as fast start are not addressed.

Table 34: MTP assumptions for use (Hours/day)

	On	On-idle	standby
VCR	0.92	9.16	8.75
DVD player	1.04	4.31	17.45
DVD recorder	1.3	12.9	8.6
DVD recorder with HDD	4.8	10.8	7.2
Blu ray player	1.04	0.5	21.26
Blu ray recorder	1.3	12.9	8.6
Blu ray recorder with HDD	4.8	10.8	7.2
Other 'new' technology	4.8	11.52	7.68

However, MTP use profiles must take into account old and new stock. This means that relatively new features such as auto-power down are underestimated since not all products will have this feature in any given year.

The evidence upon which the use profiles are based is limited. However, there is a general trend for DVD and blu-ray players to be used for a very limited time a day and the majority of the time is spent in standby. Devices with HDDs spend considerably longer.

Compiling the available data from above and including future fast start use suggests a simplified general use profile is:

Table 35: General Use Profile (Hours/day)

	DVD/Blu ray		On-idle	EPG/network download	Fast start	Standby
	Play	Record				
VR with HDD and tuner	0.75	0.25	4	Variable	0.5	18
VR with HDD no tuner	0.75	0.25	0.5	Variable	4	18
VR no HDD with tuner	0.75	0.25	2.25	Variable	2.25	18
VR (player only)	0.75	0.25	0.5	variable	4	18

3.3.2 Projectors/Beamers

The market segmentation of projectors, i.e. home cinema, office and schools, generates very different usage patterns. For EU27 projector applications, the following usage patterns are generally endorsed by manufacturers and stakeholders.

Projector Application	Average Usage (hours/day)		Annual Usage (days)
	On	Standby	
Home Cinema	0.5	23.5	365
Office (portable)	2.0	0.5	250
Office (permanent installation)	2.0	22.0	250 (on) 360 (standby)
School	6.0	4.0	200

Apparent good practice in usage patterns in schools shown in this summary is by default since strict fire regulations in schools generally dictate that most non-HVAC electrical appliances are switched off outside the average school premises occupation period of 10 hours per day.

Where ICT managers adopt best practice in the office environment, the standby hours for installed projectors may be significantly less than stated but there is little verifiable related data to qualify this estimate.

The average economic product life of a projector is six years but the projector is likely to require an average of 3 current technology lamps in that period. It is generally possible for the user to readily source and replace these lamps. The electronic and electro-mechanical components of the projector are very reliable but where they do fail, particularly in the context of the optical path electro-mechanics, repair outside the guarantee period is unlikely to be economical. The main drivers for projector replacement are, enhanced user / signal interface functions, image quality and image brightness. In schools the increasing use of the projector integrated into an interactive whiteboard system has driven the early replacement of standard projectors with projectors having specialist short-throw optics.

3.3.3 Games consoles

Games consoles use times have increased with the launch of the seventh generation products on the current market. Some of this increase in usage is due to the fact that some of the most popular games consoles on the market offer other functionalities such as DVD play back in addition to gaming. In addition, the current generation of games consoles are significantly more advanced than previous generations which have spawned substantial improvements in the sophistication of games. In addition, the ability to play games over the Internet has led to increased interactivity with fellow gamers.

Current estimates suggest that the most prolific gamers (accounting for 75% of all gaming time) use their games consoles for over 5 hours each day they play. Average use hours across each product in stock are expected to be significantly lower than this. Actual active mode use hours are based on a findings published in 2009 (The Neilsen Company 2009). Use is predicted to increase further as more games become available for download. This could encourage owners to leave games consoles on for longer periods of time as they download purchased games. Further increases in active mode time are assumed to stem from increased internet connectivity. Active mode use hours for assumed new games consoles launched on the market in 2012 and 2017 are assumed to be 2 hours per day. Active mode use for theorised future Thin Client based games consoles is also assumed to be 2 hours per day. Active mode use hours of servers in data centres, used to support Thin Client gaming, is expected to be 24 hours a day as gamers are continually serviced.

Some of the games consoles on the market offer basic power management functionality which can help to reduce overall energy consumption as consoles switch to lower power modes after a period of no use. Improvements to the power management functionality of games consoles could result in significant energy savings across the stock of products.

Product	Average use pattern - on active [hours/day]	Average use pattern - on idle [hours/day]	Average use pattern - standby [hours/day]
Microsoft Xbox 360	0.6	1.4	10.0
Sony Playstation 3	0.6	1.4	10.0
Sony Playstation 2	0.4	1.4	10.0
Nintendo Wii	0.3	1.4	10.0
Future Games consoles 2012 and 2017 Launch	2.0	1.4	10.0
Thin Client Games consoles	2.0	1.4	10.0
Thin Client Gaming (Data Centres)[40]	24.0	-	-

[40] See Task 7 for revised estimates for these usage hours.

3.4 End-of-Life Behaviour

These sound and imaging products can be described as small WEEE at end-of-life. The EC WEEE Directive sets an overall collection target for all WEEE and also sets specific targets[41] for the recovery and the reuse and recycling of consumer equipment (Category 4 appliances). Further to this, following a 2008 review of the WEEE Directive, in December 2008, the European Commission issued proposals[42] to increase targets including setting a collection target founded on a different basis (proportion of what is placed on the market). The WEEE Directive also sets requirements for the marking of equipment to inform the consumer that these appliances should not be disposed via the ordinary household waste. Member States are required to ensure that an adequate network for the collection of WEEE is provided.

3.4.1 Video Recorders/Players

Video recorders are estimated to have a lifespan of 6 years, in line with other smaller consumer electronic products. While the technical lifespan may be longer, at 7 or more years, replacement is also driven by fashion and new technology trends. In addition, the very low cost products may be designed for shorter lifespans and faster replacement cycles.

3.4.2 Projectors/Beamers

Approximately 20% of Schools and office projectors reaching the end -of - life phase are re-furbished. This is because replacement is often done under a central contract to a specialist supplier and bulk warehousing and selective refurbishment of used products becomes viable. Redistribution tends to be to markets outside the EU and to some second –hand office ICT specialist retailers within the EU (about 5% of the refurbished total). The additional life expectancy of these projectors is then invariably dictated by lamp life since the replacement lamp is likely to cost more than the refurbished projector. A two-year life following refurbishment would be typical.

Although manufacturers could do far more to standardise mechanical interfaces to enable the re-use of the lens assembly of projectors, this is rarely implemented in volume market projectors. Some high-end projectors can accept interchangeable lens assemblies (e.g. long- throw and short- throw) and these lenses have a useful recycled life.

In practice, the component parts of a projector are unlikely to be recycled as working entities and they will be scrapped in bulk from schools/ offices and through domestic waste disposal routes for home cinema products. The former bulk disposal route has a higher guarantee of the useful recycling of the component materials of the projector.

3.4.3 Games consoles

The current games consoles on the market are expected to have a lifetime of approximately 5.5 years. Given that the main devices on the market were launched less than five years ago, end-of-life behaviour for these products is not well understood. Games consoles replaced by newer models may be stored for a period of time before being consigned to the waste stream. Thus, sales of consoles in any year are not a true indicator of the numbers of consoles disposed of. However, given the large number of products in stock (approximately 87 million units – equivalent to around 400,000 tonnes of equipment), end-of-life behaviour is likely to be an important consideration for the future.

Waste Amounts form Hand-held Games consoles

In order to make an approximate estimate of the amounts of waste arising annually from discarded hand-held games consoles, we have considered the annual sales of three main types (Nintendo Game Boy, Nintendo DS, and Playstation PSP). For these types, we have estimated their annual waste arisings in the table below.

[41] For Category 4, the rate of recovery shall be increased to a minimum of 75% by an average weight per appliance, and component, material and substance reuse and recycling shall be increased to a minimum of 65% by an average weight per appliance. Note: these targets would be increased by five percentage points (i.e. 80% and 70% respectively if the EC's proposals are adopted.
[42] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0810:FIN:EN:PDF

Table 36: Waste Estimates - Hand-Held Consoles

Year	Estimated Waste Units	Estimated Mass of Waste (tonnes)
2002	26,180	6
2003	130,177	31
2004	454,357	109
2005	1,114,625	267
2006	2,104,259	505
2007	3,278,386	786
2008	4,637,010	1,112
2009	6,360,535	1,526

Although the above table shows a growth pattern of quantities of waste for the hand-helds considered, the annual waste figure for all hand-held consoles could be static due to the discarding of very early hand-helds (e.g. Tamagochis, Space Invaders and other dedicated hand held games devices) which reach the waste stream in the earlier years - 'tailing off' as newer devices replace them. Therefore, we conjecture that our 2009 estimate could be a reasonable steady-state estimate of hand-held console waste arisings. Thus, we infer that it is reasonable to suggest that the 2009 estimate could be applied across each year.

Note: an annual hand-held console waste arising of 1,500 tonnes represents about 0.2% of the total EU-27 estimated annual WEEE arisings[43].

3.5 Conclusions

The use patterns of video recorders are generally uncertain and vary widely between different data sources. Active use of the video players is generally low but a significant amount of time is spent in idle, or performing secondary functions. This could include newer features such as fast start.

The on-mode usage patterns of projectors in the market segments discussed above are well supported by the manufacturing industry and other stakeholders. Standby mode patterns are not as clear but are of far less significance in the context of the impact of the standby Regulation1275/2008[44]. The principle eco-design improvement to all categories of projectors will be in lamp efficiency and lamp life. More could be done to enable the direct re-use of a key long life component in the projector - the final lens assembly.

Games consoles are increasing in popularity as the level of game play and additional features provided by the devices increases. The amount of time games consoles are used remains relatively low but this is expected to change as the functionality of the products improves and internet connectivity becomes more widely utilised.

[43] European Commission, "2008: Review of the WEEE Directive" United Nations University, August 2007.
[44] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32008R1275:EN:NOT

4. Task 4: Assessment of Base Case

4.1 Introduction

This assessment contains all the technical inputs for the MEEUP model for the base cases of each of the product types in this study. This comprises the production phase (materials), distribution, in use phase (energy and maintenance costs) and end of life phase.

The base cases have been chosen to be sufficiently broad to cover environmental impacts across the range of each product type. Through close collaboration with industry, we have considered a wide range of actual product cases, which has lead to aggregation of product cases into a base case each for 1) Video players, 2) Video recorders, 3) Projectors, and 4) Games consoles.

This section will describe the modelling of base case models that will provide the reference for the environmental and technical/economical improvements to be established further on in the study.

4.2 Product-specific inputs

The MEEuP EcoReport assumes 1% of the total weight as spare parts. This is considered to be reasonable by the study team.

With regard to primary scrap production during sheet metal manufacturing, the EcoReport default value of 25% has been used.

The production, distribution and use phases of video players/recorders, Projectors and games consoles are considered below in sections 4.2.1, 4.2.2 and 4.2.3 respectively. The end-of-life phase considerations are presented in section 4.2.1 (video players/recorders), and essentially apply for all the base cases analysed.

4.2.1 Video Players/Recorders

The functional components that make up a video player/recorder typically include:

- Casing and chassis materials
- Disc drive
- Wiring (mains lead etc.)
- Electronics (e.g. Printed circuit board/integrated circuit)
- Ports/slots
- Packaging materials
- Instruction Manual

Production phase

The differences between disk drives and hard drives are marginal. The BOM presented below is not only representative for DVD players but also for DVD recorders, DVD recorder with hard disk drives, Blu-ray player, Blu-ray recorders and Blu ray recorders with hard disk drives on the 2008 EU market. Thus, only the use phase differentiates these items.

The material composition of video players/recorders is presented in the following Bills of Materials (BoMs) provided either by manufacturers or by disassembly of certain products. Anonymous and averaged BoM data is presented in order to protect the confidentiality of those manufacturers who provided data.

The data will be used in the definition of the Base Case models and the evaluation of best available technologies (BAT) in Task 5.

The detailed Bill of Material (BOM) data lists all materials, by weight according to the EcoReport materials list, for the base case video player/recorder. The base case is seen as being representative

of current "best sellers". The method of derivation is generally based on an average of real models, with some parameters adjusted to be more widely representative of all models.

Table 37: BOM Video player/recorder base-case

Material type	Total (g)
5-PS	60
8-PVC	200
9-SAN	20
10-ABS	150
21-St sheet galv.	500
24-Ferrite	50
25-Stainless 18/8 coil	20
29-Cu wire	50
44-big caps & coils	30
45-slots / ext. ports	45
48-SMD/ LED's avg.	35
49-PWB 1/2 lay 3.75kg/m2	100
52-Solder SnAg4Cu0.5	5
56-Cardboard	500
57-Office paper	150
Grand Total	**1915**

Table 38: Averaged Material Content of Video player / recorder by Eco Report Group

Materials	Quantity (g)	%
Bulk Plastics	430	22.5%
Ferro	570	29.8%
Non-ferro	50	2.6%
Electronics	215	11.2%
Misc.	650	33.9%
Total weight	**1915**	**100.0%**

Distribution phase

The average volumes of the packaged products for this base case have been assumed as follows:

Table 39 - Average Volume of Packaged Product

Base Case	Average volume (m^3)	Assumed dimensions of packaged product
Video players/recorders	0.02025	0.45m x 0.3m x 0.15m

Use phase

The use phase of a typical video player differs from that of a typical video recorder by virtue of the different levels of power typically consumed in each of the modes of operations. Note, from Task 3 (User Behaviour – Video player recorder general use profile), the typical time in use (about 1 hour/day) is the same for both players and recorders, and also the typical combined time in idle-mode and fast-start mode is the same for both players and recorders.

The inputs for the use phase are:

Table 40: Use Phase Inputs (Video players/recorders)

Description	Video player	Video recorder
Lifetime (years)	6	6
In use electricity consumption per year (kWh)	3.04	7.59
No. of hours per year in use	379.6	379.6
Standby electricity consumption per year (kWh)	5.10	15.92
No. of hours per year at standby	6369.25	6369.25
Idle-mode/fast-start mode electricity consumption per year (KWh)	9.44	18.88
No. of hours per year at idle-mode/fast-start mode	1573.15	1573.15

Note: idle mode/fast-start mode refers to the lowest end of the active state. Generally, after completing a current process in operating mode there is a transition to a mode, thereby standing ready to respond to the next process command while maintaining the specified normal rotation speed. When the duration of this mode exceeds a specified time without receiving any input, the device automatically moves to a standby mode.

End-of-life phase

The Waste Electrical and Electronic Equipment (WEEE) Directive applies to the end-of-life (EOL) disposal of multimedia products. These items fall under Category 4 (Consumer Equipment) in Annexes IA and IB of the Directive.

Separately collected Category 4 WEEE must have a rate of recovery of at least 75% by an average weight per appliance, and component, material and substance reuse and recycling must achieve at least a 65% rate by an average weight per appliance.

At the end of its life, the consumer should discard their EOL appliance to the separate WEEE collection system established for the proper recovery, reuse and recycling of these products. However, given the relatively small size of these multimedia items, it is quite possible that unaware consumers would dispose of their EOL multimedia items to the general household waste. Thus, not all EOL multimedia items would be presented for proper treatment. A review study[45] carried out for the European Commission estimated that overall WEEE collection percentages were observed to be about 25% for medium-sized appliance, 40% for larger appliances, and that returns of appliances lighter than one kilogramme were close to zero. For the purposes, of this preparatory study, we have assumed that, in 2008, 25% of EOL multimedia items are consigned to the proper WEEE collection system.

A very small percentage of EOL multimedia items are likely to be reused (for example, through refurbishment by organisations such as community and charity groups).

In 2008, typical separate collection facilities for WEEE are based on the consumer taking their EOL appliance to a WEEE collection point (typically at a household waste recycling centre provided by the local authority). A 'five container' system is a common approach, with containers for:

1. Large Household appliances (such as washing machines and cookers)
2. Fridges & Freezers (containing ozone depleting substances)
3. Televisions and monitors (cathode ray tubes)
4. Small mixed WEEE, and
5. Fluorescent lamps (containing mercury)

[45] "Review of the WEEE Directive: 2008", United Nations University for the European Commission, 2007

Multimedia items will most likely be consigned to the small mixed WEEE (SMW) container. A detailed UK study[46] on the composition of SMW collections has shown that Category 4 items made up about 22% of the total SMW collected. The main items found in Category 4 were video & DVD recorders, audio players/recorders, loudspeakers, and radio sets. The same study also found that the average materials composition of collected SMW was:

- 47.1% Metals
- 30.8% Plastics
- 2.1% Printed Circuit Board
- 6.1% Other materials, and
- 14% non-WEEE and unallocated

Typical current technology for treating SMW involves the use of shredding processes followed by separation of metallic and non-metallic materials. Thus, it is theoretically possible to recycle or recover energy from at least 75% of SMW (e.g. metals and plastics account for approximately 78% of SMW). Therefore compliance with the WEEE Directive targets is achievable theoretically.

In terms of typical materials and component composition, EOL multimedia products contain significant proportions of plastics. Metal casings and parts have tended to give way to the use of plastics, largely because of cost and flexibility in design.

Our assumptions for EOL phase for multimedia products are as follows:

- 25% EOL multimedia products are separately collected in accordance with the findings of the 2007 study (see footnote 43) reviewing the WEEE Directive.
- 75% of separately collected EOL multimedia products are recovered, complying with the WEEE Directive.
- 65% of separately collected EOL multimedia products undergo reuse and recycling, also complying with the WEEE Directive.
- Metals – 95% recycling is assumed (fixed in Eco-Report)
- Plastics – 1% reuse, closed loop recycling assumed. The percentage of material recycling is calculated so that an overall 65% reuse and recycling rate for multimedia products is achieved. The percentage of thermal recycling is such as to achieve an overall recovery rate for multimedia products of 75%.
- Landfill – 25% of separately collected multimedia products are not recovered.

These assumptions represent the minimum level for compliance with the WEEE Directive currently in force.

4.2.2 Projectors

The functional components that make up a projector typically include:

- Casing and chassis materials
- Cooling fan
- Lens assembly and bulb
- Wiring (mains lead etc.)
- Printed circuit board/integrated circuit
- Packaging materials
- Instruction manual

[46] CIWM/DEFRA, "Trial to establish WEEE Protocols", Mayer Environmental Ltd., January 2007.

Production phase

The material composition of projectors is presented in the following Bills of Materials (BoMs) provided either by manufacturers or by disassembly of certain products. Anonymous and averaged BoM data is presented in order to protect the confidentiality of those manufacturers who provided data.

The data will be used in the definition of the Base Case models and the evaluation of best available technologies (BAT) in Task 5.

The detailed Bill of Material (BOM) data lists all materials, by weight according to the EcoReport materials list, for the base case projector. The base case is seen as being representative of current "best sellers". The method of derivation is generally based on an average of real models, with some parameters adjusted to be more widely representative of all models.

Table 41: BOM - Projector Base-Case

Material Type	Weight (g)
1-LDPE	17.3
2-HDPE	10.6
4-PP	146
5-PS	197
8-PVC	193
10-ABS	193
12-PC	542
14-Epoxy	17
16-Flex PUR	103
18-E-glass fibre	219
21-St sheet galv.	206
22-St tube/profile	5
23-Cast iron	3
24-Ferrite	40
25-Stainless 18/8 coil	5
26-Al sheet/extrusion	130
27-Al diecast	29
29-Cu wire	142
30-Cu tube/sheet	112
31-CuZn38 cast	44
39-powder coating	2
44-big caps & coils	46
49-PWB 1/2 lay 3.75kg/m2	550
54-Glass for lamps	980
56-Cardboard	927
Grand Total	**5066**

Table 42: Averaged Material Content of Projectors by Eco Report Group

Materials	Quantity (g)	%
Bulk Plastics	756.9	14.9%
TecPlastics	881	17.4%
Ferro	259	5.1%
Non-ferro	457	9.0%
Coating	2	0.0%
Electronics	596	11.8%
Misc.	2114	41.7%
Total weight	**5065.9**	**100.0%**

Distribution phase

The average volumes of the packaged products for this base case have been assumed as follows:

Table 43 - Average Volume of Packaged Product

Base Case	Average volume (m^3)	Assumed dimensions of packaged product
Projectors	0.0405	0.3m x 0.3m x 0.45m

Stakeholders are invited to comment on whether these assumptions are reasonable.

Use phase

The inputs for the use phase are:

Table 44: Use Phase Inputs (Projectors)

Description	Input value
Lifetime (years)	6
In use electricity consumption per year (kWh)	125.0
No. of hours per year in use	500
Standby electricity consumption per year (kWh)	0.63
No. of hours per year at standby	125

Note that idle mode is not relevant for projectors (in contrast with video players/recorders and game machines which both introduce idle mode in the use phase assumption). This is because, once a projector loses signal, it goes through a short cooling down period and then enters stand-by mode.

End-of-life phase

See Section 4.2.1(End-of-life phase) above.

4.2.3 Games consoles

The functional components that make up a games console typically include:

- Casing and chassis materials
- Disk drive
- Wiring (mains lead etc.)
- Printed circuit board/integrated circuit
- Slots/ports
- Controllers
- Packaging materials
- Instruction manual

Production phase

The material composition of games consoles is presented in the following Bills of Materials (BoMs) provided either by manufacturers or by disassembly of certain products. Whilst we have tried to

consider a range of typical products, we were only able to consider one product which has been taken to represent a typical product on the market. Anonymous BoM data is presented in order to protect the confidentiality of the data provider.

The data will be used in the definition of the Base Case models and the evaluation of best available technologies (BAT) in Task 5.

The detailed Bill of Material (BOM) data lists all materials, by weight according to the EcoReport materials list, for the base case game console. The base case is seen as being representative of current "best sellers". The method of derivation is generally based on an average of real models, with some parameters adjusted to be more widely representative of all models.

Table 45: BOM Games console base case

Materials	Weight (g)
1-LDPE	11.6
8-PVC	102.9
10-ABS	1279.05
11-PA 6	13.3
21-St sheet galv.	386
23-Cast iron	0.3
25-Stainless 18/8 coil	56
26-Al sheet/extrusion	143
29-Cu wire	239.4
44-big caps & coils	501
45-slots / ext. ports	133
46-IC's avg., 5% Si, Au	47
47-IC's avg., 1% Si	31
48-SMD/ LED's avg.	50
49-PWB 1/2 lay 3.75kg/m2	5
50-PWB 6 lay 4.5 kg/m2	77
52-Solder SnAg4Cu0.5	7
56-Cardboard	1687.8
57-Office paper	242.9
Grand Total	**5013.25**

Table 46: Averaged Material Content of Games console by Eco Report Group

Materials	Quantity (g)	%
Bulk Plastics	1393.55	27.8%
TecPlastics	13.3	0.3%
Ferro	442.3	8.8%
Non-ferro	382.4	7.6%
Electronics	851	17.0%
Misc.	1930.7	38.5%
Total weight	**5013.25**	**100.0%**

Distribution phase

The typical volumes of the packaged products for this base case have been assumed as follows:

Table 47 - Average Volume of Packaged Product

Base Case	Average volume (m^3)	Assumed dimensions of packaged product
Games consoles	0.027	0.5m x 0.3m x 0.15m

Use phase

The inputs for the use phase are:

Table 48: Use Phase Inputs (Games consoles)

Description	Input value
Lifetime (years)	5.5
In use electricity consumption per year (kWh)	10.71
No. of hours per year in use	208.05
Standby electricity consumption per year (kWh)	4.02
No. of hours per year at standby	3650
Idle-mode electricity consumption per year (kWh)	26.50
No. of hours per year at idle-mode	514.65

End-of-life phase

See Section 4.2.1 above.

4.3 Definition of Base-Case

Task 4 involves the development of descriptions of average EU products that can be assumed as "base cases". The life-cycle characteristics of these base cases are built from the results of Tasks 1 to 3. These base cases will act as the foundation for Task 5 (technical analysis of BAT), Task 6 (improvement potential) and Task 7 (policy and impact analysis).

The base cases have been chosen to be sufficiently broad to cover environmental impacts across the range of multimedia products considered. Whilst we have tried to consider a range of typical products, in one category (games consoles), we were only able to consider one product which has been taken to represent a typical product on the market. In other categories, we have used averaging and aggregation of product examples to establish representative base cases. The three base cases agreed are described further below.

4.3.1 Video Players/Recorders

Two base cases have been assessed: one for a typical video player currently on the market suitable for home use, and the other for a typical video recorder. These are used typically about 1.04 hours/day and spend typically about 4.3 hours/day in idle mode and typically about 17.45 hours/day in standby mode. The remaining time these items are switched off.

4.3.2 Projectors

The projectors base-case has been established on a typical LCD projector suitable for office or school use. These are used typically for 2 hours/day and are kept in standby for about 0.5 hours/day. The remaining time these items are switched off.

4.3.3 Games consoles

The games console base case has been taken to represent a typical games console currently marketed. These are actively used typically for just over 30 minutes per day, but trends indicate that this is increasing. In addition to this, typically about 1.4 hours/day is spent in idle mode and is kept in standby for about 10 hours/day). The remaining time these items are switched off.

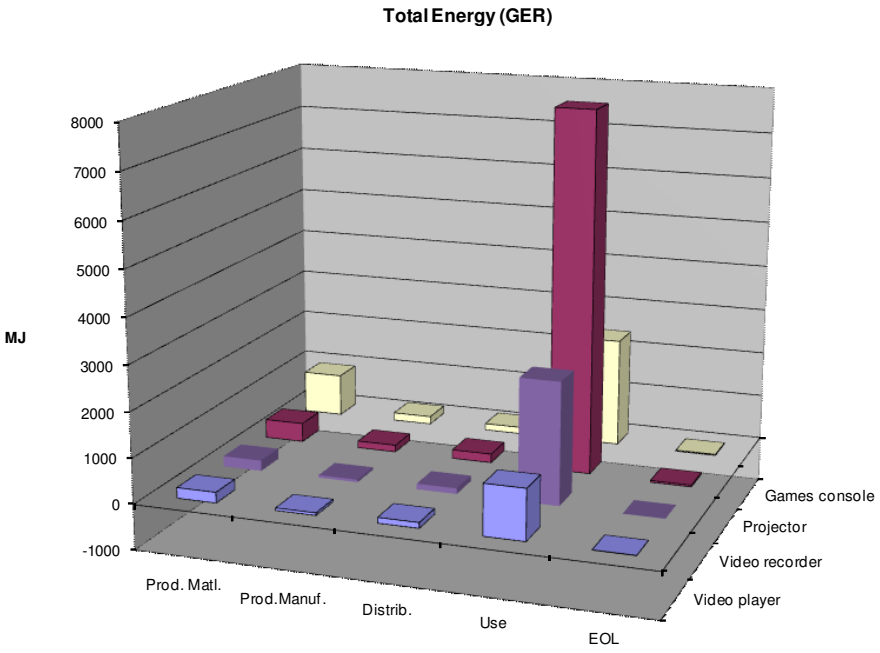
4.4 Base-Case Environmental Impact Assessment

The detailed tables showing the environmental impacts per product for each of the Base Case models developed from use of the MEEuP Methodology are presented in Appendix 2.

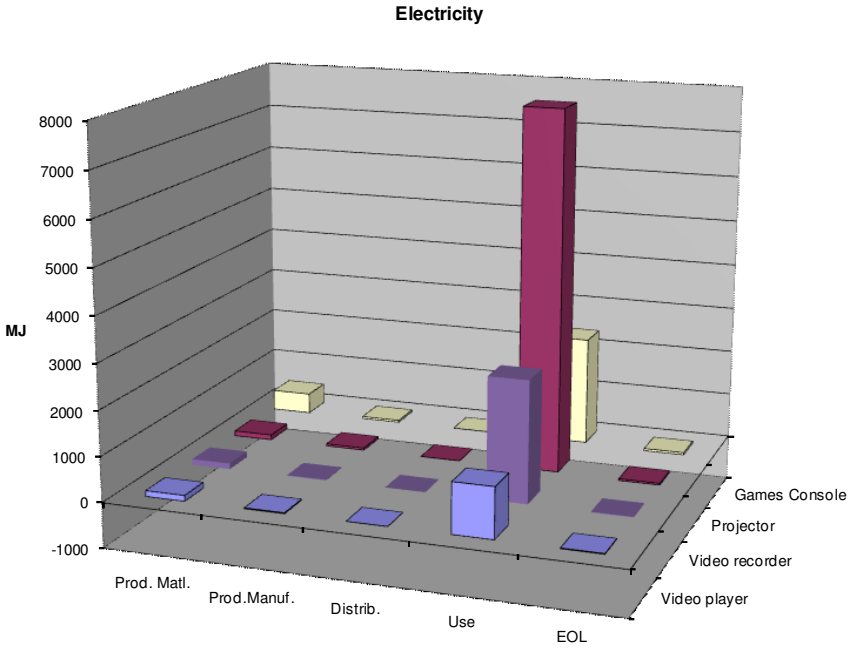
The EcoReport outputs for the environmental impact per product for each impact category by lifecycle stage for the base cases for video players/recorders, projectors and games consoles are presented graphically below. The figures presented show the relative proportions of a particular impact that are due to materials production, product manufacture, product distribution, use and end-of-life of the product. For many of these impact categories, the use phase has significantly greater impact than other stages of the product life cycle.

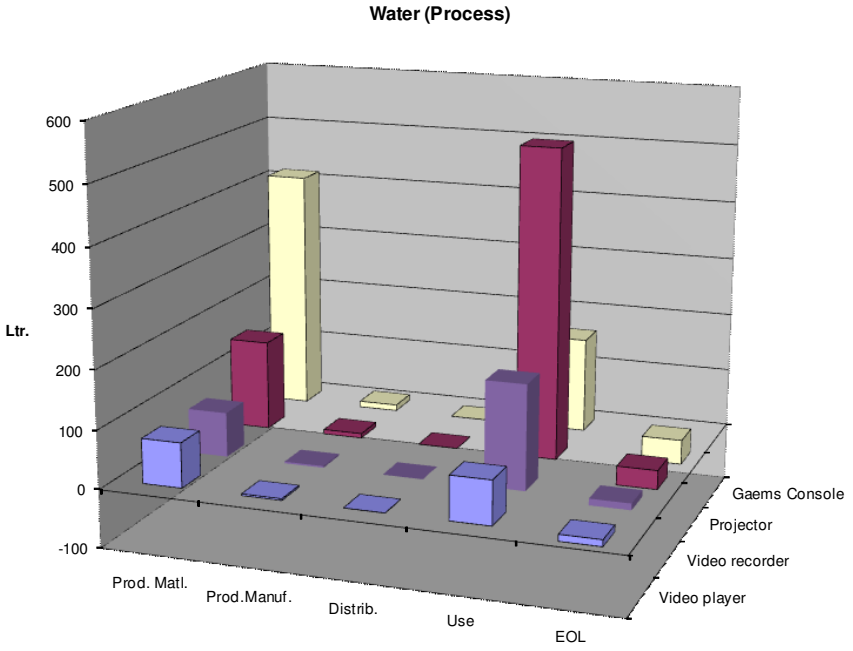
The products are compared on a product item for product item basis. Thus the relatively higher environmental impacts exhibited for projectors and games consoles are mainly due to their higher unit weights than for video players/recorders.

A figure is presented for each environmental impact. These are not directly comparable. Although, this does not necessarily mean that there is no linkage between environmental impacts. For example, one might expect that global warming impacts (GWP100) in the use phase would be linked to electricity consumed in the use phase – as a consequence of generating electricity from the combustion of fossil fuels. However, it would be wrong to say that one particular environmental impact is better than another without proper understanding of the significance of each impact.

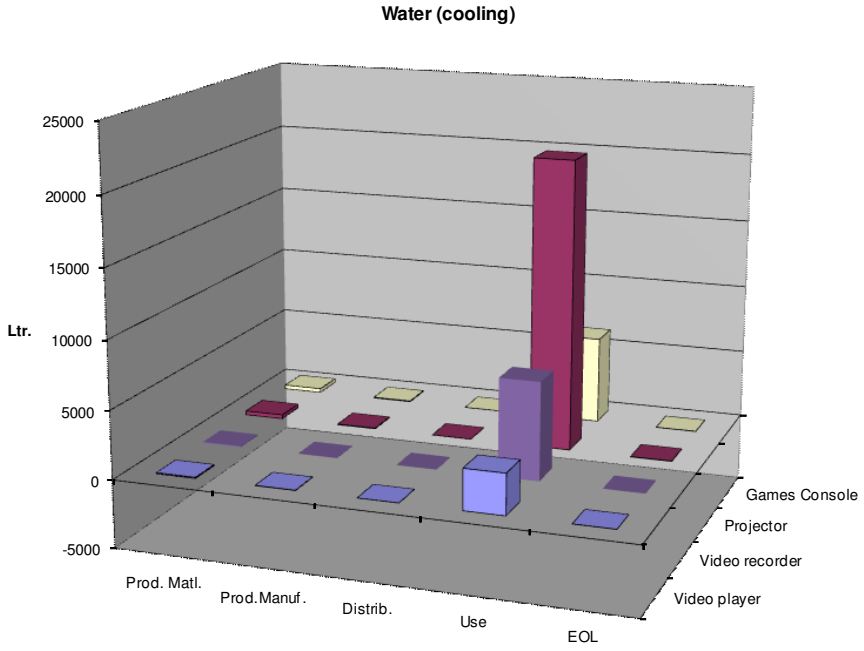


Generally, for these electricity using products, total energy (see above) should equal more or less electricity (see below). This is true for the use phase but there are differences in the production phase due mainly to the embedded energy required in plastics production.

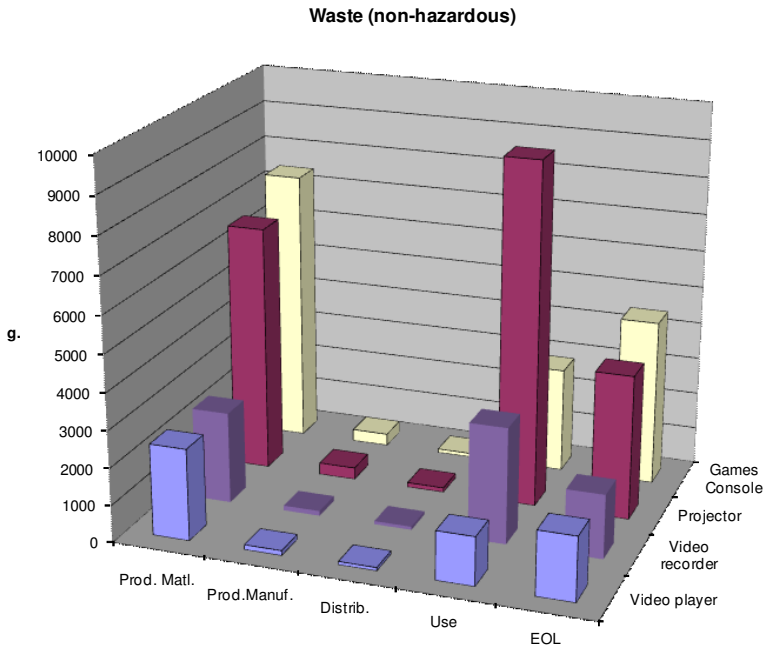




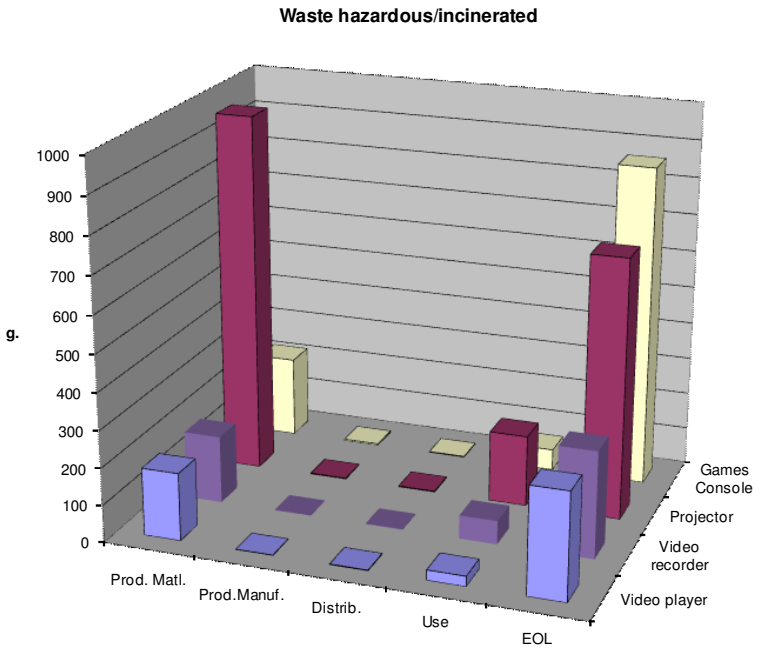
The relatively high amount of process water necessary for the material production of game consoles is due mainly to our assignment of some of the “integrated circuit” to EcoReport component “46-IC's avg., 5% Si, Au” which has a process water impact accounting for more than half of the total. The use phase impacts relate to process water for electricity consumption.



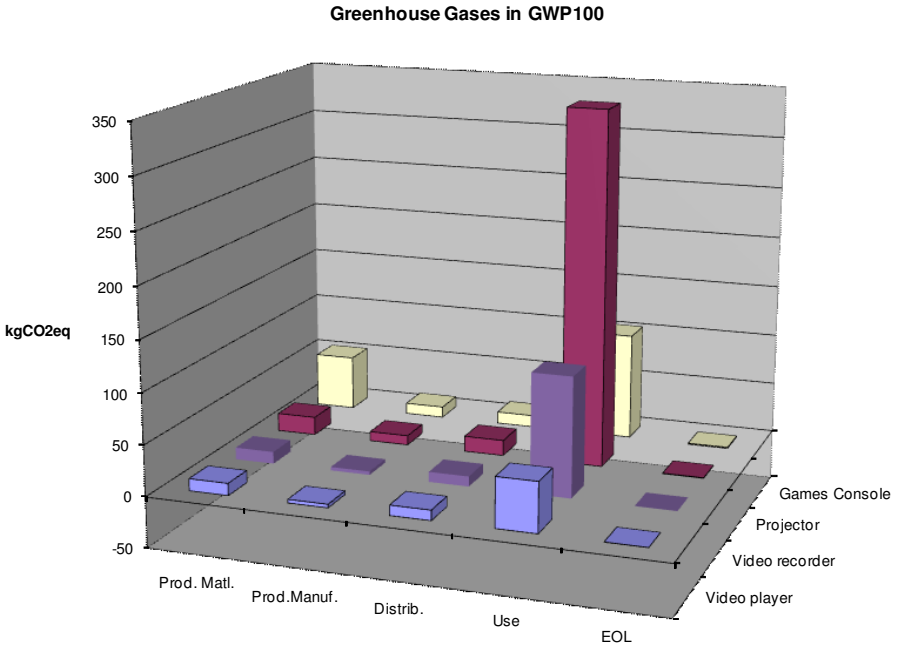
The amount of cooling water necessary for the use phase of game consoles, projector and video player and video recorder show the same proportions as electricity consumption – being related to cooling water associated with electricity production.



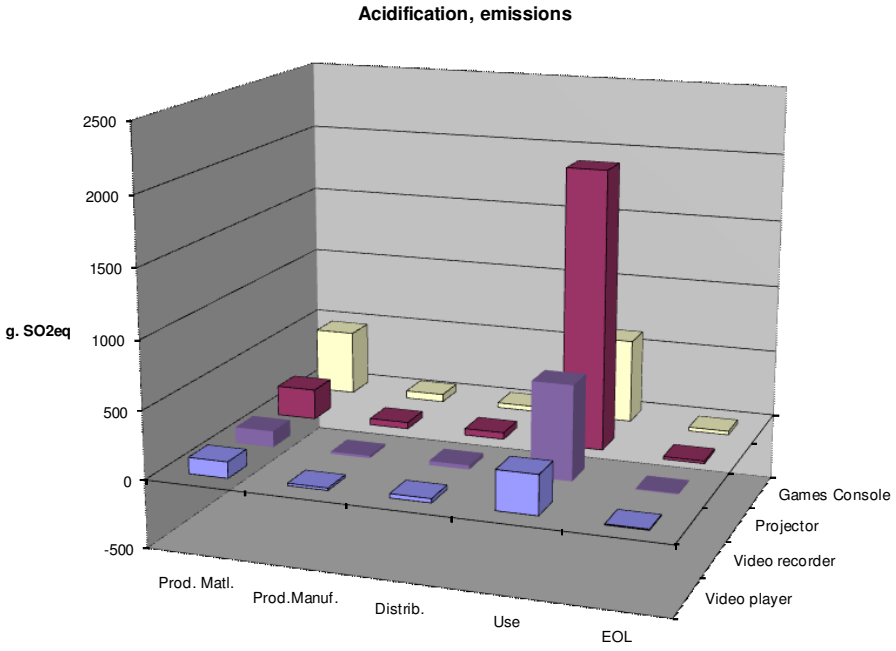
Scrutiny of the EcoReport outputs indicates that the relatively high materials production phase impacts are mainly due to the production of copper wire - the BOMs for projectors and games consoles show higher copper content. This is mainly due to the differences in unit weight compared with video players/recorders. The use phase impacts are in similar proportion to electricity consumption. The end-of-life impacts are mainly due to disposal of the product itself.



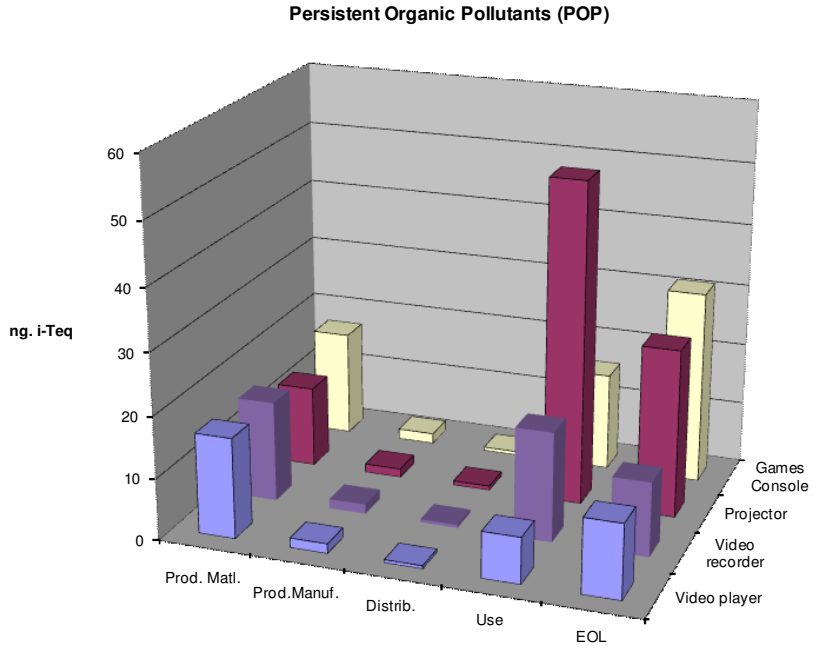
The high relative impact in the materials production phase for projectors in the above figure is due mainly to the association with printed wiring boards. The projectors BOM has much higher printed wiring board content than the BOMs for video players/recorders and games consoles. Hence the relatively higher impact. It is assumed that the hazardous materials are associated with PWB production which is known to involve copper etching processes and use of flame retardants in the substrate. The relatively high levels shown in the EOL phase are related to “Incineration of plastics/PWB not reused/recycled”.



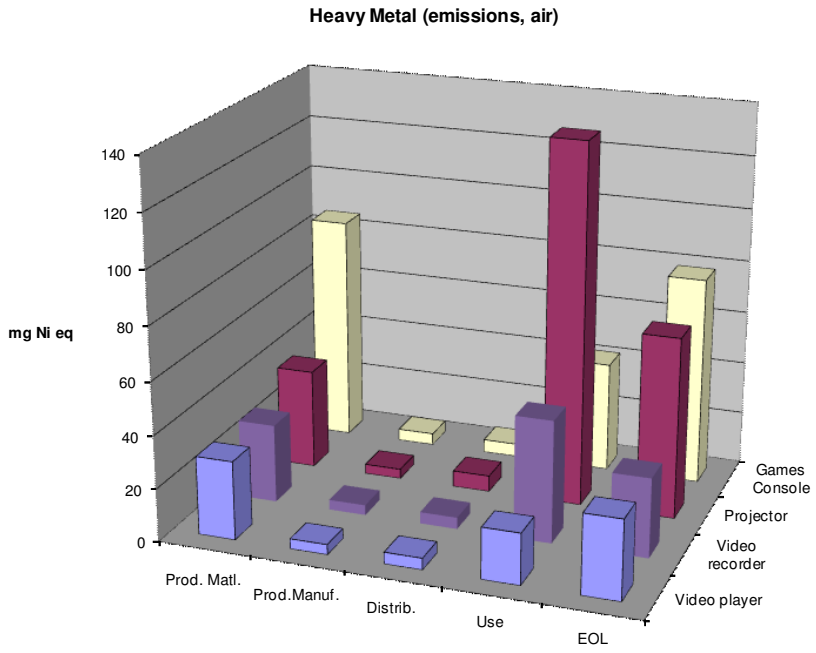
Perhaps, not surprisingly the GWP100 impacts in the use phase are in similar proportion to electricity consumption. The production of electricity involves the combustion of fossil fuels with consequent emission of carbon dioxide.



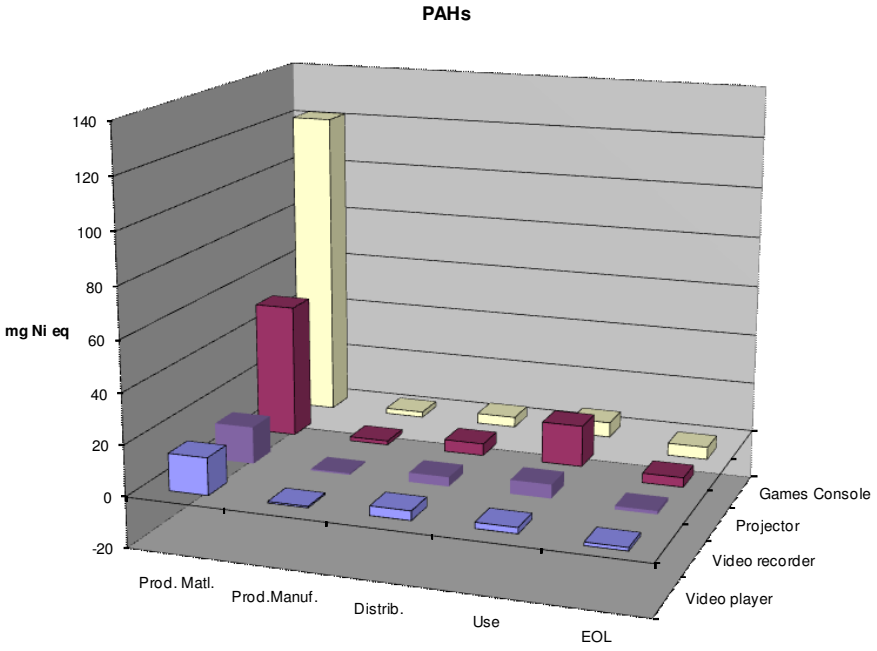
The relatively high amount of acidification emissions resulting from the use phase are in similar proportion to use phase electricity production, indicating that acidification emissions for this phase are associated with electricity production (i.e. the combustion of fossil fuels).



Again, the relatively high amount of POP emissions resulting from the use phase are in similar proportion to use phase electricity production, indicating that POPs emissions for this phase are associated with electricity production (i.e. the combustion of fossil fuels).

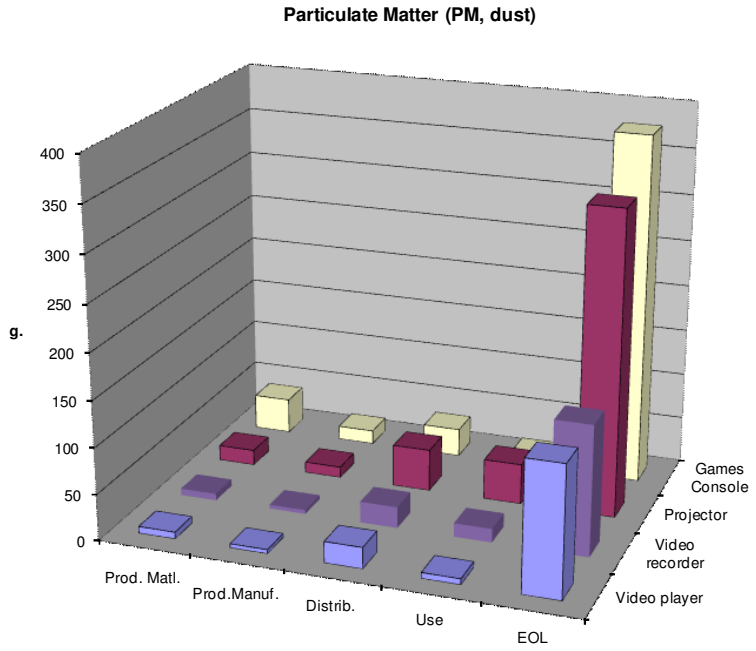


The relatively high amount of heavy metal emissions resulting from the material production of game consoles is related to the content of “46-IC's avg., 5% Si, Au” and “48-SMD/ LED's avg.” components in the games consoles EcoReport BOM. These HM emissions are presumed to be associated with the use of solder in these components. Again, the relatively high amount of emissions resulting from the use phase are in similar proportion to use phase electricity production, indicating that HM emissions for this phase are associated with electricity production (i.e. the combustion of fossil fuels).

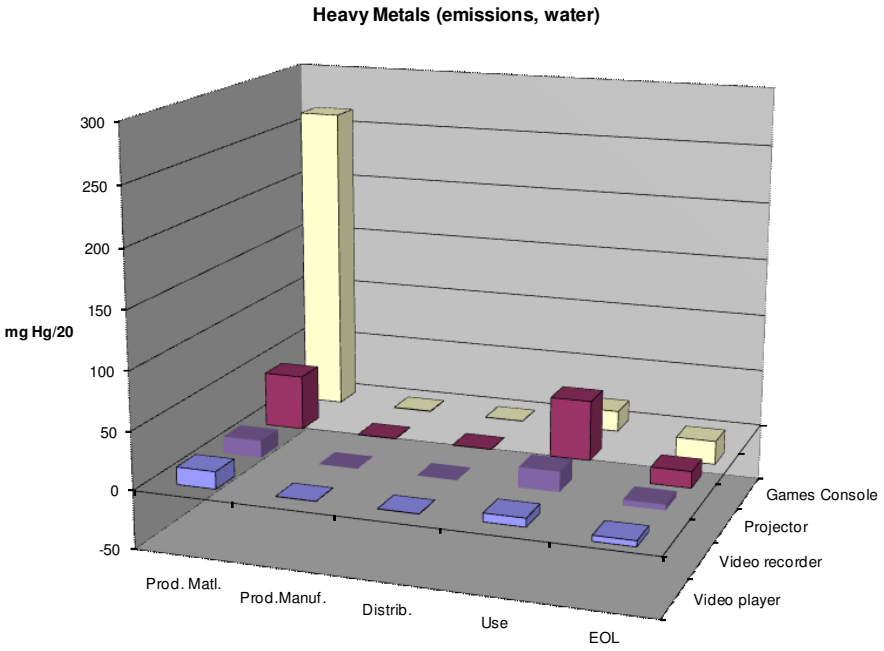


For games consoles, the relatively high impact at the materials production phase is due mainly to electronics (“44-Big Caps and coils”, and “26-Al sheet/extrusion”). Crude oil and coal deposits contain

significant amounts of PAHs. In addition to their presence in fossil fuels they are also formed by incomplete combustion of carbon-containing fuels (both fossil and biomass based). Certain PAHs are known for their carcinogenic, mutagenic and teratogenic properties. It is not possible to discern from EcoReport whether or not emissions due to "44-Big Caps and coils" and "26-Al sheet/extrusion" are related to fuel burning.



The relatively high impacts at the end-of-life phase of game consoles and projectors are due mainly to incineration of plastics and printed wiring boards ("Incineration (plastics & PWB not re-used/recycled)").



The relatively high impact at materials production phase for games consoles is due mainly to "46-IC's avg. 5%Si, Au". These HM emissions are presumed to be associated with the use of solder in these components.

It should be noted, that in many of the impact categories, the impact in the use phase of the life-cycle has the most impact, often dominating the life-cycle impact of the product for that impact category. This is particularly the case for Total Energy, Electricity consumption, greenhouse gas emissions and acidification emissions to air. See Table 49 below for a summary of use phase impacts.

Table 49: Use Phase Impact as a Percentage of Total Impact for Base Cases

Impact Category	Video Player	Video Recorder	LCD Projector	Games console
Other Resources & Waste				
Total Energy (GER)	69%	84%	89%	62%
of which, electricity (in primary MJ)	89%	95%	98%	84%
Water (process)	52%	72%	80%	30%
Water (cooling)	97%	99%	98%	95%
Waste, non-haz./ landfill	23%	41%	46%	19%
Waste, hazardous/ incinerated	8%	16%	13%	7%
Emissions (Air)				
Greenhouse Gases in GWP100	60%	79%	86%	53%
Acidification, emissions	62%	80%	86%	52%
Volatile Organic Compounds (VOC)	15%	29%	35%	10%
Persistent Organic Pollutants (POP)	20%	37%	55%	24%
Heavy Metals	22%	41%	54%	19%
PAHs	12%	24%	23%	5%
Particulate Matter (PM, dust)	3%	8%	10%	3%
Emissions (Water)				
Heavy Metals	30%	51%	51%	6%
Eutrophication	2%	4%	4%	2%

It is also noteworthy that in several of the impact categories, the impacts at the end-of-life phase are negative (i.e. beneficial impact on the environment). This confirms the objectives and aims of the WEEE Directive.

4.5 Base-Case Life Cycle Costs

4.5.1 Video Players/Recorders, Projectors and Games consoles

The lifecycle costs of the Base Case are presented in the table below. A typical lifespan of 6 years has been used for video players/recorders and projectors and 5.5 years for games consoles in the calculations. In all the presented LCC analysis, the total consumed energy, electricity rate of 0.16 euro/kWh, and a discount rate (interest minus inflation) of 2.2% has been used. Detail on the input values used in the base case EcoReports is presented in Appendix 1.

Table 50: Base Case Life-Cycle Costs per Product (Euros)

	Video Player	Video Recorder	Projector	Games console
Product Price	40	165	800	360
Installation costs	0	0	500	0
Electricity	15	36	105	32
Repair and Maintenance	0	0	371	0
Total	55	201	1,777	392

Note: For home cinema and for the use of projectors in schools there are installation costs, if the projectors are installed in a typical projection rack or cabinet.

The total annual consumer expenditure is calculated by EcoReport by multiplying the base case lifecycle cost per product by the estimated stock for the item in 2008, and is shown in the table below.

Table 51: Total Annual Consumer Expenditure (Million Euros)

	Video Player	Video Recorder	Projector	Games console
Product Price	1,300	1,568	1,280	7,416
Installation costs	0	0	800	0
Electricity	481	234	161	393
Repair and maintenance	0	0	567	0
Total	1,781	1,802	2,807	7,809

Copies of the detailed EcoReport output tables on which the above tables are based are presented in Appendix 2 for each base case.

4.6 EU-27 Total Impact

The EcoReport output tables for each base case are presented in Appendix 2. In addition to life-cycle impacts per product, the tables also illustrate the outputs from the EcoReport for the impact of base case models sold in 2008 over their lifetime and the EU impact of base case models (produced, in use and discarded).

The Summary environmental impacts of the EU Stock 2008 for each of the base cases analysed are presented below. The figures presented are the direct outputs from the EcoReport.

Note: the relation total energy/electricity is more or less the same, The EcoReport uses a conversion factor of 10,5 for converting electricity in PJ to TWh, which includes accounting for the efficiency of power stations (around 34%). Ratios of Total energy:Electricity exhibited are between 12 and 15.

Table 52: Summary Environmental Impacts EU-Stock 2008, Multimedia Products

	Video players		Video recorders		Projectors		Games consoles	
main life cycle indicators	**value**	**unit**	**value**	**unit**	**value**	**unit**	**value**	**unit**
Total Energy (GER)	**48**	PJ	**20**	PJ	**12**	PJ	**56**	PJ
of which, electricity	3.4	TWh	1.6	TWh	1.0	TWh	3.3	TWh
Water (process)*	**4**	mln.m3	**2**	mln.m3	**1**	mln.m3	**10**	mln.m3
Waste, non-haz./ landfill*	**181**	kton	**60**	kton	**30**	kton	**284**	kton
Waste, hazardous/ incinerated*	**11**	kton	**3**	kton	**2**	kton	**15**	kton
Emissions (Air)								
Greenhouse Gases in GWP100	**2**	mt CO2eq.	**1**	mt CO2eq.	**1**	mt CO2eq.	**3**	mt CO2eq.
Acidifying agents (AP)	**14**	kt SO2eq.	**6**	kt SO2eq.	**3**	kt SO2eq.	**19**	kt SO2eq.
Volatile Org. Compounds (VOC)	**0**	kt	**0**	kt	**0**	kt	**0**	kt
Persistent Org. Pollutants (POP)	**1**	g i-Teq.	**0**	g i-Teq.	**0**	g i-Teq.	**1**	g i-Teq.
Heavy Metals (HM)	**3**	ton Ni eq.	**1**	ton Ni eq.	**0**	ton Ni eq.	**4**	ton Ni eq.
PAHs	**1**	ton Ni eq.	**0**	ton Ni eq.	**0**	ton Ni eq.	**3**	ton Ni eq.
Particulate Matter (PM, dust)	**6**	kt	**2**	kt	**1**	kt	**10**	kt
Emissions (Water)								
Heavy Metals (HM)	1	ton Hg/20	0	ton Hg/20	0	ton Hg/20	6	ton Hg/20
Eutrophication (EP)	0	kt PO4	0	kt PO4	0	kt PO4	0	kt PO4

***=caution: low accuracy for production phase**

It is noteworthy that the total electricity consumption for these multimedia products (9.4 TWh) represents the equivalent of slightly less than the total electricity consumption of Lithuania[47], and is equivalent to about 0.3% of the total electricity consumed in the EU.

In terms of greenhouse gas (GHG) emissions, 6 million tonnes CO_2eq is equivalent to around 0.14% of the EU-15 base year emissions of GHG (fixed at 4265.5 mtCO_2eq)[48].

In terms of acidification impact, 40 ktSO_2eq represents about 0.9% of National Emissions Ceiling Directive target for 2010 for the EU-15[49]. In terms of heavy metals emissions to air, 6 t Ni eq represents about 0.1% of the total EU-27 emissions in 2007[50].

It is not generally easy to map MEEuP output data onto national/EC inventory data because MEEuP has its own aggregation methodology/reporting methods. Comparing these EcoReport results with the EIPRO study[51], in terms of environmental impact is only possible for those impact categories that are reported in a similar manner (e.g. Global warming and acidification). This is also because the EIPRO study presents its analysis in terms of CML impact assessment categories (e.g. abiotic depletion, human toxicity, ecotoxicity etc.) which are not strictly comparable with the categories reported by EcoReport. Thus, any correlation is very likely to be approximate. EIPRO impacts for "[A340] (Use of) household audio and video equipment" are expressed as a fraction EU-25 total. These are compared where possible with the EcoReport outputs as follows:

[47] CIA, World Factbook.
[48] http://www.eea.europa.eu/pressroom/newsreleases/GHG2006-en
[49] http://themes.eea.europa.eu/Specific_media/air/indicators/AP1,2003/ap1_emiss_SO2_FnlDrft_2003.pdf
[50] European Community emission inventory report 1990–2007 under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP),
EEA Technical report No 8/2009, ISSN 1725–2237
[51] IPTS/ESTO, "Environmental Impact of Products (EIPRO): Analysis of the life cycle environmental impacts related to the final consumption of the EU-25, EUR 22284 EN

Table 53: Comparison of EcoReport outputs with EIPRO

	EIPRO Findings	EcoReport
Abiotic depletion	0.0076	No output information
Global warming	0.0115	0.0014
Human toxicity	0.0074	Indicate single indicators: Heavy metal, PAH, POP, PM
Ecotoxicity	0.0071	
Acidification	0.0198	0.009

Clearly, we would expect the EcoReport outputs to show lower values, given that the EIPRO findings relate to both audio and video consumer equipment (and no doubt, includes televisions) rather than the limited number of product categories studied here in the EcoReport. Given the difficulties in making like for like comparisons, the above table suggests that there is a very loose agreement, and this suggests that video player/recorders, projectors and games consoles account for about one tenth of the total impact of all audio/video equipment.

4.7 Conclusions

The following draft table is presented for identification of potential ecodesign indicator for the designer.

Environmental impact according to annex I of Ecodesign Directive 2009/125/EC	Assessment environmental impact for video players/recorders, projectors and game consoles	Potential ecodesign indicator for the designer
Consumption of energy	Electricity consumption significant for projectors and games consoles?	TEC, on/idle/standby consumption, auto power down or any other energy efficiency indicator
Consumption of material	Significant PWB, ICs or other such as copper wire, Al sheet?	Less weight/volume, miniaturisation? Substitution of material? Use of hazardous substances (Covered by ROHS?) Use of recycled materials? Extension of lifetime? (such as minimum guaranteed lifetime or minimum lifetime for availability of spare parts, modules etc.)
Consumption of other resources such as fresh water	Significant process water and cooling water for all three products?	If the water consumption is only related to the electricity consumption or material production they are covered by energy/resource indicators above. If not, separate indicators may be discussed.
Emission to air, water and soil	GHG, SO2, which POP, which heavy metals, which PAHs and PM for all three products?	If the emissions are only related to the electricity consumption covered by energy indicators above. If not, separate indicators may be discussed such as in ecolabel.
Physical effects such as noise, vibration, radiation and electromagnetic fields	Electromagnetic fields significant according to EMC. Radiation, noise, vibration significant or not? Covered by other safety and health directive such as LVD?	If fully covered by EMC, LVD etc. no ecodesign indicators. If not and not significant (noise?), no ecodesign indicator necessary. If not and significant (noise?), ecodesign indicator necessary, e.g. noise in dB(A).
Generation of waste materials	Non-hazardous and hazardous waste for all three products?	If fully covered by waste legislation (WEEE and ROHS) no ecodesign indicator necessary.
Possibilities for reuse, recycling and recovery of material and/or energy	Significant environmental impact (waste, resource use) if no reuse, recycling and recovery?	If yes and not fully covered by WEEE, design for recycling indicators necessary e.g. Ease of reuse (whole item or components)?or recycling? Incorporation of used components?

No suggestions for ecodesign indicators of VPR, P and GC have been received from stakeholders.

5. Task 5: Technical Analysis BAT and BNAT

5.1 Introduction

This section presents the technical considerations of Best Available Technology (BAT and Best "not yet" Available Technology (BNAT) for the three distinct multimedia product groups of this study. The term "Best" is taken to mean the most effective in achieving a high level of environmental performance of the product. "Available" technology is taken to mean that developed on a scale which allows implementation for the product, under economically and technically viable conditions, taking into consideration the costs and benefits. This applies whether or not the technology is used or produced inside the EU Member States, so long as it is reasonably accessible to the product manufacturer. On the other hand, "Not yet" available technology is taken to mean that not yet developed on a scale which allows implementation for the relevant product, but that is subject to research and development. The three multimedia products (video players/recorders, projectors, games consoles) are considered in turn in each sub-section below.

A) Video players/recorders (VRs)

There are 2 options for a high level of energy efficiency available

- 1) Docking station architecture with external HDD.
- 2) Energy optimised Chip sets for multimedia players and recorders.

B) Projectors/Beamers

There are 4 areas in a digital projector that could be optimised:

- the Lamp/light module
- the lens system
- the light path beam splitting optics
- the elimination of leaded glass from the lens elements

C) Games consoles

There are a number of technical options for optimising games consoles:

- the inclusion of additional components to reduce the need to run non-gaming applications through the main high specification components.
- the inclusion of additional power management functionality
- using the most efficient power supplies available
- maximising processor performance scaling to reduce power consumption when maximum computing performance not required
- noting the achievements made in the personal computer industry to reduce wider environmental impacts around end of life, material content and upgradability

Evaluation of the historical development of these products is not very appropriate because the technology is changing so rapidly. Hence considerations have been concentrated on the 'here and now' and the future development scenario.

5.2 Definition of BAT

A) Video players/recorders (VRs)

1) Docking station architecture with external HDD.

There are several options to reduce the power consumption of VRs and Multimedia HDD. One solution is to exclude the HDD and to attach it via USB-OTG (On the Go). This reduces the power consumption and provides a chance to use an external HDD with the lowest power demand available. There are several manufacturers offering these options (High-definition multi-media adapter as the WD TVHD Media Player / Muvid MMP-R 100 HDD Player HDD Multimedia Center with recording-function and HDMI). The option to utilize external HDD to be attached to the player module is pushed not only by energy efficiency issues, but by fees to be paid to systems like Gema/ZPÜ in Germany (not available in the UK) and most other EU-27 member countries.

2) Energy optimised Chip sets for multimedia players and recorders.

Another option to reduce the power demand of multimedia players / recorders is the implementation of highest integrated chip solutions. The most flexible of these principles is the so-called system-on-a-chip or system on chip (SoC or SOC). SoCs are integrating all components of an electronic device into a single chip. A SoC is typically used with a processor that has power enough to run an operating system such as Linux or Windows. Another feature of SoCs is the demand for external memory to be added to the module. There are numerous chip manufacturers offering such modules. Some manufacturers call their products computer-on-a-chip" (CoC).

An example of a SoC is the XCore86, Vortex86MX or MSTI PMX-1000 introduced by Taiwan-based DMP Electronics that is one of the inventors of low power computer systems. The XCore86 is claimed to use just 1.2 Watts while running at 1GHz. Even chip manufacturer Intel is focussing on SoCs since the market of SoCs tends to be bigger than the market for PC CPUs. The Norhtec Gecko Edubook [52] that uses the same SoC has a power consumption of 10W which includes the backlit screen. Therefore, a video recorder which by definition has no screen is expected to achieve even lower power consumption.

Another example of a SoC is the Tegra 600 or 650 made by the graphic chip manufacturer Nvidia. Tegra consists of an ARM11 CPU core, a GoForce (renamed into GeForce ULV) GPU, an image processor (digital camera support), a HD video processor (PureVideo for handhelds), memory (NAND Flash, Mobile DDR), a northbridge (memory controller, display output, HDMI+HDCP, security engine) and a southbridge (USB OTG, UART, external memory card SPI SDIO, etc). Tegra includes almost all parts that are traditionally on a motherboard squeezed onto a single silicon die in a chip 144 mm2 in size. Low-power electronics is based on ARM microprocessors developed by various companies and the software for these systems is not compatible with x86 processors.

Traditionally, the footprint of video recorder was relatively large compared to the number of components inside. By using a common shape and a strong chassis, multiple devices could be easily stacked on top of each other and provided a common aesthetic. However the limiting size for most VRs is dictated by the drive, either optical or hard drive. This is because the size of the electronics and power delivery have been dramatically reduced. This has led to more modern designs with a wider variety of sizes, shapes and weights constructed from plastic instead of metal. However, modern designs often incorporate many types of material to improve appearance e.g. trimming, logos and highlighting features.

With increasing miniaturisation of electronics such as SoC, there is increased scope for reducing the size and weight of the devices, with associated reductions in material resources and transport. In addition, it is possible to design products for recycling, such as reducing the number of different types of plastics and simplifying disassembly. However, very compact products may be harder to disassemble and recycle, and lighter products may be weaker which could increase the amount of packaging required. The shifts between environmental impacts may not be straightforward and requires analysis for each product.

[52] http://www.linuxfordevices.com/c/a/News/NorhTec-Gecko-Info-Pad/

BAT for Video Players/Recorders

Adapted from with ENERGY STAR data and requirements[53] BAT would be considered to be:

DVD: 6W playback, 16W recording

DVD with upscaling: 10W playback, 16W recording

Blu-ray: 15W playback, 25W recording

Standby for all products should be 0.5W or less.

Auto power down: 30 minutes for players only, 3 hours for recording devices.

Booting time problem and Quick Start Mode

DVD recorders tested by Stiftung Warentest in September 2008 showed a range of 18 - 30 seconds for starting from standby. Blu-ray disc players as tested by chip computer magazine (02/09) needed a booting time between 46-64 seconds. However, there are Blu-ray Disc players with a start-up time of approximately 20 seconds (5 seconds to open the drawer and 15 seconds to boot).

Quick Start Mode

With DVD recorders and Blu-ray disc players, there is the so-called Quick Start Mode to shorten the starting time of these devices. This mode is available in Active Standby and can be adjusted or explicitly enabled by the user. With two of the DVD recorders tested by Stiftung Warentest in September 2008 the Quick Start Mode provided a speedy 3 seconds start of the devices and a power consumption significantly higher than in passive standby.

Given the high power consumption in active standby mode with quick start feature Auto Power Down function plays an important role. In some Blu-ray Disc players, there is the possibility that the Quick Mode with On / Off switches the TV-set simultaneously on or off. And the Blu-ray Disc Player switches to passive standby mode with the shutdown of the TV automatically. Some devices that have HDMI5 - connectivity offer the possibility to handle the whole Player/TV-set via a single keystroke.

In addition, there is another form of the active standby mode for DVD recorders: the active standby mode with timer programming. If this state is enabled the function of the timer to record programs. These DVD recorders consume significantly more electricity than in passive standby mode. Power consumption in standby is higher when the timer has been programmed to wait for a recording . According Stiftung Warentest (test 2 / 2008) the average is between 2 to 5 watts, although one device was measured at 7.4 watts. This difference is also confirmed by the average value of 7 watts in receptive state, in contrast to 5.4 watts when switched off (standby) state as measured for the components of the Action No-Energy. There should be no technical reason for a higher timer-standby. The standby regulations include an internal timer in the definition, therefore standby with timer will have to meet the 1W target in the standby regulation coming into effect January 2010. In addition, the stand-by value in the Quick Start Mode is much higher, ranging from 7 watts to 14 watts.

Blu ray disc players

The standby power consumption of Blu-ray disc players is from 0.3 to 1.2 watts. On average, the standby consumption is about 0.5 watts. However, the time from Standby mode to recording is very long. Some Blu-ray Disc players take several minutes to boot and load. According to Oeko-Institute this is primarily because a Blu-ray disc player operates just like a PC. The player first boots the operating system and then it starts to load the disc. The fastest of the tested players began playing after 46 seconds with the Blu-ray playback (source: chip.de 02/2009). To shorten that time, the Blu-ray disc player can use the Quick Start Mode.

Best available technology for recorders offers a Quick Start Mode power consumption of 9 watts (limit proposed by Oeko Institute for Blue Angel) and an Auto Power Down of 3 hours in line with current SSTB ecodesign regulations (107/2009).

For Blu Ray players without recording functionality there should be other options than Quick Start Mode to speed up the start of the device as it is available for DVD-players and discussed in BNAT.

[53] ENERGY STAR Audio/Video Specifications v2.0 http://www.energystar.gov/ia/partners/product_specs/program_reqs/AV_V2_Specification.pdf

Barriers to take up

The main barriers to take up are costs and time for development to ensure reliability and ensure the customer experience is not compromised. The consumer electronics industry is very conservative and will only adopt new technology if it offers a business advantage (lower manufacturing costs, more features). Examples of new technologies include blue lasers to read blu-ray disks.

Since the devices are relatively discrete and low power consuming compared with other products e.g. TVs, PCs, there is no consumer demand. As a result replacing reliable and known hardware or software with newer technology with unproven reliability is a business risk with no competitive advantage. This also results in a growing trend to adopt, proven and cheap PC components and software which may not be tailored to the specific task required and as a result less efficient. x86 PC architecture also benefits from a larger and more sophisticated software development community which allows new features to be rapidly introduced.

B) Projectors/Beamers

There are 4 areas in a digital projector that could be optimised areas that can be considered for BAT:

1. The Lamp/light module

Some projectors offer an eco mode with reduced brightness, a longer lamp life and a reduced power consumption by about 40% (BenQ). This solution for extended lamp life introduces limitations to the projection environment ambient lighting and is unsuitable for the principal projector markets of offices and schools.

LED modules

Lamp-free projectors eliminate the conventional lamp in the projector by using LED lighting modules. LED lighting modules are available for small and mobile projectors. LED lighting modules are potentially free from hazardous substances such as the mercury or halogen gases associated with traditional halogen and metal halide projector lamps. Light losses inherent in splitting a white light source into primary colours for modulation in the projector engine are avoided by using primary colour LED light sources. Difficulties in matching the light output efficiency of primary colour LEDs, particularly green LEDs have been resolved, currently, by the use of a Cadmium Zinc Selenide nanocrystal coating, at chip emitter level on efficient blue LEDs. This has re-introduced the issue of hazardous substances in LED light sources but a ROHS exemption has been sought and granted.

LED-based projectors have been developed and commercialized since 2007 but are still limited to lower brightness ultra-portable or pocket projectors. The advantages of LED systems are ultra-high contrast images, instant On (no warm-up period), long-lifespan, quoted at 20,000 and up to 100.000 hours, and in single chip DLP projectors, zero colour fringing (no 'rainbow effect') since a colour wheel is not needed.

Examples of commercial solutions for LED light sources include: PhlatLight LEDs from Luminus Devices, Inc. (www.luminus.com). These are larger than conventional LEDs and are designed to operate at significantly higher intensity. The LED PT-39 chipset that is powering the new Acer K10, a lightweight pocket projector is one of the first models commercialised. The PhlatLight LED PT-39 chipset is designed specifically for projection systems that use micro-displays ranging from 0.4" to 0.55" with individual red, green and blue LEDs and work in conjunction with the DLP technology. The Acer K10 was one of the first projectors that utilizes the so-called PhlatLight LED technology, but provides only 100 ANSI lumens.

The first LED powered projectors for mainstream applications that deliver all the colour and performance advantages without compromising brightness were displayed in 2008.

A LED light source life of six years, at 600 lumens of brightness is expected with a 100,000:1 contrast ratio using a DLP chipset and the Luminus PhlatLIte LED. Another advantage of LED projectors is the potential efficiency of the cooling system. Like all semiconductors and unlike the quartz glass encapsulated discharge lamp, the LED chip can be directly interfaced with a heat sink. This facilitates very efficient aircooling or water cooling. These cooling systems are based on the mature technologies used in computer and ICT main frame cooling.

Expectations for the market dominance of LED powered projectors are high, but until now the PhlatLight LEDs seem to be the only solution that is bright and efficient enough to replace conventional lamps. LED chipsets are also in production from Luminus power Acer, Delta and Chi Lin projectors.

Current developments include those from Delta Electronics, Inc., who have presented a full HD LED projector for the consumer market. The PT-121 chipset is comprised of a red, green and blue LED, and is best-suited for data projectors using micro-displays ranging from 0.65"- 1". The module offers instant start up with no warm up and cool down period as is required by conventional mercury lamp projectors. The module has more than 60,000 hours of lifetime, allowing the same light module in the projector for the whole lifetime. When combined, the red, green and blue chips produce more than 2,000 white lumens at 8,000 colour temperature in time sequential pulsed mode. There is also 100 percent uniform surface emission from the LEDs for high collection efficiency and low optical losses. In addition, the monolithic emission area per colour allows for single-lens collection and simplified optics. The Delta full HD home theatre projector will be available through the Vivitek brand. Another DLP licensees, Sim2, has also announced a new LED projector. A Norwegian brand (Projectiondesign) has implemented its LED technology ReaLED, and guarantees a 100,000 hour lifespan for the lighting module again rendering lamp replacement unnecessary.

	Examples that Christie uses	Electrical Power in(1)(W)	Raw White Lumens out of light source (lm)	Light Source Efficacy (lm/W)	Final on-screen Lumens	**Projector Efficiency(1) (W/lm)**
LED	LED 1	59	944 (2)	16.0	189	**0.31**
	LED 2	94	1481 (2)	15.8	296	**0.32**
	LED 3	132	2113 (2)	16.0	423	**0.31**
UHP (Hg)	UHP 1	350	21000	60.0	4000	**0.08**
	UHP 2	200	12000	60.0	8000	**0.08**
Xe	Xe 1	500	20000	40.0	4000	**0.13**
	Xe 2	1000	40000	40.0	8000	**0.13**

Notes:
(1) This power input is to the light source only; it does not include any power input for other electronics, and power conversion efficiency, cooling etc.
(2) Based on 1-chip projector (pulsed LED)

Illumination systems:

- UHP (Mercury vapour based high intensity discharge) lamps are selected for their high efficacy, but these do not necessarily provide the colour quality and/or brightness required by some professional products.
- Xenon arc lamps are selected for their high brightness and colour quality, but are not as efficient as the UHP lamps.
- LED's are selected for their long lifespan and good colour quality for applications that need minimum downtime, such as control rooms and signage environments, however they are not as bright or as efficient as the above.

2. The lens system

Other options are better glass lenses, an optimised coating of the lens elements and an optimised adaption of lamp aperture and lens aperture.

A different approach is the usage of an anamorphotic or anamorphic lens system. Anamorphic lenses are available for home theatre use as they are available in movie theatres. The principle of the anamorphic lens is to bring all of the projector's light to the screen by avoiding the illumination of black framing bars. Anamorphic attachments are compatible with the current light engine technologies.

Anamorphic lenses are available from brands like the Taiwanese Optoma, which supplies an anamorphotic lens attachment. The manufacturer claims a brighter image of up to 30 %, because all the light energy and pixels are used for the entire image[54].

Other suppliers are Panasonic (AG-LA7200 Anamorphic Lens Adapter for AG-DVX100 and AG-DVC80) Panamorph, Inc., and Sony (BRAVIA SXRD HD Home Theatre Projector. Sony Anamorphic zoom mode allows the viewing of up to 2.35:1 images. These anamorphic lens attachments are also available from the European lens manufacturer ISCO and from Schneider Optics. (www.isco.eu)

[54] http://www.optomausa.com/product_detail.asp?product_id=411

Anamorphic Research, LLC intended to start the production of an anamorphic lens in 2009 (estimated retail price $1,895). Marantz have also announced a Motorised Anamorphic Lens System. The cheapest module seems to be available from PRISMASONIC is a Finnish company starting at 990 €.

3. Light path beam splitting optics

Traditional discharge lamps for projectors produce white light which must be split into primary colours for the optimised projection engine light modulation systems. The splitting process involves the use of dichroic coatings on mirrors. These mirrors take the form of panel reflectors or glass block reflectors. The former are more efficient but losses in the light path at the splitting stage can still be up to 30% of the lamp's original light output. Further losses occur after light modulation in the combining process which is also based on dichroic surface reflection. Improvements in dichroic coating material and coating processes have halved this combined loss in discharge lamp projectors and total light path losses of 30% are expected in the best performing products. This loss will be halved in primary (LED) light source projectors.

4. Elimination of leaded glass from the lens elements

Glass with a high transmittance for blue light is lead-containing. The lead free glass types have significantly lower blue-violet transmittance due to the physics of absorption and light frequency. Lead containing glasses are the only ones combining a high refractive index with high blue-violet transmittance. This has been confirmed during the search for a replacement glass type. All glass manufacturers have invested heavily in intensive research for such a glass type driven by the market potential for those with the first solutions. The level of research effort has been such that it can be concluded that this glass does not exist.

The use of lead-containing glass types instead of lead-free, so-called eco glass types is still possible as far as there is a limited exemption from RoHS for optical and filter glass (Exemption 13: "Lead and cadmium in optical and filter glass"). There are fears in the industry that the exemption could be terminated after the next RoHS revision process. The accelerated development of more efficient light sources (LED) could offset the requirement for lead in the lens glass through the controlled boosting of the blue end of the spectrum in the light path.

BAT for Projectors

The generic projector lamp technology for the main European market is still the metal halide or halogen discharge lamp. This lamp type has a typical life of 2000 -3000 hours with a half life (half the light output from the lamp) of 1500 hours. BAT for such lamps has increased the lamp lifetime to 5000 hours with a commensurate increase in the half- life.

The dominant eco-impact of a projector is the energy in use which is almost entirely comprised of lamp energy. The form factors and electronics of small medium and large projectors spans the form factors of the majority of CE products and there is little potential for eco-design improvement in discharge lamp based projectors through the application of BAT other than in lamp life. Other eco-design improvements with respect to manufacturing distribution and recycling are well documented in other CE product EuP studies and are relevant to projectors.

From manufacturers' data, BAT for discharge lamp projectors may be defined as:

- Lamp life 5000 hours
- On mode Efficiency .0.07 Watts/Lumen
- Passive Standby 0.5W
- Auto power down to passive standby level with no data signal available to the projector.

Barriers to take up of BAT

As with other A/V products the main barriers to take up of BAT for projectors are costs and time for development to ensure reliability and ensure the customer experience is not compromised. The consumer electronics industry is very conservative and will only adopt new technology if it offers a

business advantage (lower manufacturing costs, more features). In current projectors, lamp efficiency and lamp life are dominant BAT criteria but impinge on the retail cost of the projector through a doubling in lamp cost. This is offset by long lamp life with fewer lamp changes (possibly none) in the lifetime of the product. For large scale projector procurement (e.g. for schools) long term running costs, especially lamp replacement costs, are important and there is no barrier to absorbing the increased cost of lamp BAT. For the consumer (home cinema) long term running costs are usually not as important as initial cost for a given specification and lamp BAT will inherit consumer resistance on a cost basis.

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C) Games consoles

There are a number of ways in which current games consoles on the market could be made more efficient.

1) Inclusion of additional components to reduce the need to run non-gaming applications through the main high specification components [same structure as for video players/recorders and projectors]

The three main games consoles currently on the market can offer additional functionalities such as DVD playback (available on two of the main games consoles) and internet browsing in addition to playing video games. These additional functionalities are less demanding in terms of computing performance requirements but are still provided through the same components and circuitry as those which facilitate gaming. This means that the components are over specified for these additional non-game playing functionalities which results in significantly increased power consumption in comparison with stand alone devices offering the same functionality. For example average power demand for DVD playback for video players and recorders is approximately 20W whilst one of the higher specification gaming consoles consumes 148W for the same functionality. Industry has suggested that the addition of DVD dedicated components could cost around €13. With prices of some DVD players as low as €14 in some EU member states it is suggested that the €13 cost of adapting the current games consoles might be overestimated. Inclusion of dedicated DVD components at the 13 Euros price margin could result in savings to the consumer of €6.50 over a 5 year lifetime[55].

2) Inclusion of additional power management functionality

As with most electronics products current games consoles on the market use considerably less power in low power modes (standby and off mode) than in on modes (active and idle). Power management functionality, where by a product can shut down to a lower power using mode when not in use, therefore holds considerable scope for energy savings amongst games consoles.

3) Using the most efficient power supplies available

The efficiency rating of power supplies can have a large influence on the power consumption of all power modes. Power supplies offering average efficiencies across different load conditions of over 90% are available on the market and could help to reduce total energy consumption of the current games consoles on the market. Games consoles manufacturers could also avoid over specifying power supplies and instead ensure that they are balanced with the power requirements of the system.

4) Maximising processor performance scaling to reduce power consumption when maximum computing performance not required

Reducing the die size of transistors can substantially reduce power requirements of CPUs whilst at the same time maintain or increase computing performance. Recent changes to one of the higher specification games consoles on the market have seen a move towards the use of 45 nanometre (nm) based processor instead of less efficient 65nm based processors. This move has helped to reduce the power consumption of the games console by 34 percent since the previous latest version and by over 50 percent since initial launch of the console on the market. Given these recent moves in one of the higher specification games consoles on the market it is assumed that the other main manufacturer could also take similar steps to improve energy efficiency through the incorporation of 45nm based processors.

[55] Assumes console used for 1 hour of DVD playback per day, average EU electricity prices of € 0.16 per kWh, normal games console DVD playback power consumption of 110W and average stand alone DVD player power consumption of 20W.

5) Reducing material content for a given functionality

One of the main games console manufacturers has recently taken the step of releasing a new smaller version of their product. This has likely resulted in a reduction in reduced environmental impacts stemming from material use. Other games console manufacturers could follow suit and develop a programme of dematerialisation.

6) Reducing the number and amount of hazardous materials

Additional concerns surrounding hazardous material content of games consoles have been raised in the past. It has been shown that some of the games consoles on the market contain phthalates, beryllium, brominated flame retardants (Greenpeace 2008). It has been noted that whilst some components contain one or more of these potentially hazardous materials there are components providing similar functionality ion each games console which do not contain these hazardous materials. This suggests that the manufacturers could produce products that contain significantly less hazardous materials if required.

7) Designing for End of Life, Material Reuse and Upgradability

The environmental attributes of personal computers are well publicised through a plethora of environmental communication systems. These environmental communications systems often go beyond addressing energy in use and hazardous material content and address other environmental attributes such as design for recycling, material reuse and upgradability. Whilst these environmental communication systems are widely used in the PC industry that are not currently widely used for games consoles.

BAT for Games consoles

BAT for games consoles needs to take into account the level of gaming functionality offered. Therefore BAT can be defined as:

Games console **without** high definition support:

- Active mode power demand during gaming: 16.4W
- Active mode power demand during video playback: 16.4W (could be reduced to 8W with DVD components included)
- Idle mode power demand: 10.5W
- Auto power down: no power management
- Standby power demand: 1.7W
- PSU efficiency: 90%+ during load
- Material content: Reduced content brominated flame retardants (BFRs) and absence of beryllium-containing alloys
- Design for end of life: no data available through declarations but assumed BAT based on best practice found in the desktop and laptop PC sectors
- Upgradability: not upgradeable but spare parts available

Games console **with** high definition support:

- Active mode power demand during gaming: 99W
- Active mode power demand during video playback: 75W (could be reduced to 8W with DVD components included)
- Idle mode power demand: 75.0W
- Auto power down: user defined power down time

- Standby power demand: 0.5W
- PSU efficiency: 90%+ during load
- Material content: Reduced content brominated flame retardants (BFRs) and absence of beryllium-containing alloys
- Design for end of life: no data available through declarations but assumed BAT based on best practice found in the desktop and laptop PC sectors
- Upgradability: not upgradeable but spare parts available

Barriers

There are a number of **barriers to the take-up** of BAT including cost and market demand influences. The main barrier to the take up of including additional function specific components in games consoles is cost. Whilst the cost of adding in additional components may be minimal there are likely to be additional costs associated with the required change in manufacturing processes and potential impacts on the ability to update media playback functionality in products already in stock.

However, unlike similar computing products such as laptop or desktop personal computers, power management functionalities on current games consoles are either rudimentary or non-existent . The higher specification games consoles on the market do offer a degree of power management functionality but settings are either not activated as default or allow for long periods of inactivity before shutting down into a low power mode. The limitations on power management stem more from possible impacts on the usability of the games consoles than from any hardware issues. That is, enabling power management could potentially interfere with game play by shutting down the games console before the user has had the ability to save their place in a game. Any moves to increase the power management enabling on games consoles would therefore require cooperation of games developers as well as Game Console manufacturers to ensure minimal impacts on gaming. Without this co-operation of games developers, there is the possibility that users would switch off power management functionality to avoid interference with game playing.

There are currently no known barriers to the take up of high efficiency power supplies. Research suggests that the price premium for an efficient power supply is approximately €2.

Once initiated, dematerialisation of products is likely to reduce manufacturing costs but this would likely require significant upfront investment by the manufacturers. Given that one of the main manufacturers has already taken this step the other two manufacturers might be forced to follow suit in order to ensure their products remain competitive in the market place.

Games console manufacturers are unlikely to communicate additional information about environmental attributes of their products unless their customers demand the information. The environmental communication systems used in the PC industry are largely tailored towards institutional purchasers who demand the information through their procurement processes. Consumers have traditionally not required detailed environmental information about the Information Technology products they purchase. Some large retailers however are showing increasing interest in using previously institutional based environmental communication systems for the consumer market. This trend might encourage the games console manufacturers to communicate wider environmental information about their products and consequently be forced to take a closer look at other environmental attributes such as design for recycling, material content, upgradability and material reuse.

5.3 Definition of BNAT

A) Video players/recorders (VRs)

Developing Future Scenarios

The pace of development in consumer electronics technology is increasing and the introduction of new innovations is seemingly endless. This is occurring in the video player/recorder market with new features appearing such as 3D and interactive media. As a result, the distinction is shrinking between

products such as video recorders, set top boxes and portable devices, especially as they all start to connect to each other via networks. This means that undertaking a task to examine future energy consumption and efficient technology based on historic products becomes less and less relevant to the market.

Instead, this section examines possible future scenarios by innovative thinking under fewer preconceptions of physical products. Basic consumer services and manufacturer demands are explored alongside the many possible technical solutions which can provide this. This leads to an examination of possible energy implications and solutions which may help mitigate them.

Consumer demands and market forces

Accessibility of content

The main role of video recorders, set top boxes and other similar devices is to make video content accessible to the consumer. Without this, there would be nothing to display on the TV screen (or projected onto a screen). Accessibility comes in a variety of forms, which serve different demands and reflect the progress of technology.

- Choice of content. To cater for different tastes and interests, there must be variety in the content offered to entertain, inform and otherwise engage the consumer.
    - Expandable storage. Over time, as more content is accumulated being able to conveniently increase the storage capacity is needed.
- Time and location shifting. This allows the consumer to access the content where and when they want rather than being restricted to a particular time or place as might occur at a cinema. The time and location being shifted can vary in range from minutes (for pausing TV to get a coffee) to years. Similarly, a person may want to watch a video in a different room, or take it to someone else's house.
    - Device shifting. To achieve location shifting, being able to access content on a variety of devices is often required. This can occur between similar devices such as between DVD players or to dissimilar devices such as from the PC to mobile phone.
    - On demand. One extreme of time shifting is having content available the instant it is wanted.
    - Reliable, archival storage. This is a subset of time shifting which, instead of storing for hours or days, could extend to years or decades. Particularly for more expensive and precious videos, being able to store it for long periods and knowing it will always be accessible is very important.

Quality of content

Alongside choice, quality is an important factor. By this it is not meant the storyline, acting, directing or special effects but the realism and involvement achieved by actively and passively engaging the viewer's senses and mind.

- Immersion (passive interaction). Being able to fully interact with the full range of human senses increases a viewer's experience of the video, for example through high definition, surround sound and 3D. Stimulating the sense of smell and touch or via direct CNS stimulation could also be introduced in the future. Another way to achieve this is to isolate the viewer from other distractions and plays an increasingly important role for portable players.
- Content 2.0. In addition to passive immersion, being able to actively interact with the video or other viewers creates a greater sense of satisfaction. The possibilities for this are very wide and, for example could include video editing, or joining groups and communities to discuss and share experiences and interests. This is similar to the Web 2.0 concept and includes Blu-ray 2.0.

Product design and price

While, quality and accessibility are the two main functions, in addition, the product design which includes aesthetics and ease of use and price of both the device and content are also extremely important. This can often determine what specific features are present in a particular device or model.

Copyright

An additional requirement by manufacturers and content providers is to prevent lost earnings which may occur as a result of stolen or illegally distributed content.

Key technology and standards and their limitations

Content choice

Providing choice has been achieved in a number of ways. For broadcast TV this comes in the form of multiple channels and different programming depending on time of day. New digital broadcast systems and higher bandwidth satellite and cable services enable an even higher number of channels to be transmitted. However, the programming is paid for by subscriptions and advertising and as a result programming is more generally limited to mass-market appeal. Other more specialised and less popular content is often not available. This large quantity of less popular media is known as the 'longtail' and tends to be inaccessible. More expensive and exclusive content may also require additional payment systems such as pay-per-view and this requires a conditional access system to enable payment and prevent unauthorised access.

Traditional physical media are also used to distribute content and to offer a large variety of content. The media itself must be easy and cheap to produce. Currently this takes the form of optical media such as DVD and Blu-ray. In future, optical disks may not be able to compete with online services and new media such as solid-state memory and flash memory card. The cost of flash memory continues to fall and offer high-capacity in more convenient and much smaller physical size. This offers the potential for environmental improvement through miniaturisation and reduced waste at end-of-life.

Time and location shifting

Broadcast systems now offer some ability to timeshift by operating multiple channels which may be delayed by a one or more hours, or repeating programming at regular intervals. For archival or more personal timeshifting, the consumer must use a recording device. Some set-top boxes include hard drives which can be programmed to automatically record scheduled programming. In addition, live pause buffers the programme being watched and enables the viewer to stop a programme e.g. for coffee breaks. Conditional access set-top boxes, or complex set-top boxes, only allow the consumer to record the hard drive to preserve conditional accessibility. However, some video recorders can record from unencrypted broadcasts to standard library media such as DVD or Blu-ray.

Standard physical library media, enables location shifting i.e. being able to play the disc in any standard machine in any location[56]. This also means for pre-recorded media, that a large market exists which enables economy of scale and lower media costs. In addition, distribution is possible through rental systems which allow time-limited viewing policy. An increasing range of portable DVD and Blu-ray players are also entering the market which allow the consumer to watch videos anywhere and while travelling.

Physical media, has the advantage of long reliability, particularly for optical discs were no physical wear occurs and can be used for archiving for long periods. In addition there is virtually no storage limit since more cheap physical media can be purchased. Players can also be replaced as necessary without compatibility concerns extending the life of the content purchased.

The disadvantage of physical media for distributing video is that it is unable to provide on demand, unless the video is already to hand. Distribution either requires delivery of discs by post or collection in shops. It also only partially addresses the longtail media problem since producing smaller numbers of unpopular content which must be stored and distributed globally may not be profitable. We will use the term offline storage to describe this type of media and distribution.

Local and local networked storage

Local network storage, such as hard drives enable fast access to media and timeshifting. However, because it is not a standard library format it is not always possible to location shift if devices are not compatible. There are currently a few solutions to simplify location shifting:

- A local network which can stream or copy media from one device to another. This requires multiple devices to be powered on. Due to incompatible formats, this may require hardware and network support such as on-the-fly re-encoding of media into a compatible format.
- Portable media players are popular and is now increasingly a function provided by mobile phones. They also benefit from being considerably smaller than portable DVD players. With the correct dock or cables, many players can output video directly to the TV using digital or analogue signals at higher and higher video quality.
- The local storage may also be portable such as external USB hard drives but this still does not guarantee compatibility where other devices may not have a USB port or are unable to read in the media files.

[56] There may be some region protection to prevent unauthorised viewing in different countries.

Videos and content are bought and downloaded from online video stores. Servers and data centres will be needed to store and serve the videos. An important benefit of online distribution is that the long tail can be more easily addressed since there is little to no additional cost for distribution.

In common with physical library media, local storage does not provide instant on demand video and downloading over the Internet can take considerable length of time depending on the speed of the Internet and size of the video.

There are already a number of stores which are compatible with different products and software. However, this current fragmentation could confuse consumers who may be wary of committing to a particular brand and service.

Many devices with hard drives will be installed inside the device cannot be easily changed. This means that the storage capacity is fixed and limited. Storing a large number of videos this way can be more expensive. External hard drives are also more expensive than current optical discs.

However, costs continue to fall and storage density and capacity continues to increase. Media servers with very large storage capacity are becoming cheaper and could address the storage limitations of single video recorder devices. The likely usage scenario would therefore be to leave the device powered on all the time for downloading and streaming media.

Online storage

Online services describe on demand and streaming video. This could be relatively simple such as Youtube or may offer additional pay to view functions. Online services have the advantage of instant access but only if a network connection is present. These online services can provide compatibility with multiple devices, subject to licensing issues, and would enable full time and location shifting. In reality, however, streaming services like download services tend to be restricted to particular devices and software. But to online storage, systems could be used, such as peer-to-peer cloud storage or content distribution networks.

Online storage could also be used to upload personal radios and media, and in theory could represent an ideal archival system fully backed up by high reliability data centres. However, this could require such action service. In addition consumers may prefer physical media in their own possession and may not yet trust companies to protect their data especially with cloud type storage and potential bankruptcy.

Hybrid services

As technology converges, it is expected that these three systems will converge either within products or within a networked service. For example a DVD player can also be network connected to download videos which may also be burnt onto a DVD for archiving or watching elsewhere. This convergence and increased sophistication however, may come at the cost of higher product prices and more complex user interfaces.

Immersion (passive interaction)

The main way to improve the immersion is improving the sound and 2D picture quality. This means increasing the resolution, colour and also the number of frames per second. The sound quality can be improved by increasing the frequency range and resolution. 2D surround sound through multiple speakers or virtual speakers is also common. Advances to the market include 3D surround sound and 3D video.

The raw sound and video data is processed by an algorithm to reduce the size and store it in a format readable by the device using it. A number of different algorithms are used by different devices which can also be protected against unauthorised access by encryption. This can cause compatibility problems between devices.

Providing higher quality video increases the amount of data. This means that higher storage capacity is needed for a given video and more powerful computation is required in terms of bandwidth and data processing. To reduce the data storage requirements, more advanced algorithms are used to encode the data. A consequence of this is even greater processing power required. 3D is expected to increase the processing and bandwidth requirements further.

Another way to improve quality is post-processing of the video, the most common of these is upscaling of standard definition broadcast and DVD content to high definition. High end video products also have increased post-processing. As the name suggests, this also increases the processing requirements.

More advanced encryption is also being used to protect the data.

Highest quality is also not required by all devices, particularly portable products with limited screen sizes and resolutions. To increase battery life and make more efficient use of limited storage, less powerful processors are often used which are unable to process the large amounts of data using the complex algorithms of high definition content.

Network standards such as Digital Living Network Alliance (DLNA) allow re encoding of video on-the-fly to stream to other devices. This is a now a common feature on game consoles. Portable devices are also provided with software to convert files into compatible format by changing the algorithm and/or the resolution and bit-rate.

For online storage using streaming, it is expected that the data centre will re encode the file. Scalable video codecs can provide video at a number of different levels of quality. This could reduce the requirement for re-encoding and the associated processing.

Content 2.0

Providing more general interaction requires a two way network to interact, most probably the internet. More general purpose computer processing capabilities are required to provide capabilities for newer features and functions. In addition, the ability to easily update the software of the device to take advantage of the functionality is also required. Without this, consumers could be left with rapidly obsolete products.

Summary

In summary, the perfect video system would provide instant access at very high quality, in a format compatible with all devices. This would only be possible with very high speed and ubiquitous internet access. However, the future will be a compromise of the various solutions:

- Offline storage – very high quality media, limitless storage, very cheap. Cannot provide on demand. Is not very good for short term recording, live pause. Best suited for pre-recorded media intended for long lifetime
- Local network storage – no discs to handle, very fast random read and write access suited for live pause and short term storage. Not expandable, Not always portable, not on demand. Possibly long download times for high quality video.
- Online – on demand, potentially very wide choice. Higher quality requires faster internet.

A few factors determine what mix of the above will dominate:

- Internet speeds
- Online video marketplaces , choice and availability
- Consumer compromise for high quality vs. instant access
- Existing libraries

Internet speed

However, the speed of internet in Europe is highly variable within countries and regions. Due to the cost of installing infrastructure, larger, affluent cities generally have faster internet compared to rural areas. It is not expected that bandwidth will be available for blu-ray quality video. Therefore, optical media will continue to exist but its market will be smaller.

Video marketplaces

The immaturity and competition between video marketplaces creates confusion and commits users to particular hardware. Furthermore, European copyright licensing is very fragmented, which means that launching a Europe-wide service could take a long time to negotiate with each copyright licensing associations. This means that one of the key advantages, variety of content is not immediately realised. This slows the uptake of services, although as demonstrated by itunes, a simple and innovative platform can rapidly gain market share and provide access for consumers.

Picture quality vs. access speed

Picture quality varies very widely between different services, comparing e.g. Youtube with blu-ray. Consumers appear happy to sacrifice quality for price as demonstrated by the popularity of mp3s vs. CDs, SACDs and Youtube videos playback on high definition TVs. This means that DVD quality will continue to exist, and pushes consumers towards network and online services which offer faster access.

Existing libraries

Consumers may have extensive personal libraries on DVD and converting them to online or network storage is a time consuming process and unlikely to happen as long as cheap blu-ray and dvd hardware continues to exist. The same can be seen for CDs which all still widely used although sales are declining

Functions/usage modes and energy implications

General purpose computing

New products need to be able to perform more general purpose computing. This increases the energy consumption because hardware cannot be optimised as well compared to performing a few very specific functions.

Re-encoding video, especially in software, is also processor and energy intensive. As the number of encoding systems increase, the processor again must be more general purpose and will be less efficient.

More complex software increases the boot (start up) time of devices which results in pre-emptive booting either automatically (fast start) or by the user to improve the response time. This puts the device in a higher power mode when it is not required, increasing energy consumption.

Network standby

Devices will remain in network standby mode to enable remote access to files and features from other devices. This could increase energy consumption compared to passive standby because additional electronic components may be required to stay active to wait and respond to remote requests. It is expected that the Networked standby Preparatory Study will research possible technology solutions. This will be addressed in Task 6 and 7. It is useful to note, however, that a mobile phone‘s primary function is to wait for phone calls in network standby mode and will consume less than 0.05W.

Downloading/serving modes

Once the device is woken out of network standby, downloading and serving files will also consume more power than standby and network standby modes. The length of time spent in this mode depends on the size of the file and speed of data transfer. Increasing the network speed, however, also tends to increase the power consumption. Streaming videos also results in two devices in an active mode rather than one.

Technology solutions and standards

Reducing processor requirements:

- Reduce/Standardise video encoding and encryption making optimal use of scalable video codecs to minimise re-encoding. There may also be licensing issues that need to be addressed to increase uptake.

Reduce fast start use and/or fast start mode power consumption

- Increasing the speed of the booting process can reduce the demand for fast start. This can be achieved by software optimisation of the kernel, minimising the stack and running processes in parallel. This requires additional development including close collaboration between hardware and software designers.

Efficient software and power management reduces the need to use more powerful processors and only powers the components in use. Developing software to maximise the use of hardware instructions and features, minimise the number of instructions taken to complete a particular task. For example, video decoding can be achieved through multiple steps using generic mathematical instructions, or a few steps using dedicated decoding hardware instructions. Similarly, creating

efficient data structures can reduce the memory requirements and the amount of data being transferred and processed.

Software can also unnecessarily force hardware into higher power modes by continuously 'polling' – rather than sending instructions as needed and the receiving hardware acting on this, it sends an instruction at regular intervals, even to say there is no instruction with the receiving hardware active to receive the signal. Conversely, some hardware is able to switch off when not in use, and may require a software instruction to do so. Therefore, software can be developed which minimises communication with other parts/components and instruct them to switch off, or move into a lower power mode until it is actively required.

Computational efficiency, data efficiency, and context-aware software modules can contribute to developing applications that are energy efficient. There are several resources available from white-papers to developer kits.

The main obstacle that prevents manufacturers from using energy efficient software is the fear of software bugs. Most manufacturers of consumer electronic products implement existing software that has been used for many years and seems to be free of bugs because they may not have allocated the manpower and finances to write and test new energy efficient software. In addition, more resources are needed to allow closer collaboration between the hardware and software developers. Furthermore, hardware developers may need to create more tailored and efficient software development kits to compile the software.

Optimise CPUs for energy efficiency. This includes techniques such as:

- Efficient instruction set/architecture (e.g. ARM, in-order)
- Reduce feature size
- Transistors optimized for reduced current leakage
- Hardware video decoding and encoding
- Gating unused sections of the processor to be switched off when not in use.
- SoC
- Voltage frequency scaling reduces power consumption when the processor is doing less work. Optimising the CPU could require increased R&D and solutions such as reducing feature size can require new fabrication technology with costs in €billions. However, many of the technologies already exist and are applied in mobile phones and higher value devices.

Hard drive power consumption

- SSD including future improvements to power supply[57] and inductive coupling[58]
- Firmware designed to provide performance required rather than maximum (highest power consuming) performance

Very low power network standby – taking a lead from the way this is done for mobile phones

- Use secondary processor
- Energy efficient wifi chip

Low power network 802.3az requirement (and wireless equivalent). Low power network adapters are able to reduce the bandwidth from 1000Mbps to 100Mbps and lower to match the amount of data being transferred. Lower bandwidth reduces the power consumed. In addition, newer network adapters can adjust the signal power depending on the distance between devices and signal strength.

Power management

- Auto-sleep, standby
- When streaming media over network can we transmit whole file as fast as possible to local device memory and allow server to go back to sleep?

[57] http://techon.nikkeibp.co.jp/english/NEWS_EN/20090212/165501/
[58] http://techon.nikkeibp.co.jp/english/NEWS_EN/20090213/165593/

- Change Blu-ray standards to allow player to auto-standby when showing Bluray menu irrespective of disc instructions.

Additional solutions could also include:

- Prefer stateless (thin client) devices without energy consuming hard drive. This also consolidates media to fewer servers, reducing the number of devices that need network standby.
- Using peer 2 peer to reduce download time and data centre capacity requirements

But whether this reduces or increases overall energy use depends on the media network and wider infrastructure. For example a low power thin client might be connected to a very high power server which would create a net increase in energy consumed.

5.3.1 BNAT for Video Players/recorders

Based on the above discussion, BNAT would be defined as a product which consumes less than 5W in on mode, with a standby of 0.1W or less. It would not have a fast start mode, and would auto power down within 5 minutes in idle mode.

In general, the main barrier is the extra cost and time needed to develop efficient products and ensure they are still reliable. This is more difficult against the current market trend to reduce costs and introduce new features as fast as possible.

B) Projectors/Beamers

The generic discussion on A/V products in A above, covering consumer demand, market forces, quality of content and product design and price points to some key drivers for BNAT in projectors. Product convergence will lead to projector design with more versatility in signal source docking. Potable high efficiency signal sources (e.g. mobile phones and high capacity personal data storage devices with high speed internet access) will replace the PC as the signal source for many projector applications. To facilitate this, projectors will feature wireless connectivity to such devices and in built docking. BNAT in these signal source developments is mirrored in the technology solutions discussed in (A) above, as is the trend to System on a Chip for the complex processing required by the best current future light engine technology.

The principal BNAT development in projectors in the next decade will be in the light source. High power, high efficiency primary colour LEDs and lasers will dominate this development. The ability to interface such devices with efficient cooling will reduce the form factor of medium to large projectors. It is expected that oil-cooled junction LEDs currently under development for street lighting will have projector applications within three years. This combined with the precision moulding of efficient anamorphic lenses would provide a step change in light engine efficiency. Some of this efficiency could be traded off to eliminate the lead content of lenses and the use of lead and Cadmium in light path filters. The timing of the withdrawal of ROHS exemption will be critical in this context. The proposed 2010 review for projector components is obviously far too early for such applications to support the withdrawal of ROHS exclusions. Mature research projects for the professional projector (E-Cinema) industry have shown that laser light source may provide an alternative to LED sources will have limited applications in all but portable/personal (low output) projectors.

5.3.2 BNAT for projectors.

- High Efficiency LED and Laser light sources virtually eliminating RoHS banned substances in light path elements.
- Predicted On-mode efficiency of 0.05 W /lumen
- Passive standby of 0.5W including wireless network standby.
- Auto power down to passive standby after defined period of inactivity.

Barriers

The barriers to the achievement of these BNAT criteria are mainly restricted to the development timeline of high output LEDs and safe laser implementation. Fortunately investment in these developments spans many product industries and will not be constrained by the small size of the global projector market.

C) Games consoles

Developing Future Scenarios
Attempting to identify what the next generation of games consoles is difficult as there are a number of possibilities. Firstly, manufacturers could continue down the same path and develop increasingly sophisticated games consoles where all processing power is located in the console itself. In this scenario there would likely be some further convergence with other electronics products such as video players, video recorders and possibly set top boxes. A second foreseeable scenario would see manufacturers favouring thin client based games consoles with data centres providing the processing power required to deliver increasingly complex games.

Consumer demands and market forces
If the next generation of games consoles take a more holistic approach to entertainment provision then many of the points made for video players and recorders will also be relevant for games consoles. In addition to possible consumer demands for potential increases in the quality and accessibility of video content the same issues will hold true for gaming content in both the next generation of traditional or thin client based games consoles.

Manufacturers of games consoles have previously expressed a growing interest in delivery of games through internet based services as opposed to traditional optical media. This presents the manufacturers with the opportunity for more profit through tighter control of games software distribution and a reduction in production costs over standard media such as DVDs.

Consumers may also favour purchasing games through internet based services due to the on demand nature and convenience of purchasing at home.

Key technology and standards and their limitations
As with video players and recorders there are a number of future technology implications associated with changes in functionality and delivery of content via the internet or continued delivery through traditional media.

The major difference between consumer preference for video content and game play is that a significantly larger percentage of consumers demand the best game quality available. This preference for high quality gaming is witnessed through the large sales volumes of high specification games consoles despite the availability of other less technically sophisticated games consoles on the market. The ability to offer gaming via thin client games consoles will therefore be highly dependent on the availability of super-fast broadband connections. The delivery of games for traditional games consoles via the internet will also be heavily influenced by the speed of connections but to a lesser extent than for thin client gaming.

Functions/usage modes and energy implications
Continued games console convergence with other electronics products such as video players and recorders holds the potential to significantly impact general usage patterns and energy use. Some of the current games consoles on the market are sophisticated devices that utilise all, or nearly all, of their considerable processing power to provide functionality that could be supported with significantly less powerful components. If games consoles become increasingly powerful in the future there is a possibility that delivery of other functionality other than game playing will be even more inefficient. This could cause large impacts especially if consumers choose to purchase a games console to perform many media functions and hence increase usage time considerably.

As with video players and recorders an increasing usage of network connections could also result in an increase in energy consumption as games consoles spend more time connected and less time being completely switched off by users.

Delivery of games, and possibly video content, through internet based services could also increase in use energy as games consoles stay on for longer periods of time as software is downloaded. However, the impacts from the extra time spent in on modes during downloading would have to be compared with the impacts offset from the manufacture of traditional media.

The move towards thin client based games consoles could also result in significantly more energy usage in Data Centres. This extra usage of Data Centres and the consequent energy impacts would need to be compared to any potential energy savings from the replacement of high specification games consoles with thin client games consoles that would likely be less energy intensive.

Technology solutions and standards
Further efficiency improvements in CPU design could be achieved through reduction of the transistor size to 32nm. CPUs based on a 32nm process are expected to be widely available for personal computers during 2010. Games consoles could also adopt these 32nm based processors to further increase energy efficiency.

Many low power consumer electronics products rely on System on Chip (SoC) architectures where a processing core, graphics processing and I/O components are combined onto a single chip. Developments in chip design for personal computers will lead to the launch of main processors and integrated graphics processing units onto a single chip during 2010. Integrating components onto a single chip holds the promise of further efficiency gains which could be transferred to games consoles in the future.

Processor performance scaling can be used to reduce power consumption when CPUs and GPUs are not being used to their full extent. This technology is often utilised in laptop PCs where the frequency of CPU cores can be scaled back during times of reduced computing requirements. This technology could be employed in games consoles to ensure that when full graphics and computing power is not required to perform a function (e.g. video playback) overall power consumption can be reduced.

At least one manufacturer in the notebook PC industry is also developing enhanced power management techniques for whole chipsets rather than just CPUs. These advanced power management technologies could also be included in future games consoles to ensure that only components required during the delivery of any functionality are powered.

Any moves towards thin client based games consoles would also necessitate closer investigations around Data Centre design with a focus on energy efficiency. This would include issues such as server energy efficiency, server utilisation efficiency, efficiency of Data Centre cooling and efficiency of supporting products.

Manufacturers of high specification games consoles typically launch products to market with the most technologically advanced processor available within a certain price bracket. As concurrent iterations of the same products are launched to market manufacturers include processors that offer the same level of performance but usually with a smaller transistor size and lower price bracket. This approach therefore results in future iterations of the same product being more energy efficient whilst saving the manufacture money. Manufacturers could offer purchasers of the original iterations of products to purchase the new more energy efficient versions of processors as they come to market. This would have the effect of reducing the energy consumption of the products already in stock.

5.3.3 BNAT for Games consoles

Defining a BNAT for games consoles is dependent on the functionality and form of future products. The BNAT for a traditional games console would be similar to the BAT definition:

High specification future Games console:

- Active mode power demand during gaming: 99W
- Active mode power demand during video playback: No more than discrete device offering the same functionality

- Idle mode power demand: introduction of advanced power management technologies to reduce on-idle power to less than 20% of active mode power.
- Auto power down: products to power down after shortest possible time after period of inactivity. Possible inclusion of presence sensors to facilitate power down when users leave room (providing no downloading activity taking place)
- Standby power demand: less than 0.5W
- PSU efficiency: 95%+ during load
- Material content: Reduced content of all hazardous components and reused material content
- Design for end of life: products optimised for disassembly and material recovery
- Upgradability: modular design to allow users ability to procure energy efficient components

The BNAT for a thin client based Games console would be:

- Active mode power demand during gaming: 15W
- Active mode power demand during video playback: no more than discrete device offering the same functionality
- Idle mode power demand: 1.0W to maintain network activity
- Auto power down: after 5 minutes of inactivity
- Standby power demand: less than 0.5W
- PSU efficiency: 95%+ during load
- Material content: Reduced content of all hazardous components and reused material content
- Design for end of life: products optimised for disassembly and material recovery
- Upgradability: modular design to allow users ability to procure energy efficient components
- Data Centre: optimised design to reduce energy consumption

Barriers

There are a number of prospective **barriers to the take-up** of BNAT including cost and market demand influences.

As with BAT the addition of functionality specific components could add a small amount of cost to manufacturing and hence final product. However, these upfront costs could potentially be recouped by the consumer in energy savings. Recouping of initial cost increases will be more likely if future games consoles are used for longer periods of time. Manufacturers could also employ more advanced power management technologies to power down more components when not in use.

The potential barrier to power management take up under BNAT are the same as those listed under BAT. That is, increasing the power management functionality on games consoles would require greater cooperation between the hardware manufacturers and the software developers. This situation might be less likely to occur if thin client games console become the dominant gaming platform as manufacturers would likely have much closer control over delivery of games software in this situation.

Whilst there are currently no known barriers to the take up of current high efficiency power supplies costs could increase as the efficiency of power supplies passes the 90% efficiency mark.

Manufacturers are often able to reduce the size of games consoles after several iterations of the same product. Manufacturers are unlikely to make a games console larger than necessary due to user preference for smaller devices and the additional material costs involved. However, manufacturers could promote dematerialisation of products during the design phase as well as during iterations of products to market.

Increasing consumer awareness of the environmental impacts associated with the products and services they procure, may promote games console manufacturers to not only reduce in use energy consumption but also consider some of the wider environmental impacts of their products such as material content, design for recyclability and the inclusion of reused material. Upgradability of products, such as the provision of more energy efficient processors as they become available, is more likely to negatively impact the manufacturers' income and therefore less likely to occur without incentives.

There are unlikely to be significant barriers to the uptake of efficient data centres in a thin client games console scenario due to the fact that manufacturers, or their suppliers, would be required to pay the electricity running costs. They would therefore have a large incentive to ensure that their gaming services were being delivered through energy efficient data centres.

With effective design for environment programmes in place some of the larger and more contentious environmental impacts of future products could be illuminated before they arise. Given the increasing awareness of environmental issues amongst their customers it is expected that manufacturers will enhance the consideration of environmental impacts during the design phase of future products.

5.4 Conclusions

The pace of development in consumer electronics technology is increasing and the introduction of new innovations is seemingly constant. What might have been considered as BNAT (Best "not yet" Available Technology) can become BAT very quickly. Thus, improvements tend to be accommodated within the design cycle typical for these products. BNAT options for these multimedia products relate to changes in product type and consumer behaviour and response to innovations on the ways that the consumer's visual experience is enhanced.

6. Improvement Potential

6.1 Identification of Improvement Options

The following design improvement options have been considered:

- Auto Power Down (APD) feature
- Operational mode requirements (efficiency improvement of active/idle/quick start mode)
- Hard On/Off switch
- Product Lightweighting
- PVC-free products
- BFR-free products
- Improved recyclability
- Increased product durability (lifetime)
- Reusable components
- Minimum recycled content requirement for plastics

Additional to the consideration of these, the study team describes briefly how aspects of product leasing systems could have a part to play in contributing towards more resource efficiency whilst addressing consumer affordability.

The improvement options listed are considered in more detail below. Note: the assumptions made for each option are those made by the study team and are considered to be reasonable given the wide range of imponderables that can affect these products.

6.1.1 Auto Power Down (APD) feature incorporation

It should be noted that APD is only one aspect of automated energy saving possibilities. The concept of auto power management (APM) should also be considered by designers. APM can be achieved in many ways covering all modes. This option (APD) has been analysed to illustrate the potential improvements. With regard to minimising the overall typical annual energy consumption of the product, the incorporation of an APD feature into the product could make major savings in typical times spent by these products in higher power consuming modes[59]. Such a feature would enable the product to enter a lower power consuming mode after a pre-set time period during which there has been no activity / interaction by the consumer. Such a time period would need to take into account various aspects of these products (e.g. the need for a lamp cooling period for projectors[60]) as well as imposed requirements (e.g. download of updates for games consoles, or user requirements for recording of video for video recorders). This latter aspect is important for maintaining the 'user experience' (e.g. a negative perception might encourage users to over-ride any factory-set APD default setting).

[59] Similarly, major savings are possible through auto power management features that could be applied to all modes of operation.
[60] If the lamp is not cooled down its internal components are very fragile and would break if the projector is moved before cooling is completed. For larger lamps cooling is essential to avoid differential contraction in the lamp envelope - this could shatter if the lamp cooling is abruptly interrupted. Actual projectors use a capacitor to store the electricity needed for the lamp-cooling phase. Disconnecting the projector doesn't break the lamp anymore.

Although it should be borne in mind that this product group is one that is experiencing rapid technological change, it is possible that a consequence of incorporation of an APD feature could be the effective extension of the product's lifetime by virtue of the reduced number of hours (annually) in one or other operational modes. If so, there could be a beneficial impact on the second hand market.

For the assessment of this option, the following assumptions have been made:

Product Type	Changes to Base Case
Video Player	50% reduction in time spent in standby-mode plus 20% reduction in time spent in idle-mode. Product life extension by 1 year. Cost to add APD: negligible
Video recorder	50% reduction in time spent in standby-mode. No reduction in time spent in idle-mode. Product life extension by 1 year. Cost to add APD: negligible.
Projector	20% reduction in time spent in standby-mode. Product life extension by 1 year. Cost to add APD: negligible.
Games console	50% reduction in time spent in standby-mode plus 25% reduction in time spent in idle-mode. Product life extension by 1 year. Cost to add APD: negligible.

APD is a useful feature and relatively easy to implement. APD could be implemented on a software basis and does not need any hardware changes. For devices that could be connected to the Internet and offer an option for upgrades over the Internet even devices in the stock could be upgraded, providing additional improvement. Costs for the implementation of APD are difficult to calculate. For assessing this option, additional costs for each single device have been assumed as zero.

6.1.2 Operational Mode Power Improvements

The Base Cases assessed in Section 4 were chosen to represent the typical / average product on the market in 2008 for each of the product groups – video players, video recorders, projectors and games consoles. The power requirements inputs to the Eco-report tool for these Base Cases were based on typical power requirements for on-mode, idle (quick-start) mode, and standby mode.

This improvement option (efficiency improvement of active/idle/quick start mode) considers a hypothetical situation where all of the products in use on the market have operational power requirements that are as efficient as possible (i.e. equal to BAT). These BAT power requirements[61] have been taken from the definition of BAT for each product given in section 5. Effectively, this situation represents the case where mandatory efficiency improvements would have been put in place a few years ago such that all products on the market would now be compliant. As such, the study team has made the assumption that the costs of compliance (if any) have therefore been absorbed within the design cycle of the product (i.e. zero additional cost assumed).

The BAT power requirements used for each product and mode are presented in the table below and are compared with the corresponding power requirements used in the assessment of the Base Cases. These BAT power requirements have been used in the assessment of this option.

Table 54: Mode Power Requirements (W) - BAT and BC (Base Case)

	On-	mode	Idle-	mode	Standby-	mode
	BAT	BC	BAT	BC	BAT	BC
Video players	6.0	8.0	6.0	6.0	0.5	0.8
Video recorders	15.6	20.0	12.0	12.0	0.5	2.5
Projectors*	153.9	250.0	0.0	0.0	0.5	5.0
Games consoles	38.4	51.5	25.4	51.5	1.1	1.1

* BNAT considered to be very close to BAT for projectors[62]. Therefore BNAT has been used for projectors.

[61] Examples would be improved components, like processor, efficiency of the internal power supply, storage technology, system architecture, and increased efficiency of the power supply by use of 90+ or 95+ power supply unit. Also power management pre-settings are options.
[62] High efficiency lamp sources are very close to market for all projector types considered in this study. Hence, what was previously considered to be BNAT is rapidly becoming BAT.

6.1.3 Hard off-switch incorporation

The provision of a hard on / off switch gives a clear indication to the consumer that their product can and should be switched off when not being used. The cost impact to the consumer of providing such a switch on the product is considered to be small. Therefore the price is unlikely to be a major determinant in the consumer's purchasing decision making. However, for manufacturers, the cost issue could be more significant. For example, if the manufacturing costs are between 10 and 20% of the purchase price (the margin covering the transport costs, warehousing, import tax (VAT) and customs fees as well as, service/warranty costs and margins for the importer, the distributor and the shop), the price of the hard off-switch would be between 5 and 10% of the respective manufacturing costs. Since an increasing number of products will be products integrated into a network an hard on / off switch will lose its function and remain as a cost factor only.

Many consumers cannot be relied upon to switch off their products after using them[63]. There are many reasons for this. However, the study team would expect that, from an energy saving point of view, provision of a hard on / off switch could achieve the same or more savings as an APD feature. The reasoning for this is that the product is more likely to be switched off by the consumer immediately after use rather than to spend a set time-interval in standby-mode prior to APD. However, for projectors, where a lamp cooling phase is necessary, the study team would expect the relative savings to be small.

As mechanical on / off switches are more prone to failure than electronic equivalents, it would seem likely that product lifetime would be inferior to a product with an APD feature. On the other hand, product lifetime may be increased, for example, through increased time spent switched off. For this analysis, we have assumed no change in product lifetime.

Note, some stakeholders consider prescribing of a hard off-switch as prescribing technological solutions.

For the assessment of this option, the following assumptions have been made:

Product Type	Changes to Base Case
Video Player	10% reduction in time in on-mode. 100% reduction in time in standby-mode. Cost of switch leads to 4 Euro increase in product price.
Video recorder	10% reduction in time in on-mode. 50% reduction in time in standby-mode. ~10% reduction in time spent in idle-mode. Cost of switch leads to 4 Euro increase in product price.
Projector	10% reduction in time in on-mode. Cost of switch leads to 8 Euro increase in product price.
Games console	10% reduction in time in on-mode. 10% reduction in time in idle-mode. Cost of switch leads to 4 Euro increase in product price.

6.1.4 Product Lightweighting

Manufacturers are constantly seeking ways to improve their products and to reduce costs. This is a natural consequence of the competitive market in which they find themselves. Although the evidence that manufacturers are using product lightweighting as a design strategy is sparse, product lightweighting can offer a means of reducing costs. For example, if the product is made in China and air freighted, or transported a significant distance by road, then cost savings can be a significant driver for making lighter weight products. However, many products are manufactured abroad and then shipped now-a-days, in which case weight is less of an issue. Where product lightweighting results in a smaller product, there may also be savings to be gained through reductions in the associated packaging of the new smaller product. An example of product lightweighting is the Sony 'PS3' games console. Sony's newer 'PS3 Slim' version games console is significantly lighter in weight than their original 'PS3' games console.

[63] It is noteworthy that, for the standby and televisions regulations, the ecodesign consultation forum and committee discussions reflected to NOT address hard off-switch options.

Consumers also benefit by having access to better and cheaper products. However, consumers may perceive that their lighter weight product is flimsy and less robust than their older models, which could have a negative effect on product lifetime.

Product lightweighting could be a useful procedure if it provides a material reduction. In several cases the lightweighting is associated with a change to lighter materials - for example, switching from steel casings to plastic casings - that could present more difficulties for recycling. Whereas steel is easily recycled, the infrastructure for plastics recycling is less well established. Consequently, rather than undergoing closed loop recycling, plastic material tends to go to incineration plants or is downgraded to park furniture, fence posts or similar.

For the assessment of this option, the following assumptions have been made:

Product Type	Changes to Base Case
Video Player	10% reduction in typical product weight (equally over all materials / components used). 5% reduction in packaged volume. Product lifetime reduced by 1 year. 10% reduction in product price.
Video recorder	10% reduction in typical product weight. 5% reduction in packaged volume. Product lifetime reduced by 1 year. 10% reduction in product price.
Projector	10% reduction in typical product weight. 10% reduction in packaged volume. Product lifetime reduced by 1 year. 5% reduction in product price.
Games console	10% reduction in typical product weight. 5% reduction in packaged volume. Product lifetime reduced by 1 year. 5% reduction in product price.

6.1.5 PVC Free Products

Polyvinyl chloride is one of the most widely produced plastics. It is cheap and durable, and can be made softer and more flexible by the addition of plasticizers. In this form, it is used, amongst other things, in electrical cable insulation.

Additives used to change the consistency of the PVC can leach out of PVC products. Phthalate plasticizers have been a particular concern. In January 2006, the European Union placed a ban on six types of phthalate softeners, including DEHP (diethylhexyl phthalate), used in children's' toys[64]. Furthermore, the environmental group Greenpeace has advocated the global phase-out of PVC because they claim dioxin is produced as a by-product of vinyl chloride manufacture and from incineration of waste PVC in domestic garbage (Note: the generation of dioxin is controllable in waste incineration through shock cooling of waste gases)..

Given these concerns, it is perhaps not surprising that some manufacturers have chosen to 'move away' from using PVC. For example, The Japanese car companies Toyota, Nissan, and Honda are claimed to have eliminated PVC in their car interiors since 2007, and, in the Americas, Apple claim to have made their MacBook computers free of BFRs, PVC, and lead, and with lead-free and arsenic-free displays[65].

For the assessment of this option, the following assumptions have been made:

Product Type	Changes to Base Case
Video Player	Replace any occurrences of PVC in BOM with ABS. 5 percentage point reduction in waste to landfill. 10 percentage point increase in recycling and 5 percentage point increase in thermal recovery of plastics.
Video recorder	As for Video players.
Projector	As for Video players.
Games console	As for Video players.

[64] See Directive 2005/84/EC. http://eur-lex.europa.eu/LexUriServ/site/en/oj/2005/l_344/l_34420051227en00400043.pdf
[65] http://www.apple.com/macbook/environment.html

6.1.6 Brominated Flame Retardant (BFR) Free Plastics

BFRs are additives to plastics. BFR is the commonly used name for a group of brominated organic substances that have an inhibiting effect on the ignition of combustible plastics (and other combustible organic materials). They are commonly used in electronic products as a means of reducing the flammability of the product. BFRs have a widespread number of applications because of their exceptional effectiveness at fire prevention.

There are many variants with varying chemical properties and there are several groups including:

- Polybrominated diphenyl ether or PBDE,
- Polybrominated biphenyl, or PBB
- Polybrominated cyclohydrocarbons

Many brominated chemicals are coming under increasing criticism. Concerns have been raised that these chemicals, including PBDE, could have harmful effects on humans and animals. Indeed, the Council and European Parliament concluded that EU wide marketing and use restrictions on pentabromodiphenyl ether, in the form of a ban, would provide the most appropriate means for controlling the risk associated with the substances. This took the form of the 24th amendment (2003/11/EC) to Council Directive 76/769/EEC.

For other BFRs, the situation is more uncertain. For example, TBBPA (tetrabromobisphenol A) is commonly used in circuit boards and is bound into the structure of the circuit board substrate during manufacture. Therefore leachable levels of TBBPA are expected to be low. Chemical analysis results showed that the levels of TBBPA found were low – ranging between 0.01% (100ppm) and 0.1% (1000ppm). As these results related to equipment manufactured at least 10 years ago, these levels can be considered to be likely maximum levels. These levels are below levels that might be considered a concern.

The European Commission reported in 2008[66] on the results of the risk evaluation and the risk reduction strategies for certain substances including: 2,2',6,6'-tetrabromo-4,4'-isopropylidenediphenol (tetrabromobisphenol A). The risk assessment with regard to atmosphere, human health and workers, consumers and humans exposed via the environment concluded that no risks were expected. However, with regard to the aquatic and terrestrial ecosystem, the Commission concluded that there is a need for further information and testing.

Greenpeace campaigns for the use of BFRs (including TBBPA) to be phased out due to concerns about what may happen to these materials during high temperature processes used in some recycling or disposal operations.

Not surprisingly, given the uncertainty surrounding the use of BFRs, some manufacturers are reducing their use of BFRs in plastics by using alternative flame-retardants and changing the ventilation systems for their products to increase cooling.

Some manufacturers are also considering introducing nitrogen or phosphorous-based flame retardants in circuit boards as a replacement for TBBPA. For example, the Sony Vaio uses different casing materials and Apple Macbook Air computers have reduced the need for BFR's[67].

The European Brominated Flame Retardant Industry Panel (EBFRIP) is a sector group of Cefic, the European Chemical Industry Council. EBFRIP represents the industry position on environmental, health, and legislative issues, and seeks to promote rigorous and balanced assessment of risk in the use of BFRs.

For the assessment of this option, the following assumptions have been made:

[66] (2008/C 152/02), Communication from the Commission on the results of the risk evaluation and the risk reduction strategies for the substances: sodium chromate, sodium dichromate and 2,2',6,6'-tetrabromo-4,4'-isopropylidenediphenol (tetrabromobisphenol A)
[67] http://www.greenpeace.org/international/campaigns/toxics/electronics/what-s-in-electronic-devices/bfr-pvc-toxic#bfrproblem

Product Type	Changes to Base Case
Video Player	70% waste to landfill. 10% plastics recycling and 15% thermal recovery of plastics.
Video recorder	As for Video players.
Projector	70% waste to landfill. 15% plastics recycling and 10% thermal recovery of plastics
Games console	As for Video players.

Note: It was not possible to select BFR free plastic or circuit board equivalents in Eco-report. However, these materials are likely to be more recyclable/reusable when free of substances of concern. Hence the above assumptions regarding end-of-life treatment.

6.1.7 Improved Recyclability

There are many ways that the recyclability of the product can be achieved. With regard to materials recyclability, avoiding mixture of plastics might be an option. Other options might be using alternative polymers or materials that are easier to recycle or designing easier access to components. The BAU situation in this analysis is where the minimum recovery and recycling requirement of the WEEE Directive is complied with in 2008.

Design for recycling can take many forms. The fundamental approach is where the product designer takes into account how the consumer is most likely to dispose of their product when it reaches end-of-life. This is not an easy task because consumer attitudes and behaviour towards waste can change over time. Such changes are mainly as a consequence of general waste awareness campaigns being promoted at local authority level and through manufacturers' environmentally-friendly product promotions. In addition, the recycling infrastructure can also change over time and can have a significant effect on consumer behaviour. However, it can almost certainly be assumed that consumers will favour recycling over disposal and will increasingly consign their end-of-life equipment to the separate collection facilities made available under the WEEE Directive.

One area worthy of focus is that of promoting plastics recycling. Plastics have frequently replaced the use of metals in these multimedia products mainly for reasons of versatility. However, the down-side with regards to end-of-life management is that products tend to contain a range of different polymers tailored to meet specific design requirements. Consequently, at end-of-life, the plastic parts that can be removed/dismantled for recycling comprise a mixture of different polymers. These are costly to separate into individual polymer streams. As a result, the recycling levels of these plastics 'mixtures' are sub-optimal. If products could be designed to use fewer (or even single) polymer types, then the cost barrier to recycling would be lowered thereby resulting in greater amounts recycled. Higher recycling levels would subsequently result in less material being sent to either landfill or energy recovery facilities.

For the assessment of this option, the following assumptions have been made:

Product Type	Changes to Base Case
Video Player	55% of product to landfill. Plastics EOL management = 25% Plastics recycling. 5% plastics reused, 5% Plastics to thermal recovery. As polymer changes would be within the design cycle, no change to costs has been assumed.
Video recorder	As for Video players.
Projector	As for Video players.
Games console	As for Video players.

6.1.8 Increased Durability (Extended product lifetime)

This option is likely to be unpopular amongst the industry because this product field is one that is currently undergoing rapid technological change and product innovation. Thus, extending the lifetime of a product could work against the impetus to produce better and better products and could stultify product innovation. Furthermore, it could be argued that as the energy efficiency of products tends to

be better in newer models than in older models, then it does not make sense to keep these older models in use any longer than necessary. (Note: this has certainly been the case in the past for large household appliances. However, it also needs to be pointed out that, in time, this argument would deliver ever diminishing returns as the incremental improvements in efficiency get smaller and smaller).

The benefits of the option of increased durability would be possible reduced materials consumption (avoided production impacts, resource efficiency) and consequently reduced amounts reporting to end-of-life management each year. These benefits would need to be balanced against the possible costs (e.g. extra costs of better quality materials and components, energy costs).

For the assessment of this option, the following assumptions have been made:

Product Type	Changes to Base Case
Video Player	50% increase in product lifetime. 10% increase in product price.
Video recorder	As for Video players.
Projector	As for Video players.
Games console	As for Video players.

6.1.9 Reusable Components

This design option is where certain components can be designed to have longer lifetimes than the overall product, allowing the components to be used in future models. This would avoid the need for future purchases of complete units to replace an older model. An example of this might be an interchangeable lens assembly for a projector which can be fitted into future models (sold without lens assembly)[68].

The benefits of this option lie in resource efficiency gains. Although this would not be realised with the 'first use' product, the benefits would be spread over the lifetime of the reusable component. It may also be possible that a second-hand market in the exchange of reusable components could develop. Other examples might include:

- A plug-in DVD/BluRay drive (video players/recorders, games consoles)
- A plug-in WiFi module

For the assessment of this option, the following assumptions have been made:

Product Type	Changes to Base Case
Video Player	10% reduction in materials. 10% reduction in landfill. 20% reduction in product price. 4 Euro increase in installation costs and repair / maintenance costs.
Video recorder	10% reduction in materials. 10% reduction in landfill. 10% reduction in product price. 8 Euro increase in installation costs and repair / maintenance costs.
Projector	10% reduction in materials. 10% reduction in landfill. 10% reduction in product price. 40 Euro increase in installation costs and repair / maintenance costs.
Games console	10% reduction in materials. 10% reduction in landfill. 10% reduction in product price. 18 Euro increase in installation costs and repair / maintenance costs.

6.1.10 Minimum Recycled Content for Plastics

This is an option that would go beyond current legislative requirements for environmental improvements to electrical and electronic equipment, but could be used as a marketing tool by

[68] Note: standardisation of lens apertures would be required, but this is commonplace for cameras anyway.

manufacturers to promote the enhanced environmental credentials of their product over competitors, and thereby possibly increase their market share.

The environmental NGOs are keen on this option because successful application of a minimum recycled content requirement sends out a clear message that plastics recycling is viable whilst at the same time creating a market outlet for reprocessed plastics in the manufacture of new plastics components (i.e. closing the loop). Another aspect of such a 'virtuous circle' is that the use of plastics containing substances of concern would be discouraged where these are difficult to recycle or banned under the various EC Directives such as RoHS and Marketing & Use Directives (ref Section 1.4).

Once the decision to use minimum recycled content plastics is made, the design option is simple to apply through the specification of plastic materials and components.

The assessment of this option using the Eco-report tool is beset with difficulties because the LCA impact data contained within the tool is most likely to have been derived from specific product data for virgin production of plastics without consideration of the impacts and benefits of plastics recycling[69]. Thus the tool cannot provide an accurate output of the potential benefits of higher closed loop recycling of plastics. However, the study team can make assumptions about the anticipated changes to end-of-life treatment of plastics to illustrate (at least) some of the partial benefits of this option.

For the assessment of this option, the following assumptions have been made:

Product Type	Changes to Base Case
Video Player	Same as for 'Improved Recyclability' option above.
Video recorder	Same as for 'Improved Recyclability' option above.
Projector	Same as for 'Improved Recyclability' option above.
Games console	Same as for 'Improved Recyclability' option above.

6.1.11 Combination of Options

The options considered above are not necessarily mutually exclusive. It is possible that greater benefits may be achieved by appropriate combinations of options. For example, where one option offers (say) significant energy savings and another option offers (say) reduced waste arisings, then it may be possible to gain both benefits together by combining the options. The situation is likely to be more complex where savings overlap, i.e. the savings may not necessarily be additive. However, for the options considered, combinations were found to be additive within the margin of error. Full investigation of this aspect is beyond the scope of this preparatory study.

The selection of appropriate combination options will be guided by the results of the single options assessment. The combination options investigated are presented in Table 59 in subtask 6.2 below.

6.2 Analysis of BAT and LLCC

For the purposes of this analysis the design options identified in subtask 6.1 have been numbered as follows:

Table 55 - Individual Design Options

Option No.	Option Description
1	Auto power down after set time
2	Operational mode requirements
3	Hard off switch
4	Product lightweighting
5	PVC free

[69] The Eco-report Tool is a 'Black box', which prevents scrutiny of the internal LCA data used.

6	No BFRs
7	Improved recyclability (plastics)
8	Extend product lifetime
9	Reusable components (e.g. lenses)
10	Recycled content level for plastics

These design options identified should be ranked regarding the Best Available Technology (BAT), which was defined in subtask 5.1, and the Least (minimum) Life Cycle Costs. This involves:

- Ranking of the options identified, considering possible trade-offs between different environmental impacts;
- Estimating the accumulative improvement and cost effect of implementing ranked options simultaneously, whilst also taking into account 'rebound' side effects of the individual design measures, and
- Ranking the accumulative design options, drawing a LCC-curve and identifying the Least Life Cycle Cost point and the BAT point.

For products, where the analysis has indicated that 'energy consumption in use' is, by far, the most significant impact of the product, the drawing of the LCC-curve can be constructed without the need to consider the other environmental impacts associated with the product. However, in the case of the multimedia products covered in this preparatory study, a comprehensive assessment of the importance of each environmental impact has been carried out.

6.2.1 Ranking of Options

When comparing options, difficulties can arise. For example, if one option can offer potential savings in electricity consumption and another option can offer potential savings in (say) the amount of non-hazardous waste to landfill, which option is better? Comparing the importance of individual environmental impacts is a well-known problem to life-cycle assessment practitioners. The usual solution is to adopt a method of standardisation of the importance of different impacts. Normally, this is done within the context of the particular assessment under consideration. Such a standardisation could be based on expert/panel decision, but this approach runs the risk of being biased (because it reflects the opinion of the particular group of experts used). An alternative, more objective approach[70] is to compare the particular environmental impact for the product under consideration with the total European environmental impact for that impact category (e.g. electricity consumption of the product with total electricity consumption in Europe in a given year).

For consideration of the ranking of options for this preparatory study, the latter approach, called normalisation, has been taken. The figures for these total European impacts have been derived from either published data (e.g. Eurostat, European Environment Agency) or from CML[71] life-cycle normalisation data. Table 56 below shows the derived figures.

[70] The approach has been used in the EIPRO study
[71] CML, Institute of Environmental Sciences, Leiden University, http://www.leidenuniv.nl/interfac/cml/ssp/index.html

Table 56 - Total Annual Environmental Impacts (EU-27)

Impact Category	Amount	Units	Reference
Resources:			
Materials	48.5	Mt	Plastics. Ref: Plastics Europe (demand by EU converters)
	206	Mt	Ferrous metals. Ref: Iron & Steel Statistics Bureau
	1.8	Mt	Non-ferrous metals. Ref: World Bureau of Metal Statistics (Al, Cu, Pb, Ni, Zn)
	10	Mt	Glass. Ref: EC Summary of Impact Assessment on WEEE (SEC(2008)2934)
	88	Mt	Paper/Cardboard. Ref: CEPI (EU consumption)
Total Energy Consumption	74,438,775,000,000	MJ	Ref: Eurostat, Energy - Monthly Statistics, EU-27, 2008
Total Electricity Consumption	2,843,240	GWh	Ref: Eurostat, EU-27, 2007 (Industry+Transport+Household/Services)
Total water use	247,000	M m3	Ref: http://ec.europa.eu/environment/water/quantity/pdf/exec_summary.pdf
Total non-haz waste	2,947	Mtpa	Ref: http://epp.eurostat.ec.europa.eu/statistics_explained/index.php?title=File:Generation_of_waste,_total_arising_and_by_selected_economic_activities.PNG&filetimestamp=20090430100020
Total Haz waste	89	Mtpa	Ref: http://epp.eurostat.ec.europa.eu/statistics_explained/index.php?title=File:Generation_of_waste,_total_arising_and_by_selected_economic_activities.PNG&filetimestamp=20090430100020
Emissions (air)			
Total GHG emissions	5,045	Mt CO2eq	Ref: Eurostat, March 2010, Using Official Statistics to calculate GHG emissions - a statistical guide
Total acidifying potential	16,800	Kt SO2 eq	Ref: CML Characterisation and Normalisation factors
NMVOC	8,951	Kt	Ref: EEA Air pollutant emissions EU-27 2007
POPs	5,728	g i-Teq	Ref: http://www.pvc.org/Sustainability/PVC-recycling-in-Europe/PVC-incineration-dioxins, EU-15+No and CH, 1995
HM (air)	121,479,208	t Ni eq	Ref: CML Characterisation and Normalisation factors
PAHs	30,600,000	kg	Ref: CML Characterisation and Normalisation factors
Total PM formation (PM10)	18,320	Kt	Ref: EEA Air pollutant emissions EU-27 2007
Emissions (water)			
HM (water)	42,773	t Hg	Ref: CML Characterisation and Normalisation factors
Eutrophication	13,200,000,000	kg PO4eq	Ref: CML Characterisation and Normalisation factors

Table 57 below summarises the Eco-report outputs for the environmental impacts of the Base Cases for the stock in 2008.

Table 57 - Summary Environmental Impacts of Base Cases (Stock 2008)

Category	Units	Video players	Video recorders	Projectors	Games consoles
Materials	kton	62	18	7	103
Total Energy (GER)	PJ	47.9	20.1	12.1	56.4
of which, electricity	TWh	3.4	1.6	1.0	3.3
Water (process)	mln.m3	4.3	1.7	0.9	9.6
Waste, non-haz./ landfill	kton	180.7	59.9	30.0	284.2
Waste, hazardous/ incinerated	kton	11.4	3.5	2.4	15.2
Greenhouse Gases in GWP100	mt CO2eq.	2.4	1.0	0.6	3.1
Acidifying agents (AP)	kt SO2eq.	13.8	5.6	3.2	18.6
Volatile Org. Compounds (VOC)	kt	0.1	0.0	0.0	0.2
Persistent Org. Pollutants (POP)	g i-Teq.	1.2	0.4	0.1	1.2
Heavy Metals (HM), air	ton Ni eq.	2.8	0.9	0.4	4.0
PAHs	ton Ni eq.	0.6	0.2	0.1	2.6
Particulate Matter (PM, dust)	kt	5.9	1.7	0.7	9.7
Heavy Metals (HM), water	ton Hg/20	0.8	0.3	0.1	5.6
Eutrophication (EP)	kt PO4	0.1	0.0	0.0	0.1

Table 56 and Table 57 have been used to derive a normalisation factor for each impact category on the relative importance of each impact category in relation to the total European impact for that category. For comparison of product types, the results have been normalised in the table below.

Table 58 - Relative Importance of Impact Categories (Normalised)

	Video players	Video recorders	Projectors	Games consoles
Materials	5.01%	3.66%	2.13%	6.45%
Total Energy (GER)	0.02%	0.02%	0.02%	0.02%
of which, electricity	34.48%	40.13%	45.31%	26.18%
Water (process)	0.50%	0.49%	0.47%	0.87%
Waste, non-haz./ landfill	1.76%	1.46%	1.28%	2.15%
Waste, hazardous/ incinerated	3.67%	2.81%	3.40%	3.80%
Greenhouse Gases in GWP100	13.75%	13.91%	13.79%	13.48%
Acidifying agents (AP)	23.57%	24.07%	24.32%	24.63%
Volatile Org. Compounds (VOC)	0.30%	0.24%	0.19%	0.45%
Persistent Org. Pollutants (POP)	5.99%	4.90%	3.01%	4.71%
Heavy Metals (HM), air	0.65%	0.54%	0.38%	0.74%
PAHs	0.60%	0.47%	0.45%	1.89%
Particulate Matter (PM, dust)	9.18%	6.87%	4.83%	11.73%
Heavy Metals (HM), water	0.51%	0.44%	0.43%	2.92%
Eutrophication (EP)	0.00%	0.00%	0.00%	0.00%
TOTAL:	**100.00%**	**100.00%**	**100.00%**	**100.00%**

The high impact of acidification shown in the table above is believed to be a consequence of the emissions of acidifying agents during electricity generation.

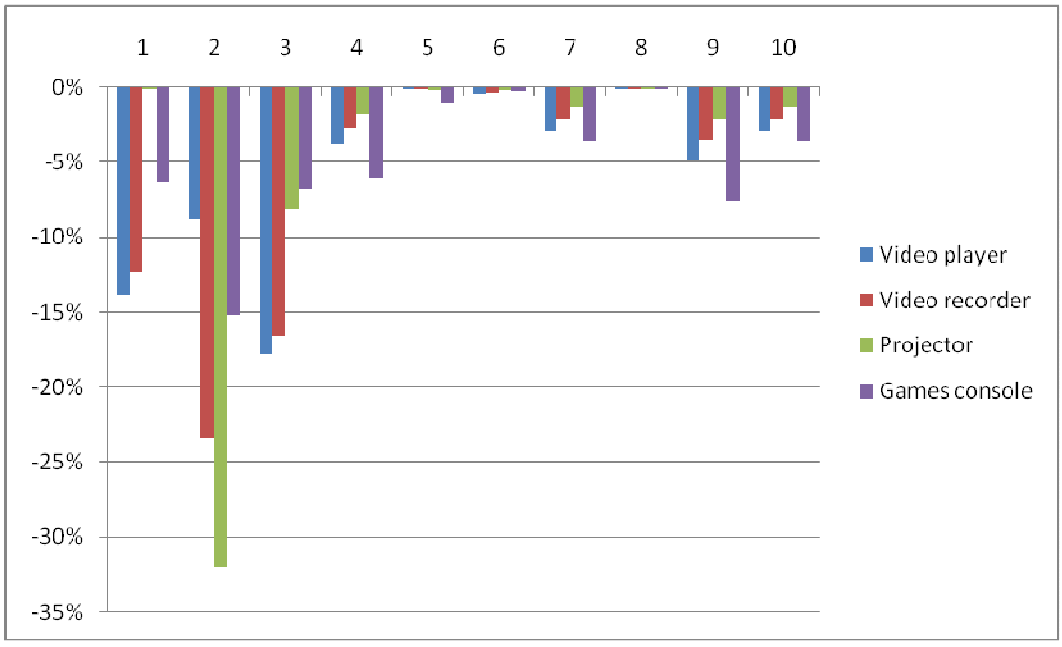
These calculated normalised scores are reasonably consistent across all four base cases considered. These reflect the similarity of impacts exhibited by these product types. Note: it is worth pointing out that there may be causal linkages between different impacts. For example, the normalised scores for electricity consumption and acidification may be connected due to the way that electricity is generated. For every base case and option considered, the normalised factors for each impact category can be calculated and then totalled to give a total score for each base case and each improvement option (the study team shall refer to these as 'Option Scores'). These option scores have been used to assess the relative importance of a particular design option whilst taking into consideration <u>all</u> environmental impact categories. Note: it has been assumed that no impact category is more important than another, hence no weighting between impact categories is applied, but the normalised factors derived indicate the importance within the context of the total European impact for each category. The option scores are compared with the base case option scores in order to identify which options offer greater benefits. The option score for option "j" would be calculated as follows:

Equation 1 - Calculation of Scores

$$Total\ score\ for\ option\ j = \sum_{i=1}^{n} Wij \div Ti$$

Where W_{ij} is the impact for the i^{th} impact category for option j, and T_i is the total European impact for the particular i^{th} impact category.
For each individual option, the scores obtained relative to the base case (i.e. Base Case is zero) for each product type are presented graphically in Figure 15 below.

Figure 15 - Scores for each individual design option



Note: negative numbers denote savings / improvements.

Although these option scores are presented without consideration of the relative life-cycle cost changes for each option, the relatively higher negative scores (savings) are derived for options 1 (auto power down), 2 (Operational mode requirements), 3 (off switch), 4 (product lightweighting), 7 (improved recyclability), 9 (reusable components) and 10 (minimum recycled content for plastics) for all product types.

6.2.2 Estimating Accumulative Improvement Potential

Combining two or more individual design options has the potential to achieve greater improvements than individual design options on their own. Implemented together as part of the design cycle of these products, it may be possible to exploit cost savings or cost cancelling out. Thus, the life cycle cost of implementing a combination option may turn out less than the sum of the costs of the individual options. This would result in a 'win/win' solution being found. Clearly, what is and what is not possible to achieve is a well-guarded secret within the design departments of each company. Therefore, the study team has applied its expert judgement to estimate savings possibilities.

Clearly, option 1 and 3 are extremely unlikely to be combined in practice, because they are essentially doing the same action. Indeed, the study team would go further to suggest that the uptake of option 3 is likely to be very low because of the greater additional costs compared with option 1. Also, as options 7 and 10 are essentially addressing the same issue (that of recycling of plastics) with different approaches, it would not make much sense in combining these together unless there were costs that could be compensated for by costs savings elsewhere (in this assessment, none have been identified).

Given the rapid technological change that these multimedia products are currently experiencing, option 8 (extend product lifetime through improved product durability) has not been considered for grouping because a) it has a relatively low score (low savings potential), and b) it would tend to act against product innovation and is more appropriate to 'more mature technology' products.

Thus the main improvement suggestions are options 1, 2, 4 and 9. These have been used to generate accumulative design options. From inspection of the LCC savings of the individual options, the following combinations would appear to offer the greater chances of complementary overall savings (both impacts and costs).

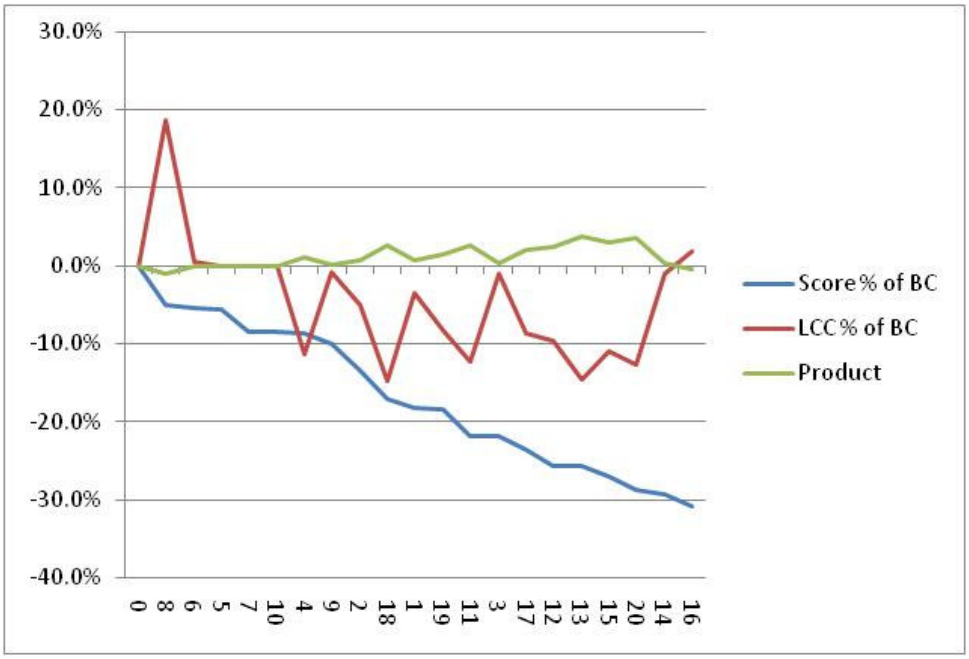
Table 59 - Accumulative Design Options

Option No.	Combinations	Description
11	1+4	APD feature and product lightweighting
12	3+4	Hard off-switch and product lightweighting
13	1+4+9	APD feature, product lightweighting and reusable components
14	3+4+9	Hard off-switch, product lightweighting and reusable components
15	1+4+9+(7 or 10)	APD feature, product lightweighting, reusable components and improved recycling
16	3+4+9+(7 or 10)	Hard off-switch, product lightweighting, reusable components and improved recycling
17	1+2	APD feature and operational mode requirements
18	2+4	Operational mode requirements and product lightweighting
19	2+4+9	Operational mode requirements, product lightweighting and reusable components
20	1+2+4+9	APD feature, Operational mode requirements, product lightweighting and reusable components

These combination options have been assessed using Eco-report in the same way as for the individual options. The results for these have been appended to the results for the individual options to provide an array of option scores and the associated LCC costs for the options in order to draw a LCC-Curve for each product type. In order to scale these on the same graph, percentage variation from base case (BC) has been used. The LCC-curves are presented in Figure 16 to

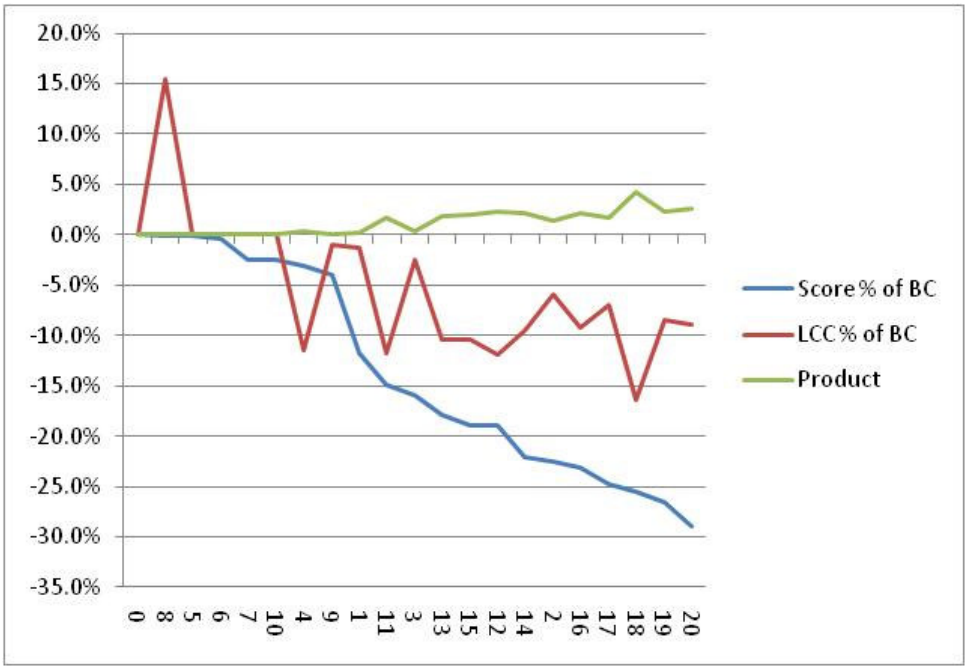
Figure 19 below. The BAT point is the option number that delivers the greatest improvement score, and the LLCC point represents the point where both improvements in score and improvement in LCC is optimised. This is the option where the product of the improvement in score and improvement in LCC is the greatest (i.e. the maximum point on the “Product” curve in each of the figures.

Figure 16 - LCC-Curve (Video players)



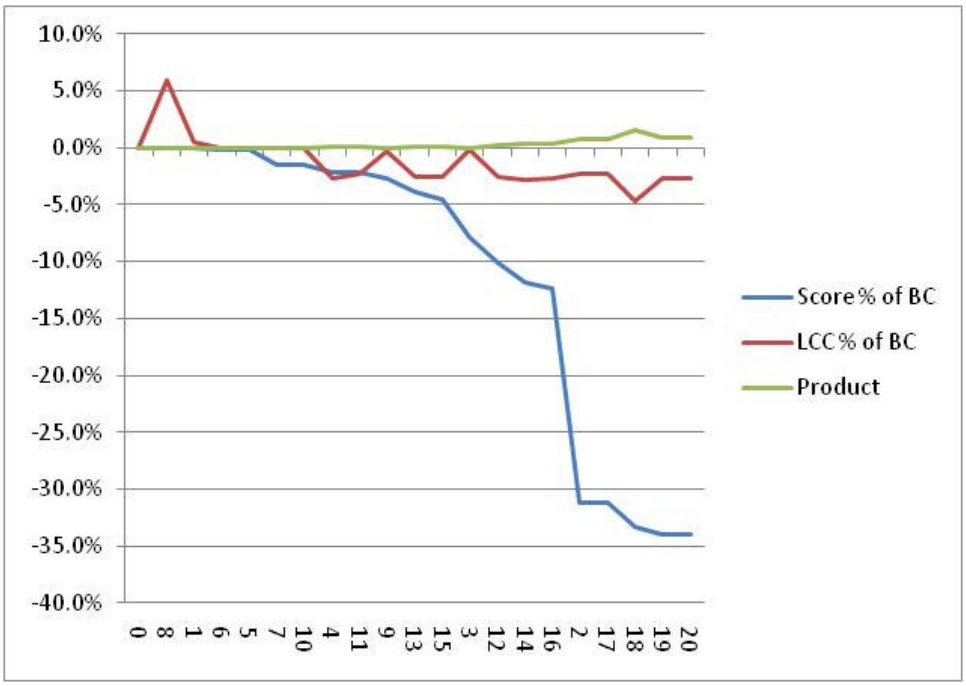
Although the study team have yet to consider a sensitivity analysis of the main parameters, the LCC-curve for video players would suggest that the LLCC point occurs for option 13 (a combination of APD feature, product lightweighting and reusable components). Coming close to this are option 20 (a combination of APD feature, operational mode requirements, product lightweighting and reusable components) and option 18 (a combination of operational mode requirements and product lightweighting). The figure implies that the BAT point (option 16) is likely to be a multiple combination of several individual options probably a combination of operational mode requirements, product lightweighting, reusable components, APD feature, hard off-switch, and improved recycling.

Figure 17 - LCC-Curve (Video recorders)



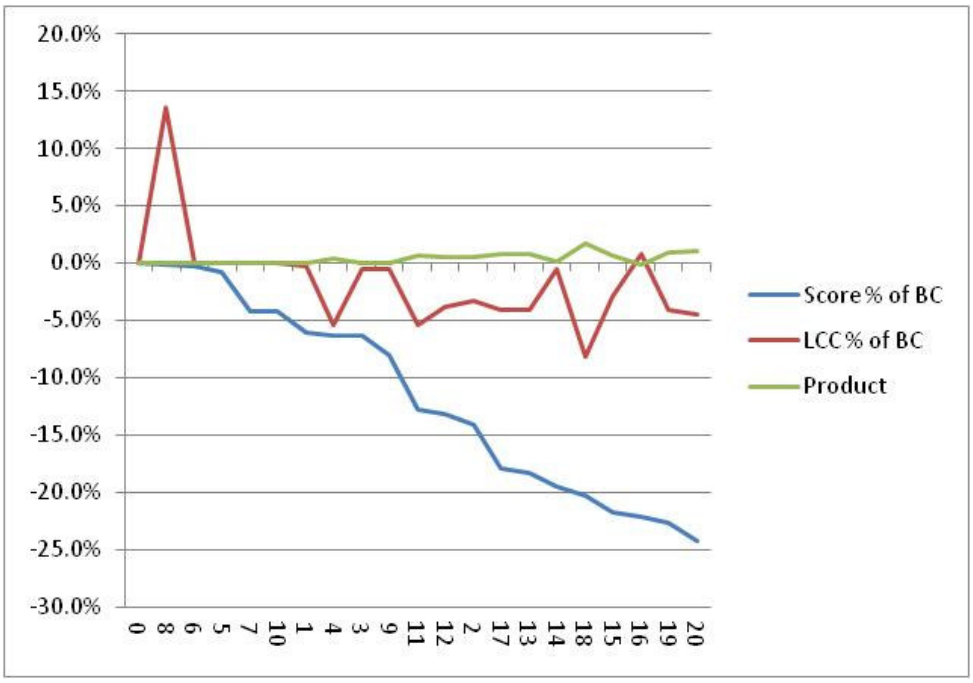
For video recorders, the LLCC point would appear to be option 18 (a combination of Operational mode requirements and product lightweighting), but a sensitivity analysis of the main parameters is required to confirm this. Worthy of mention are options 11/12 (indicating there is very little difference in the figure between the options with hard-off switch/APD) with reference to the task 7 recommendation for video players/recorders. Again, the figure implies that the BAT point (option 20) is likely to be a multiple combination of several individual options probably a combination of operational mode requirements, product lightweighting, reusable components, APD feature, and hard off-switch.

Figure 18 - LCC-Curve (Projectors)



For projectors, the position for the LLCC point is option 18 (Operational mode requirements and product lightweighting) appearing to offer the greatest savings score at low LCC. Again, this observation is in the absence of a sensitivity analysis on the main parameters. The figure implies that the BAT point is, as expected, the setting of operational mode power requirements to the BNAT (very soon to become BAT) with reusables components (Option 20, a combination of APD feature, Operational mode requirements, product lightweighting and reusable components). Note that option 2 has a lower LCC than option 1.

Figure 19 - LCC-Curve (Games consoles)



For games consoles, the LLCC point appears to be option 18 (Operational mode requirements and product lightweighting). Coming close to this is option 20 (APD feature, Operational mode requirements, product lightweighting and reusable components). Worthy of mention is option 11 (APD feature and product lightweighting) - see task 7 recommendations for game consoles. Again, a sensitivity analysis on the main parameters is required to confirm this. Again, the figure implies that the BAT point (option 20) is likely to be a multiple combination of several individual options probably a combination of operational mode requirements, product lightweighting, APD feature, reusable components, improved recycling, and hard off-switch.

To summarise:

Item	LLCC Point	Combination of:	BAT point	Combination of:
Video player	Option 13	1+4+9	Option 16	3+4+9+(7 or 10)
Video recorder	Option 18	2+4	Option 20	1+2+4+9
Projector	Option 18	2+4	Option 20	1+2+4+9
Games console	Option 18	2+4	Option 20	1+2+4+9

6.3 BNAT and long-term systems analysis

Due to the commercially sensitive nature of research and development, it is difficult to persuade manufacturers to disclose those developments that they have in the pipeline for introduction in the coming two or three years. The following is an educated assessment of likely new product developments.

Video players/recorders

A comprehensive discussion of the long-term potential for video players/recorders has already been provided in subtask 5.3 (Definition of BNAT). In the long-term, the perfect video system would be a compromise of offline storage, local network storage, and on-line. The mix would be determined by a number of factors dominated by internet speeds, the on-line video marketplace, consumer compromise between high quality and instant access, and existing libraries.

Technical solutions are likely to be developed that would cover reducing processor power requirements, disk drive power consumption, network standby power consumption, and using efficient software and power management for minimising fast start use and/or fast start power consumption.

The discussion in subtask 5.3 concluded that BNAT for video players/recorders is defined as:

"a product which consumes less than 5W in on-mode, with a standby of 0.1W or less, does not have a fast start mode, and would auto power down within 5 minutes in idle-mode."

The improvement of idle / quick start mode can be considered to be under BAT. The possible savings have been assessed under options 2 and 17 in the previous section.

It was also concluded that the main barrier is the extra cost and the time needed to develop efficient products whilst ensuring product reliability – difficult to achieve against the current market trend to reduce costs and introduce new features as fast as possible.

Several brands are developing new online storage options. These are Internet access providers such as Deutsche Telekom, 1&1, HDD suppliers such as LaCie wuala (http://www.wuala.com/), Apple and others. They are implementing big "server farms" at present. This would increase the online traffic to another dimension and create a vast demand for energy for the servers and for the additional Internet infrastructure.

Concerning the plastic material content there are similar requirements from Blue Angel (UZ-144) for this category as for projectors mentioned below. (The English version of UT-144) is not available yet)

Projectors

The technology development situation for projectors appears to be moving rapidly in the area of light source developments through the development of high efficiency primary colour LED sources. This combined with the precision moulding of efficient anamorphic lenses would provide a step-change in light engine efficiency. It is quite possible that BNAT will become BAT within three years or sooner. Many of the design options assessed in the previous section could be consequential in these developments (e.g. use of LEDs with efficient cooling allowing the form factor of projectors to be reduced thereby contributing to product lightweighting, reusable lens assemblies etc.). Thus the choice of potential design options and combinations of these bears a reasonable reflection of these developments.

The material requirements from Blue Angel UZ 127 for projectors are worthy of mention (see box below) as these requirements could have an influence on future levels of plastics use and its subsequent recycling.

(3.3 Material Requirements for Plastics used in Casings and Casing Parts)

The plastics used in device casings may not contain halogenated polymers and additions of halogenated organic compounds (e.g. as flame retardants).

The following substances shall be exempt from this rule:

· Process-related technologically unavoidable impurities.

· Fluoroplastics as, for example, PTFEs.

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· Plastic parts weighing less than 25 grams. However, these parts may not contain PBBs (polybrominated biphenyls),

PBDEs (polybrominated diphenyl ethers) or chlorinated paraffins.

Substance bans according to Section 5, Electrical and Electronic Equipment Act (ElektroG) shall be complied with.

In addition, no substances may be added to the plastics which are classified according to Directive 67/548/EEC as

· carcinogenic according to Carc.Cat.1, Carc.Cat.2 or Carc.Cat.3,

· mutagenic according to Mut.Cat.1, Mut.Cat.2 or Mut.Cat.3;

· reprotoxic according to Repr.Cat.1, Repr.Cat.2, or Repr.Cat.3

or which are classified in TRGS 905.

Compliance Verification

The applicant shall name the casing plastics used in parts weighing more than 25 grams (Annex 5 to the Application). With respect to the ingredients and flame retardants the applicant shall prompt the plastic suppliers to present a written statement (Annex 6). This also applies to the recyclate plastics used. Provided that the flame retardant data (chemical designation, CAS-No.) have to be treated confidentially the plastics supplier shall be entitled to directly file Annex 6 with RAL.

Games consoles

It is difficult to predict which way forward will be taken in the next generations of games consoles. Many factors are involved relating to consumer demands, functions/usage modes required and their energy consumption implications, product convergence, technology limitations (e.g. internet speed), and processor developments. Two possible routes were discussed in subtask 5.3 – high specification games console and thin client based console. The conditions for BNAT have been described for both in subtask 5.3.3.

The energy efficiency of newer models of a product tends to improve over time through frequent adjustments/improvements to model versions. This makes it difficult to be too prescriptive about requirements for on-mode power consumption limits. Furthermore, the games console industry has commented that on-mode should take into consideration the on-mode situation for PC gaming machines in order to establish a level playing field for both gaming products (see subtask 7.1).

6.4 Sensitivity analysis of the main parameters

6.4.1 Price Sensitivity

It is clear from the assessment of improvement options that the assumed product price is a major parameter that can affect the LCC-curve – especially for options 4 (product lightweighting) and 8 (extension to product lifetime). The effect of product price variation on the Base Cases has been examined by applying a 5% increase and decrease to the product price in the Eco-report. The resulting effects on the unit life cycle costs for each product type are presented in the table below.

Table 60: Unit LCC Variation in Relation to Product Price Variation

Product Price Variation	Video Players	Video recorders	Projectors	Games consoles
+5%	103.7%	103.9%	102.2%	104.6%
0	100.0%	100.0%	100.0%	100.0%
-5%	96.3%	95.7%	97.7%	95.4%

The table above indicates that the product price has a significant effect on the life cycle cost of the products – much greater than the effects of changes to electricity prices or discount rates (see next section).

The effects of price sensitivity on the total consumer expenditure on these products for 2008, 2014 and 2020 are presented graphically in Appendix 1. For each product type, the variations in consumer expenditure reflect the unit life cycle cost variations.

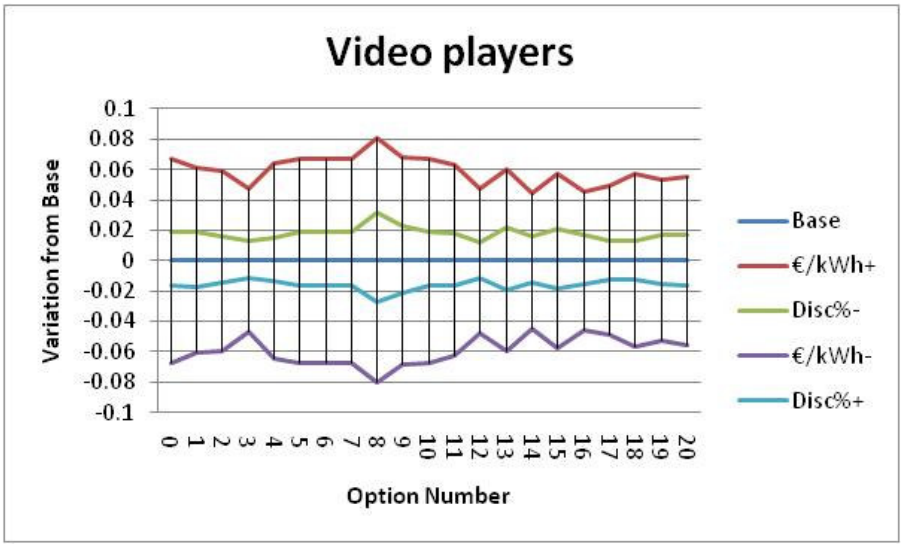
6.4.2 Cost Sensitivity

The price of electricity consumed and the applicable discount rate could have a significant effect on the LCC of video players, recorders, projectors and games consoles. The variation in production costs has already been included among the options assessed (where product price has been varied according to the assumed effects of certain options). Thus, the following relevant factors have been analysed:

- Price of energy (electricity) – increase/decrease by 25%
- Discount rates – increase/decrease by two percentage points

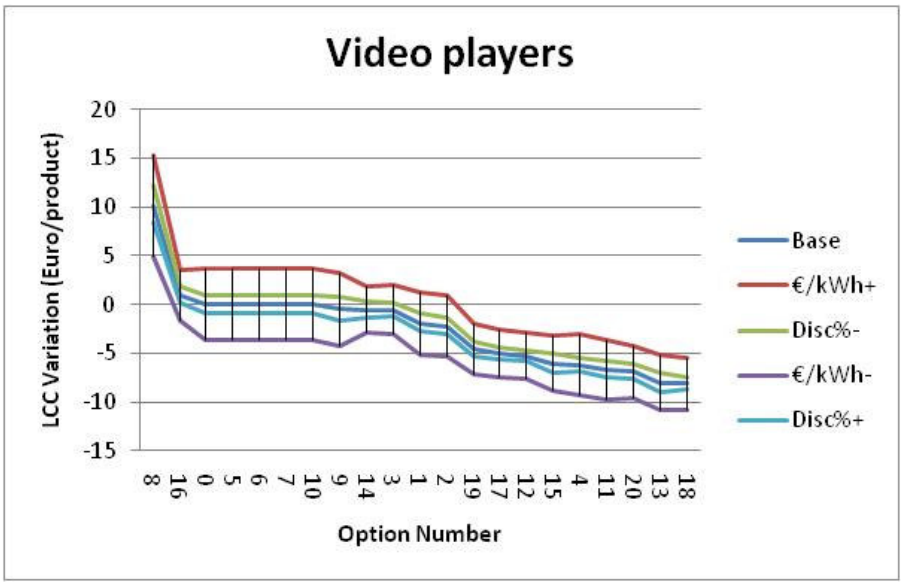
The variation of LCC resulting from the above changes has been calculated (through Eco-report) for the Base Cases and for each of the options (1 to 20) for each of the product types. Results tables for each product type are presented in Appendix 1. Generally, a plus or minus 25% change in electricity price results in about a 4-8% change in the life cycle costs of each product, and a plus or minus 50% change in the applicable discount rate results in about a 2% change in life cycle costs of each product. There is a slight variation option by option. This is illustrated for video players below.

Figure 20 - Option Sensitivity to Electricity Price and Discount Factor



And the variation from the original Base Case LCC can be plotted as follows.

Figure 21 - LCC sensitivity to Electricity Price and Discount Factor



LCC savings appear on the above figure as negative numbers for Euros per product. The figure suggests that options 19, 17, 12, 15, 4, 11, 20, 13 and 18 can result in clear LCC savings (i.e. always negative) despite the variations to electricity price and discount factors used, given the bounds of variability due to the assumed price changes and discount rate changes. However, it must be pointed out that there could well be LCC savings for other options if price changes and discount rate changes are not as great as those assumed for this analysis.

The Figures for video recorders, projectors and games consoles are presented in Appendix 1. These illustrate that clear LCC savings are possible for the following options for each product type.

- Video recorders – Options 2, 17, 18, 20, 16, 14, 13, 15, 4, 11 and 12
- Projectors – Options 11, 2, 17, 13, 15, 12, 20, 19, 16, 4, 14 and 18
- Games consoles – Options 15, 2, 12, 17, 19, 13, 20, 4, 11 and 18

In conclusion, given the assumptions made, this sensitivity analysis suggests that, apart from product lightweighting (option 4), the options most likely to deliver clear savings are combinations of individual options which seek to maximise the environmental benefit.

6.4.3 Use Pattern Sensitivity

The original initial screening produced during the early stages of this study indicated the possible energy savings potential for these products (video players / recorders, projectors, and games consoles). The purpose of this screening was to illustrate the approximate scale of the potential savings in electricity consumption that might be possible. These were estimated at savings[72] of 12.44 TWh by 2015 and 15.04 TWh by 2020 based on the usage patterns that were assumed for the different products (hours per day in the various operational modes of the products. These usage patterns were based on estimation of the average times spent in the various modes as a consequence of the consumers' use of the products (see Task 3 Section – Consumer Behaviour). These estimations were based on the limited data available. Feedback received from the second stakeholder meeting and the draft Task 1-5 Report was in general agreement with these estimations, but there were a few exceptions - enough to justify examining the sensitivity of the eco-report results to changes in usage pattern.

The assessment of the base cases has indicated that the total electricity consumption for the stock in 2008 is about 9.37 TWh (c.f. 8.63 TWh in the first screening). The difference in the two estimates is

[72] A significant part of these savings can only be achieved with operational mode power requirements.

most likely attributable to additional electricity consumed in the other life cycle stages for these products. Whilst the initial screening forecasted a modest increase in overall EU stock in use levels, given the rapid development in technology, the stock in later years comprises mainly newer models with greater power demands and longer active use times due to many factors including increased functionality enhancing the 'consumer experience' . The initial screening suggested that total electricity consumption will rise significantly (to 25.91 TWh in 2015 and to 29.67 TWh in 2020). This is another important reason for examining the sensitivity of usage pattern.

Manufacturers of these products are continuously improving, where possible, the efficiency of their models, which helps to reduce the overall electricity demand. However, it is clear that significant savings could be achieved through changing usage patterns (e.g. time in active-mode, fast-start-mode and idle-mode kept to the minimum necessary). Encouraging change towards more efficient usage patterns has been dealt within the assessment of improvement options. The analysis of usage pattern sensitivity to the basic estimations will enable us to see how significant those improvement options will be in comparison with the effects of variability in usage pattern.

Table 61 - Usage Patterns (Base Cases) (Hours/day)

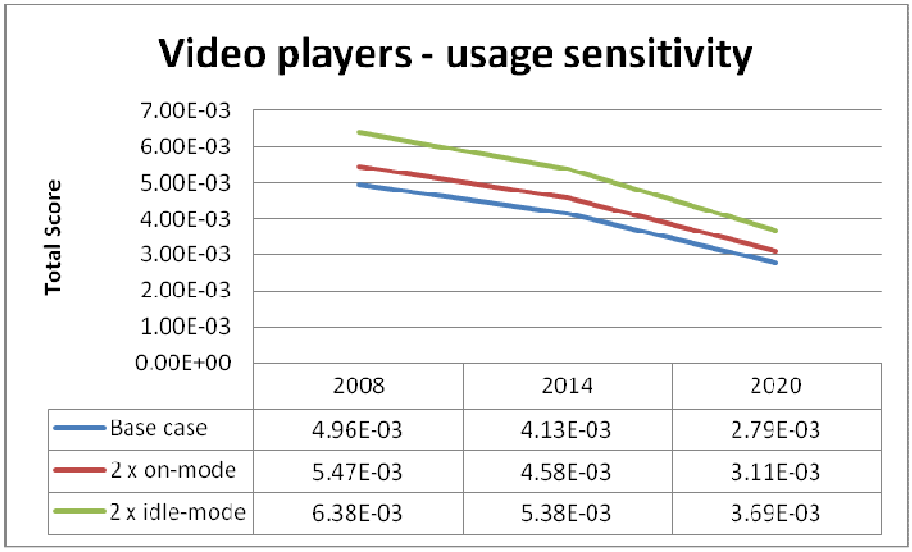
Mode	Video player	Video recorder	Projector	Games console
on/active mode:	1.04	1.04	1.37	0.57
Idle mode:	4.31	4.31		1.41
Standby mode:	17.45	17.45	0.34	10.00
Off	1.20	1.20	22.29	12.02

Establishing a typical usage pattern for these products was difficult given the limited data to date. Individual consumer usage can vary widely. For example, impromptu internet polls amongst gamers often indicate that some gamers can spend over 10 hours per day on their games consoles at weekends. However, these gamers probably represent the extreme end of high usage. Conversely, some games consoles may be used only on rare occasions. A typical average usage is hardly going to reflect these extremes. Thus it is not surprising that stakeholder responses to the usage patterns used for this study have varied widely. To embrace these stakeholder responses the study team have examined the following intentionally wide variations and their impact on the base cases.

- A doubling of the time spent in active mode (on-mode), and
- A doubling of the time spent in idle or quick-start mode.

Given that the study team are examining average timings, the former represents a major shift in the balance of consumers who are heavy users of their products, and the latter represents a major shift in the balance of consumers who either do not switch off their products or leave them on purpose in quick response mode for convenience.

The full results from these input changes to the EcoReport for the four base cases are given in Appendix 1. As an example, the results for video players are shown graphically in the figure below which clearly shows the effects on the total environmental impact scores. (Note: the stock levels for video players has been forecast to decline in future mainly through the substitution by video recorders).



	2008	2014	2020
Base case	4.96E-03	4.13E-03	2.79E-03
2 x on-mode	5.47E-03	4.58E-03	3.11E-03
2 x idle-mode	6.38E-03	5.38E-03	3.69E-03

The figure above shows that the score variation for changes in idle (quick-start) mode times is approximately three times that for changes to on-mode times. This is a reflection of the difference between the average on-mode time and the average idle-mode time used in the Base Case. Thus, as a first approximation, an increase of about one hour/day to either the average on-mode time or average idle-mode (quick start) tends to increase the total environmental impact score by about 10%. This approximate relationship has also been found to be the case for video recorders and games consoles, which show similar approximate increases. (Note: the results for projectors are different, because these products tend to be either on or switched off when not being used, and there is no idle / quick-start time).

This level of variation in the total environmental impact score is about the same order of magnitude as the level of benefits derivable from the improvement options assessed earlier. Thus it is very important that the average times in the various operational modes represent as closely as possible the average of actual usage patterns for these products. By applying a wide variation to the limited user behaviour data used , the study team have demonstrated there is a relative robustness (e.g. 100% increase to operational mode times often leads to a modest increase in total environmental score). However, better user behaviour data is needed. Such information on user behaviour is being further researched (for example, the games console industry claim to be working on further analyses of consumer usage patterns). Confidence in the average times for the various operational modes will increase as more data becomes available.

6.4.4 Uncertainty of technology development

The products in this study are in a field of rapid technology change. There is a high degree of uncertainty about which ways technology developments might go. Thus, it is only possible to make qualitative opinions (see task 7) and therefore a sensitivity analysis of this aspect has not been taken into account.

6.5 Conclusions

In all of the product types assessed in this task, there is a common theme of improvement suggestions that appear to offer the LLC point. These are:

- Operational mode requirements
- Product lightweighting
- APD feature
- Reusable components

Combination of two or more of these above improvement options leads to the LLC point for these products. This provides the basis upon which recommendations for policy actions can be made (see Task 7). Note that although the incorporation of APD (option 1) showed little improvement for projectors, this does not mean that its use as an improvement option should be ignored. A power down feature is already utilised in conventional projectors as part of the lamp cooling regime for protecting the lamp life. With technology trends towards the use of LED/laser lamp combinations in projectors, lamp life protection is no longer an issue. Therefore it is important to ensure that APD is retained and not dispensed with (see Task 7).

7. Policy and impact analysis

7.1 Introduction

Task 7 looks at suitable policy means to achieve the separate potential improvements for the three product groups (Video players / recorders, Projectors and games consoles) providing the specific performance of BAT or BNAT for each product group as specific benchmarks, using dynamic aspects concerning the further development of each *product group, implementing measures or voluntary agreements, standards, labelling or incentives, relating to public procurement and economic instruments.* It draws up scenarios for the years 1990–2025 quantifying the improvements that can be achieved versus a Business-as-Usual (BAU) scenario and compares the outcomes with EU environmental targets, the societal costs if the environmental impact reduction would have to be achieved in another way.

Task 7 provides specific estimates of the impact on users (purchasing power, societal costs) and industry (employment, profitability, competitiveness, investment level, etc.), explicitly describing and taking into account the typical design cycle (platform change) in a product sector for all three product groups.

In Task 7 an analysis of which significant impacts may have to be measured under possible implementing measures, and what measurement methods would need to be developed or adapted is provided.

The analysis of the three different product types is presented separately as follows:

- Video players / recorders
- Projectors
- Games consoles

7.2 Video Player/Recorder

7.2.1 General considerations

Anticipated potential developments in video player/recorders technology

Potential developments in video player recorders are explored in task five, and present a very diverse range of possible products. The most significant changes are expected to be:

- new storage media, in particular solid-state
- higher power standby or idle modes to reduce start up and transition times between standby and on modes
- increases in networking and Internet access
- higher quality and more of immersive audio and video

The consequence of the technology changes is that on power, and standby power could increase to accommodate the increased functionality and processing requirements to decode and access video content. This could also result in different use profiles such as downloading or consumers choosing more on-demand content instead of traditional broadcast TV. Because of the different potential routes for product development it is difficult to specify and predict power levels and technologies. There are a number of general technologies and standards that can help manage and control power consumption which could be applied or should continue to be applied aggressively.

However, it is also recognized that while on power may increase use time can be low and does not represent a significant portion of the total energy consumption.

Definition of video player/recorders and excluded products

Following the definition risk assessment of Task 1, the definition of video players/recorders is given in the box below:

Based on the definition risk assessment, a video player/recorder is a stand alone device whose primary function:

- **Decodes video to an output audio/video signal**
- **from recorded or recordable media via a powered or integrated media interface such as an optical drive, USB or HDD interface**
- **Has no tuner[73] unless it records on a removable media in a standard library format[74]**
- **Is primarily mains powered**
- **Does not have a display for viewing video**
- ~~**Is not designed for a broad range of home or office applications**~~
- Video recorders additionally provide the option to record video and audio on a data storage medium.

It is proposed that the task 1 definition 'is mains powered' be changed to 'is primarily mains powered' to prevent a potential loophole for video player/recorders that might use auxiliary battery power for eg maintaining clock functions when unplugged or back-up functions. This includes common products such as DVD players and Blu ray players or recorders.

The final bullet point, designed to distinguish between a computer and video recorder is removed because it is not possible to clearly define what is a 'broad range of home or office applications'. Computers are not considered to fall into the definition because they are general purpose electronics with a broad range of functions. To ensure that there is no overlap between the products groups, computers are explicitly excluded from the scope of any policy recommendation for video players/recorders.

Current video player/recorder devices include:

- DVD players
- DVD recorders (with and without HDD)
- Blu-ray players
- Blu-ray recorders (with and without HDD)
- HDD players

Video player/recorders are considered to be a subset of a larger group of audio/video equipment. Common audio/video equipment not covered under the definition of video player/ recorders include:

- complex set-top boxes
- simple set-top boxes
- camcorders
- cameras
- televisions
- computers
- game consoles

[73] A tuner decodes broadcast signals to audio/video signal.
[74] An industry agreed format defining file structure, media encoding and physical format which provides media compatibility across products.

- audio only media players/recorders
- portable media players
- thin clients for only streaming video
- ambient devices[75] and internet connected consumer electronic providing background data and streaming such as the Chumby[76]. These products require a display for interaction and are therefore excluded.

In addition, the recommended policy and ecodesign requirements are not intended to cover:

- stand-alone video cassette recorders – a video player recorder that is only capable of accessing video content from analogue magnetic tape media.
- professional video equipment which use non-standardised video signals such as SDI or are classified under EN 60601-1-2 for medical equipment, EN 50130-4:1995 + A1:1998 + A2:2003 or EN 55103-1-2.
- video player/recorders with integrated audio amplifiers which are designed to be connected directly to unpowered speakers. There is no test data that suggests the audio circuitry can be power managed to consume 0W due to high integration of the processing electronics. The audio amplifier segment that could not be separated for testing purposes gives the main part of the energy consumption of such devices. Audio amplifiers are not in the scope of the study. While, it is possible to set such criteria on a voluntary agreement based on limited available data, this is not considered sufficient for an implementing measure. With additional data an adder could be developed to take into account the additional overhead if necessary, but this has not been addressed in this study.

High performance video player/recorders

There is a small market for video players and recorders with very high specifications in terms of the materials, aesthetic design, electronic design and performance. These generally provide higher video and audio quality by improving the electronics used. For audio/video this includes reducing the electrical noise in the output signals using very high quality filtering of the power and discrete components. The devices are also able to read the disc data with higher accuracy without relying on error correction data. Because the data is encoded in a lossy format, the audio/video can be improved by using more advanced decoding and post processing which the user to adjust to suit their tastes. Another key benefit is the timing which determines when the individual audio and video frames are played is also more accurate.

High performance products also provide an important market route to introduce new innovations very rapidly. By selling the products as early as possible and at a relatively high price, the R&D costs can be recovered sooner and the forward risk of investment is reduced. This is not possible with very low margin mainstream market devices. These innovations are often introduced to the mainstream market over time. A very basic example of this is the Blu-ray player which started at approximately €1,000 when introduced in 2006 offering much higher quality than DVD. The price of a BD player has now dropped by a factor of 10 and will likely continue to fall.

As a result of the improved performance and immature technology, the power consumption of high performance devices is generally higher than mainstream devices, which use more mature, lower cost, highly integrated components. While there is a very wide range in the power consumption, from 35-150W they generally consume around 50W and the technology does not exist to reduce this without significant additional R&D investment and delaying the time to market, which increase the risks of such a development. Therefore, high performance products could require additional consideration when developing policy.

The development of highly integrated chips that offer an additional increase in power efficiency is only feasible for the mass market. The minimum order for such chips is one million pieces. There is no European manufacturer left that is in the position to order such an amount of silicon. As a result there is no sales organisation for such chips available in Europe. However, the technological knowledge and competence to improve the product quality concerning video and audio is still available in Europe.

[75] http://en.wikipedia.org/wiki/Ambient_device
[76] http://www.chumby.com/

Limiting the power consumption for high-end devices to a level that is possible for single-chip mass-market products could erase the technological knowledge in Europe, making Europe totally dependent on Asian manufacturers.

The above description however, is also not easily converted into a product definition to differentiate the products in a policy. This is because the differences are always compared against the mainstream products, and as the innovations are integrated into the mainstream the target constantly moves. As a result, predicting the path and rate of innovations and improvement is very difficult. In addition, the differences can be very difficult to measure because the different approaches to innovation can reflect the subjective nature of our senses.

The sales volume of High End devices in the DVD/BD/HDD-Player segment by pieces that starts at a price level of about € 1000 in EU-27 is below 1% of the total sales in this product category.

Relationship to Commission Regulation No 107/2009 on simple set-top boxes and draft voluntary agreement on complex set-top boxes

Of the excluded products, the most similar are simple set-top boxes and complex set-top boxes, as defined by adopted and proposed measures implementing the Ecodesign Directive. The current definition is designed such that these three types of equipment are mutually exclusive. Therefore a device cannot be regulated by more than one of the three possible vertical policy measures. This is achieved by the third bullet in the definition 'has no tuner unless it records on a removable media in a standard library format' which is the opposite statement to the set-top box regulation.

The functions unrelated to the standard library media are very similar, such as the ability to watch and record television to a hard drive. The power consumption in such modes are currently also relatively similar and there is very little difference between the technology and components utilised to provide the functions.

In future, as product functionality increases, products become more networked and the content delivery systems, through broadcast signals and Internet, become more intertwined, the current definitions and ecodesign requirements might no longer reflect new products introduced to the market.

However, the development of the current definitions and policies were not initiated solely as a response to functional or technical differences between products. Instead, it addressed different market trends by prioritising simple set top boxes whose very rapid sales were driven by the digital switchover in the short term when there were no available digital TVs. For complex set top boxes, service providers also provide the complex set-top box equipment matched to their specific infrastructure rather than giving consumers the choice which has led to a voluntary agreement involving both the hardware manufacturers and the service providers. The current manufacturers of set-top box and video player/recorders are also not the same. This could pose a problem because current regulations do include the market differences in the product definitions and only define the products based on the technical criteria and functions.

The timeline for this trend is not entirely clear but is likely to be dependent on the telecommunications infrastructure available in each country. Consolidation of manufacturers, overlap of market and increasing overlap in functionality suggests that in future, ecodesign policies which cover video equipment more broadly are likely to become necessary. There are already some products that are classified as complex set top boxes since they provide conditional access but are not linked to specific service providers. Video recorders with complex set top box functionality are similarly expected very soon, and their power requirements, use pattern and therefore energy impacts could be more closely related to CSTBs than older video recorders.

Therefore, a relatively short review period of two to three years is suggested for any policy measure on video players/recorders. This could also help ensure a fairer playing field for competing products.

7.2.2 Energy-efficiency requirements

Video players/recorders operational modes

Two operational mode groups are defined which are broken down into six operational modes. The modal groups are distinguished by whether primary functions are being actively provided to the user, including critical supporting functions to the primary function. The groups differ from U.S. ENERGY STAR and German Blue Angel but are designed to create a clear demarcation between energy consumed doing almost no useful work, and energy used for useful work albeit potentially inefficiently. The operational modes are further broken down into a number of example use cases.

- **In low power mode**s, the product is not performing any user requested activity or actively supporting user requested activities. The key low power modes are:
  1. Off/ standby or equivalent power mode – provides only reactivation and indication of status functions as defined by Commission Regulation No 1275/2008 on standby and off mode and meeting the required power limits
  2. Network standby – provides additional reactivation from another device via an external communication path or network integrity as defined by the draft Preparatory study: Lot 26: Network Standby[77]

The network standby definition currently being developed in the Preparatory Study is still not finalised but the essential elements are included in the definition above and fully addresses video player/recorders. While the original definition did not clearly differentiate between eg a bundled remote control and other external communication paths, this has been raised by stakeholders and is expected to be addressed in subsequent revisions.

  3. Fast Start (or Quick start) –a low power mode which is able to transition to an active mode in less than five seconds

- **On modes**
  4. Background Secondary/supporting functions including:
     a) EPG updates (only if the device is equipped with a tuner), firmware updates
     b) Content navigation
     c) Internet access
     d) Video upscaling
     e) High definition decoding (vertical image resolution of 720 or higher)
     f) 3-D decoding
     g) Using video recorder tuner to provide TV with video signal (no live pause)
  5. On-play/ Video playback – conversion of encoded video into a standardised video signal including:
     a) From media interfaces.which is powered by the device. Where the media interface is the system of electronic components which is capable of reading stored data directly from the physical medium.
     b) From directly attached, device powered media interfaces
     c) From external, network attached or independently powered media (Independently powered media are HDDs for example connected via USB-OTG, but powered by their own internal or external power supply.)
     d) Video on demand (can include simultaneous recording for buffering)
  6. Recording – writing media content onto a storage medium including:
     a) From tuner or external device *without* decoding/re-encoding of video
     b) From tuner of external device with decoding/re-encoding of video
     c) From one media to another *without* decoding/re-encoding of video
     d) From one media to another with decoding/re-encoding of video
     e) Live pause of TV - This is a TV viewing mode whereby the device provides a continuous buffer of the TV channel being viewed. This allows the user to pause or rewind the programming. The buffering does not re-encode the signal and can be of varying storage capacity.

[77] http://www.ecostandby.org/

In addition, there are transition modes between low power and on-modes as different functions are being activated/deactivated such as from standby to on-mode and disc loading times.

It is important to note that background and secondary functions can take place independently of, or during video playback and recording.

Potential for setting minimum requirements

In this assessment the first tier is assumed to apply in 2012. As discussed in section 7.2.1, it is necessary to assess if the set-top boxes and video player/recorder policies should be integrated. However, a tentative 2nd tier is proposed based on assumed technical improvements and no changes to the product functionality.

It is not practically possible to address every operational mode and use case individually due to a lack of data, the complexity and time involved for a test methodology, and because the list of on-mode functions continues to develop and is unlikely to ever be complete and up to date unless revised semi-annually. Furthermore, the time spent in many of the use cases such as accessing internet content or content navigation is understood currently to be very low. For video players, such as DVD players, even the primary function of disc playback is not consuming the majority of the energy. As a result the potential energy savings are low and not addressed, except to lock in current efficiencies and reduce potential risks of future inefficiency. Recorders display this trend more so and spend a very short period of time performing their primary function of recording to a standard library media. This would mean that a policy to reduce this would not be proportionate. In addition, while DVD recorders are expected to have limited sales by 2012, there are currently only 2-3 Blu-ray recorders on the market. This means that the data available is not sufficient to set recording power requirements.

However, it is possible to select a few very common mode and use cases for which there is sufficient test data which is believed to represent a range of products on the market providing power consumption and use time for energy savings. These are the low power modes (1. to 3.), playback from a powered media interface (6. a), and live pause of TV (7. e).

Low power Mode

Based on the use pattern of 14 hours in fast start at 8W for a video player and 4hr in standby at 0.5-1W, the daily energy consumption in low power mode is 116-120Wh. Applying the Standby Regulation No 1275/2008 power requirements, in 2012, the maximum power is 0.5W-1W and the daily energy consumed in the same 18hr period is 9-18Wh depending on the presence of an information display. Therefore, a user selectable fast start feature, which is enabled by default during initial setup of the device, and featured in product marketing, results in a five to tenfold increase in energy consumption.

To ensure that the value of Regulation No 1275/2008 is not lost, it is recommended that the energy consumption for all low power modes is limited. This can only be achieved by confirming/updating the standby/off mode limits of horizontal Regulation No 1275/2008 for video players and recorders, limiting the fast start usage, power consumption or setting a typical energy consumption. While a TEC would offer the most flexibility for the product design, the increased complexity required in the policy to define the low power mode group and the potential confusion expressed by video player/recorder stakeholders from a partial TEC means that the power mode and usage limits are preferred. There are limited technology options to reduce the power consumption without increasing the transition time which means that usage is the primary focus. However, the transition time from standby to on-mode is falling and can transition in 15s or less. This means that the user experience is not as significantly impacted by limiting use. Therefore it is recommended that for video players only the "as shipped" set up for fast start is to be disabled.

For video recorders, the ability to start very rapidly to record is an important part of the user experience. However, this is generally only required while the TV is actively being used. Without specifying the precise technique, the use of fast start is expected to be limited to approximately four hours. This could be achieved, for example, by using HDMI-CEC or a timer that activates in line with normal usage patterns.

The Commission Regulation No 642/2009 on televisions requires that off mode is reduced to 0.3W unless a hard-off switch is provided, in which case the requirement is 0.5W. This is suitable for video players and recorders, which have generally already achieved this. A device providing passthrough for a video or broadcast signal is currently not considered a standby mode, and could present a possible loophole. However, since there is no evidence that devices are not meeting standby requirements, there is no benefit expected from changing this.

The requirements do not address network standby or transition modes because the time spent in these modes is considered very low after being addressed by APD. In particular, network standby modes are used to wait for a communication to trigger an event, eg receiving updates, an unknown time. However, for example, because Blu-ray firmware is updated over the internet, the update is sent on demand of the product rather than the product having to wait to receive the update at a particular time. Most devices therefore check for updates when they are switched on and do not have to remain in network standby. Any changes to this and additional allowance for network standby will depend on the results of the network standby preparatory study and for example it is expected that energy efficiency Ethernet standards (IEEE 802.3az[78]) is implemented.

Video playback from directly attached, device powered interface

'Video playback from directly attached, device powered interface' will be referred to as 'on-play mode'

Because newer devices provide a number of additional supporting functions in on-play mode, such as accessing Internet content, it is proposed that only standard definition and high definition playback is addressed in any ecodesign requirements. Any high definition playback should not include any additional functions such as 3-D playback or BD Live (BD-Live is a newly developed Blu-ray feature that enables the user to access content via your internet-connected Blu-ray player.). This means that no adders are needed, or given, for additional functions since they are not being tested. An advantage of this approach is that it encourages power management of the device, allowing higher power consumption when performing a multiple functions simultaneously while trying to ensure that these features and associated hardware are power managed when not in active use.

Because the limits are proposed for 2012, the ENERGY STAR program requirements for audio/video version 2.0 form the basis for the energy efficiency requirements. Adapting the tier 2 limits, this the suggested power limits for playback of standard definition source video via a powered media interface is 10W, and the playback power for high definition content is 20W. This gives an average power (for HD and SD) of 15W. The main differences are that no recording power limit is set, and the 10W is applied to all standard definition players, irrespective of upscaling. This better represents the limited future developments in the DVD market and prevents future inefficiencies being introduced, as well as recognising the higher consumption of Blu-ray players when playing standard definition video. Current best in class Blu-ray players are currently claiming average playback power of 13W. Although future forecasting suggests that many products will already reach this target under a BAU scenario, there is no technical information suggesting a more stringent target can be attained.

Video recorders are currently unable to meet the same on-play power because the additional components required for recording (tuner, encoder, memory etc) currently cannot be disabled or power managed when not in use. These components consume approximately 15W. While this is expected in the longer term, because it is not current technology it is not possible to introduce the same mandatory power requirements as video players in the first tier. Video recorders are also expected to shift from DVD recorders to BD recorders, and policy must reflect the change in technology. However, there are currently only three current generation Blu-ray recorders on the market with a power consumption between 37-38W. These would also be classified as high end products based on the €1000 threshold. The suggested Tier 1 limits are suggested at 30W. Due to the future development potential, an indicative Tier 2 limit for 2015 is suggested at 20W. However, a review of the regulation is needed before the Tier 2 comes into force.

Live pause

Similarly to the on-play mode requirements, since the Blu-ray recorders are unable to power manage individual components, the Tier 1 limit is set at 30W and Tier 2 at 20W. The tier 1 limit is similar to the

[78] http://www.ieee802.org/3/az/index.html

CSTB on-mode power consumption which the devices are likely to resemble but with the additional optical drive and video encoding requirements.

Alternative requirements for video recorders – adapted TEC from proposed CSTB self-regulation

Recognising the similarity of next generation video recorders with complex set top boxes and also the differences in the market structure, an alternative policy measure is to align the ecodesign requirements with the CSTB voluntary agreement. The TEC can be extended for on-play mode with an additional allowance for the standard library drive, and is suggested at 7kWh per year based on 1 hour use and 4 hour in low power. It is useful to recognise that at €0.16 per kWh this is equivalent to €1.12 of electricity a year.

The advantage of the approach is it offers additional flexibility for new products and fairer competition between products offering similar and overlapping services.

The CSTB self-regulation is still a working document[79] and the Tier 2, which is due to take effect in 2013 is undergoing revision and expected to be more stringent. As a result, it has not been possible to analyse the impacts and savings.

Potential video players/recorders power management requirements

The Commission Regulation No 1275/2008 on standby and off mode contains requirements in 2013 for auto-power down functionality to standby or off mode (or another suitable low power mode) which could apply to video player/recorders. The text of this power down requirement is shown below:

> *When equipment is not providing the main function, or when other energy-using product(s) are not dependent on its functions, equipment shall, unless inappropriate for the intended use, offer a power management function, or a similar function, that switches equipment after the shortest possible period of time appropriate for the intended use of the equipment, automatically into:*
>
> - *standby mode, or*
> - *off mode, or*
> - *another condition which does not exceed the applicable power consumption requirements for off mode and/or standby mode when the equipment is connected to the mains power source. The power management function shall be activated before delivery.*

If the 'main function' for video player/recorders are interpreted as the on mode group this scope is too limited. APD functions should be provided in other modes. This approach has already been used for simple set-top boxes and televisions. Therefore, the operating modes during which auto power down functionality could be enabled are listed below:

- fast start
- content navigation
- live pause
- And any other condition not providing playback or recording

It would be expected that APD transitions to a standby or off or equivalent power mode.

Furthermore, the Commission Regulation No 1275/2008 only states that a product should 'offer a power management function or a similar function'. It is neither specified that the power management function should be enabled by default when shipped nor that the APD should be activated after a given time. It is suggested that an APD function should be enabled by default and that deactivating the function in any initial setup menu requires secondary confirmation, with a warning about increased power consumption.

It is suggested that APD is enabled by default and activates after no user input in less than:

- 30 minutes for video players unless in play-mode

[79] See http://ec.europa.eu/energy/efficiency/ecodesign/forum_en.htm

- three hours for video recorders unless in record or play mode

Thirty minutes for video players is in line with many current devices on the market and ENERGY STAR on audio/video version 2.0, while three hours is equivalent to Commission Regulation No 107/2009 for simple set-top boxes. The difference accounts for the different use patterns, in which recording devices can be used for extended periods watching live TV.

Since multiple APD signals can be sent from the timer and HDMI, it is expected that the device can use some logic to apply APD. At its most basic, the first APD signal should cause the device to power down to standby. However, eg, if the device is switched on by HDMI, it is reasonable for a video recorder to wait for an HDMI signal to power down to standby. The procedure used by the device must be described in the manual.

However, some discs do not allow APD to activate and remain in the content navigation or play mode indefinitely. This is determined by the specification of the library media (Blu-Ray Association or BDA). The manufacturers have limited input in the specification development to prevent unfair influence and therefore cannot force this. In addition, it is not appropriate for some discs eg used for demonstrations or information displays to stop playing. Therefore, a separate policy should be initiated to work with the BDA and disk publishers to ensure that all published discs will allow APD to activate once playback of the disc content has finished where appropriate.

Secondary functionalities

It is not suggested that secondary functionalities such as internet access and downloading EPGs or firmware updates are considered for minimum requirements. This is due to relatively short periods of time performing such functions and a large number of new secondary functions being introduced. Secondary functions are also performed simultaneously with the primary function such as internet access for BD Live, and would require a large number of power adders to be developed.

High end products

Since it is not possible to define high end devices without creating a loophole to avoid regulation, manufacturers could be allowed to introduce a certain limited number of devices (per year), which would be exempt from a potential ecodesign measure.

There are basically two solutions available to handle the problem of the niche market High End devices:

a. The number of High End devices that could be produced by a manufacturer would be limited to a certain amount of devices. The manufacturer would provide a self-assessment with the declaration of conformity. The number of the device under such a limitation would be printed on the accompanying technical documentation. While the limitation of the number of products would limit the impact of these products to the environment, the self-assessment would be difficult to control by the market surveillance.

b. As solution that is better to control and more difficult to circumvent there could be a hologram sticker or vignette, which a manufacturer must attach to the exempt devices. These stickers are sold by request by a European foundation as a self-organisation of the European industry. The price of the sticker should be as high as needed to cover the processing costs and to prevent mass-market manufacturers from applying to the sticker instead of complying with the regulation.

So these devices could easily be identified in the field by government departments and market surveillance. The total number of exempt devices could be monitored by the issuing authority preventing misuse of this allowance provision. As a crosscheck option a database open to the public would list all the exempted devices and provide short background information why the product is exempted.

Such a regulation would give manufacturers the possibility to produce limited numbers of non mass market High End devices for development, proof-of-concept / market acceptance studies and for highly demanding special niche market requirements (audiophile music lovers, professional/semi professional use, laboratory use etc.). While audio is not a topic of this study it is the audio sector of

High End DVD and BD-players that is responsible for the majority of the additional power consumption of the High End products compared to standard mass-market devices. It is not possible to separate the power demand of each sector of the device to measure it separately without destroying the device, since the video and the audio part are using the same data stream.

There are several High End DVD- and BD-players on the market with video only as a secondary function. The main purpose of these players is the playback of high quality audio files that can only be played with these players for example DVD-Audio, SACD, multichannel audio 5.1 and 7.1 and BD-Audio). These special low loss formats need a better than standard processing of the audio content.

Using a vignette system to identify High End products and separate them from mass-market devices will provide several advantages for all stakeholders.

- Market surveillance would be easy and fake products almost impossible due to the vignette and the online database.

- An additional off-line database using payment data for the vignette provides additional safety for the system that cannot be hacked from outside.

- Each product can be identified via the coded vignette and database entry

- Each vignette shows a product code and a serial number

- Any fake could be detected easily

- Online registration is easy

- Registration data include power consumption data according to EN 60065

- Activation of the registration after payment

- Free access to all online-database information

- Statistics about sales and environmental impact can be provided easily

- Options to circumvent are almost impossible, due to
    - individualised vignette/sticker on the device
    - database with free access via Internet
    - activation of the registration upon arrival of payment
    - security backup database without Internet connection

As such a system would be open for every manufacturer of High End products it is not against any free trade agreements or WTO agreements. The whole process is completely transparent. The foundation is running the system on a non-profit basis. A council will supervise the whole procedure. Access to testing facilities provides the permanent option to check the data provided by the manufacturers.

With the statistics based on the vignette database on hand the environmental impact of the sales of High End devices can be calculated and after four years after implementation respective measures should be revisited. When a specific High End technology moves to the mass-market, this movement results in a significant price drop that shifts the product out of the scope of the vignette system. Such a market driven automatism makes the vignette system flexible and efficient. The vignette system covers only future regulations and will not focus on any exemption from existing regulations. Existing regulations must be definitely out of the scope of such a system.

An exemption on the basis of the EMC classification could be suitable for professional products. It is not feasible for consumer High End devices as the use high-class power supplies with excellent filtering against noise coming from and going back to the grid.

TWh saving potential

The baseline consumption is based on consumers enabling fast start in Blu-ray players and recorders which effectively disables the standby and off modes. Since this function is not present in DVD players, this use pattern is assumed and has not been verified. The use patterns are taken from Task 3.

It is also assumed that some improvement in efficiency will occur in Blu-ray players and recorders as part of normal product development.

Because high end products constitutes less than 1% of the VPR market, the difference in energy consumed is well within the margin of error in the model. Therefore, this has not been included.

The savings from the above energy efficiency requirements, particularly from the reduction in fast start power and use results in (ignoring rounding errors) savings of:

Year	Baseline consumption (TWh)	Policy option consumption (TWh)	Savings (TWh)
2014	**8.3**	**5.0**	**3.2**
2020	**9.1**	**2.6**	**6.6**

Savings are based on the following use and power assumptions:

Stock

Product	EU-27 stock [units in 2008]	EU-27 stock [units in 2015]	EU-27 stock [units in 2020]
DVD player	156,978,107	50,345,349	18,144,821
DVD recorders	24,126,266	15,222,748	188,864
DVD recorder with hard disk drives	14,386,635	15,025,132	420,044
Blu-ray player	4,456,560	79,516,626	88,601,509
Blu-ray recorders	-	10,071,310	5,228,580
Blu ray recorders with hard disk drives	-	10,061,310	5,001,828
Other future video recorders	2,000,000	40,501,185	120,834,449

Daily Use Patterns

Base case

	on-record (hr)	on-play (hr)	live-pause (hr)	fast start (hr)	standby (hr)
DVD player		0.75		0.5	18
DVD recorders	0.25	0.75		2.3	18
DVD recorder with hard disk drives	0.25	0.75	9	2.3	10
Blu-ray player		0.75		14.25	5
Blu-ray recorders	0.25	0.75		14	5
Blu ray recorders with hard disk drives	0.25	0.75	9	5	5
Other future video recorders	0.25	0.75		14	5

Policy IM

on-record (hr)	on-play (hr)	live-pause (hr)	fast start (hr)	standby (hr)
	0.75		0.5	18
0.25	0.75		2.3	10
0.25	0.75	4	2.3	10
	0.75		0.5	18
0.25	0.75		4	15
0.25	0.75	4	4	15

Power consumed

Base case

	on-record (W)	on-play (W)	live-pause (W)	fast start (W)	standby (W)
DVD player		8		6	0.8
DVD recorders	20	20		12	0.8
DVD recorder with hard disk drives	25	20	20	20	0.8
Blu-ray player		18		8	0.8
Blu-ray recorders	32	32		8	0.8
Blu ray recorders with hard disk drives	34	34	34	8	0.8
Other future video recorders	10	10		5	0.8

Policy IM Tier 1

on-record (W)	on-play (W)	live-pause (W)	Fast start (W)	Standby (W)
	8		6	0.3
20	20		8	0.8
25	20	20	8	0.8
	15		8	0.3
25	25		8	0.8
30	30	30	8	0.8
10	10		5	0.5

The power consumption has changed from the 2008 base case, and assumes a reduction in power for new all current generation BD products.

Policy IM Tier 2

	on-record (W)	on-play (W)	live-pause (W)	Fast start (W)	Standby (W)
DVD player		8		6	0.3
DVD recorders	20	20		8	0.8
DVD recorder with hard disk drives	25	20	20	8	0.8
Blu-ray player		15		8	0.3
Blu-ray recorders	25	25		8	0.8
Blu ray recorders with hard disk drives	30	25	25	8	0.8
Other future video recorders	10	10		5	0.5

Daily energy consumed

Base case

	on-record (Wh)	on-play (Wh)	live-pause (Wh)	fast start (Wh)	standby (Wh)
DVD player	0	6	0	3	14.4

Policy IM Tier 1

on-record (Wh)	on-play (Wh)	live-pause (Wh)	Fast start (Wh)	Standby (Wh)
0	6	0	3	5.4

DVD recorders	5	15	0	27.6	14.4		5	15	0	18.4	8
DVD recorder with hard disk drives	6.25	15	180	46	8		6.25	15	80	18.4	8
Blu-ray player	0	13.5	0	114	4		0	11.25	0	4	5.4
Blu-ray recorders	8	24	0	112	4		6.25	18.75	0	32	12
Blu ray recorders with hard disk drives	9.25	27.75	333	40	4		7.5	22.5	120	32	12
Other future video recorders	2.5	7.5	0	70	4		2.5	7.5	0	10	8.5

Policy IM Tier 2

	on-record (Wh)	on-play (Wh)	live-pause (Wh)	Fast start (Wh)	Standby (Wh)
DVD player	0	6	0	3	5.4
DVD recorders	5	15	0	18.4	8
DVD recorder with hard disk drives	6.25	15	80	18.4	8
Blu-ray player	0	11.25	0	4	5.4
Blu-ray recorders	6.25	18.75	0	32	12
Blu ray recorders with hard disk drives	7.5	18.75	100	32	12
Other future video recorders	2.5	7.5	0	10	8.5

This shows that the majority of savings result from the reduction in use time, particularly from reducing fast start. Disabling fast start by default for BD players is responsible for approx 2/3 of all the savings in 2015. Most of the remaining savings from reducing fast start use in BD recorders, however, some projections sales and stock of BD and DVD recorders in 2015 are over five times smaller. This could reduce the energy savings attributable to the policy recommendations for recorders to less than 0.2 TWh.

The savings potential from the first screening is not commensurate with the updated savings because the calculations have changed significantly.

The first screening is based on the saving made if there were no efficiency improvements since 2008. However, the updated savings potential takes into account efficiency improvements already achieved since 2008 and expected in the future without policy intervention. For example, Blu-ray player on-play power consumption has dropped 40% from 30W to 18W. In addition, the first screening assumes that all products in stock have achieved the power requirements. The updated savings take into account the stock churn and that some older products will still be in use in future.

However, the savings are very sensitive to the assumptions made about the use and power consumption of a fast start mode in both the baseline and policy scenario.

7.2.3 Other considerations on ecodesign requirements

Other environmental impacts of video players/recorders

There are a number of other environmental impacts associated with video players/recorders. These include impacts from resource extraction, material content, manufacturing, recycling and final disposal. However, given that no ecodesign measures for other electronics products have included wide ranging requirements on non-energy in use impacts it would seem unsuitable to suggest these type of requirements for video players/recorders in isolation.

It is suggested material impacts are better addressed in a horizontal measure across material types since many consumer electronics and IT products share similar components and materials. However, it is not clear how a base line material use can be set. Current optical disk players weigh around 2 kg but can vary from half to five or more kilograms depending on the features.

In addition, some of the material use is also a result of aesthetic design decisions, such as the ability to stack consumer electronics products on top of each other. This also requires rigidity to withstand the weight of other devices placed on top of it. Product appearance is also an important market-differentiating factor for products and manufacturer branding. The design and materials choices are considered a product function although not necessary to provide the products electronic functions. And because additional material increases product cost, it is expected that the materials use is minimised while still being able to meet design criteria.

Relevance of energy or eco labelling, benchmarks, public procurement etc

The minimum requirements set are already very ambitious based on current available technology but reflect the expected improvements in technology by 2012. Achieving the requirements would result in a narrower range in power consumption between competing products of a similar type eg Blu-ray players.

Generally labelling is most effective when there is a wide range in power consumption between products. This means that meaningful savings are gained by choosing a more efficient product. However, the power consumed by mainstream products is generally low and the range is small. Therefore, the differences between different efficiency grades for mainstream products will be around 1W and savings will be small. A-G or similar EU energy labels are therefore not expected to be practical or effective for low power devices such as video players recorders.

However, an EU energy label could be introduced for play mode that ignores all differences between products, reaching from high-end to simple standard definition DVD players. Such a label would have a power range between 10W to 80W, with a simple 10W range for each class. This would quickly identify the difference in power consumption between different product types - DVD will be ‘A’ class, blu-ray ‘B’ class, DVD recorders ‘C’, Blu-ray recorders ‘D’, high end ‘D,E,F,G’.

Applying the label in this way would present a departure from the current EU labels, which take into account, eg TV screen size or fridge volume. Consumers must also be fully informed so that they understand that, eg an ‘A’ class Blu ray recorder is unlikely to ever be available. Therefore this label is unlikely to produce short to medium term improvements. However, over the longer term, it could drive innovation so that the future formats replacing Blu-ray will be more efficient.

Other voluntary labels such as used for public procurement which only require one additional level may be more effective and more practical to develop criteria. The direct influence of public procurement criteria is to remove the possibility of product sales to public bodies for not compliant products. Therefore, if the public bodies occupy a large proportion of the total market the more effective procurement policy will be. For consumer electronics, this share is less significant than eg ICT which is essential business equipment. Futhermore, differentiation between power consumption (and related economic savings) of mass-market devices is low since most of them will use similar highly integrated chips so other economic and cost savings through price discounts for bulk orders will be more relevant for public procurement. However, public procurement rates of video recorders/players is much lower than other products where public procurement is considered very effective, such as ICT. Therefore, for public procurement criteria to be effective, the public bodies

would also need to have a strong commitment to increasing awareness and providing information to the general public and businesses.

From a power consumption perspective, in the short term, the difference between on-play power of different Blu-ray players is large enough to merit a procurement requirement. However, in future, and as the minimum requirements take effect, this is likely to reduce. Instead, additional criteria which limit the functionality of the product, such as disabling fast start, and only restricting the procurement of higher power recording products is more effective. Furthermore, given the limited content and the benefits of high definition playback for some public bodies, it may be possible to set on-power playback criteria to 10W, effectively restricting the market to DVD players and other very efficient devices.

A number of voluntary eco labelling schemes which support public procurement already exist internationally. Currently, ENERGY STAR is considered to set the most effective ecodesign requirements. However, unlike ICT equipment, public procurement of consumer electronics is relatively low and limited mainly to healthcare and education sectors. As a result it is not suggested that any additional requirements should be introduced but existing schemes compared and adopted.

Eco labelling for the consumer market is generally not considered to be effective for small, relatively low powered consumer electronics. However, it could be more useful and effective if it was integrated into a voluntary agreement and marketed by manufacturers to help expose free riders. A number of guidelines already exist for operating such labelling schemes.

Another potential eco label option is to develop EPEAT specifications[80], which has been successfully used to develop specifications for desktop and computer laptops and being developed for televisions and other products. The advantage of EPEAT is that it uses a clear stakeholder engagement process and addresses wider ecodesign requirements beyond just power. Provided that the stakeholders are empowered to engage fully in the discussions, criteria are transparent and have significant support.

Measurements requirements and existing test procedures

Four modes are identified for ecodesign requirements, these are:

- Standby/off
- Fast start
- On-play (HD and SD)
- Live pause

Standby should be measured in line with IEC62301 and Commission Regulation No 1275/2008.

Fast start can be measured in a similar procedure to standby.

Live pause should be measured in line with the on-mode power measured for Commission Regulation No 107/2009.

On-play can be measured in line with U.S. ENERGY STAR on audio/video 2.0. This should be performed using the IEC62087 video content in standard/high definition.

To fully address all testing requirements, the Commission should mandate the European Standardisation Organisations to agree on-play and fast start power management.

Potential for Self-regulation

Self-regulation is a potential regulatory concept, which can be applied to video recorders, although it will require more careful management than the complex set-top box voluntary agreement. The CSTB VA is likely to be successful because the manufacturer and the service providers are both expected to sign up. Since the service providers are effectively the CSTB customer, and there are a limited number of service providers, it ensures demand for the product and lower risk for the manufacturer. By

[80] http://www.epeat.net/StandardsDevelopment.aspx[80]

contrast, video recorders are sold directly to consumers who are much less likely to demand more efficient products. This means there is no disincentive for free riding. Furthermore, industry has not expressed any interest in developing self regulatory measures and it is therefore not viable.

In addition self-regulation should provide more frequent reports and assessments of new functions and a potential energy impacts.

Advantages	Disadvantages
Can react more quickly to technology changes in rapidly evolving product area	Large number of manufacturers when OEM/ODM and product specifiers (eg major retailers) are included. This could slow down progress and weaken any targets.
Provides alternative to implementing measure which would struggle to address differences of high end products.	Reduced transparency in development of ecodesign requirements.
Can integrate power requirements with high profile labelling and marketing schemes	Most of the DVD players and HDD Players/ Recorders are not marketed by the A-brands, but by different local B-brands that are not available for any Self-Regulation.
Provides route to integration with complex set-top box voluntary agreement	

Product information and reporting

Products are expected to declare the following information regarding:

- On-play mode power for standard definition and high definition playback where available (W)
- Live pause power consumption where available (W)
- Fast start power (W)
- Standby and off power (W)
- APD time (hr) and behaviour when used with eg HDMI-CEC
- Information showing increased power consumption resulting from disabling any power management or APD functions.
- Product weight (kg)
- Use of Halogenated flame retardants and PVC

This data provides the key aspects used for assessing environmental performance against future implementing measures. It also provides data on key criteria raised in the preparatory study for which ecodesign criteria might be developed in future. By providing this data, future ecodesign assessments can be made with accurate and complete data of the European market.

7.2.4 Policy scenarios

Policy scenarios for video players/recorders

Two policy scenarios are proposed, implementing measure or voluntary agreement.

These would take effect in 2012 and set ecodesign requirements:

Product	Operating mode	Tier 1 requirement (2012)	Potential Tier 2 requirement (2015)
HD Video players	On-play mode – video playback fromdevice powered interface HD and SD capable players	<= 10W for SD playback <= 20W for HD playback OR <= 15W average of SD and HD	-
SD Video players	On-play mode – video playback from device powered interface SD only players	<= 10W	-
Video recorders including video recorders with HDD	Live pause	<= 30W	<= 20W
Video recorders	On-play mode - video playback from device powered interface	<= 30W	<= 20W
Video players and recorders	Fast start	<= 8W	-
Video players and recorders	Off mode or standby or equivalent power condition	<= 0.3W for players/recorders with no hard on switch <= 0.5W for players/recorders with hard on switch	

Fast start should be disabled by default on video players. An additional confirmation describing the increase in power consumption compared to standby mode is also required.

Video recorders should restrict the fast start mode to 4 hours or only when the TV is on.

This use profile depends on APD requirements which are enabled by default and transition the player/recorder from menu navigation, live pause, fast or other conditions not providing on-mode functions to standby or off or equivalent mode after no user interaction after less than:

Video players: 0.5h
Video recorders: 3h

A revision is due in 2014 to ascertain the viability of the proposed Tier II power requirements and assess whether an integrated policy approach with set top boxes is more effective.

The best available technology is currently considered to be:

- Auto power down enabled
- Live pause 37W inc Blu-ray recorder[81] , 13.6W (device has no optical drive),
- On power 13W (Blu ray player), 37W (blu ray recorder[82])
- Standby power 0.1W (Blu-ray player),0.7W Blu ray recorder)
- No fast start but boot from standby in 15s

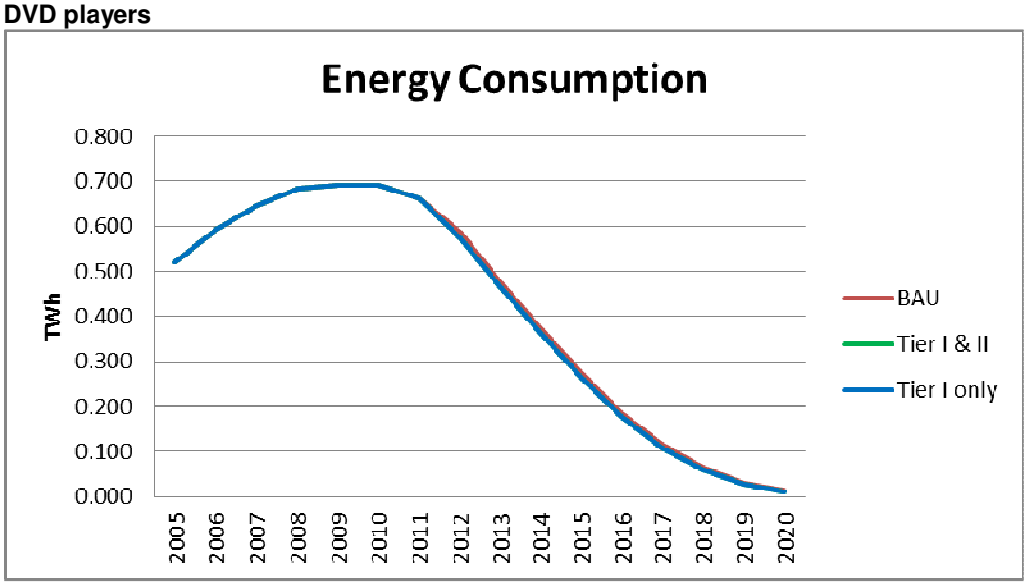
[81] Similar products announced for Japan only consume 21-31W
[82] Similar products announced for Japan only consume 21-31W

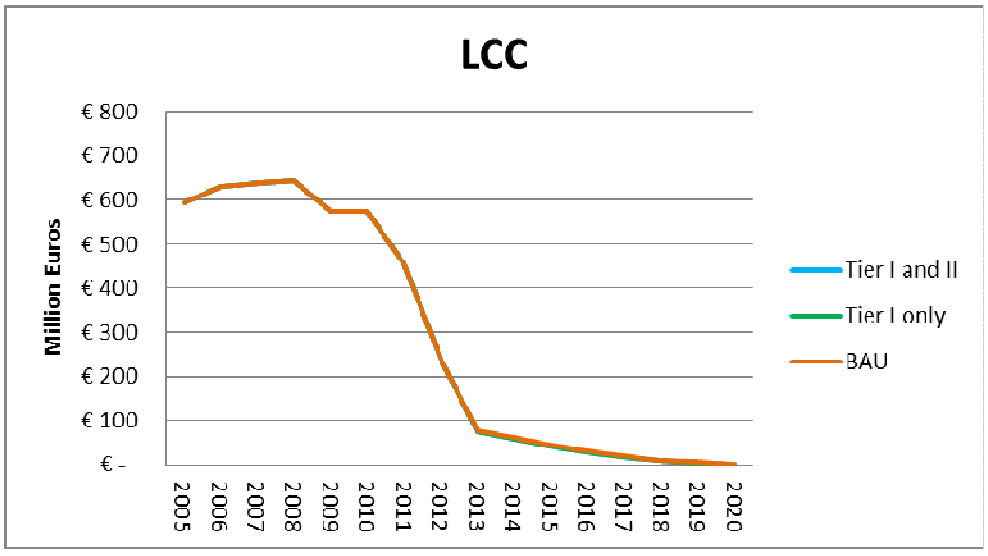
Main parameters for a simple tool for the European Commission for estimating the impacts of different scenarios

A simple calculation tool would allow the following variables to be changed:

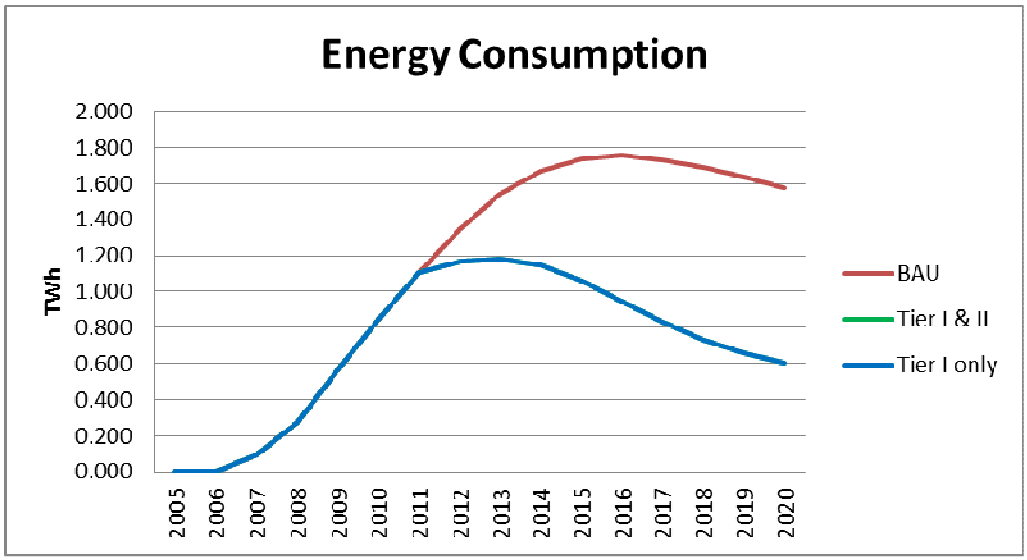
- power limits
- use profile
- sales/stock
- % stock impacted by policy measure
- Cost

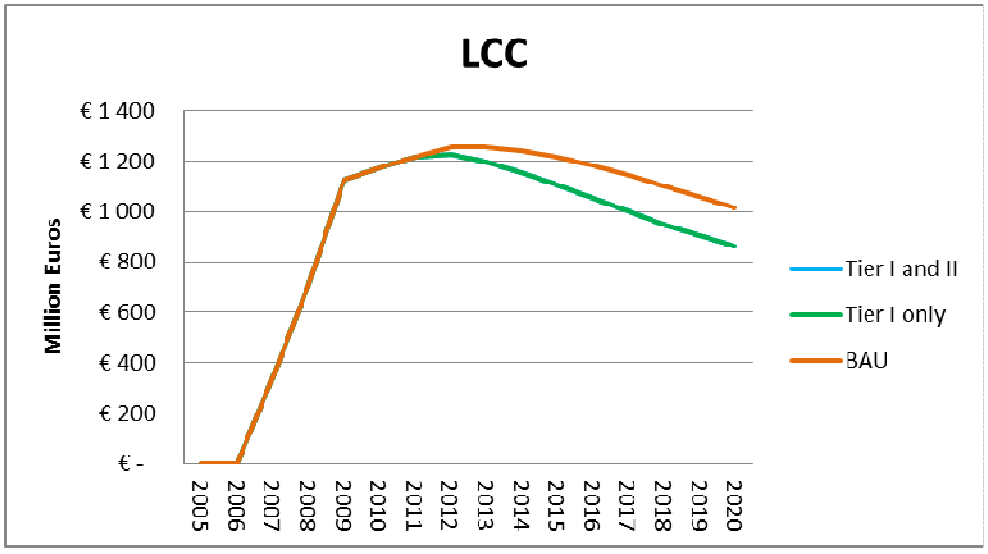
DVD players



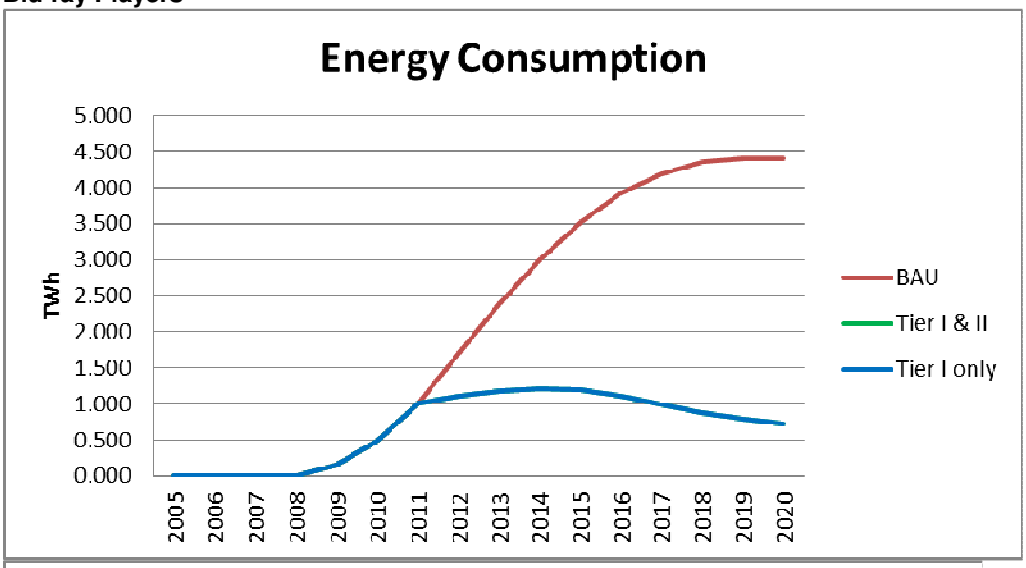


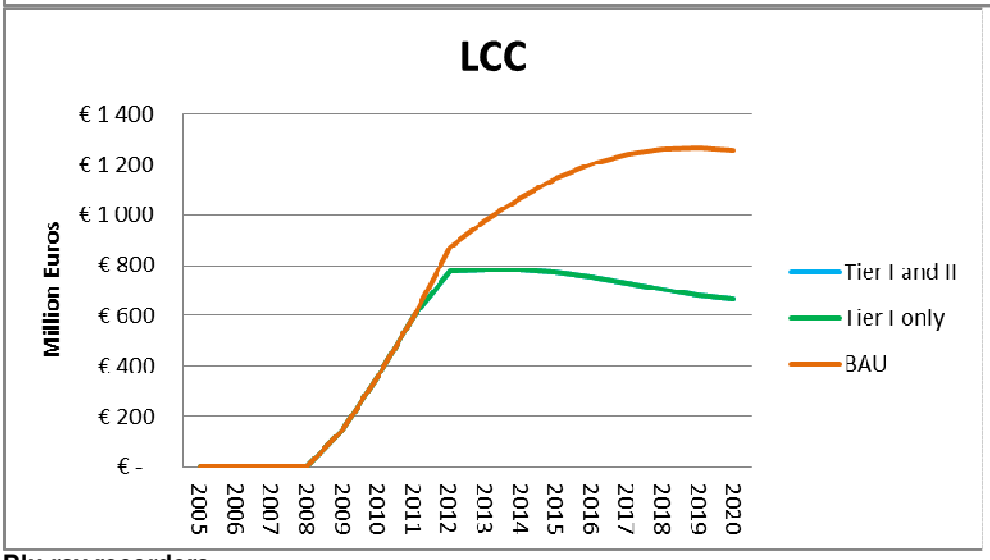
DVD recorders



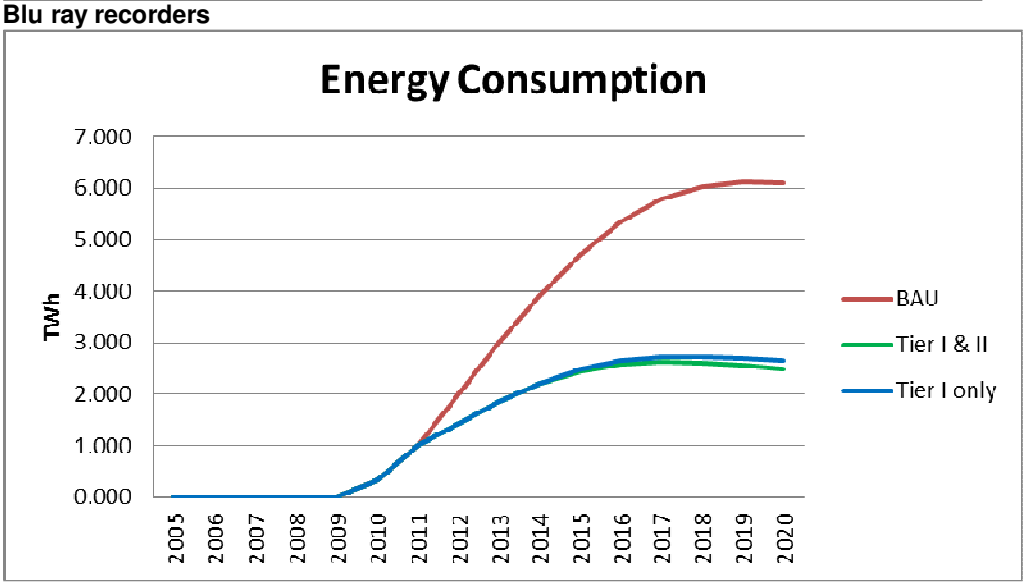


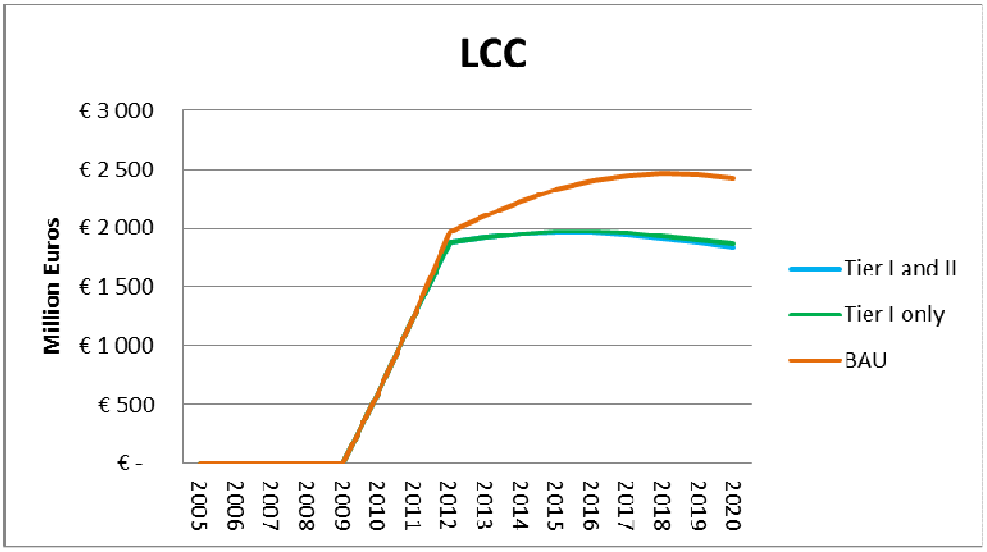
Blu ray Players





Blu ray recorders





7.2.5 Impact Analysis

Monetary impacts for categories of users in particular as regards affordability and life cycle cost of the product;

There would be no negative effect on the users as a result of the proposed policy. This is because there are no additional costs assumed, and therefore only savings are accrued. This is equivalent to Option 17 in task 6. The savings would not be distributed evenly across all users because it is expected that some video players and recorders at the high end would be exempted from any minimum power requirements and therefore do not provide any savings to the user. However, the 98+% of users who purchase cheaper, higher volume models will benefit, assuming that they chose not to disable the APD functions.

Impacts on the functionality of the product, from the perspective of the user;

There are no expected impacts on the functionality because the proposed policy is designed such that the requirements only apply to the simplest mode of use, ie playback. This allows all secondary and supporting functionality to be active as required but helps ensure they are not active when not required by the user.

However, the proposed requirements do restrict the power and time spent in fast start modes. This could result in slower transition times from standby to on-mode, and therefore delay the user wanting to record or watch a video. As products continue to develop, it is expected that the delay can be further minimised. In addition, by altering the boot sequence, the user interface and buffering data, the perceived delay for the consumer can also be minimised. It is expected that the combination of these will reduce any transition times to an acceptable level for the user.

Monetary impacts on the manufacturer regarding redesign, testing, investment and/or production costs;

The timescale for the proposed policy is designed to be sufficiently long for the redesign to occur within normal design cycles, therefore creating no additional cost to the manufacturer. In addition, almost no additional hardware components are required, since the redesign occurs in software and within the silicon. There may be a requirement for increased memory to buffer data but this will be available at no additional cost due to the falling cost of solid state memory and shrinking transistors. However, it may reduce the rate at which the product manufacturing cost can be reduced. Doing so could negatively impact the sales of very low-cost products which rely on very high volume sales at low profit margins. This could also benefit other manufacturers since it can help resist the rate of commoditisation.

Further impacts on manufacturers, such as imposed proprietary technology or administrative burdens;

The study team is currently unaware of any proprietary technology that will be required to meet the energy performance levels proposed. This is because the improvements are based on well known techniques that have been applied in other consumer electronics products by a number of different manufacturers.

There are additional administrative burdens on manufacturers arising from the requirement to test and declare the environmental performance of their products. However, the proposed policy does not require every device manufactured is tested, and it is likely only a very small subset is tested. Such testing and reporting is also increasingly commonplace and provided voluntary by manufacturers. This also means that the administrative burdens are not significantly higher than current practice.

Impact on the competitive situation of the market; such as market share of products already complying with the envisaged minimum requirement, market shares of remaining models after the minimum requirement is introduced, competitive advantage or negative impacts on the competitive situation of some market players (e.g. SMEs, regional players) or reduction in consumer choice;

Only 18% of BD players across all years of testing can meet the requirements, however, 46% of models tested in 2010 can meet the envisaged requirement, and it is expected that many more models will seek to meet this level as part of ENERGY STAR. This will favour global manufacturers with US presence since it gives them an additional advantage in other markets for meeting the requirement. The majority of manufacturers are global and so the advantage is likely to be negligible, especially given the lead time before any requirements are expected to come into effect. While some brands are focused in individual member states, they are manufactured under license from large OEM/ODMs which often use one design across many brands. This means that they are large enough to be competitive. No current models are able to meet the BD recorder power requirements. However, six newer models announced on 24 August 2010 for the Japanese market will do so[83].

There are a few smaller manufacturers designing specialist devices, however, since their market niche comes from higher specification, more advanced products requiring higher levels of product research and development, they are expected to be able to maintain that niche. It may also be the case that if a high end product is defined and excluded then many of the SMEs will be exempt.

- Impacts on EU firms' competitiveness outside the EU and on importers;

Since the consumer electronics market is global, there are no expected effects on the competitiveness of EU firms outside the EU or on importers.

- Impact on innovation or research and development;

By offering an possible exclusion for very high end products it is also expected that innovation is not restricted and new functions can continue to be introduced into the market very rapidly before being efficiently integrated into more mainstream models. This helps reduce the forward risk of investing in new technology. However, in the normal design cycles before the requirements come into effect, some research and development will likely need to be directed to improving efficiency. This is not considered to be a negative impact on innovation but a positive realignment of research priorities to environmental impacts.

- Any significant social impact, such as impacts on employment and labour conditions, health and safety or equality of treatment and opportunities.

No other significant impacts are expected.

7.3 Digital Projectors

7.3.1 General considerations

Anticipated potential developments in projector technology

Potential developments in projectors are explored in Task 5, but are, since the start of 2010, in a very transient stage, which may dramatically influence the Task 5 BNAT analysis. The revolutionary development that has precipitated this is the replacement of the projector discharge lamp with a combination of Blue Laser and Red LED light sources. This development appears to promise a major impact on, the potential energy efficiency of the projector in on mode, the light source life (extended from 2500 hours to 20,000 hours) and through more efficient cooling, the form factor of the projector casing (potential reduction in volume of 50%). But, there is still no clear indication from the Projector Industry of the cross-industry potential for this intellectual property protected development, currently progressed under just one projector manufacturer. The technology was presented first at CES 2010 in January 2010. At this final stage of the study no evidence has been presented by the Industry, even under non-disclosure agreements, to support a claimed BNAT potential projector energy efficiency improvement of 50% from projector solid state light sources. Consultation with key industry projector designers has underlined that it is impossible to predict the potential performance of Solid State Illumination in the context of projectors beyond 2012.

Lamp replacement, by LED light sources, in smaller very portable projectors, has produced no improvement in on-mode energy efficiency.

Developments that can be identified for projectors with cross- industry application include:

- Inbuilt docking and control for mobile devices capable of providing the highest quality graphic, video and audio digital data sources.
- Inbuilt high density Blue Ray Disc playback
- 3D projection
- Increased network connectivity for wired and wireless LAN and WAN (including Internet)
- Lead–free lens glass
- Mercury–free discharge lamps.
- Ultra High Performance mercury vapour high intensity discharge lamps with modulated power drive to match picture luminance content.

Because over 98% of projector on–mode power is rested in the lamp power requirement, none of the built in media and data source technology changes in the above list should have a significant impact on total on-mode power and should be power managed to have little or no impact when not required (e.g. during testing for on-mode power efficiency conformance declaration). But standby power could be challenging to the designer if the requirements set in Commission Regulation No 1275/2008 on standby/off mode are to be met by products with wired or wireless local network data sources for the content and control of displayed images.

Definition of the projector and excluded products

Revising the definition risk assessment of Task 1, and taking into consideration stakeholder input the final task 7 definition of a projector given in the box below:

A projector is a primarily mains powered, optical device, for processing analogue or digital video image information, in any, broadcasting, storage or networking format to modulate a light source and project the resulting image onto an external screen. Audio information, in analogue or digital format, may be processed as an optional function of the projector.

The projector market has seen a trend to very compact and personal projectors which use an external mains power supply, but can run for a limited time on internal batteries. It is proposed that the task 1 definition statement **'is mains powered'** is qualified to **'is primarily mains powered'** to prevent a potential loophole for these portable and personal projector products.

Professional projectors are excluded from the scope of this study. These products may be qualified by the following Study team and Industry proposal:

A professional projector is tested to, and meets EMC class A requirements using at least one of the below standards:
EN 55022 (EMC class A) [Information technology equipment - Radio disturbance Characteristics - Limits and methods of measurement]

and / or

EN 55103 [Electromagnetic compatibility - Product family standard for audio, video, audio-visual and entertainment lighting control apparatus for professional use].

A projector may not be classified as a professional projector, just by virtue of meeting EMC class A requirements, if it is available to the retail market as a stand-alone product for light industrial or home use applications and can meet its primary function as defined *(in the box above)* without the support of other equipment in an installation unless it also fulfils at least one of the following requirements:

1. Two (or more) lamp systems installed

2. Professional system installation is necessary [instruction manual lists required items to install the projector, such as PC, LAN Cable, iLINK cable, tripod, camera + lenses, capture card, colour illuminance meter]

3. An SDI interface is installed

4. Five BNC signal input terminals installed (BNC is a professional connector)

5. Professional lamp replacement is required where lamp assembly is a replaceable item [instruction manual clearly states that only qualified service personnel can carry out lamp replacement)].

It should be noted that a declaration of compatibility with EMC class A requirements requires that a product is subjected to an assessment of electro magnetic emissions in test conditions involving very sophisticated testing equipment and an anechoic electro magnetic radiation environment. Market surveillance authorities would be required to conduct EMC class A product conformity assessments in appropriate laboratory conditions. The laboratory assessment should confirm that the electro magnetic emission levels in manufacturer specified parameters (for projectors, wide spectrum RF emissions and distortion imposed on the AC mains supply) are within class A limits.

Relationship between Commission Regulation (EC) No 642 /2009 (TVs) and projectors.

There is no potential overlap of the regulation for TVs or TV monitors using projection technology with the projector product. This is avoided by the phrase in the projector definition "and projects the resulting image onto ***an external screen".*** If the projector has a built in screen it falls under the TV monitor category of Regulation 642/2009.

Relationship between Commission Regulations (EC) No 244/2009 and 245/2009 (Home and Office Lighting) and projectors.

The lamp or light source in a projector is a special purpose lamp and has exemption from Commission Regulations (EC) 244/2009 and 245/2009.

7.3.2 Energy Efficiency Requirements

Projector power modes

Two power mode groups are defined which are broken down into sub modes. The modal groups are distinguished by whether primary functions are being actively provided to the user, including critical supporting functions to the primary function.

Low power modes
In low power modes, the product is not performing any user requested activity or actively supporting user requested activities. The key low power modes are:

- 1. Off/ standby or equivalent power mode – provides only reactivation and indication of status functions as defined by Commission Regulation No 1275/2008 on standby and off mode and meeting the required power limits.

- 2. Network standby – provides additional reactivation from another device via an external communication path or network integrity communication. Network standby is defined by the draft Preparatory study: Lot 26: Network Standby[84] but the following detailed qualification is suggested based on comment to lot 26 (definitions) from stakeholders.

Networked standby mode means a condition during which the product is
- directly or indirectly connected to the mains, and
- is connected to a network with the respective network interface enabled,
- and provides one or more of the following functions:
- reactivation via network;
- network integrity communication (This may apply to schools projectors which require network connectivity (LAN and WAN) for classroom interaction purposes)

Directly or indirectly connected to the mains means that the product can either draw electricity from the mains power outlet itself or can receive power via another product that draws power from the mains.

Connected to a network with the respective network interface enabled means that the product is connected to a network and that signals from that network can be received and analysed (this may include decoding and verifying), or signals can be sent.

A network means a connection between at least two physically separated products.
For wired networks *connected* means that a cable is connected to a (network) port of the product. For wireless networks connected means the product is physically able to receive/send (wireless) signals, i.e. an antenna is connected/part of the product.

Reactivation via network means that based on an incoming signal the process of switching the product into another mode is initiated.

Network integrity communication means maintaining a network connection by executing a network protocol, including the exchange of status information. This function may be proxyed to another device capable of reactivating the projector when required to save projector standby power (e.g. router with mini- server functionality or LAN server).

- 3. Fast Start (or Quick start) –a low power mode which is able to transition to an active mode in less than five seconds. This will only apply to non-discharge lamp light sources e.g. LED. (Given that there are unlikely to be built in recording functions in a projector, there should be no power overhead implications in the incorporation of such a mode in the projector operational scenarios)
  .

[84] http://www.ecostandby.org/

- 4.Lamp cooling mode – usually a short term mode(typically less than 4 minutes) The projector has transitioned from the primary, active mode, of projecting images and the lamp is switched off, This transition is either user activated (off or standby selected) or may occur automatically with a projected or audible warning, if no projection data is detected from any internal or external source (this is the equivalent of Auto Power down – APD) The cooling period is usually under the control of internal temperature detectors. After an appropriate temperature is reached the projector is automatically switched to the network standby mode or the lowest power standby mode, or off. The duration of the automatic power down period from the cessation of an input signal to the lamp switch off point is often user- variable

On - mode

- 1.Video projection – conversion of video input data into light path modulations using:
  a) Data from internal device powered memory and media drives or portable media interfaces (docks)
  b) Data from external, networks or independently powered media sources.
- 2. Eco Video projection (as 1 above but with lamp power reduced by 20%)
- 3 Background secondary supporting functions including:
  a) Video upscaling / image enhancement
  b) High Definition decoding
  c) 3D decoding
  d) Content navigation and image manipulation through direct controls, or a remote control or LAN wired or wireless control.

Potential for setting minimum requirements

In this assessment, the first tier is assumed to apply in 2012. A second tier was considered for 2015 on the assumption that the projected light output efficiency could be increased to 0.05 W/lumen through claims associated with recent solid state illumination developments. No supporting evidence has been made available to the study team for these claims and minimum requirements for Tier 2 from approximately 2015 are unlikely to be very much different to Tier 1 unless based on conjecture.

The EU27 volume market for projectors is dominated by standard XGA products with a rated total light output of 2,000 to 4,000 IEC (ANSI) lumens (white). Current product data shows that the efficiency of a standard projector, based on a metric of Watts/Lumen of total projected light, is at best (BAT) 0.07 W/lumen and at worst 0.22 W/lumen. The average volume market standard projector has an efficiency of 0.13 W/lumen. (It should be noted that the gathered light efficiency of a typical projector lamp for these products before light path losses, is high, with BAT providing over 60 lumens /W)

From an examination of 2010 projector power requirement data it is clear that in setting minimum on-mode efficiency requirements an allowance has to be made for the reducing efficiency of projectors as rated total projected light output is reduced. Further allowances have to be made for projectors with Wide and Short-throw lenses. For the latter allowance, light loss coefficients recently agreed by the main projector Industry players for the 2010 Japanese Eco-Mark minimum requirements are recommended (ref. Appendix 5). These are:

- Short Throw Lens loss Coefficient = 1.3
- Wide Lens loss coefficient = 1.1

The following example shows how these coefficients may be applied in the context of a minimum efficiency requirement.

Category < 2500 lumens:
Standard lens: Minimum Efficiency = 0.105 W/Lumen
Short-Throw lens allowed Minimum Efficiency = 0.105 * 1.3 W/Lumen
Wide Lens allowed Minimum Efficiency = 0.105*1.1 W/Lumen
Short- Throw + Wide lens allowed Minimum Efficiency = 0.105*1.3*1.1 W/Lumen

The accepted Industry definition of a Short-Throw lens in this context is a Lens with a short throw ratio of<0.75 allowing a projected image of 200cms. (Measured horizontally from a projection distance from the screen of <150cms).

The accepted Industry definition of a wide lens is a lens that will allow a projected image resolution of WXGA (1280 X 768 dots) or higher.

The projector Industry has not agreed a coefficient for the colour filtering and image contrast enhancement light output loss inherent in home cinema projectors. Examination of available 2010 data for this genre of projector shows a significant inconsistency in the impact of image processing on the basic efficiency. Some home cinema projectors are not much worse than the average standard projector efficiency 0.13 W/lumen and some degrade efficiency to worse than 0.8 W/lumen. From an examination of available data on 2010 home cinema projectors, the study team recommend that an allowance based on a coefficient of 1.4 is made for light path losses in these projectors.
It is noted that the home cinema projector market is less than 10% of the total EU27 market for projectors and it is predicted to be the first projector market to be seriously reduced by the impact of lower cost, very large screen, TVs. But a coefficient must be agreed by the Industry if these projectors are to be the subject of a minimum efficiency regulation. Otherwise the regulation would have to exclude this projector category and that action would generate a potential conformance loophole. This loophole could allow projectors, normally subject to the limits of a regulatory category, to avoid conformance by a quasi- categorisation as “Home Cinema Projector”.

Low Power Mode limits

Applying the Standby and Off-mode Regulation No 1275/2008 power requirements, in 2012, the following low power mode limits should apply:

- Off **0.5W**
- Standby **1.0W** (with status display)
- Network Standby **1.0W** (with status display)

For network standby low power mode, no extra allowance has been factored in to the limit since it is likely that, for example, network integrity data exchanges could use a very short duration timed window as implemented in some network connected STBs or may be proxyed to another supporting product (e.g. LAN server, router with mini-server).

On mode (lamp active standard lens) including background secondary supporting functions (3 a-d)

The following on-mode efficiency limits, before the application of any allowance coefficient for special features should apply in 2012.

Effective Flux (Total Projected Light output) X lm	Efficiency Limit W/lm
X < 2,500	**0.105**
2,500 ≥ X < 4,000	**0.095**
4,000 ≥ X < 5,000	**0.085**
X ≥ 5,000	**0.080**

Potential projector power management requirements

The Commission Directive No 1275/2008 contains a requirement in 2013 for an auto-power down (APD) function to standby or off mode (or another suitable low power mode). This should apply to projectors. The text of this power down requirement is shown below:

When equipment is not providing the main function, or when other energy-using product(s) are not dependent on its functions, equipment shall, unless inappropriate for the intended use, offer a power management function, or a similar function, that switches equipment after the shortest possible period of time appropriate for the intended use of the equipment, automatically into:

- *standby mode, or*
- *off mode, or*
- *another condition which does not exceed the applicable power consumption requirements for off mode and/or standby mode when the equipment is connected to the mains power source. The power management function shall be activated before delivery.*

In practice, the protection of the lamp life in a projector is still a design priority and an APD function is currently a normal projector design criterion. As a typical feature an on screen display with "No signal" appears, sometimes accompanied by an aural warning, when the input projection data is interrupted and if there is no user input for more than 10 minutes. If there is a trend to very long life lamp solution this function could become unnecessary as a design criterion for lamp life protection but APD should still apply to all projectors so that the totally dominant lamp energy may be saved when there is no detected data at the projector input interfaces.

In addition, the following recommendations are made which could be covered by voluntary industry initiatives:

- Implement HDMI-CEC to any projector with Home Cinema application.

Secondary functionalities

The power requirement impact of secondary functions in a projector (e.g. removable media interfaces, media transport power) are not considered in the minimum requirement discussion for these products because of the total dominance of the lamp power requirement in the primary functional state of the product. Secondary functions should also be subject to power management in an energy efficient design...

TWh saving potential

The baseline consumption for the assessment of energy savings potential is based on industry specifications of the average projector in the EU 27 volume market of 2,000 to 4,000 Lumens and relevant researched usage patterns. The recommended volume market efficiency limit of 0.095 W/Lumen provides an average reduction of 27% in the on-mode power requirement of a current average volume market projector (current average efficiency = 0.12 W/Lumen). The saving potential per annum is shown in the following table:

Year	Baseline Consumption TWh	Policy Option Consumption TWh	Savings TWh
2015	2.042	1.480	0.548
2020	2.155	1.573	0.582

These savings are overestimated for 2015 because the calculation assumes that all stock will perform to the MEPs introduced in 2012. However, there are likely to be a large number of older products still in stock. The 2020 results are more accurate because the majority of products will be produced after 2012, based on a 7 year life.

The stock, usage patterns and baseline data used to calculate energy consumptions and savings is:

Projector Type	Stock (Millions)		Average Usage hrs / day		Usage Days / Year		Baseline Power (W.)	
	2015	2020	On-mode	Standby	On-mode	Standby	On-mode	Standby
Home Cinema	0.8	0.85	0.5	23.5	365	365	300.	1.0
Office Portable	2.80	2.98	2.0	0.5	250	250	320	1.0
Office Fixed	0.40	0.43	2.0	22.0	250	360	320	1.0
Schools	4.0	4.25	6.0	4.0	200	200	320	1.0

The first screening estimating energy consumptions and potential savings (based on an initial estimate of 36% improvement in on-mode power over baseline on-mode power) showed a potential saving of 0.85 TWh in 2015 and 0.84 TWh in 2020

7.3.3 Other considerations on ecodesign requirements

Other environmental impacts of projectors

There are a number of other environmental impacts associated with projectors. These are principally associated with the mercury content of discharge lamps and the lead content of the glass in optical path lens assemblies. Both of these issues are being addressed by the Industry and covered by the RoHS Directive. Manufacturers have developed and will apply mercury free lamps and lead free glass to projectors as new designs and production runs are implemented. The resolution of the transfer to LED and laser lamp technology may be the main catalyst for this change. The issue of the use of Cd (although in microscopic proportions) for LED colour temperature control will still remain an issue to be resolved under RoHS exemption.

In considering environmental impacts from resource extraction, material content, manufacturing, recycling and final disposal for projectors it should be noted that this product genre has a comparatively small European market with no predicted upturn in stock levels. Given that no ecodesign measures for other electronic products have included wide ranging requirements on impacts other than energy in use, it would seem unsuitable to suggest these types of requirements for projectors in isolation. A more detailed discussion on other environmental impacts relevant to projectors is given under this heading in games machines. It is suggested that material impacts are better addressed in a horizontal measure across material types since many consumer electronics and IT products share similar components and materials. Material impacts could also be addressed under a projector eco labelling scheme. However the study team have noted that many key projector manufacturers produce a “Total Environmental Declaration - TED” for their products under the ECMA 370 pro-forma or an internal pro-forma covering the same data input points. Material content, recyclability and hazardous substance content are particularly well documented. The study team recommends that a reporting pro- forma such as the ECMA -370 should be a requirement under a possible IM regulation for the information provided by the manufacturer of each projector product brought to the EU27 market. Such information will be invaluable to future analysis of the impact of eco-design and other environmental measures.

Relevance of energy or eco labelling, benchmarks, public procurement etc

A number of voluntary eco labelling schemes which support public procurement already exist internationally for the projector product. These have the largest impact on major public procurement standards. Since the largest market in the EU27 is for Schools Projectors, a European ecolabel, could radically influence the average eco impact of this product genre.

A mandatory energy labelling scheme for projectors could generate a large number of functional adders in the label class calculation. For example short throw lenses and image filtering are two issues which would adversely impact the classification of a projector but are essential parameters for schools and home cinema projectors respectively. In addition considerable attention would have to be paid to the improvement of existing testing standards contributing to the on-mode energy efficiency metric for projectors if a meaningful and accurate demarcation of labelling steps is required.

At the end date of this study, the verifiable BAT open to all projector Industry manufacturers provides an efficiency of 0.07W/lumen for a standard projector in the mass market category 2,500 to 4000 lumens total projected light output. This is considered a suitable benchmark for a standard mass market projector.

Measurements requirements and existing test procedures

Two modes are identified for ecodesign requirements, these are:

- Standby/off

- On Mode

Standby should be measured in line with IEC62301 and Commission Regulation No 1275/2008.

On mode should have a power requirement measurement made under the product stabilisation and measurement conditions and power metering requirements of IEC 62087-2:2008 with the projector displaying maximum resolution images processed from an external digital signal source.

During the measurement of on-power the total; luminous flux output of the projector should be measured according to EN 61947 – 1:2003 using a “Standard” white screen.

The projector Industry is currently debating an alternative luminous efficiency measurement for projectors involving primary colour rather than white light projection measurements. Since this proposal will be based on a combination of test methodologies embedded in various standards, and is apparently opposed by significant parts of the Industry it is too early to formally recommend this approach. But the study team detects that, at the closing date of the study, there is growing agreement in the Industry which could allow a projector specification to declare of maximum projected light output for both, primary colour illuminance and white light illuminance. If this could be formally agreed on, it may then, in the opinion of the study team, be acceptable to the industry to quote the projector efficiency (W/lumen) using the current white light measurement.

In the event of an ecodesign regulation for projector products a mandate to CEN / CENELEC to produce a supporting harmonised standard should require that careful consideration is given to the issue of a methodology for measuring the efficiency of a projector in terms of Watts / unit light output but that such consideration should include issues of colour primary testing, image quality and special lens characteristics (short throw and wide lens). Furthermore, the issue of a test methodology that considers the TEC efficiency of a projector with a modulated lamp or modulated solid state illumination technology will require careful consideration. In this context recent discussions between the study team and Industry on the application of the dynamic test clip power measurement methodology for TVs (IEC62087-2-2008) for the projector on-mode power declaration, has met with considerable interest and this topic should be recommended to CEN / CENELEC for further detailed consideration. The study team recommend that the following information is provided with the declared white light and coloured light illuminance of the projector :

- The optimum area of screen to be used with the projector
- The distance of the projector from the centre of the screen (on an axis perpendicular to the screen) during illuminance testing.
- The setting or named operational mode of the projector during illuminance testing (ideally the delivered mode to the user for the intended use of the projector should be used –i.e. the “out of the box ”setting)

Potential for Self regulation

Self-regulation is a potential regulatory concept which could be applied to projector manufacturing. However the industry is notoriously competitive in a comparatively small total world market for the product genre. Intellectual property is carefully guarded and new lamp developments could introduce a large spread of on-mode efficiency in cross-industry products for a given market application. In these circumstances a voluntary agreement is likely to set a poor ecodesign minimum requirement at the outset. An Industry voluntary agreement is not recommended.

Product information and reporting

Projector products are expected to declare at least the following information:

- Luminous efficiency of the projector according to the agreed testing standard (W/lumen) for both colour primaries and white light, stating distance of projector from test screen.
- Recommended Optimum screen area
- Power requirement of the projector in on (image projection) mode (W)
- Lowest power requirement of the projector in a reactivation mode (W)
- Power requirement of the projector in off mode if applicable.
- Average lamp-life (hours to 50% of rated projected light output (EN/IEC/ANSI lumens –white)

- Hazardous substance content of lamp (mg.)
- Basic details of the supplied projection lens category (e.g. “Short Throw”) and options for lens category interchange.
- All signal and network interface categories
- Maximum picture resolution and native aspect ratio of the projected picture.
- Noise generated by the projector (dBA)
- Weight of projector unpacked and ready for use (Kg)
- User information on, optimum use of projector to minimise energy wastage and maximise lamp life
- User information on handling and disposal of projector lamp (if replaceable)
- Total Environmental Declaration in ECMA -370 pro-forma (it is suggested that this declaration is only required once for a given product design and that there should be no requirement to update the declaration for that product design to accommodate revisions of the ECMA pro-forma.
- EU ecolabel (if and when one becomes available)

7.3.4 Policy scenarios

Policy scenarios for projectors

A single policy scenario is proposed for projectors - an Implementing Measure.

Based on the current efficiency metric of W/lumen, for 2012, the study team recommend the following on-mode limits for the principal light output categories of projector. These limits do not include allowances for special lenses and special image processing.

Effective Flux (Total Projected Light output) X lm	Efficiency Limit W/lm
X < 2,500	**0.105**
2,500 ≥ X < 4,000	**0.095**
4,000 ≥ X < 5,000	**0.085**
X ≥ 5,000	**0.080**

A basic projector benchmark for the projector mass market (products in the category 2,500 to 4000 lumens) would be 0.07 W/lumen.

The best available technology is currently claimed to be the mixed LED and laser diode DLP design that was displayed first at the US CES in 2010. Since this technology is based on proprietary IP that is not licensed to third parties it could not be used as a benchmark at present. More importantly, verification of the claimed high efficiency (0.05 W/lumen) is still required. Products on the market, currently using this technology, are no more efficient than discharge lamp products. It is predicted, from many Industry sources, that new light source technologies with similar or even better energy efficiency than those currently claimed but not verified, will emerge within the next months, but verification of efficiency claims, for the purposes of precise policy recommendation may well be hampered by the commercial sensitivity of such developments. The study team strongly advise that the Commission conducts an ongoing review of such developments and introduces a second Tier of on-mode power requirement limits when new, cross-Industry efficient light sources become available.

At the end date of this study, the verifiable BAT open to all projector Industry manufacturers provides an efficiency of 0.07W/lumen for a standard projector in the mass market category 2,500 to 4,000 lumens total projected light output.

The implementing measure could be complemented by an Industry voluntary agreement to eliminate mercury from all projector lamps and lead from light path glass by an agreed timeline. However Ultra High Performance (UHP) mercury vapour lamps driven by dedicated control modules probably represent the only lamp technology openly available to all projector manufacturers that has the potential to meet the power limits proposed for the implementing measure and the timeline for such a voluntary agreement would need to take this into consideration. It should also be noted that UHP mercury vapour lamps have the potential to provide a lifetime close to that of the lifetime of the projector product with current usage patterns.

Although still a preoccupation with some eco-labels, noise levels are not considered an issue for policy scenarios that would uniquely target projectors amongst all the CE products with fans. Current fan technology and future lamp efficiency will ensure noise levels well below normal “quiet room “ambient” noise. However if the Commission wish to consider a noise policy, the study team have noted that although most projectors have a noise rating below 40dBA and at best, from data available, 24dBA, a small percentage of projectors are working close to the limit of ambient noise for daytime rooms, suggested by the World Health Organisation (45dBA) The study team suggests that this level of 45dBA is regarded as a limit for projectors. Although it should be noted that digital TV set top boxes with hard drive storage sometimes exceed this limit and may well be in the same room as a projector.

An eco labelling which supports public procurement, based on criteria generally accepted internationally is recommended, since this would have the largest impact on public procurement. Since the largest market in the EU27 is for Schools Projectors, ecolabels, such as Blue Angel, the Eco-Flower or EU Energy Labelling could radically influence the average eco impact of this product genre. A mandatory energy labelling scheme for projectors could generate a large number of functional adders in the label class calculation. For example picture enhancement and short throw lenses are two issues which would adversely impact the classification of a projector but are essential parameters for home cinema and schools projectors respectively. These issues must be taken into account for labelling. There would also be a requirement to strengthen the testing methodology used to calculate the projector efficiency. As for TVs, an ideal methodology for labelling, would be one that includes the declaration of the on –mode power in actual use on relevant image data, not pure white light or colour primary test sequences.

Power management requirements (APD) where the projector begins a lamp shut-off and cooling sequence when no video projection data is detected for 10 minutes should apply to all projector light source technologies, even those with a very long life.

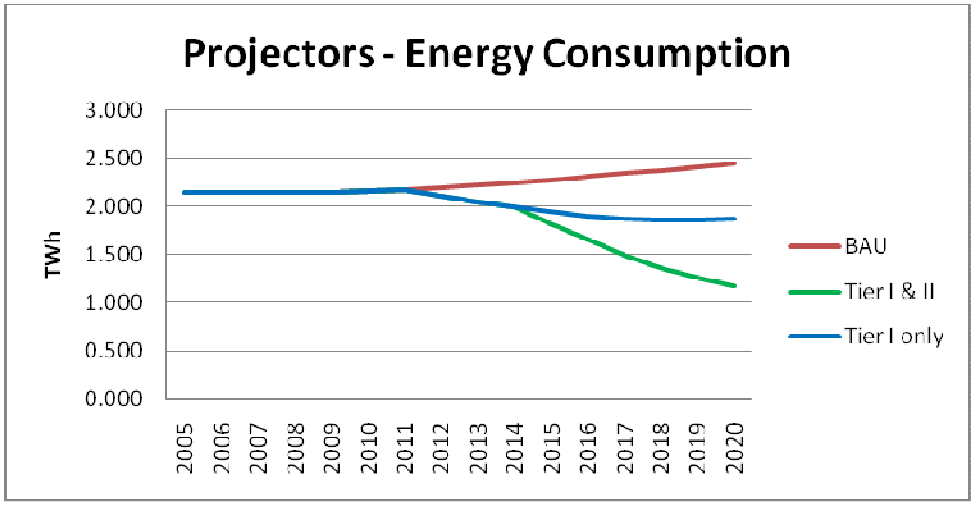
All projectors should have an easily selectable reduced power operating mode (Eco-mode) primarily to conserve energy but also to extend projector lamp life where applicable (In current implementations the eco mode reduces light source power drive by at least 20% from full rated power and up to 50% in projectors with more than one eco-mode option).

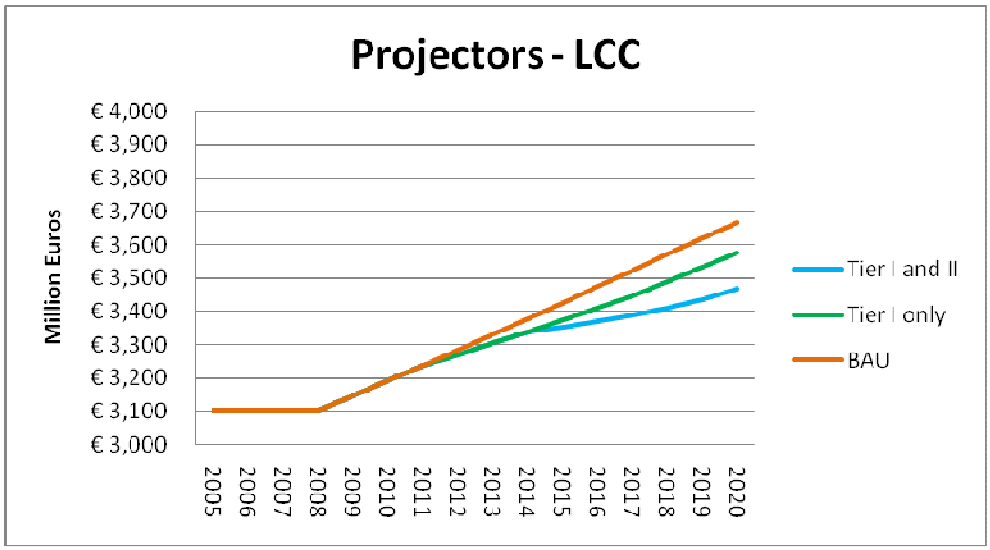
Main parameters for a simple tool for the European Commission for estimating the impacts of different scenarios

A simple calculation tool would allow the following variables to be changed:

- power limits
- use profile
- sales/stock
- % stock impacted by policy measure
- Cost

Using a rounded up EU27 stock model of 10,000,000 products, an average base case power requirement of 255W, a Tier 1 average efficiency improvement of 18% and a speculative Tier 2 efficiency improvement of 50% the following examples of simple tool outputs are shown.





7.3.5 Impact Analysis

Monetary impacts for categories of users in particular as regards affordability and life cycle cost of the product (confirming or modifying the results obtained in subtask 6.1);

There would be no negative effect on the users as a result of the proposed policy. This is because there are no additional costs assumed. This is equivalent to Option 17 in task 6. The research and development costs of energy efficiency improvements in light source technology are likely to be born, in the main, by much larger industries than the projector industry (e.g. automobile headlamp development). Efficient light sources, especially those based on solid state diodes, will foster cooler running more compact products with a commensurate reduction in the weight of housing materials. BAT and BNAT light source technology provides further LCC saving in that the useful “lamp life” is potentially the same as, or greater than the life of the product with current usage patterns.

Impacts on the functionality of the product, from the perspective of the user;

There are no expected impacts on the projector product functionality under the policy suggested. In practice BNAT light sources are likely to improve the start up and power down delays common to

current projector lamp technology. Developments in built - in media players are unlikely to impinge on projector “start up” time and it is unlikely that projectors will provide a recording function (the most common source of long start up delays).

Monetary impacts on the manufacturer regarding redesign, testing, investment and/or production costs (confirming or modifying the results obtained in subtask 6.)

It is possible that some projector manufacturers may need to move on to UHP lamp technology to achieve the energy efficiency requirements. This may impact on the cost of very basic projectors. These represent a very small part of the European market and the UHP lamp technology is available to all manufacturers.

Further impacts on manufacturers, such as imposed proprietary technology or administrative burdens.

There may be additional administrative burdens on manufacturers arising from the requirement to test and declare the environmental performance of projector products. But these are mitigated by restricting suggested policy principally to energy efficiency in the context of the LCC option. A supporting requirement for an energy label need not increase these burdens if appropriate care is taken in the development of a harmonised testing standard and the suggested requirement of a “Total Environmental Declaration" in ECMA 370 pro-forma is something already undertaken by the key manufacturers supplying the EU27 market.

Impact on the competitive situation of the market; such as market share of products already complying with the envisaged minimum requirement, market shares of remaining models after the minimum requirement is introduced, competitive advantage or negative impacts on the competitive situation of some market players (e.g. SMEs, regional players) or reduction in consumer choice;

Based on 2010 Industry data in the public domain it is estimated that 47% of standard projectors in the mass market category (2,000 to 4,500 lumens total light output) will meet the suggested efficiency limits of 0.105 to .085 W/lumen. 46% of projectors with special lens characteristics will also meet these limits if the suggested correction coefficients for light losses are applied. Data for home cinema projectors allows less reliable analysis but applying the suggested correction coefficient of 1.4 about 38% of these projectors would meet the limits.

The structure of the manufacturing industry for projectors is international and based on large OEMs. There should be no competitive advantage to, or negative impact on, any of these players as a result of the suggested minimum requirements. Where SMEs are involved in projector manufacturing, their market niche is the higher specification, more advanced products that are invariably part of an installation and usually categorised under the definition of professional products. These are recommended for exclusion from the suggested policy.

- Impacts on EU firms’ competitiveness outside the EU and on importers;

The energy efficiency requirements required in the policy scenario for projectors will not require special products to be produced for the EU 27 market. Therefore there are no expected effects on the competitiveness of EU firms outside the EU or on importers. The requirement for more efficient lamps (UHP) may in fact benefit European Industry in the policy proposals since advanced R&D for such products is centred in the EU.

- Impact on innovation or research and development;

By offering a possible exclusion for “professional” products and suggesting a reasonable time line to a step change in light source efficiency for the main projector EU 27 market, it is expected that innovation will be fostered rather than restricted with research priorities catalysed to concentrate on the development of high efficiency light sources.

- Any significant social impact, such as impacts on employment and labour conditions, health and safety or equality of treatment and opportunities.

No other significant impacts are expected.

7.4 Games consoles

7.4.1 General considerations

Anticipated potential developments in game console technology

The games console market is currently dominated by three main manufacturers, all of whom produce games consoles offering similar functionalities, albeit with different levels of sophistication. Attempting to identify if there will be a paradigm shift in the way these manufacturers, or others entering the market, will deliver game playing to users in the future is almost impossible. Manufacturers have already stated that they have not yet decided on the technical characteristics of their next generations of games consoles.

Whilst it is difficult to accurately predict the future form of games consoles it is possible to consider some of the potential development possibilities. In the first scenario, manufacturers will continue with the development of stand alone games consoles but with further increased functionality and sophistication delivered through more technically advanced components such as faster central and graphics processing units (CPU and GPU) and higher chip integration. In the second scenario, games consoles manufacturers could seek to remove some of the expensive internal components from games consoles by moving towards thin client based gaming. In this second scenario, the thin clients would likely be less sophisticated that the current games consoles on the market with much of the processing power moved to Data Centres.

The way in which energy is used for gaming in the future is likely to change under each of the above scenarios. As the energy implications of the second scenario are outside of the remit of this preparatory study it is necessary to concentrate on the energy implications of the first scenario.

Current games console manufacturers claim that they have not yet finalised decisions about the technical functionality and consequently power demands of their future devices. Therefore it is not possible to accurately predict power demands of future products. However, there are certain generic steps that could be taken within either an implementing measure or voluntary agreement to increase the energy efficiency of future games consoles. These options are discussed later in the report.

Definition of games consoles and excluded products

Revising the definition risk assessment in Task 1, the final task 7 definition of games consoles is given in the box below:

A "Games console" is a mains powered stand alone device which is marketed as a product providing video game playing as its primary function through an external screen and which has the following features:

Hardware Architecture

- CPU
- System memory
- Video architecture
- Network architecture
- Optical drives (optional)
- Hard drives or other internal memory (optional)
- Mains connected internal or external power supply unit

Input devices

- Typically hand held controllers or other interactive controllers rather than keyboards or mice

Optional Secondary functions

- Optical disk playback
- Digital picture viewing (via an external screen)
- Digital music playback
- General internet connectivity

Excluded components or functionalities:

- Integrated screens
- Conventional Personal Computing (PC) operating systems
- Internal batteries for powering products over extended periods of time

The definition above has remained largely unchanged since the Task 1 report as the same games consoles remain on the market. It is suggested that a small change is necessary to also include the term "general internet connectivity" under the optional secondary functions list. This is to reflect the fact that games consoles are being increasingly used for general internet based applications in addition to their main game playing function and other secondary media play back functions.

It is also necessary to add in a separate definition to aid in the distinction between games consoles offering high performance gaming compared to more standard performance. Higher performing games consoles can currently be defined as those which support high definition images. As such as the additional definitions should also be considered:

- "**High Definition Games console**": can support gaming at 720p high definition output (native resolution of 1280×720)
- "**Standard Definition Games console**": can only support output at resolutions of below 1280x720

Involvement of Game Publishers in a potential measure

Game publishers should be involved in a potential measure for two main reasons. Firstly, the programming of games can have a significant influence on power demand due to differing amounts of processing required of the CPU and graphics processing unit (GPU) of the games console generating different processor workloads. Secondly, the way in which games are coded can have a large impact on the sophistication of power management functionality offered by games consoles. That is, whilst most games consoles can automatically power down, irrespective of whether or not games support the functionality, gamers would be more likely to disable power management functionality if there was an impact on their gaming.

It is therefore suggested that to ensure that future power management functionalities are both effective and likely to be accepted by users it is essential to ensure that game publishers are covered by any ecodesign measures. The games publisher industry body has been engaged in the ecodesign preparatory study. Games publishers would be required to work with the game developers to ensure that new games were able to support power management technologies. In the course of the preparatory study, it became clear that the games developers were not necessarily open to the concept of changing their games so that they could support power management functionalities. Due to the licensing/franchising structure of the games industry the hardware manufacturers could urge the games publishers to co-operate up to some extent. The Commission might wish to consider whether the games themselves should also be explicitly addressed within future implementing measures or voluntary agreements.

Relation between the draft computer measure and a potential games console measure

The European Commission released two working documents on implementing measures for computers in December 2009[85]. In addition to household and office based computers, the draft measures address the energy consumption of gaming PC's. At the time of writing, the draft measures

[85] http://ec.europa.eu/energy/efficiency/ecodesign/forum_en.htm [85] http://ec.europa.eu/energy/efficiency/ecodesign/forum_en.htm

were undergoing review but it is understood that measures on gaming PC's are likely to address idle, sleep and off power modes as well as power management functionality.

Before assessing whether the same ecodesign measures could be applied to both gaming PC's and games consoles it is first necessary to look at the similarities and differences between the two product types.

There are a number of similarities between games consoles and gaming PC's such as providing users with a gaming experience, as well as providing secondary functions such as optical disk play back and internet connectivity. In essence, these products are constructed of similar components and materials. Despite these functional and technical similarities, there are many differences between the two product types.

Games consoles can be used as the main media player in a household as they are connected to TV set, whilst gaming PC's in contrast are less likely to be used as the main household media player since they are connected to a separate PC monitor (although it is recognised that this situation might change in the future).

There are also fundamental differences in the way in which games consoles and gaming PCs are delivered to the market. Gaming PCs are normally modular devices providing users with the opportunity to upgrade components. This upgradability provides users with some degree of control over increasing the functionality on their gaming PC to keep up to date with latest developments. In contrast, games consoles are largely closed box systems where levels of technical functionality are determined by the manufacturers. Rather than continually updating the technical parameters of games consoles, manufacturers and games developers continually identify ways to optimise gaming performance with the set hardware architecture of the console. Major changes to the technical functionality of games consoles are only implemented on launch of a new generation of console. These different approaches to increasing gaming performance mean that the hardware improvements in gaming PCs tend to occur more quickly and at a more constant pace than in games consoles. If ecodesign measures were to be placed on these two types of gaming devices then differences in the pace of technical change would also need to be considered.

Current generation high specification games consoles do not generally contain components that are comparable to components found in large numbers of gaming PCs. For example, current generation high specification games consoles currently include approximately 512MB of RAM (256MB for video and 256MB for system). By contrast gaming PCs normally include a minimum of 4GB of RAM. However, the amount of RAM in these two types of gaming devices is not a good indicator of technical performance as large amounts of RAM are required in gaming PCs to support large operating systems whereas the games consoles have small operating systems which, in part, reduces the need for large amounts of RAM. Games consoles also tend to have lower specification hard disk drives included on purchase than those found in gaming PCs. For example, the maximum hard disk drive found in a current generation high specification games console is 250GB which would be deemed small for a gaming PC. It is possible to upgrade some games console hard drives, any ecodesign measure which treated games consoles and gaming PCs equally would need to take hard disk drive size into consideration.

Image output quality also varies considerably between current high definition games consoles and gaming PCs. Current high definition games consoles can support gaming at 1080p high definition output (native resolution of 1920×1080) (although one manufacturer has commented that their console is likely to support high definitions in the near future). In contrast, the highest specification discrete GPUs used in gaming PCs can support output at resolutions of 2560x1600 across three displays.

Use profiles of games consoles and high specification PCs, such as gaming PCs, can also differ significantly. The current draft ecodesign requirements for desktop PCs include a use profile which assumes average usage of approximately 9 hours a day for desktop PCs and 7 hours a day for notebook PCs. These use hours take account of PC usage in non-domestic environments. As such, the use hours included in the ecodesign measures would be inappropriate for usage with games consoles.

Newer gaming PC's on the market are significantly more sophisticated than the current games consoles on the market in terms of graphics processing power (offering more than double the graphics

processing power of the highest specification games console). The difference in performance attributes between these products types is likely to increase in the near future as the current generation of games consoles are only likely to undergo relatively minor amendments by manufacturers. Gaming PCs also offer significantly more functionality than games consoles, including the ability to provide multi-tasking of office based functions as well as video and other media editing.

The values in Table 62**Error! Reference source not found.** shows the draft ecodesign idle mode power requirements for desktop and notebook PCs (at the time of writing) which offer comparable graphics processing capabilities to the two main high definition games consoles currently on the market. The allowances described in Table 62 related to discrete desktop GPUs categorised as "G4a" and "G4b" in the draft ecodesign measure for computers (where discrete GPUs are classified according to memory bandwidth and classed between G1 and G5b). The highest performing desktop PC GPUs are categorised as "G5a" and "G5b" with products in the latter category currently providing up to 4.64 Teraflops of processing power (twice the graphics processing power of the highest specification games console currently on the market).

Table 62 – Draft Ecodesign Requirements Desktop and Notebook PCs with discrete GPUs

PC Type	GPU Teraflops Processing	GPU Idle (W)	Approx. GPU Allowance Idle (W)	Approx. Base Unit Allowance Idle (W)	Approx. Total Allowance Idle (W)
Desktop PC Category D	1.36	18.0	16.8	65.0	81.8
Desktop PC Category D	2.09	27.0	23.1	65.0	88.1
Notebook PC Category C	1.12	9.3	0.5	32.0	32.5
Notebook PC Category C	2.24	18.7	14.6	32.0	47.0

Whilst the current generation of high specification games consoles do not meet all of the technical criteria for "Category D" desktops or "Category C" notebooks (such as minimum amounts of RAM) they are deemed to offer similar levels of gaming performance as the higher specification personal computers.

It is clear that the draft ecodesign requirements for desktop PCs and notebook PCs are more ambitious than the current idle mode power requirements for high definition games consoles on the EU market (games console power data is shown in **Error! Reference source not found.**).

In terms of energy use, there are some examples of good practice in terms of energy efficiency in desktop and notebook PCs that could be applied to games consoles. For example, many desktop and notebook PCs now include CPUs and GPUs that include power gating functionality, meaning that CPUs power demand can increase or reduce depending on processing demands. Games console CPUs and GPUs do not currently offer any significant amounts of power scaling functionality meaning that power demand remains relatively constant irrespective of computational demands.

Manufacturers of games consoles have significantly more control over the design of the entire games console (as well as internal components) than many gaming PC manufacturers. Gaming PC manufacturers are reliant on components manufactured by other organisations and might not have any input into their design. Bigger production volumes could reduce costs for these components since they could be used in other non-gaming PCs as well. Games console manufacturers by contrast have significant control over the design of almost all components. Games console manufacturers could therefore be seen as having greater potential to consider and implement energy efficiency in their products.

Given that there are significant differences between the two different types of gaming products it is suggested that applying the same ecodesign measures to both product groups would be

inappropriate. There is already precedent under ecodesign for distinguishing between products that offer the similar functionality. Gaming desktop PCs and Gaming notebook PC's are not considered equally under prospective measures so it is perhaps appropriate to also draw distinctions between the approaches for games consoles and gaming PCs.

Whilst the same ecodesign measures might not be suitably applied to both gaming PCs and games consoles there are some common similarities in the way these products use energy and so measures could take similar approaches albeit at different levels.

There are also some common environmental impacts between games consoles and gaming PCs that could be more easily considered within the same ecodesign measure. These environmental impacts include, material content issues, design for end of life, material selection and warranties.

7.4.2 Energy-efficiency requirements

Game console operational modes

There are a number of different power modes found in games consoles. The major sources of power mode definitions are those found in the draft ENERGY STAR specification and those found in the recently completed test methodology developed by NRDC (a US based NGO)[86,87]. The most important different power modes and definitions listed below are largely taken from the draft ENERGY STAR games console specification and the NGO test methodology are listed below:

- **Active Mode** - The power mode in which the game console is interactively manipulated by the user in response to prior or concurrent user input. This can include functionalities such as:
  - *Game Play*: A game is actively being played and the console is receiving user input.
  - *Media Play*: The media player is loaded and media is actively being played.

The "Active Mode" is defined as "Game Play" within the NGO test methodology. The definition is therefore largely consistent with the draft ENERGY STAR specification when describing the situation where a game is being actively played.

The NGO test methodology further defines "Media Play" into "Video Playback Blu-ray Disc" and "Video Playback DVD". The separation of the "Media Play" into these separate power mode definitions is sensible given the small amount of extra power required to play high definition video. However, DVD playback is likely to become less important in the future as higher definition media becomes the norm.

Idle Mode – The power mode in which the games console is running but not providing any user requested functionality.

- This can includes states such as:

  - *Game Play Idle*: A game is loaded, from any source, while not actively being played and the console is receiving no user input.
  - *Game Pause*: An actively played game is paused and the console is receiving no user input.
  - *Media Play Idle*: The console's media player is loaded while no media is actively played; media play idle includes title/root menu for movies.
  - *Media Pause*: The media player is paused while media is actively being played.
  - *System Idle*: Applies to all non-game play menus (e.g. root menu) and periods of idle not covered by Game Play Idle or Media Play Idle.

The NGO test methodology includes a power mode called "Home Menu (aka System Menu, Cross Media Bar, or Dashboard)". This power mode is most closely related to the "System Idle" power mode defined as under the draft ENERGY STAR specification. The draft ENERGY STAR specification includes power demand requirements for the "System Idle" mode rather than any of the other modes

[86] http://www.energystar.gov/index.cfm?c=revisions.game_console_spec
[87] http://www.nrdc.org/

that could be used to define "idle" above. There is some concern that the "System Idle" mode is used for only very short periods of time on games consoles (one manufacturer estimates that only 15% of all "on time" would be spent in the "System Idle" mode) and as such could be said not to be strongly representative of the "idle mode" found in current generation games consoles.

The main games console manufacturers have all expressed concern that the above definition of "Game Play Idle" is not suitable for their products. The manufacturers state that additional functions other than user orientated inputs are supported in this power mode. For example, manufacturers state that some games are continually refreshed with images redraw on the screen to maintain the view of the game. In addition, it has been stated that consoles may also load next scenes in the background during this power mode. It is also claimed that user input can also continue remotely over the internet, even if the local user is inactive, when users are involved in multi-player on-line games. These additional functions would suggest that "Game Play Idle" mode as described above is not applicable to products as they are currently designed due to other functionality being active during this mode.

To avoid these issues it is suggested that the definition be changed to:

- Game Play Idle: A game is loaded, from any source, while not actively being played and the console has received no local user input for a period of ten minutes.

The above change to the "Game Play Idle" definition takes into account the other functions performed during periods of inactivity but clarifies that after a ten minute period of inactivity then the console would be deemed to have entered an idle mode. This would provide the manufacturer with some scope to determine how to provide the "Game Play Idle" mode. For example, the manufacturer could choose to reduce gaming functionality through pausing the game (i.e. entering a "Game Pause" mode) and therefore enable some internal components, such as the main GPU, to be power managed. It is recognised that this type of solution would require changes to the way in which current games consoles operate and would likely require the inclusion of additional internal RAM to enable the main components to power down in a Game Play Idle or Game Pause mode without unduly affecting gaming performance.

The next section discusses the lower power modes found in games consoles. The terminology used for these modes can vary between different programmes. The main definitions are listed below and then cross compared.

- **Sleep Mode** – is in a low power mode which the games console is capable of entering automatically after a period of inactivity or by manual selection.
    - *User-Initiated*: Game consoles should wake within 120 seconds of initiation of wake event, or
    - *Automatic*: This ability to automatically wake is typically independent of user interaction and does not require concurrent user input.
    - The console is capable of automatically waking from sleep mode to perform "System Maintenance and Download," or "Set Top Box Functions," as defined below and/or perform other system-level functions. When a game console wakes from sleep mode without user input, it must automatically re-enter sleep after any maintenance activity or download is complete.
    - Additional functions available in this state are:
        - Active Network Link; and
        - Active Wireless/IR connection to remotes.

The following "Networked standby" and "Standby" power modes are derived from ecodesign preparatory study on networked standby (lot 26)[88] and Commission Regulation No 1275/2008 on standby and off-mode which could be deemed applicable to games consoles.

- **Networked standby mode** – this is the power mode where a products is:
    - directly or indirectly connected to the mains, and is
    - connected to a network with the respective network interface enabled (meaning that signals from that network can be received and analysed (which may include decoding and verifying), or signals can be sent) and provides one or more of the following functions:

[88] http://www.ecostandby.org/

- reactivation via network (means that based on an incoming signal the process of switching the product into another mode is initiated).
- network integrity communication (means maintaining a network connection by executing a network protocol, including the exchange of status information).

There are many similarities between the US EPA definition of "Sleep mode" and the proposed ecodesign lot 26 definition of "Network Standby". The ecodesign lot 26 "Network Standby" defined power mode would be applicable to games consoles when they are connected to a network.

- **Standby mode** - means a condition where the equipment is connected to the mains power source, depends on energy input from the mains power source to work as intended and provides only the following functions, which may persist for an indefinite time:
  - reactivation function, or reactivation function and only an indication of enabled reactivation function, and/or
  - information or status display
  - 'reactivation function' means a function facilitating the activation of other modes, including active mode, by remote switch, including remote control, internal sensor, timer to a condition providing additional functions.

The US EPA draft ENERGY STAR game console specification does not include a definition for a power mode where a games console is not connected to a network. The "standby" power mode definition, taken from the Commission Regulation No 1275/2008 would likely apply to games consoles when in a low power state but not connected to a network.

- **Off Mode** – The power consumption level in the lowest power mode which cannot be switched off (influenced) by the user and that may persist for an indefinite time when the appliance is connected to the main electricity supply and used in accordance with the manufacturer's instructions.

The draft ENERGY STAR games console specification also does not included a definition for a power mode where the games console is placed into its lowest power mode. The above definition, also taken from the Commission Regulation No 1275/2008, would likely apply to games consoles in a situation where a user has pressed a power button on the product and reactivation is only possible by repressing the button.

The NGO developed test methodology includes two "off/standby" modes which differ slightly from the above definitions. The two power modes used in the proposed test methodology are:

- **Off/Standby after pressing the Off button**
- **Off/Standby when switched Off from controller**

The two off/standby modes are further defined by two statements in the test conditions section of the methodology which state:

- Network connection: For consoles with wireless capability, power to a wireless LAN radio (e.g. IEEE 802.11) should remain on during testing and must maintain a live wireless connection to a wireless router or network access point, which supports the highest and lowest data speeds of the client radio, for the duration of testing. For consoles without wireless capability, the Ethernet connection should be enabled.
- Wake-on-LAN (WOL) enabled

The two conditions above dictate how the two "off/standby" modes listed in the NGO test methodology compare to the other low power modes described earlier.

For example, if a games console includes an enabled network interface (which provides a reactivation via network and/or maintains network integrity communication) in either of the above mentioned Off/Standby modes then these modes would likely be considered "Network Standby". If no WOL or wireless functionality is present in the "Off/Standby after pressing the Off button" mode, and no reactivation is possible other than manual intervention, and the product does not contain an information or status display, then this mode would likely be considered "Off mode" as defined in

Commission Regulation No 1275/2008. The same lack of enabled network interface in the "Off/Standby when switched Off from controller" mode would therefore likely result in this mode meeting the definition of "Standby" in Commission Regulation No 1275/2008.

- **System Maintenance and Download:** Applies to times when the console is actively engaged in system maintenance or download functionality after waking or in response to user input.
  - *System Maintenance*: Game console operating system patching, game updates, or other updates delivered and installed.
  - *Download*: Files actively downloaded onto a local storage media for concurrent or future use.

A network means a connection between at least two physically separated products. For wired networks connected means that a cable is connected to a (network) port of the product. For wireless networks connected means the product is physically able to receive/send (wireless) signals, i.e. an antenna is connected/part of the product.

Potential for setting minimum requirements

It is suggested that there is much potential to increase the energy efficiency of many of the power modes listed above. This section of the report investigates the potential for setting minimum requirements on each of the above power modes.

Active Mode

Active mode occurs when games consoles are providing full functionality either in terms of game playing or in terms of secondary media functions. Any attempts to limit the energy use of games consoles in active mode whilst providing gaming could directly affect the complexity of gaming offered by the product. That is, a cap on active mode power whilst in game play mode could effectively also place a cap on the technical sophistication of the game play. As such it is recommended that no minimum power requirements are set for active mode whilst in game play.

Some stakeholders have commented that by not addressing active mode power demand ecodesign measures would fail to address the primary function of games consoles and would therefore not encourage game console manufacturers to integrate energy efficiency as a horizontal priority in the development of their next generation. It was suggested that all other ecodesign measures adopted have addressed the active modes of products.

However, it is also important to point out that the draft ecodesign measure on computers does not address the active mode of any computing products. It is suggested that active mode power demand requirements were not proposed for computers due to the potential impacts on the functionality of the products. It is also important to point out that PCs tend to spend considerably more time in idle mode than in active mode, suggesting that caps on the active mode might have relatively small savings potential.

Whilst placing absolute limits on the amount of power used during active mode could impact the functionality of future games consoles, it would be possible to set active mode power efficiency requirements that take into account the amount of power used for a given level of functionality. Taking an efficiency approach to active mode power demand would therefore allow manufacturers to provide increased levels of functionality provided that it was offered in a power efficient manner. The development of efficiency metrics would require the development of new methodologies to measure both the active mode and the levels of functionality provided by games consoles. Development of these methodologies could be considered as part of the further work required ahead of setting any ecodesign measures for games consoles.

One manufacturer has also provided an example of how active mode might be addressed as part of a TEC based approach to games console energy efficiency. This is discussed in more detailed within the TEC section of the report.

Idle Mode

The idle mode of games consoles occurs when the product is switched "on" but is not offering any user interactive functionality.

As previously mentioned, some manufacturers state that the "System idle" power mode most closely represents "idle" in games consoles. However, within the current games consoles on the market the idle power demand (either in "System Idle", "Game Play Idle" or "Game Pause" is not significantly lower than the active mode power demand. This small power gap occurs despite the fact that large ranges between active mode and idle mode power demands can be seen in similar products such as PCs. This suggests that existing technologies, found in PCs, could be used within future games consoles to help reduce idle mode power demand.

The next section of the report discusses the potential for setting energy in use ecodesign requirements for games consoles in each of the aforementioned power modes.

Power Demand for High Definition Games consoles in different modes

The long lifetime of each particular games console design allows the manufacturers to offer high specification products on launch of a new console and then maintain this level of specification whilst at the same time reducing power demand through the inclusion of more efficient components. Table 63 shows the average active and idle power demands for the current generation of high specification games consoles when launched onto the market.

Table 63 – Active and Idle Mode Power at Product Launch

	Active (W)	Idle (W)
Average at launch	172.0	162.0

Manufacturers have provided some information about the power demands of their current high definition games consoles in the different active and idle modes. The confidential nature of the delivered power demand values has meant that the raw data could not be published. The values shown in Table 64 are estimated average power values for the two high definition games consoles on the market (based on the latest versions of each product type for which manufacturers have provided data).

At the time of writing it is understood that one manufacturer is soon to release a more efficient version of their slimmed down product with power savings estimated at approximately 15%. It is understood that these forthcoming power savings have been achieved through reducing the transistor size on the GPU to 45nm.

Table 64 – Modal Power Demand Data for High Definition Games consoles

Function	Power Modes	Estimated Power Demand (W)
Gaming	Game Play - 1 Player	93.3
	Game Play - 2 Player	92.3
	Game Pause	92.8
	Game Play Idle	92.8
System Idle	System Idle	74.5
Media Playback	Media Play	74.9
	Media Pause	73.9
	Media Play Idle	73.9

Internet Browsing	Media Play	74.1
Audio Listening	Media Play	74.6
	Media Pause	75.6

Efficiency improvements have also been made in standard definition games consoles since they were launched to the market. Table 65 shows the difference in power demand resulting from the development of a more efficient GPU.

Table 65 – Modal Power Demand Data for Standard Definition Games consoles

Product	System Idle (W)	Game Play (W)	Game Pause (W)
Standard definition console after GPU modification	17.0	18.0	18.0
Standard definition console before GPU modification	12.0	14.0	14.0

The differences in the power demand values shown in Table 64 and **Error! Reference source not found.**Table 65 illustrate some of the efficiency improvements that some of the manufacturers have made since launching their products to market.

Whilst improvements have been made since first launching the products to market, the values in **Error! Reference source not found.**Table 64 illustrate the small differences in power demands between the various on modes. The lack of divergence between active mode and idle mode power demands suggests that games console manufacturers have perhaps not taken full advantage of all of the latest energy efficient technologies found in some personal computer CPUs and GPUs. Power gating on the CPU for example allows sections of processing units to be powered down when not in use. The introduction of new materials has also allowed some CPU manufacturers to reduce current leakage within parts of the CPU that have been powered down during power gating, further reducing overall CPU power demand.

In addition there are other technologies included in some newer notebook PCs which allows primary graphics cards to be completely powered down when not in use. This type of aggressive power management technology could also be considered for inclusion within games consoles to shut down the main GPU when not in use (although this would necessitate the addition of a smaller GPU and hence added cost). Games console manufacturers have taken advantage of other power reduction techniques, such as reducing fabrication size of chip structures (smaller structures of the chip layout can reduce the power demand of the chip) and so could also seek to implement other power saving technologies found in PC products. Inclusion of these power technologies found in similar products could help to reduce idle mode power considerably.

One manufacturer has also suggested that they have no plans to include media play dedicated chips in their new generation of games consoles. That is, the inclusion of lower power demanding processors that could run some of the secondary functions instead of relying on the main CPU and GPU to provide these functions. The manufacturer has stated that the inclusion of dedicated components to just run media functions would add additional costs to their games console. In addition, it has been claimed that there would be technical barriers in attempting to deliver secondary media functions, such as DVD playback, at the same power demand level as a single function DVD player. Furthermore, the manufacturer claims that the inclusion of media play specific components would not allow any evolution of format or function that could occur over the relatively long life time of a particular games console design.

It is important to note that manufacturers state that the “Game Play Idle” mode in games consoles is an active mode and not and idle mode and this is the reason for the small differences between power demands in the “Game Play” (active) and “Game Play Idle” modes. Manufacturers have also stated that the “System Idle” mode is more analogous with an idle mode. The reader is reminded that little time is generally spent in the “System Idle” mode during normal use so any power reductions made in this mode might not have a large over impact on games console energy use.

The US EPA, through the ENERGY STAR programme[89], has already undertaken some work on the potential reductions in idle mode power demand possible for games consoles. The draft ENERGY STAR idle mode power specifications and expected timelines are shown in Table 66.

Table 66 – Draft ENERGY STAR Specifications for Games console System Idle

Tier and Effective Date	System Idle (W)
Tier 2 (Effective July 1, 2011)	≤ 45.0
Tier 3 (Effective July 1, 2012)	≤ 25.0

It should be noted that the draft ENERGY STAR specification only relates to "System Idle" and not to "Game Play Idle". Power demands in "Game Play Idle" could likely be higher than in "System Idle" as more complex graphics are often displayed on screen.

It is assumed that, in developing the idle mode requirements, the US EPA have investigated the potential power savings achievable in similar product types such as desktop, notebook and workstation personal computers to garner an understanding of potential reductions in power demand when maximum computing performance is not required. However, it is also important to note that at the time of writing the US EPA have postponed finalisation of the ENERGY STAR games console specification. Some games console manufacturers have suggested that finalisation of the specification has been postponed due to industry concerns about the specification values.

One manufacturer has provided some alternative suggested idle mode values, shown in Table 67 to be considered for ecodesign requirements of current and future games consoles.

Table 67 – Manufacturer Suggested System Idle and Media Play Mode

Product Type	System Idle Mode (W)	Media Play Mode (W)
Standard definition (without HDMI slot)	≤ 20.0	≤ 20.0
High definition (with HDMI slot)	≤ 90.0	≤ 90.0
Next Generation (specification to be defined)	≤ 70.0	≤ 70.0

Given these concerns it is necessary to consider whether the idle mode limits included in the draft ENERGY STAR specification are achievable and whether the above limits provided by one of the manufacturers are stretching enough in games consoles. As previously mentioned there have been significant improvements in the power management of CPUs within desktop PCs in recent years. Table 68 shows the very high power demand reductions between active and idle modes for two high specification (a quad core and a six core) desktop PC CPU's. There are significant improvements in changing the chip production process to smaller structures as the reduction in power results in less heat. This reduction in heat means that the size of heat sinks can be reduced and also decreases ageing of the components.

Table 68 – Potential of Power Management at the CPU level

CPU	Idle (W)	Active (W)	% Power Reduction in Idle Mode
Intel Core i7 980X	6.3	136.8	95%
Intel Core i7 975	6.3	133.2	95%

Such large reduction in power demand between maximum and idle modes cannot be expected for complete products due to the large number of additional components, which require power during idle modes. Table 69 illustrates the power demand reductions possible between maximum and idle modes in a sample of personal computers[90].

[89] US Environmental Protection Agency, ENERGY STAR Program Requirements for Computers Version 5.1, Game Console Requirements – Draft Final, available from http://www.energystar.gov/index.cfm?c=revisions.game_console_spec
[90] Data sourced from three personal computer manufacturers' publically available Ecma-370 declarations

Table 69 – Potential of Power Management at the Product level

Product Type	Number Products Sampled	Reduction in Power Demand Between Maximum and Idle Mode		
		Average % Reduction	Highest % Reduction	Lowest % Reduction
Desktop PC	25	-49%	-65%	-29%
Notebook PC	27	-77%	-89%	-54%
Workstation PC	7	-46%	-74%	-20%
All PCs	59	-58%	-89%	-20%

Figure 22 below shows a graph of active and idle power demand for the sample of desktop and notebook PCs. Using the linear formula from the desktop PC examples it is possible to estimate future idle mode power, shown in Figure 22, that could be achieved in next generation games consoles taking account of current technology available in desktop and notebook PCs into account.. The values shown in Figure 22 illustrate that the tier II draft ENERGY STAR idle mode specifications could be achieved if current desktop PC power saving technologies were included in future games consoles (providing that active mode power of games consoles remains at around 80W). The tier III draft ENERGY STAR idle mode specifications could be met by games consoles if they adopted average power management performance found in notebook PCs. It is necessary to point out that the reductions in active mode power demands, illustrated in Figure 22 and Table 70, are based on products which include CPUs manufactured by leading CPU manufacturers. As such it should be considered that the potential reductions from active mode shown in Figure 22 are based on personal computers which include some of the best quality CPUs.

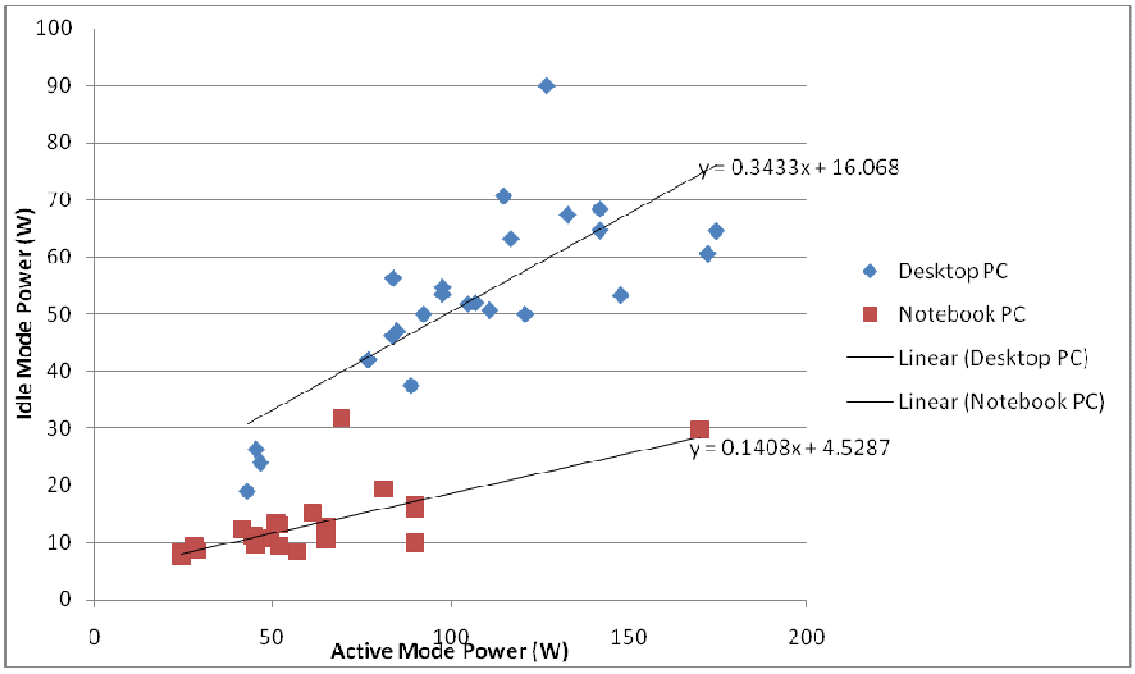


Figure 22 – Active and Idle Mode Power Demand for a Sample of Desktop and Notebook PCs

Table 70 – Active and Corresponding Idle Mode Power Demand

	Based on Desktop PC		Based on Notebook PC	
Active Mode Power (W)	Idle Mode Power (W)	Reduction from Active to Idle	Idle Mode Power (W)	Reduction from Active to Idle
40.0	29.8	26%	10.2	75%
60.0	36.7	39%	13.0	78%
80.0	43.5	46%	15.8	80%
100.0	50.4	50%	18.6	81%
120.0	57.3	52%	21.4	82%
140.0	64.1	54%	24.2	83%
160.0	71.0	56%	27.1	83%
180.0	77.9	57%	29.9	83%
200.0	84.7	58%	32.7	84%
220.0	91.6	58%	35.5	84%
240.0	98.5	59%	38.3	84%
260.0	105.3	59%	41.1	84%

As previously mentioned, the long design cycles and high costs involved in developing new CPUs for games consoles (~$400 million for the CPU in one of the high definition Game Consoles) would mean that requiring major changes to the CPUs in the current generation of games consoles would cause significant problems. However, interested parties should look towards the improvements made in the power management of personal computers CPU's and assess whether these improvements could be applied within the next generation games consoles.

Interested parties could also look towards other power saving technologies developed for personal computers. Developed for notebook PCs, where reduced power consumption is essential for a long battery life, Nvidia's "Optimus" technology facilitates complete powering down of discrete GPUs during periods of inactivity with no impact on functionality91. Other manufacturers have developed similar technologies for their own notebook PCs92. Switching off of discrete GPUs has also been shown to be possible in desktop PCs although uptake of this technology in desktop PCs remains limited.

It should be noted that one of the main games consoles manufacturers has tested the power consumption of a workstation PC to illustrate that the difference between active mode and game pause mode power demand is not always as large as between active mode and idle mode. The results of the testing can be seen in Table 71**Error! Reference source not found.**.

Table 71 –Active, Game Paused and Idle Mode Power Demand in a workstation PC

System Details	Active (W)	Game Pause (W)	Idle Mode (W)
HP Workstation xw4600 OS: Windows XP CPU: Intel Core2 Duo E8500 @3.16GHz GPU: NVIDIA Quadro FX570 Game installed: Doom3	111.1 – 114.0	111.1 – 114.0	76.0 – 90.0

[91] http://www.nvidia.com/object/optimus_technology.html
[92] http://www.apple.com/macbookpro/performance.html

The results suggest that within a workstation PC Game Play and Game Pause modes draw approximately the same amount of power and that the idle mode power demand is significantly lower than the other two modes. The manufacturer therefore suggests that power demand reductions in PCs should be based on the difference between active and game pause rather than differences between active and idle mode.

It is suggested that the manufacturer test results do raise an important issue that power demand during game pause in a PC might not always be significantly lower than the active mode power demand. It is also important to note that the testing was completed on a workstation PC rather than a desktop or notebook PC. Workstation PCs are primarily designed to serve as high specification PCs and manufacturers have therefore not traditionally placed a heavy emphasis on energy efficiency in these types of PCs. Nevertheless, further testing could be carried out to determine whether "game pause" power demand in desktop and notebook PCs is more closely matched to the active mode than idle mode power demand. It would also be important to identify the cause for the continued large amount of power demand in game pause modes and whether any technical fixes to the issue are available (such as the inclusion of lower powered GPUs to render images during game pause modes).

Sleep Mode/Standby

The US EPA have included a range of sleep mode power demand requirements in the draft ENERGY STAR specification for games consoles. These requirements are shown in Table 72.

Table 72 – Draft ENERGY STAR Specifications for Games console Sleep Mode

Tier and Effective Date	Sleep Mode (W)	
	Wireless AP/Router Functions not engaged:	Wireless AP/Router Functions engaged:
Tier 1 (Effective July 1, 2010)	≤ 2.0 plus an additional 0.7 for WOL enabled devices	≤ 10.0
Tier 2 (Effective July 1, 2011)	≤ 1.0 plus an additional 0.7 for WOL enabled devices	≤ 5.0
Tier 3 (Effective July 1, 2012)	≤ 1.0 plus an additional 0.7 for WOL enabled devices	≤ 5.0

As previously discussed the sleep mode of games consoles closely matches the ecodesign preparatory study's definition of "Networked Standby", and when not connected to a network the Commission's definition of "Standby".

The definition of standby as used in the Commission Regulation No 1275/2008 could likely be considered to apply games consoles where the product is sat in a standby mode with no connectivity to any network. The standby definition would also apply where the only active network is through the low power Bluetooth protocol such as that sometimes found between controllers and base unit.

The application of the "Networked Standby" definition for games console is more complex. Where a games console remains connected to the internet (either through Wi-Fi, LAN or Ethernet connection) solely for the purposes of facilitating "System Maintenance and Download" or "Set Top Box Functions," or perform other system-level functions then this mode would be considered a "Networked Standby" mode.

The "networked standby" mode of games consoles under the conditions described above would closely match the off mode definition included in the draft Commission Regulations on computers. The draft requirements in the Commission Regulation on desktop computers for off mode are 1.0W (0.5W by 2013) with a 1.7W allowance for WoL. Given the similarities between the products the same power demands, and WoL allowance (when required), could be used for games consoles in a future ecodesign requirement.

However, a low power mode in a games console which provided more functionality than just maintaining a live network connection, such as the ability to wake within a short time frame, would

more closely match the definition of "sleep mode" found in computers. The ENERGY STAR v5.0 for computers defines sleep mode as:

"Sleep Mode: A low power state that the computer is capable of entering automatically after a period of inactivity or by manual selection. A computer with sleep capability can quickly "wake" in response to network connections or user interface devices with a latency of ≤ 5 seconds from initiation of wake event to system becoming fully usable including rendering of display. For systems where ACPI standards are applicable, Sleep mode most commonly correlates to ACPI System Level S3 (suspend to RAM) state"[93].

The draft ecodesign sleep mode requirements for computers were not finalised at the time of writing but early indications suggest that desktop PCs could be allowed to use between 4W to 6W and notebook PCs 3W in sleep mode (plus 0.7W allowance for WOL functionality). These relatively high values (given an older ENERGY STAR v4.0 specification which allowed 4W for desktop PCs and 1.7W for notebook PCs in sleep mode (plus an additional 0.7W for WOL functionality)) have been suggested because the functionality offered in the sleep mode of PCs could increase in the future. Allowing more power demand in sleep mode could result in extra functionalities being supported in that mode that could only previously be supported in idle mode (therefore meaning less time could be spent in idle mode). This could consequently result in less energy use overall as the increased sleep mode power demand is still significantly lower than idle mode power demand.

There are some other instances where games consoles have a higher power demanding "networked standby" mode. Some of the current games consoles on the market provide wireless access point or router functions. That is, the games consoles can be connected to separate devices and allow these secondary devices to connect to the internet via the console. When this functionality is set up by the user a games console will sit in a network standby mode waiting for a wake signal. One of the most popular high definition consoles on the market used approximately 24W during this network standby mode at product launch (the latest version of the console uses 9W during this power mode). Part of this high power demand is due to the internal fan of the games console continuing to operate even after the system is turned off. An improved and more energy efficient cooling concept should provide a much lower power demand. A power demand of approximately 10W is required by a lower specification machine when connected to the internet in standby mode.

A number of organisations are currently undertaking work on small network equipment in order to identify potential energy savings as well as to set targets. The European Commission already has a Code of Conduct in place for Broadband Equipment[94]. The US EPA is also in the beginning stages of developing ENERGY STAR specifications for small network equipment[95]. Future ENERGY STAR small network equipment specifications should be reviewed in line with any finalised ENERGY STAR specifications on games consoles.

The European Commission's Code of Conduct on the energy consumption of broadband equipment already includes target power demand values for products providing internet connectivity in domestic premises. Table 73 below illustrates the low power and on power demand targets for Wi-Fi access points. It is clear that the CoC targets are significantly more stringent than the ENERGY STAR sleep mode requirements for games consoles when wireless router functions are engaged.

It should be noted that the Commission's CoC is focuses on devices which provide network connectivity as their primary function and therefore power demand targets are likely too strict for the multifunctional games consoles. However, given the relatively small differences between the draft ENERGY STAR specifications and the Commissions CoC targets it is assumed that games consoles might not require significantly more power than single function devices when providing network functions.

[93] http://www.energystar.gov/index.cfm?fuseaction=products_for_partners.showComputers
[94] European Commission, Code of Conduct on Energy Consumption of Broadband Equipment Version 3 18 November 2008, available from http://re.jrc.ec.europa.eu/energyefficiency/pdf/CoC%20Brodband%20Equipment/Code%20of%20Conduct%20Broadband%20Equipment%20V3%20final.pdf
[95] US EPA, Small Network Equipment, http://www.energystar.gov/index.cfm?c=new_specs.small_network_equip

Table 73 – Target EC CoC Wi-Fi Equipment Power Demands

	Tier 2009/2010:		Tier 2011:	
Equipment	**Low-Power-State (W)**	**On - Power-State (W)**	**Low-Power-State (W)**	**On - Power-State (W)**
Wi-Fi Access Points with single band IEEE 802.11b/g or 11a	3.0	4.0	2.3	3.6

As no further information is currently available about the power demands of games consoles in the higher power demanding networked standby power mode it is suggested that the ENERGY STAR sleep mode requirements from 2011 could be considered as future ecodesign requirements (if no TEC type approach is suggested and functionality in this power mode does not increase significantly in the next generation games consoles).

Manufacturers have commented that the power demands listed above are too ambitious for their current generation of games consoles. Indeed one of the main games console manufacturers has provided some alternative sleep mode power allowances for consideration as future ecodesign requirements. These manufacturer sleep mode allowances are shown in Table 74.

Table 74 – Manufacturer Suggested Ecodesign Requirements for Games console in Sleep Mode

Product Type	Sleep Mode (W)
Wired WOL	≤ 3.0
Wireless WOL	≤ 5.0
Wireless AP/router	≤ 7.0

The power demands of the lowest power demanding mode (off/standby mode) found in current generation games consoles are significantly lower that the values proposed by the manufacturer above (apart from when the game console is acting as a wireless AP/router). This suggests that the manufacturer may be expecting the functionality offered during the lower power modes (i.e. sleep mode) of future games consoles to increase.

It is suggested that many of the draft ENERGY STAR “sleep mode” power demand values listed above could be met by current games consoles but only when those products were in an “off” or “standby” mode rather than a “sleep mode” condition where functionality is increased.

Future ecodesign measures placed on the low power modes of future games consoles will need to take functionality into account. That is, where functionality in a lower power mode is limited to WOL then ecodesign limits could be developed more in line with the draft ENERGY STAR specifications shown in **Error! Reference source not found.**. However, where low power modes offer increased functionality, and therefore more closely match the ENERGY STAR definition of “sleep mode” for PCs, then future ecodesign requirements should be developed more in line with the “sleep mode” requirements suggested by the manufacturer (or those found in the ecodesign measures for computers (where functionality is the same or similar)).

It is important to consider that energy use resulting from low power modes in future games consoles could increase significantly where “sleep mode” becomes the dominant low power mode.

An alternative TEC approach, discussed below, could reduce the need to set limits on individual power modes (e.g. for sleep mode) and instead provide an energy budget across all power modes under a predetermined use profile.

Off Mode

As mentioned earlier in the document, it is assumed that the off mode (when no network is active, no information display is present and no reactivation is available other than the physical pressing of a button) of games consoles likely meets the definition of "off mode" in the Commission Regulation No 1275/2008. Therefore the off mode of games consoles is likely already appropriately covered by an ecodesign Regulation and so no further power requirements are deemed necessary.

TEC Approach

Whilst the US EPA have chosen to develop power limits for games consoles in the draft ENERGY STAR specification, typical electricity consumption (TEC) approaches (measured in kWh/year) have been used in ENERGY STAR for similar products such as desktop PCs. Initial analysis suggests that a TEC approach for games consoles might be ineffective given uncertainties surrounding the amount of time an average games console spends in active and idle modes. However, one games console manufacturer favours the development of a TEC approach for games consoles within a future ecodesign measure.

A TEC approach could provide manufacturers with some flexibility in the way they balance the power demand between different power modes. To identify a suitable TEC approach for games consoles it would be necessary to include a suitable energy limit (measured in kWh/period of time) for games consoles. The kWh/period of time would need to be based on a suitable use profile and approximate power demand values (recognising that power demand could vary between power modes to allow for flexibility).

Table 75 shows some use profile data provided by one manufacturer. This use profile data provides a good indication of the average number of hours per day that games consoles are powered on. Further work is still required to identify a good quality use profile for use in a TEC based ecodesign measure however as there is no clear indication of the amount of time games consoles spend being actively played (active mode) as opposed to simply being left on (idle mode).

Table 75 – Manufacturer Measured Average Use Profiles

Function	Active and Idle Mode Hours/day	Share of Time
All	2.1	100%
Game Play	1.4	66%
Movie/Video Playback	0.4	17%
Internet Browsing	0.1	5%
Other Functions	0.3	12%

Using the assumption that 30% of the time is spent in "idle mode" (idle mode is used to indicate the periods of time where the console is powered on but not being actively played) it is possible to estimate the TEC for high definition games consoles that are currently on the market. The calculations are shown in Table 76. The inclusion of active mode into the TEC calculation, a departure from the personal computer TEC approach listed in the draft ecodesign measure, was included following a suggestion from one manufacturer.

Table 76 – Estimated TEC values for current high definition games consoles

Function	Hours/ day	Time in Each Function (%)	Estimated Share of Time During On Modes		Active		Idle		Stand by/ Off Power	TEC Based on Manufacturer Use Hours
			Active Mode	Idle Mode	Time (Hours/ day)	(W)	Time (Hours/ day)	(W)	(W)	kWh/year
Game Play	1.4	6%	70%	30%	1.0	93.3	0.4	92.8	0.9	48.1
Movie/Video Playback	0.4	2%	70%	30%	0.3	74.9	0.1	73.9	0.9	9.9
Internet Browsing	0.1	0%	70%	30%	0.1	74.1	0.0	74.1	0.9	2.9
Other Functions	0.3	1%	70%	30%	0.2	74.6	0.1	74.6	0.9	7.0
Standby/Off	21.9	91%							0.9	6.9
All/	24									74.8

Applying the reductions seen between active mode and idle mode for desktop PCs, as illustrated in Table 76, it is possible to recalculate the estimated TEC limit as shown in Table 77...

Table 77 – Estimated TEC values for current high definition games consoles if average desktop PC active to idle reduction is included

Function	Hours/ day	Time in Each Function (%)	Estimated Share of Time During On Modes		Active		Idle		Stand by/ Off Power	TEC Based on Manufacturer Use Hours
			Active Mode	Idle Mode	Time (Hours/ day)	(W)	Time (Hours/ day)	(W)	(W)	kWh/year
Game Play	1.4	6%	70%	30%	1.0	93.3	0.4	48.1	0.9	41.2
Movie/Video Playback	0.4	2%	70%	30%	0.3	74.9	0.1	41.8	0.9	8.6
Internet Browsing	0.1	0%	70%	30%	0.1	74.1	0.0	41.5	0.9	2.5
Other Functions	0.3	1%	70%	30%	0.2	74.6	0.1	41.7	0.9	6.1
Standby/Off	21.9	91%							0.9	6.9
All/	24									65.2

Whilst the above TEC calculation may be suitable for current generation high specification games consoles (i.e. the active mode power requirements are known) it is unlikely to be suitable for future games consoles where active mode power might increase. As previously mentioned, any restriction placed on the active mode is likely to impact the functionality of future products. It is not currently possible to predict the active mode power demand of future games consoles as manufacturers have stated that they are, at the time of writing, undecided on future specifications. As such, the exact amount of energy allowable for any future games console under a TEC approach will need to be decided once there is a clearer idea about future active mode power demand.

A TEC approach would not automatically limit future growth in active mode power but by tying an idle mode power to active mode power in an increasingly stringent relationship it could encourage manufacturers to try and further limit active mode power (since the required gap between “active” and “idle” would increase with growth in active mode power demand).

Manufacturers have stated that they are unable to provide estimated active mode power demands for future products as final specifications are undecided. Without a known active mode power limit it is therefore not possible to provide suggested TEC limits for future games consoles. It will therefore be continually difficult to identify appropriate TEC limits for games consoles until it becomes possible to identify future active mode power demands. This situation causes difficulties for regulators and manufacturers as any TEC based limits introduced through ecodesign measures would have to be developed retrospectively after the games console has been designed. This would result in the same position at present in that setting ecodesign measures on the power demand of games consoles already on the market could cause manufacturers excessive redesign costs. On the other hand,

setting ecodesign measures before future games consoles have been designed could limit innovation and cause market distortions towards other gaming products such as gaming PCs. A potential solution could be to develop a TEC formula that is based on both Game Play mode (active mode) efficiency and which addresses idle mode power demand through set percentage reductions from Game Play active mode power demand.

Game Play mode efficiency could be expressed as:

Game Play mode efficiency	=	Graphics processing power (gigaFLOPS) / Game Play mode power (W)

The Game Play mode efficiency of one of the current high definition games consoles on the market would be calculated as (based on computational performance provided by one of the main manufacturers):

Game Play mode efficiency	=	2180 gigaFLOPS / 99W	22.02 gigaFLOPS/W

In contrast the highest specification desktop PC GPU currently on the market has a Game Play mode performance of:

Game Play mode efficiency	=	4640 gigaFLOPS / 294W	15.78 gigaFLOPS/W

Given that it is the Game Play mode that needs to be defined for a TEC approach the formula would need to be expressed as:

Game Play mode power (W)	=	Graphics processing power (gigaFLOPS) / 22.02 gigaFLOPS/W

For a future games console providing graphics processing power at 4.64 teraFLOPS the Game Play mode power demand based on current efficiencies would be:

Game Play mode power (W)	=	4640 gigaFLOPS / 22.02 gigaFLOPS/W	=	210.7 W

With a formula approach based on current active mode efficiency to identify the Game Play mode power of future games consoles it would also be possible to determine the idle mode power using the desktop PC formula illustrated earlier in Figure 22. It should be noted that the formula illustrated in Figure 22 does not take account of increasingly wide reductions between active and idle power demand as the active mode power increases. Any move to clarify this suggested approach should consider this factor. The idle mode power for the above product providing 4.64 teraFLOPS of graphics processing would therefore be calculated as:

Game Play Idle mode power (W)	=	0.3433 x 210.7 + 16.068	=	88.40 W

The resulting Game Play Idle mode power demand of 88.4W is significantly higher than the 70W "System Idle" ecodesign measure for future games consoles suggested by one of the manufacturers. This difference could be due to a number of factors including; expected power differences between "Game Play Idle" and "System Idle" in future products, expected wider gaps between active mode and idle mode in future products or perhaps lower Game Play mode power demand than the 210.7W estimated above.

It is also important to consider earlier discussions about the exact definition of "idle mode" in games consoles. All manufacturers claim that the Game Play Idle mode is an active mode and not an idle mode. The three main manufacturers agree that the "System Idle" mode is a closer match to the idle mode found in desktop and notebook PCs. However, as suggested earlier it might also be possible for manufacturers to power down additional components in a "Game Play Idle Mode" or "Game Pause

Mode" as described earlier in this report. It is suggested that as significantly more time is likely to be spent in "Game Play Idle Mode" or the "Game Pause Mode" compared to "System Idle" then these modes are more important to use in a TEC approach.

The calculated Game Play mode power and the idle mode power values could then be used in a formula to help determine maximum permissible TEC (kWh/year) limits for future games consoles.

For games consoles which use under 25W in active mode the above approach will not result in any required reductions in idle mode power.

Within any TEC approach it would also be necessary to take the various possible sleep/standby and off mode power requirements into account. Table 78 shows an example TEC allowance for all low power modes based on the manufacturer requested sleep mode power demands and the draft ENERGY STAR specifications for standby mode (listed as Sleep mode in ENERGY STAR). In the example 30% of the low power mode time is allocated to the sleep mode with the remainder allocated to the standby mode. These time splits are based on assumption as no further data is available. The results show that for a games console equipped with wireless WOL in the sleep mode a total of 21.46 kWh/year could be provided (it is expected that this value would then be added to the TEC allowance for the active and idle modes).

Table 78– Example TEC allowance for low power modes

Product Functionality	Sleep Mode (W)	Standby Power (W)	Sleep Mode (Hours/day)	Standby Mode (Hours/day)	Total TEC Allowance (kWh/year)
Wired WOL	3.0	1.7	6.6	15.3	16.67
Wireless WOL	5.0				21.46
Wireless AP/router	5.0				21.46

Table 79 shows the savings in TEC that a manufacturer could make (and consequently apply to the active and idle mode allowance) by shipping games consoles with a reduced power demand in the low power modes.

Table 79 – Example TEC savings from the use of Standby instead of Sleep for low power mode

Product Type	Sleep Mode (W)	Standby Power (W)	Sleep Mode (Hours/day)	Standby Mode (Hours/day)	Total TEC (kWh/year)	Saving from use of Standby (kWh/year)
Wired WOL	3.0	1.7	0.0	21.9	13.56	3.1
Wireless WOL	5.0				13.56	7.9
Wireless AP/router	5.0				13.56	7.9

The sleep mode functionality of next generation consoles should be considered nearer to the date at which ecodesign measures will be defined. This is important as significantly increased functionality in sleep mode might allow some functions to run in sleep mode that would otherwise need to be run in active or idle mode. This could result in savings that would be reduced through encouraging manufacturers to ship games consoles to power down to a standby rather than sleep mode.

The above approach could provide the potential for setting ecodesign measures for games consoles that are yet to be developed without negatively impacting innovation or promoting unfairness in the marketplace. However, before TEC limits could be proposed for use in an ecodesign measure it would first be necessary to develop an accurate methodology for determining the Game Play mode efficiency of games consoles. The proposed use of FLOPS stems from both GPU and games console manufacturers using this metric to communicate graphics rendering performances of their products. The results of these tests across multiple games consoles could then be used to help determine the FLOPS/W active mode efficiency formula. There are some methodologies in use for PCs, such as the 3DMark methodology, which could be used for reference. The 3DMark methodology provides a means

of benchmarking the performance of PCs 3D graphic rendering and CPU processing capabilities in order that different PC hardware configurations can be compared on an accurate basis.

The methodology described above provides a suggested solution for defining the Game Play mode and idle mode power demand in future products. It would also be necessary to determine if all functions offered by games consoles should be allowed to consume the same amount of power in idle mode (i.e. assess whether the same percentage power reductions from Game Play mode apply to media play, media idle, media pause or for other functions such as internet browsing). Previous sections of this report have included discussion about the reasons why the inclusion of specific lower powered components to run media functions could be problematic in future games consoles. Without the inclusion of these media play specific components it is likely that media play power demand would be similar to the "System Idle" or "Game Play Idle" power demand. As such it is suggested that energy use associated with media play, media play idle and media pause is assumed to be the same as "Game Play Idle", "Game Pause" or "System Idle" (or whichever power mode is used to represent "idle").

Tier I – Idle Mode Power Limits – 2014

The previous draft of this report stated that all games consoles first placed on the market after the Tier I implementation date should meet the following power demand limits:

Table 80 – Draft ENERGY STAR Specifications for Games console Idle Modes

Tier I	System Idle (W)	Game Play Idle (W)
All Games consoles placed on the market after 1.1.2014	≤ 45.0	≤ 45.0

Games console manufacturers have expressed concerns that the idle mode power values shown in Table 80 are unrealistic for next generation games consoles. However, only one manufacturer has provided alternative idle mode values (shown in Table 67). It is not possible to identify how challenging the above idle mode values are until the specifications of the next generation of games consoles becomes clear. However, as shown above idle mode power demand values could still be met using best practice technologies found in laptop PCs even if active mode power demand grew to 260W.

Given the uncertainty over the specification of future games consoles, future ecodesign requirements on idle mode could also be developed using the active mode efficiency formula and reductions from active mode discussed in the TEC section above (as shown in Table 81). This would allow greater consideration of future product functionality.

Table 81 – Suggested Formula For Developing Idle Mode Power Limits

Tier I	System Idle and Game Play Idle (W)
All Games consoles placed on the market after 1.1.2014	$\frac{0.3433 \times \text{Game Play Power Demand} + 16.068}{}$

As previously mentioned, further work would be required to enhance the suggested formula above, in particular to take account of increasing divergence between idle mode and active mode as active mode power demand grows.

It was also suggested in the previous draft of the report that the implementation date of any Tier II requirement would need to be around 2020 due to the long life cycle of each generation of games console. It is considered that 2020 was too far into the future to set requirements as the products could have changed dramatically by that time. However, one stakeholder commented that ecodesign requirements can help to ensure that energy efficiency is made a priority in the design of new generations of products and these next generations do not have significantly higher power demands than previous products. The stakeholder continued by stating that long term ecodesign measures could be set but reviewed and revised if strong evidence is produced to prove that the measures cannot be met.

It is suggested that future measures, beyond those suggested above, are considered before new generations of consoles are released to the market i.e.) for the consoles expected to be released around 2020. However, it is suggested that, given the fast pace of technological progress in games consoles, the necessary background analysis should be conducted at a suitable time in the future where potential power demand or energy efficiency measures can be assessed against technologies on the market at that time.

Potential for game console power management

The Commission Regulation No 1275/2008 also contains requirements in 2013 for auto-power down functionality to standby or off mode (or another suitable low power mode) which could apply to games consoles. The text of this power down requirement is shown below:

> *When equipment is not providing the main function, or when other energy-using product(s) are not dependent on its functions, equipment shall, unless inappropriate for the intended use, offer a power management function, or a similar function, that switches equipment after the shortest possible period of time appropriate for the intended use of the equipment, automatically into:*
> - *standby mode, or*
> - *off mode, or*
> - *another condition which does not exceed the applicable power consumption requirements for off mode and/or standby mode when the equipment is connected to the mains power source. The power management function shall be activated before delivery.*

As the Commission Regulation No 1275/2008 wording applies to a large range of electronic equipment it could be viewed as not being specific enough for games consoles. One of the applicability concerns centres on the wording, “unless inappropriate for the intended use” included in the Directive. Games console manufacturers have raised concerns that auto-power down features are not always appropriate for their products due to potential impacts on gaming. Given this potential inapplicability of the power down requirements in Regulation 1275/2008 it is necessary to visit this issue in more detail. Further discussion on the power management functionality in games consoles is discussed in the next section.

Another area of concern with the Regulation 1275/2008 text and its applicability to games consoles is the requirement that products should “after shortest possible period of time appropriate for the intended use of the equipment” power down into a standby or off mode (or other applicable low power mode). This requirement does not include any mandatory limits on the period of time a product can stay inactive before powering down and does not require that the auto-power down function is set as default on shipment. Therefore, a potential exists for long intervals of inactivity to be allowed in games consoles before powering down. Long periods of inactivity before power down might be considered appropriate by gamers and manufacturers if powering down after a short period of time impacted usability of the games consoles.

The US EPA appears to have recognised, within the draft ENERGY STAR specification, that powering down games consoles after short periods of inactivity has the potential to negatively impact the usability of products. As such the draft ENERGY STAR specifications include a tiered approach to power management to ensure that most negative impacts on the usability of games consoles can be avoided.

The auto power down requirements included in the draft ENERGY STAR specification can be seen in Table 82.

Table 82 – Draft ENERGY STAR Specifications for Auto Power Down

Tier and Effective Date	Auto Power Down Requirements
Tier 1 (Effective July 1, 2010)	A game console in any state other than *Game Play*, *Game Pause*, *Game Play Idle*, or *Media Play* must auto-power down within 1 hour of user inactivity (i.e. the console receives no user input for 1 hour or more). A game console in *Game Play* or *Media Play* may not automatically power down. The game consoles must be shipped with these settings enabled by default.
Tier 2 (Effective July 1, 2011)	A game console in System Idle, Game Play Idle, Game Pause, Media Play Idle and Media Pause, or any state other than Game Play or Media Play must auto-power down to a sleep mode within 1 hour of user inactivity (i.e. the console receives no user input for 1 hour or more). On resume, a game console should return to the previous mode that the console was in prior to sleep unless there was an interruption in power to the console during sleep. In addition, after an automatic wake event, the console must power down immediately after performing required System Maintenance and Downloads or STB Functions. A game console in Game Play or Media Play may not automatically power down. The game consoles must be shipped with these settings enabled by default.
Tier 3 (Effective July 1, 2012)	A game console in System Idle, Game Play Idle, Game Pause, Media Play Idle and Media Pause, or any state other than Game Play or Media Play must auto-power down to a sleep mode within 1 hour of user inactivity (i.e. the console receives no user input for 1 hour or more). On resume, a game console should return to the previous mode that the console was at prior to sleep unless there was an interruption in power to the box during sleep. In addition, after an automatic wake event, the console must power down immediately after performing required System Maintenance and Downloads or STB Functions. A game console in Game Play or Media Play may not automatically power down. The game consoles must be shipped with these settings enabled by default.
Note on Tier 2 and Tier 3 Games Compatibility	When operating games published on or after the effective date of the Tier 2 requirements, the console must automatically save a user's place in a game (as defined by that game's game play model) to allow auto-power down to a sleep mode and return and return the user to that place upon resume from sleep. Note: This requirement does not apply to operation of games published prior to the Tier 2 effective date, including "legacy" games developed for older consoles.

The tier I ENERGY STAR criteria for auto power down only relates to media idle and system idle power modes. Therefore for these requirements to be effective the users need to have exited a game and left the games console in the system idle power mode for at least an hour. This auto power down requirement would therefore not function if a user loads a game and then leaves the games console inactive for a period of an hour. Two of the main games consoles on the market already include the ability to allow users to select power management functionality that works across all power modes (this is available as an option and not set as default). It should be noted that whilst the games consoles will shut down in game play mode and progress made in a game will not be saved automatically.

The tier I ENERGY STAR criteria could therefore already be met by at least two of the main games consoles on the market.

The tier II and tier III ENERGY STAR criterion includes a broader range of power modes that need to be supported by games consoles when offering auto power down functionality. As a result of this required broader support the US EPA has also recognised the need to address the issue of game compatibility with auto power down functionality. Ensuring that games can be automatically saved when the games console powers down is an important consideration to limit the chances of users

disabling the power down functionality. The US EPA has also included a caveat that games published before the effective date of the criterion do not need to offer this functionality. This is to ensure that games published in the past do not need to be recoded to support the auto power down functionality. It is recommended that these games should include an on-screen message when started reminding users to power down the console after use.

Since publication of the last draft of this task 7 report the main manufacturers have worked with a number of NGOs to develop a proposed APD approach for games consoles. This proposal can be seen in Table 83 below.

Table 83 – Draft Industry/NGO Auto Power Down Specification

Auto-Power Down (outline proposal)

The following requirements form the basis of an advanced auto-power down proposal (APD) for games consoles. As such this proposal represents overall best practice for games consoles, and defines advanced features that may be considered best practice across several categories of Energy related Products.

- This auto-power down proposal applies to all new game consoles placed on the market from the implementation date, except for consoles that use less than 20W in gaming mode which will be exempt until January 1, 2014.
- The timeline for implementation of this proposal shall be determined in accordance with the ErP regulatory process.
- Consoles will be shipped with auto power-down enabled such that the user does not have to opt-in to activate the APD function in accordance with ErP regulatory requirements.
- The user shall not be automatically prompted to permanently disable the auto-power down at any point.
- The user shall have the option to disable APD for game mode only and for all modes. Consoles shall present the option of disabling APD for game mode only first so as to encourage users to leave APD enabled for other modes.
- The user shall 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.
- After activation of auto power-down, consoles will switch-off to standby and/or allowable sleep modes as defined already in accordance with EuP regulatory requirements.
- The trigger used to activate auto power-down is user inactivity, and this will function across all console modes (with the exception of the specifically defined exemptions explained below). The period of inactivity required to trigger auto-power down will differ depending on the specific use of the consoles as defined further below.
- By default, auto power-down must be set at 1 hour or less for all consoles sold from the time of the last user input. Consoles shall not auto-power down during the first 4 hours while audio-visual media playback remains active (including video files, streaming audio-visual content, IPTV or Digital TV)
- In limited circumstances users may be prompted to cancel the APD timer temporarily to allow certain types of games or media content to run without user input e.g. simulation games which run without user input for periods longer than 1 hour:
  - Upon starting such games or media content the user will be prompted to temporarily suspend auto-power down if required.
  - Auto-power down will be re-enabled when the console is next powered on.
- 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 will be included in auto-power down power measurements.

- Console operating systems must support auto-save and resume by providing means:
  1. For notification between the console and software in advance of impending auto-power down
  2. To enable game software to save information as appropriate to avoid loss of user data or game position
  3. To ensure users can be automatically returned to their saved game after an auto-save event.
- A test methodology for use in conformity assessment, market surveillance, and enforcement should be developed and adopted by the appropriate standards bodies to ensure harmonized implementation.

The industry/NGO APD proposal includes additional detail beyond the draft ENERGY STAR APD requirements but there are several outstanding issues with the proposal that warrant further investigation.

The industry/NGO APD proposal states that manufacturers agree to apply the APD requirements to all new games consoles placed on the market after a pre-defined date. Further discussions could take place with the manufacturers to identify whether the APD settings could also be applied to the millions of games consoles already in stock.

The APD proposal includes the statement, “The user shall have the option to change the time settings for the auto-power down function from within the equivalent system settings menu options”. This requirement could be expanded to state the time settings that could be applied e.g.) in intervals of 15 minutes.

The term “user inactivity” would also likely need further clarification to ensure that it is possible to clearly define periods of inactivity.

The APD proposal states that, “By default, auto power-down must be set at 1 hour or less for all consoles sold from the time of the last user input”. A 1 hour period of inactivity is a significant amount of time for a product to be left in an on mode whilst not providing any function. It is suggested that a 30 minute period of inactivity is a long enough period of inactivity before APD is triggered. Manufacturers and NGOs have suggested that a 30 minute power down is too short a time period of inactivity before powering down as it will impacts usability of the consoles and encourage users to disable APD settings. It is suggested that whilst 30 minutes is too short a time period for some users it will not be too short for other users. Those users that find a 30 minute period of inactivity too short before powering down could be given the opportunity of changing the APD settings to 1 hour.

One of the games console manufacturers also stated that continually powering down after 30 minutes could cause damage to components due to thermal expansion and contraction caused by changes in temperature. Another manufacturer has stated that they do not share these concerns and that their console would not be damaged by a 30 minute APD requirement.

The industry/NGO APD proposal also includes the statement, “Consoles shall not auto-power down during the first 4 hours while audio-visual media playback remains active (including video files, streaming audio-visual content, IPTV or Digital TV)”. The 4 hour period matches the ecodesign requirement for APD in televisions. However, a 4 hour period of inactivity for disc based media before APD is triggered could be seen as too long. That is, if a film lasts 1.5 hours then the console could remain in an active mode for a further 2.5 hours before powering down. It is suggested that for disc based media the console should power down before 4 hours of inactivity. The proposed APD requirements do not also directly address the issue around DVD incompatibility with APD.

Potential game console power management requirements

As previously mentioned there are three games consoles currently dominating the market. Two of these consoles, both of which support high definition, are already able to support auto power down but not necessarily support auto save in games. It is suggested that APD requirements are first introduced for the high definition games consoles as they use considerably more power in active and idle modes

than the lower definition console and with similar use profiles the potential savings could be considerably higher. Actual savings will be dependent on the amount of time games consoles spend in idle modes with no user activity. One manufacturer is currently investigating the amount of time its consoles spend in idle modes. Results were expected in May 2010.

The following APD requirements for games consoles were previously suggested for future ecodesign requirements in an earlier draft of this document:

- **Tier I – Implementation to be 6 months after publication of ecodesign measure**
  All games consoles ((with active or idle mode power demand of over 50W) in any power mode other than Game Play, Game Pause, Game Play Idle or Media Play must auto-power down to a sleep/network standby/standby mode within 30 minutes hour of user inactivity. A high definition game console in Game Play or Media Play may not automatically power down. All high definition games consoles must be shipped with these auto power down settings enabled as default.

- **Tier II/1 – Implementation date in line with the APD requirements date in Commission Regulation No 1275/2008 (2013)**
  All games consoles in System Idle, Game Play Idle, Game Pause, Media Play Idle and Media Pause, or any state other than Game Play or Media Play must auto-power down to a sleep/network standby/standby mode within 30 minutes of user inactivity. On resume, a game console should return to the previous mode that the console was in prior to sleep/network standby/standby unless there was an interruption in power to the console during sleep. In addition, after an automatic wake event, the console must power down immediately after performing required System Maintenance and Downloads or STB Functions. A game console in Game Play or Media Play may not automatically power down. When operating games published on or after the effective date of the Tier II requirements, the games console must support automatic saving of a user's place in a game (as defined by that game's game play model) to allow auto-power down to a sleep/network standby/standby mode. The game consoles must be shipped with these settings enabled by default.

- **Tier II/2 – Implementation date in line with the APD requirements date in Commission Regulation No 1275/2008 (2013)**
  All games placed on the market on or after the Tier II implementation date must support auto-save ahead of a games console powering down to a sleep/network standby/standby mode after a period of inactivity not exceeding 30 minutes. Any games first placed on the market before the Tier II implementation date are not required to support auto-save functionality.

The following discussion points were raised as a consequence of the initial APD ecodesign requirements suggested above:

- One manufacturer had commented that they would not make use of the exemption on "Game Play" in any APD functions that are updated on their games consoles. The manufacturer stated that the only trigger that will be used to activate APD will be user inactivity and that this would function across almost all console modes.

- The manufacturer commented that an APD set to engage within 30 minutes of inactivity would likely be disabled by heavy users and could also cause the shortening of the CPU and GPU due to frequent powering down. The manufacturer also suggested that the default power down time should be extended to 1 hour for gaming applications and 3 hours to allow for movie play-back.

- Another manufacturer commented that their current games console cannot differentiate between interactive modes in which controllers are engaged and passive modes which do not require user input. They stated that a 30 minute APD would result in a premature power-down during media playback where no ongoing user input is required. The manufacturer proposed a three-hour default setting for APD. They also stated that if a shorter time limit was required they would need at least three years to phase in the necessary hardware changes.

- It was suggested that 30 minutes is a long period of time for games consoles to remain inactive without powering down. It is recognised that one of the high specification games consoles on the market cannot currently support a 30 minute power down due to conflicts with the media modes. A possible solution to this issue would be to allow users to temporarily disable the APD functions

before the start of a film. The console could then revert back to the 30 minute power down once the user has finished with the media mode. Users could also be forewarned on an impending APD engagement in game modes to ensure that usability impacts are limited.

- Desktop PCs and notebook PCs are frequently shipped with APD set to engage after 30 minutes of inactivity. There appears to be little evidence to suggest that lifetimes of these PC products is being adversely affected by the APD functionality. Further details about the usage frequency of gamers should be requested from manufacturers to identify the level of risk, in terms of damage to the CPU and GPU, associated with a 30 minute APD.

- It was assumed that games console manufacturers would have enough control over the development of games to ensure compatibility with the APD requirements. The business model of the games consoles manufacturers is based on the development, design, manufacture and marketing of the consoles as well as on licensing the games produced by independent games publishers. Contracts between the games console manufacturers can vary according to a number of factors such as exclusivity of the game for a specific console, attractiveness of the game for the users and merchandising options. Games publishers usually pay for the development of games following negotiations with the games console manufacturers. However, some games are developed independently by game developers and then sold to a games publisher on completion.

- Given that games console manufacturers have a significant but not complete influence over the design of games for their consoles it is suggested that the games themselves are implicitly covered by any future implementing measures addressing auto-save functions associated with APD.

The suggested APD requirements mentioned above could still be used in future ecodesign requirements. However, it is suggested that as industry and NGOs appear to have reached an agreement on a set of APD requirements then these should be considered for use in future ecodesign requirements (with the necessary changes included as discussed above).

Secondary functionalities

Optional Secondary functions of games consoles are
- Optical disk playback (playback of DVD and BD)
- MPEG playback from HDD
- Digital music playback (playback of CD)
- Digital picture viewing
- Support for internet browsing

Potential for minimum requirements for secondary functions

The secondary functions of one of the main games consoles on the market are used for 17% of the total average usage time of 14h 57m per week which equate to 2h 33m per week.

Reducing the power consumption of games consoles during secondary functions of playback for BD or DVD to the power demand levels found in single function products would demand the inclusion of an extra chip set for these functions, i.e. the integration of a highly integrated BD or DVD chip that only provides media playback at low power consumption. This would make the consoles relatively inflexible, if future features for these media would be available. While at present it is possible to upgrade the operating system software of the current games consoles to extend functionality (e.g. to support 3D playback) for example this would be not possible with specific BD/DVD playback chips optimised for the lowest possible energy consumption. These function specific chips would only work with their integrated and fixed system that is not upgradable via software/firmware.

In addition, the implementation of additional silicon for the secondary functions would be not useful for just 17% of the on-mode time, since this could add additional power consumption for the other 83% of the on-mode time.

Implementing measures for secondary functions of games consoles.

For Tier 1:
APD 30 minutes after last user input and process initiated by this input is finished.

For Tier 2:
With the higher integration of the chips used in the games consoles and the expected trend to integrate CPU and GPU as single chip solution the power demand of the device should be reduced by approximately 30%. A move towards the inclusion of power gating technologies currently available in PCs could also facilitate reduced power consumption during secondary functions as CPU power demand is reduced in line with demand.

Impact of secondary function on power management requirements

Each kind of media has to follow specific protocols. For example it is not possible to implement an APD functionality that shuts down a DVD in the start mode. If the user puts a DVD in the tray and does not start the film, APD could not be activated. For CD and BD the procedure seems to be different.

The proposed APD requirements do not directly address the issue around DVD compatibility with APD. It is assumed that most users will at least start a DVD once placed into a games console so impacts from this incompatibility are assumed to be small. In addition it is likely that DVD usage will reduce significantly into the future further minimising any negative impacts of this incompatibility.

TWh saving potential

Table 84 illustrates the potential EU wide energy savings in 2016 and 2020 if the above policy measures were to be implemented. Savings have increased by a considerable amount since the first screening exercise (which suggested 2.8TWh total savings by 2020) due to upwardly revised stock values, increases in assumed usage in the base case and indications that technologies now exist to allow considerably reductions in both idle mode power and time spent in idle modes.

Table 84– Expected Savings from Instigating Policy Measures for all Games consoles

	All Functions	
	2016	2020
Policy Scenarios	**Energy Savings (TWh/year)**	**Energy Savings (TWh/year)**
TEC Requirements)	0.7	2.1
Power Down (30 min)	1.3	1.6
Power Down (30 min) and TEC Requirement	2.1	3.7

7.4.3 Other considerations on ecodesign requirements

Other environmental impacts of games consoles

There are a number of other environmental impacts associated with games consoles. These include impacts from resource extraction, material content, manufacturing, recycling and final disposal.

The recovery of plastics from waste electronic and electrical equipment remains challenging. The large number of plastics used in products, incompatible plastics used within the same product and the attachment of other materials to plastics can all cause issues with the separation of plastics during recycling processes and therefore limit the ability to ensure plastics can be reused.

At least one manufacturer has taken steps to improve the recyclability of their products. For example, steps have been taken to reduce the number of polymers in casings which can help to reduce the

production of mixed waste plastics at end of life. In addition, some manufacturers have labelled plastic parts to facilitate easier material identification if manual disassembly is used as an end of life option.

In addition to reducing the numbers of plastics types in products, ensuring compatibility of plastics and labelling of plastic types there are other steps that could be taken to improve the recyclability of electronic equipment such as games consoles when sent to mechanical recycling processes. For example, infrared spectroscopy techniques have shown some promise to help separate mixed waste plastics arising from WEEE. However, this technique can be hampered by plastic colorants such as carbon black which absorbs significant amounts of light and makes it difficult to identify underlying plastic types.

In an attempt to extend the life of games consoles at least one manufacturer has also developed an extended out of warranty service to repair and refurbish products.

It should be noted that the task 6 report did not highlight the end of life as a major impact area and so action on other environmental impacts should perhaps take priority.

Wider measures for electronics products in general could take the form of those listed in the task 6 report such as product light weighting. As there are limited numbers of games consoles on the market it can be difficult to identify how much product light weighting is possible. This consideration is especially relevant around the time of releases of new generations of games consoles where there is perhaps no base case to refer back to on suitable resource use. In the most recent generation of games consoles on the market, one console manufacturer has already taken steps to reduce the amount of resources used in their product. It is suggested where one manufacturer is able to show a clear ability to reduce product weight then other manufacturers should be strongly encouraged to follow suit. It is also recommended that manufacturers be encouraged to consider product light weighting from initial product conception. For example, manufacturers could strive to ensure that the first iterations of a new games console do not contain more material than the latest version of their previous console.

There have also been concerns raised about the hazardous material content of games consoles. It has been shown that some of the games consoles on the market contain phthalates, beryllium, and brominated flame retardants. It has been noted that whilst some components contain one or more of these potentially hazardous materials there are components providing similar functionality in each games console which do not contain these hazardous materials. This suggests that the manufacturers could produce products that contain significantly less hazardous materials if required. Hazardous material content of game consoles, as well as of video players and recorders as well as projectors are covered by RoHS/REACH in the EU and so should it is suggested should not be tackled separately in any ErP ecodesign measures for these product groups.

The use of the IEC 62075 standard (or others such as the ECMA 370 or IEEE 1680 series) could provide some assistance in reducing wider environmental impacts, including product light weighting, as it provides a general framework for helping product designers to reduce environmental impacts at the product design stage. The generalist nature of the IEC 62075 standard, however, does not provide clear product specific guidelines on reducing product material use and so its impact is likely to be minimal.

There are also several projects underway which are attempting to develop truncated life cycle assessment methodologies for electronics products. One such project, the Sustainability Consortium, is a collaborative project which is seeking to identify ways in which to standardise and simplify the communication of life cycle information about products through the development of tools and shared databases of information[96]. Future, ecodesign requirements could utilise these types of initiatives, once complete, and be based on whole life cycle impacts. This would remove the need to set individual requirements for different aspects of product design and potentially cover all major environmental impacts with a single requirement.

Given that no ecodesign measures for other electronics products have included wide ranging requirements on non-energy in use impacts it would seem unsuitable to suggest these types of requirements for games consoles in isolation. Nevertheless, addressing these other non-energy in use impacts is an important issue that could be addressed in future ecodesign measures.

[96] http://www.sustainabilityconsortium.org/

Given that there are a considerable number of common environmental impacts between games consoles, gaming PCs and many other types of electronic products it might be expedient to consider developing a horizontal ecodesign measure to address these wider environmental impacts. These wider environmental impacts include, material content issues, design for end of life, material selection and warranties.

One stakeholder suggested that a generic requirement for providing technical data according to standard IEC 62075 or sustainability consortium schemes could be included as a Tier I requirements coming into force in 2012. The communicated data could then be used to help define additional specific requirements in a Tier II requirement.

Relevance of energy or eco labelling, benchmarks, public procurement etc.

In addition to minimum ecodesign requirements there are a number of other policy initiatives that the Commission could consider supporting in order to further reduce impacts from games consoles.

The most widely known voluntary environmental initiative in the electronics arena is ENERGY STAR. The ENERGY STAR label has been very effective at driving energy efficiency of a range of electronics products. However, the EC-US agreement on ENERGY STAR only covers office equipment and does not currently extend to game consoles. Whilst, ENERGY STAR holds the potential of encouraging games console manufacturers to increase the energy efficiency of their products it is assumed that the minimum mandatory ecodesign measures will be similar to the draft ENERGY STAR specifications and so further additional measures within ENERGY STAR would be required if additional savings are to be achieved.

The EU Ecolabel already includes specifications for some electronics products and so could be extended to cover games consoles. The EU Ecolabel typically includes specifications that cover around the top 10% to 20% performing products, in terms of environmental performance, on the market. The small number of games consoles on the market might mean that the EU Ecolabel would have less impact on buyers' decision making than in other product areas where there is greater choice of products offering the same functionality. That is, buyers are perhaps less likely to choice an eco-labelled product over a non-eco-labelled products unless other higher priority decision factors such as price and gaming performance are equal.

The effectiveness of any eco-label for games consoles would also highly depend on the cooperation of the manufacturers and whether there was a business argument for applying for the label. If one manufacturer applied for the label then the other two manufacturers might be forced into also applying for the label or otherwise face the risk of being perceived not to have considered environmental impacts during the design of their games console... As mentioned earlier any ability of the label to act as a buying criterion would also need to be considered alongside the functionality offered by products.

However, the EU Ecolabel could be developed to reflect the best performance of the games consoles on the market (across multiple environmental impact categories) and automatically apply to the one product that met the specification. This process could be useful where one manufacturer has not taken the same steps as a competitor to reduce environmental impacts such as in use energy or reductions in material usage.

The strength of benchmarks would likely be limited given the small number of games consoles on the market. Performance benchmarks might be relevant if the functionality of the games consoles are taken into account and more types of products become available. A current benchmark could be set on the idle mode of high definition games consoles on the market to clearly identify the better performer. Table 85 contains some suggested benchmark levels for high definition games consoles which would mark one of the two high definition products on the market as "A" (best practice) and the other "B" in terms of energy efficiency. Again this could be used as a marketing advantage for the better performing product.

Table 85 – Potential Benchmark Levels for High Definition Games consoles

		Class A	Class B
Function	**Power Modes**	**Power Demand (W)**	**Power Demand (W)**
Gaming	Game Play	≤ 88	≤ 99
	Game Play Idle	≤ 88	≤ 98
System Idle	System Idle	≤ 70	≤ 85
DVD Playback	Media Play	≤ 57	≤ 80
	Media Play Idle	≤ 57	≤ 80
Internet Browsing	Media Play	≤ 67	≤ 84
Audio Listening	Media Play	≤ 67	≤ 84

As previously stated the technology already exists for games console manufacturers to be able to reduce the power demand of their products whilst not in active use. A financial incentive for the manufacturers to further investigate energy saving opportunities could prove useful. However, when it is considered that the development of the CPU in one of the latest high definition games consoles cost approximately $400 million any incentives would need to be considerable in order to encourage further change.

Measurement requirements and existing test procedures

There are currently no EU standards for the measurement of games console energy use. The US EPA has defined a test measurement for games consoles in the draft ENERGY STAR specification. If this measurement methodology were to be used in support of ecodesign measures there would be a need to further clarify the terminology of power modes and in particular the sleep/network standby/standby power modes.

The draft ENERGY STAR test methodology is shown in Table 86:

Table 86 – Draft ENERGY STAR Test Methodology for Games consoles

Test Procedure for All Modes for Game Consoles
Measurement of ac power consumption of a computer should be conducted as follows:

Unit Under Test (UUT) Preparation
1. Record the manufacturer and model name of the UUT.
2. Record basic information about the computer's configuration – computer type, operating system name and version, processor type and speed, total and available physical memory, etc.
3. Ensure that the UUT is connected to a TV(s) which support all of the output types supported by the UUT.
a. For each output that supports APD, repeat step 10 of this procedure.
4. Connect an approved meter capable of measuring true power to an ac line voltage source set to the appropriate voltage/frequency combination for the test.
5. Plug the UUT into the measurement power outlet on the meter. No power strips or UPS units should be connected between the meter and the UUT. For a valid test to take place the meter should remain in place until all power data is recorded.
6. Record the ac voltage and frequency.

Active Mode Testing
7. Turn on the console and wait until the operating system has fully loaded.
8. If necessary, run the initial system setup and allow all preliminary tasks and other one time/periodic processes to complete.
9. Ensure that the UUT is configured as shipped including all accessories, power management settings and software shipped by default.

10. For each applicable video output, wait for 15 minutes and ensure the output goes blank after the prescribed time.
11. System Idle:
a) Place the system in a state without a game or any media loaded.
b) 5 minutes after completing 11a, set the meter to begin accumulating true power values at an interval of greater than or equal to 1 reading per second. Accumulate power values for 5 additional minutes and record the average (arithmetic mean) value observed during that 5 minute period.
12. Wait one hour and verify that the system goes into a low power state.
13. Bring the console back into its OS-loaded state.
14. Game Play Pause (Tier 2 and Tier 3, only):
a) Start active game play with a game offered with the console and pause the game.
b) 5 minutes after completing 14a, set the meter to begin accumulating true power values at an interval of greater than or equal to 1 reading per second. Accumulate power values for 5 additional minutes and record the average (arithmetic mean) value observed during that 5 minute period.
c) Repeat steps 12 and 13.
15. Game Play Idle:
a) Load a game and start game play. Ensure no subsequent user input to the console.
b) 5 minutes after completing 15a., set the meter to begin accumulating true power values at an interval of greater than or equal to 1 reading per second. Accumulate power values for 5 additional minutes and record the average (arithmetic mean) value observed during that 5 minute period.
c) Repeat steps 12 and 13.
16. Media Pause:
a) Open the console's media player, then load and pause a movie or song.
b) 5 minutes after completing 16a., set the meter to begin accumulating true power values at an interval of greater than or equal to 1 reading per second. Accumulate power values for 5 additional minutes and record the average (arithmetic mean) value observed during that 5 minute period.
c) Repeat steps 12 and 13.
17. Media Play Idle:
a) Open the console's media player and load a movie or song. Ensure no subsequent user input to the console.
b) 5 minutes after completing 17a., set the meter to begin accumulating true power values at an interval of greater than or equal to 1 reading per second. Accumulate power values for 5 additional minutes and record the average (arithmetic mean) value observed during that 5 minute period.
c) Repeat steps 12 and 13.

Sleep/APD Mode Testing
18. After completing the Active Mode measurements, place the computer in its Sleep/APD mode. Reset the meter (if necessary) and begin accumulating true power values at an interval of greater than or equal to 1 reading per second. Accumulate power values for 5 additional minutes and record the average (arithmetic mean) value observed during that 5 minute period.
19. If the console supports Wireless AP/Router Functions, repeat the measurements from Step 18 with these features enabled.

Continuing Verification
This testing procedure describes the method by which a single unit may be tested for compliance. An ongoing testing process is highly recommended to ensure that products from different production runs are in compliance with ENERGY STAR.

It is suggested that whilst the US EPA have drafted a test methodology for games consoles a more robust and tailored methodology would be needed for use in any ecodesign measure. The robust test methodology would need to take account of a number of issues not covered in the ENERGY STAR test methodology such as manufacturers' claims that the power demand of individual CPUs can vary by as much as 25%. The test methodology would also need to take into account any differences in definitions of power modes and differing approaches to limits such as measurement of TEC limits. In addition, if a TEC approach, following the suggested method highlighted earlier in this report, is used a test methodology will be required to identify the computational performance of games consoles.

The US based NGO, NRDC, have also developed a test methodology for games consoles which can be seen in Table 87 below.

Table 87 – Draft NRDC Test Methodology for Games consoles

Test Method for Energy Efficiency of Game Consoles - DRAFT

Scope

The purpose of this test method is two-fold:

1) Measure game console energy use in the major operating modes
2) Verify conformity with the auto-power down standard.

This test procedure covers the game console major operating modes listed below. It is understood that not all game consoles provide all the modes listed.

1) Home Menu (aka System Menu, Cross Media Bar, or Dashboard)
2) Game Play
3) Video Playback DVD
4) Video Playback Blu-ray Disc
5) Video Streaming HD
6) Off/Standby after Auto-Power Down
7) Off/Standby after pressing the Off button
8) Off/Standby when switched off from controller
9) Other modes for research purposes

Testing Requirements

Game and Media Selection

- Game title: Select the top 3 selling game titles for the console under test in the previous calendar year. Use top selling games for the previous generation console in case of a console generation change. Use 3 randomly selected launch titles if the UUT is a brand new console with no existing compatible games in the previous year.
- If none of the selected game title support auto-save and resume, pick another game title which support auto-save and resume.
- DVD title: The Lord of the Rings: The Return of the King" (2003)
- Blu-ray Disc title: pick same movie as DVD title
- HD video streaming title: Same movie as DVD and Blu-ray title

Number and selection of units to be tested

The selection and number of units to be tested shall follow the requirements of the regulation or voluntary standard this test procedure is being used to verify.

Approved meters, testing accuracy and test conditions

Per Energy Star specification for Computers.

Unit Under Test (UUT) Preparation

1) Record the manufacturer and model name of the UUT on the test sheet.
2) Connect to display through HDMI connection if available, or AV connection if the console is not High Definition capable.
3) Power the UUT on.
4) Console to peripherals connections, such as Infra Red and Bluetooth, should be configured as shipped.
5) Network connection: For consoles with wireless capability, power to a wireless LAN radio (e.g. IEEE 802.11) should remain on during testing and must maintain a live wireless connection to a wireless router or network access point, which supports the highest and lowest data speeds of the client radio, for the duration of testing. For consoles without wireless capability, the Ethernet connection should be enabled.
6) Ensure DVD upscaling is set to on
7) Remove any disk (media or game) from UUT.
8) Apart from above settings, ensure that the UUT is configured as shipped including all accessories and motion sensor bar if available connected, Wake-on-LAN (WOL) enabled, power management and software shipped by default.
9) Power the UUT off.
10) Connect an approved meter capable of measuring true power to an ac line voltage source set to the appropriate voltage/frequency combination for the test.
11) Plug the UUT into the measurement power outlet on the meter. No power strips or UPS units should be connected between the meter and the UUT. For a valid test to take place the meter should remain in place until power data is recorded for all modes.
12) Record the ac voltage and frequency.
13) Power the UUT on.

Energy Consumption Measurement and Auto-Power Down Verification Test Method

The following modes, if provided in the UUT, shall be tested as indicated below:

Home Menu Testing

14) Power the UUT on.

15) Wait until the operating system has fully loaded, and the Home Menu is displayed and stable.
16) Disable all power management.
17) Set the meter to begin accumulating true power values at an interval of less than or equal to 1 reading per second. Accumulate power values for 5 minutes and record the average (arithmetic mean) value observed during that 5 minute period.

Game Play

18) Repeat the steps in this section for each of the 3 test game titles.
19) Insert the game disk into the console.
20) Launch game, select appropriate menu options until game is ready to play.
21) If the game has an introduction movie, let it run till completion or skip it.
22) Set the meter to begin accumulating true power values at an interval of less than or equal to 1 reading per second. Accumulate power values for 5 minutes and record the average (arithmetic mean) value observed during that 5 minute period.
23) During that 5 minute period, play the game normally including continuous user input such as movement, direction change and shooting (when appropriate), so that testing conditions are as representative as possible of typical game play. Continuous input is defined as input at least every 10 seconds.
24) Exit the game and eject the disk.

Video Playback DVD

25) Insert the test DVD movie.
26) Navigate through DVD menu and play the video for 15 minutes.
27) Set the meter to begin accumulating true power values at an interval of less than or equal to 1 reading per second. Accumulate power values for the first 5 minutes of the video and record the average (arithmetic mean) value observed during that 5 minute period.
28) Eject the DVD.

Video Playback Blu-ray Disc

29) Insert the test Blu-ray Disc (BD) movie.
30) Navigate through BD menu and play the video for 15 minutes.
31) Set the meter to begin accumulating true power values at an interval of less than or equal to 1 reading per second. Accumulate power values for the first 5 minutes of the video and record the average (arithmetic mean) value observed during that 5 minute period.
32) Eject the BD.

Video Streaming HD

33) Enter the console's online movie service, and access the test movie (same title as for the DVD and Blu-ray test).
34) Play the movie for 15 minutes.
35) Set the meter to begin accumulating true power values at an interval of less than or equal to 1 reading per second. Accumulate power values for the first 5 minutes of the video and record the average (arithmetic mean) value observed during that 5 minute period.
36) Exit video streaming mode, go back to Home Menu.

Off/Standby after pressing the Off button

37) Press Off button
38) Wait for 5 minutes for the Off/Standby mode power to stabilize
39) Set the meter to begin accumulating true power values at an interval of less than or equal to 1 reading per second. Accumulate power values for 5 minutes and record the average (arithmetic mean) value observed during that 5 minute period.
40) Power the UUT back on.

Off/Standby when switched Off from controller

41) Power UUT Off using controller. If the controller offers several ways to power the console Off, use the most commonly used/most intuitive way, and record your choice
42) Wait for 5 minutes for the Off/Standby mode power to stabilize
43) Set the meter to begin accumulating true power values at an interval of less than or equal to 1 reading per second. Accumulate power values for 5 minutes and record the average (arithmetic mean) value observed during that 5 minute period.
44) Power the UUT back on.

Menu APD

45) Wait until the operating system has fully loaded, and the Home Menu is displayed and stable.
46) Wait for 65 minutes and do not perform any interaction with the console or controller so as not to delay APD.
47) Set the meter to begin accumulating true power values at an interval of less than or equal to 1 reading per second. Accumulate power values for 5 minutes and record the average (arithmetic mean) value observed during that 5 minute period.
48) Power the UUT back on.

Game Play APD

49) Wait until the operating system has fully loaded, and the Home Menu is displayed and stable.
50) Pick test game title that supports auto-save and resume, insert disk into console
51) Start game, move beyond any introduction section, play game regularly for 5 minutes
52) Wait for 65 minutes and do not perform any interaction with the console or controller so as not to delay APD.
53) Note the time when the console auto-powers down.
54) Set the meter to begin accumulating true power values at an interval of less than or equal to 1 reading per second. Accumulate power values for 5 minutes and record the average (arithmetic mean) value observed during that 5 minute period.
55) Start the timer
56) Power console back on by pushing a button/key on the controller or console
57) Measure the time until the game is back to its auto-resume location
58) Note whether the game appears to be at or close to its location prior to the device entered APD, or if it went back to the game start point.

Disk-Based Media Play APD

59) Power the UUT back on.
60) Wait until the operating system has fully loaded, and the Home Menu is displayed and stable.
61) Insert movie test title into console
62) Start the movie, move beyond movie menu
63) Once movie is playing, start timer
64) Wait for 245 minutes and do not perform any interaction with the console or controller so as not to delay APD.
65) Verify that the console does not auto-power down while the movie is actively playing (not including menu mode at end of the movie).
66) Note the time when the console auto-powers down.
67) Set the meter to begin accumulating true power values at an interval of less than or equal to 1 reading per second. Accumulate power values for 5 minutes and record the average (arithmetic mean) value observed during that 5 minute period.
68) Power the UUT back on

Streaming Media Play APD

69) Wait until the operating system has fully loaded, and the Home Menu is displayed and stable.
70) Locate test movie title on Netflix
71) Start the movie, move beyond movie menu
72) Once movie is playing, start timer
73) Wait for 245 minutes and do not perform any interaction with the console or controller so as not to delay APD.
74) Verify that the console does not auto-power down while the movie is actively playing (not including menu mode at end of the movie).
75) Note the time when the console auto-powers down.
76) Set the meter to begin accumulating true power values at an interval of less than or equal to 1 reading per second. Accumulate power values for 5 minutes and record the average (arithmetic mean) value observed during that 5 minute period.
77) Power the UUT back on

Other modes

- Console functionality and use may evolve rapidly as these entertainment devices are reprogrammable. For example, and not exhaustively, consoles may also be used for:
  a) Internet browsing
  b) Video calls and conferencing
  c) IPTV
  d) Social networking
  e) Picture browsing
  f) Text messaging
  g) Research modelling e.g. Folding at Home
- Where any significant function (accountable for more than 5% of the console energy use) is developed equivalent to other consumer electronics devices, and where these functions have notably different power use than the 'home menu' mode, additional test modes may be defined similar to those above.
- To ensure consistency between product categories, functions equivalent to PC functions e.g. internet browsing will be considered equivalent to 'home menu' as for PC energy measure which considers active mode as equivalent to idle mode.

End of test procedure.

The NRDC test methodology contains additional detail beyond that found in the draft ENERGY STAR methodology.

There are several aspects of the NRDC test methodology that require further consideration. Firstly, the test methodology uses the “Home Menu (aka System Menu, Cross Media Bar, or Dashboard)” mode to reflect a games console idle mode (This mode has previously been defined as “System Idle” in this document). As previously mentioned in this report there are issues surrounding the use of “System Idle” to reflect the idle mode of games console. The biggest issue is that minimal amounts of time are spent in “System Idle” and so any ecodesign requirements that are based on this power mode might not encourage significant reductions in energy use. Further work could be conducted on this aspect of the test methodology to identify whether “Game Play Idle” or “Game Play Pause” could be used instead.

A second issue with the NRDC test methodology is that whilst it addresses the “Game Play” mode (otherwise known as active mode) it does not provide any method of determining efficiency in this mode (in terms of Flops/W as discussed earlier). The additional of this aspect to the NRDC methodology would be essential if efficiency measures are to be applied to the “Game Play” mode of games consoles.

The NRDC test methodology also assumes a 4 hour period of inactivity during disk based media play mode. As suggested earlier in this document a 4 hour period of inactivity during disk based media functions could be considered excessive.

NRDC have wisely attempted to “future proof” the test methodology with the inclusion of the statement, “Where any significant function (accountable for more than 5% of the console energy use) is developed equivalent to other consumer electronics devices, and where these functions have notably different power use than the ‘home menu’ mode, additional test modes may be defined similar to those above”. However, in order to identify whether an individual function accounts for more than 5% of total energy use it would be necessary to have access to detailed use profiles and to continually review them for all consoles on the market. This issue could become complicated as manufacturers have previously stated that it is not always possible to identify use hours in different modes of operation. It is therefore suggested that any test methodology used behind future ecodesign measures should be regularly subjected to formal review to gain agreement on which power modes and functions should be covered. The test methodology could then be changed once agreement has been reached on any important alternations.

The Commission could consider mandating a standardisation body to develop an appropriate test methodology for games consoles and use the NRDC test methodology as a starting point.

The IEC 62075 standard (which has also been translated into member state standards) could provide a useful starting point for measures aimed at addressing wider environmental impacts of games consoles (and other electronics products). However, some areas of the IEC standard are not defined well enough to be used in a mandatory measure. As such the Commission could consider mandating a standardisation body to review the IEC 62075 standard, as well as other wider environmental impact standards such as the Ecma 370 and IEEE 1680 series, with a view to developing well defined wider lifecycle criteria and measurement methodologies that could be used in future ecodesign measures.

Potential for self-regulation

A voluntary initiative could be seen appropriate for the current generation of games consoles on the market but could only focus on auto power down requirements such as those listed in the joint industry/NGO proposal... It would likely not be possible to also include voluntary requirements for power reductions in any idle or active power mode as this would necessitate the development of new components for inclusion in existing products. This would likely result in high cost for the manufacturers and a disincentive to join a voluntary programme.

In consultations, some non-governmental organisations have raised the concern that there might not be a sufficient number of games console manufacturers in the market place for a voluntary programme to be effective. Their main concern centres on the fact that if just one manufacturer was to default on a voluntary initiative then the failure rate would be 33.33%.

Surveys of users could easily be conducted to assess compliance levels.

A voluntary agreement could provide manufacturers with some flexibility around how they develop future products to reduce overall energy consumption without the potentially restrictive mandatory measures. A voluntary measure could also allow closer working with the manufacturers during the design and development of future games consoles. Any such voluntary agreement could then also promote additional energy saving technologies for use in future games consoles.

Possible Product Information requirements

Manufacturers should be asked to report on the following power demands of their products and publish this information in an openly available website:

- Game Play (W)
- Media Play (W)
- System Idle (W)
- Game Play Idle (W)
- Media Play Idle (W)
- Game Pause (W)
- Media Pause (W)
- Sleep/network standby/standby (W) (Wireless AP/Router Functions not engaged)
- Sleep/network standby/standby (W) (Wireless AP/Router Functions engaged)
- Off Mode (W)
- TEC (kWh/year) (if used)

If a product model is placed on the market in multiple configurations this information should be reported for all configurations as power demands can alter significantly with the inclusion of different components.

This type of power data could be used by the Commission to track the performance of games consoles on the market over time. The data could be used to compare against the performances of similar products in the market place such as personal computers to ensure that common power saving technologies are being adopted by games console manufacturers.

7.4.4 Policy scenarios

Policy scenarios for games consoles

The following APD requirements for games consoles could be considered:

- **Tier I – Implementation to be 6 months after publication of the ecodesign measure**
  All games consoles (with active or idle mode power demand of over 20W) should meet the APD requirements listed in the joint industry/NGO APD proposal.

- **Tier II – Implementation from 2014**
  All games consoles should meet the APD requirements listed in the joint industry/NGO APD proposal.

The following power demand limits could also be considered:

- **Tier I – TEC approach – 2014**

All games consoles first placed on the market after the Tier I application date should meet the following TEC requirements:

Tier I	TEC (kWh/year)
All Games consoles placed on the market after application date	To be decided after development of suitable test methodology for assessing games console computational performance.

If a TEC approach is not deemed suitable for games consoles the following modal limits could be considered:

- **Tier I – Sleep/Standby Mode Power Limits – 2014**
  All games consoles first placed on the market after the Tier I implementation should meet the following power requirements:

Tier I	Standby Mode (W)	Standby Mode (W)
	Wireless AP/Router Functions not engaged:	**Wireless AP/Router Functions engaged:**
All games consoles placed on the market after implementation date	≤ 1.0	≤ 5.0
WoL allowance (provided for automatic updates when connected to the internet)	0.7	

Where sleep mode functionality is shown to be significantly increased (to the extent that it is similar to the sleep mode found in desktop and notebook PCs) then the following additional power demand limits could be considered.

Tier I - All games consoles placed on the market after implementation date	Sleep Mode (W)
Wired WOL	≤ 3.0
Wireless WOL	≤ 5.0
Wireless AP/Router Functions engaged	≤ 5.0

- **Tier I – Idle Mode Power Limits – 2014**
  All games consoles first placed on the market after the Tier I implementation date should meet:

Tier I	System Idle (W)	Game Play Idle (W)
All games consoles placed on the market after implementation date	≤ 45.0	≤ 45.0

An alternative approach based on the following example formula could also be considered:

Tier I	System Idle and Game Play Idle (W)
All Games consoles placed on the market after implementation date	0.3433 x Game Play Power Demand + 16.068

The above policy measures have been suggested in line with earlier findings within this report. It has been shown that each of the above policy measures can be technically achieved through the implementation of widely used technologies on the market (though recognised that the technologies may only be available in similar products and not necessarily games consoles). However, it is also recognised that the current generation of games consoles on the market would not be able to meet these proposed policy measures, with the exception of the auto power down requirements, without considerable financial costs being incurred by the manufacturers. The proposed implementation times have been developed with the above considerations in mind.

It has been suggested that the proposed power demand requirements listed above should not be implemented until 2014 as it is unlikely that the current generation of products on the market would be

able to meet these requirements. The 2014 date is suggested to ensure that only new models of games consoles are required to meet the measures. It would also be possible to develop an alternative definition for future games consoles (e.g. increased RAM requirement) to ensure that only completely new models of games consoles are covered by the measures.

The above proposed power requirements should also be considered alongside the current best practice performances shown in Table 88 and Table 89.

Table 88 – Current Best Practice Levels for High Definition Games consoles

Function	Power Modes	Power Demand (W)
Gaming	Game Play	≤ 88
	Game Play Idle	≤ 88
System Idle	System Idle	≤ 70
DVD Playback	Media Play	≤ 57
	Media Play Idle	≤ 57
Internet Browsing	Media Play	≤ 67
Audio Listening	Media Play	≤ 67

It is suggested that whilst some standard definition games consoles might remain on the market for several more years, the power demands of these products are very low in comparison to the high definition games consoles on the market and therefore do not perhaps need to be addressed in a future ecodesign measure. Table 89 illustrates the current best practice levels for standard definition games consoles on the market[97].

Table 89– Current Best Practice Levels for Standard Definition Games consoles

a. Function	b. Power Modes	c
d. Gaming	e. Game Play	
	Game Play Idle	≤ 10.5

It should be noted that a games console manufacturer disputed the figures shown in Table 89. The manufacturer claimed that the power demand in main standard definition games consoles is shown previously in Table 65.

Main parameters for a simple tool for the European Commission for estimating the impacts of different scenarios

A simple calculation tool has been developed which includes the functionality to allow the following variables to be changed:

- power limits
- use profile
- sales/stock
- % stock impacted by policy measure
- Cost

[97] NRDC, 2008, Lowering the Cost of Play, available from http://www.nrdc.org/energy/consoles/files/consoles.pdf

Figure 23 illustrates the estimated energy consumption of games consoles on the EU market as well as the potential savings available from implementation of the different policy measures discussed above.

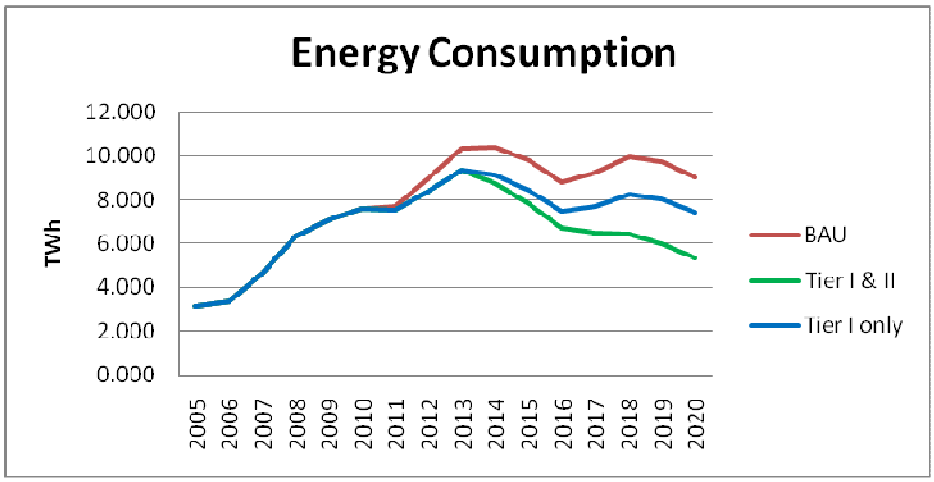


Figure 23 – Estimated Energy Consumption of Games Consoles in the EU

Figure 24 illustrates the life cycle costs (LCC) associated with games consoles on the EU market. The calculator assumes a constant games console purchase price of €360 and electricity price of €0.16 per kWh within each of the three scenarios LCC differences between the three scenarios are limited to electricity running costs over the lifetime of the games consoles.

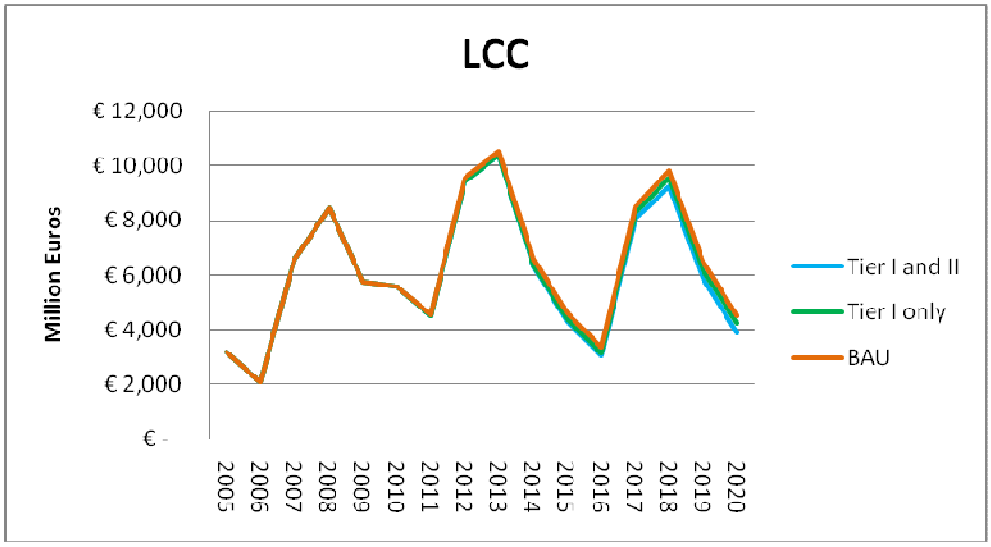


Figure 24 – Estimated Life Cycle Costs associated with Games Consoles

7.4.5 Impact Analysis

This section of the report investigates the impacts of the proposed ecodesign requirements for game consoles.

Monetary Impacts for categories of users in particular as regards affordability and life cycle cost of the product and on the manufacturer regarding redesign, testing, investment and/or

production costs

The proposed ecodesign requirements primarily focus on the power demands of future games consoles. As these products have yet to be developed, the manufacturers are given the opportunity to consider the proposed requirements during their design phase. This ability to consider product attributes at the design stage could have significantly less financial impact than having to adapt current designs and consequently manufacturing lines. However, financial impacts on future products will increase if manufacturers are forced to develop completely new technologies in order to meet requirements. Manufacturers have commented that the financial impacts of the measures suggested above are not yet known and so cost impacts cannot be adequately defined.

It is therefore important to ensure that future requirements are based on improvements possible with current technology or technology already in development.

If manufacturers' costs are not significantly increased there is little reason to think that purchase costs to the user would increase. Indeed, the inclusion of many of the proposed requirements could reduce users' costs due to reductions in energy use over the course of the games console's lifetime.

Further impacts on manufacturers, such as imposed proprietary technology or administrative burdens

It is not envisaged that proprietary technologies will need to be included in future games consoles to ensure that the proposed ecodesign measures could be met. Games console manufacturers will likely need to adopt technologies that have already proven effective in the computer industry. As previously mentioned, this uptake of computer technologies may result in some additional burdens being placed on the games console manufacturers.

There are likely to be additional administrative burdens placed on manufacturers as a result on needing to test and report on the energy efficiency of their games consoles. Additional testing and reporting impacts should be minimal given the small number of games console models placed on the market and the fact that some energy efficiency testing is already undertaken by manufacturers.

Impact on the competitive situation of the market; such as market share of products already complying with the envisaged minimum requirement, market shares of remaining models after the minimum requirement is introduced, competitive advantage or negative impacts on the competitive situation of some market players (e.g. SMEs, regional players) or reduction in consumer choice;

Two out of the three games consoles currently on the market could meet the APD ecodesign requirements. It is assumed that 100% of next generation games consoles will be able to meet these same APD ecodesign requirements. All games consoles currently on the market would struggle to meet the non-APD policy measures listed above. However, it has been shown that the inclusion of technologies already found in similar computing products could enable manufacturers to ensure that future games consoles can meet the suggested policy measures. Given the small number of games console models on the market it is assumed that 100% of products will be able to meet future, agreed upon ecodesign, requirements.

The current games console market is very competitive and dominated by three manufacturers. It is not expected that the technical parameters laid out in the proposed requirements would have a significant impact on competition. Each manufacturer has a high degree of control over the energy efficiency of their games console and so could more easily include the technologies available on the market into their products in order to meet the proposed requirements. Competitive issues would therefore likely not arise because one manufacturer found it more difficult than other to meet the proposed requirements. Competitive issues could be raised if schemes are developed to rank products according to performance (such as benchmarking). Competitive issues could also arise if the timing of the ecodesign measure means that one manufacturer needs to ensure compliance of a new product ahead of another manufacturer. In this instance, the first manufacturer to launch a new product to market may need to invest more to include newer more energy efficient components into products.

Impacts on the functionality of the product, from the perspective of the user

The functionality of games consoles is unlikely to be heavily impacted by the proposed requirements and timelines.

Stakeholders have previously suggested that APD functionality could impact usability of games consoles in a number of ways. Firstly, it has been suggested that users experience could be impacted if games consoles powered down whilst in game play mode as the users position in a game would be lost. This situation would occur where games did not support auto-save. In recognition of this concern a proposed requirement has been included that games placed on the market after 2013 should support auto-save. Stakeholders have also commented that users could employ APD functionalities as a way of saving progress in games at any point and so make games easier to complete. It is suggested that the ability of a user to "cheat" a game is not a major functionality impact but rather a choice for the user.

The proposed requirements for idle mode power are unlikely to have any major impacts on functionality as the games consoles provide little functionality during idle modes. Functionality impacts could occur if the idle mode requirements impinge on active mode power demand which determines the level of functionality offered by the games console. This situation could occur where idle mode power demand requirements could not be achieved without limiting the active mode power. The proposed idle mode power requirement of 45W represents approximately 59% of the active power demand (108.3W) found in current high definition games consoles on the market. If the active mode of the next generation increases to 200W then the 45W idle limit will require active mode power demand to be reduced by 78%. A reduction of 78% in active mode power is still achievable using current technologies but future active mode power demands significantly above 200W would make the 45W idle mode proposed requirement challenging.

The majority of the proposed sleep/standby mode requirements are likely to have little impact on the functionality of games consoles as the requirements can be met by current consoles on the market. The exception being the sleep/standby requirements which reflect the condition where a games console is providing wireless access point or router functionalities. Some of the current games consoles on the market would not be able to meet this requirement. Other products already on the market which offer similar functionalities would be able to meet the sleep/standby proposed requirement of 5W. It is therefore assumed that manufacturers of future games consoles would be able to ensure that their products employ readily available technologies so that the requirement can be met without impacting functionality.

Impacts on EU firms' competitiveness outside the EU and on importers

There are currently no games console manufacturers head quartered in the EU. There are a significant number of games developers and games publishers in the EU however. These game developers and game publishers will be impacted by the proposed APD requirements in that they will need to ensure that future games support auto-save. Impacts on these companies are expected to be small as the proposed requirements are only applicable to future games where programming can be more easily tailored to support auto-save.

There is a potential that importers into the EU could be disadvantaged if ecodesign requirements were set with excessive stringency so as to require the development of different models of games console for the EU market. It is therefore recommended that any ecodesign measures are not set at too high a level of stringency in order to mitigate the need for separate games consoles to be developed just for the EU market.

Impact on innovation or research and development

The proposed requirements are likely to have a largely positive impact on games console innovation as manufacturers will be required to consider energy efficiency of their products in more detail. The added research on energy efficiency could potentially result in less resources being available for other research areas. The greater share of research budget given to energy efficiency is likely to be minimised as the proposed requirements are largely based on technologies already available in the market place.

Any significant social impact, such as impacts on employment and labour conditions, health and safety or equality of treatment and opportunities

The proposed requirements are not expected to stimulate any negative or positive social impacts in areas such as employment, labour conditions, health and safety or equality of treatment and opportunities.

Appendices

Appendix 1: Base Case EcoReport Input Tables

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Appendix 1

Base Case EcoReport Input Tables

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Video Player

Table 90: INPUTS FOR EU-Totals & economic Life Cycle Costs – Video player

nr	INPUTS FOR EU-Totals & economic Life Cycle Costs Description		unit	Reference
A	Product Life	6	years	Task 2 section 1.4
B	Annual sales	32.5	mln. Units/year	Task 2 section 1.3.3
C	EU Stock	171	mln. Units	Task 2 section 1.3.4
D	Product price	40	Euro/unit	Task 2 section 1.5.1
E	Installation/acquisition costs (if any)		Euro/ unit	
F	Fuel rate (gas, oil, wood)		Euro/GJ	
G	Electricity rate	0.16	Euro/kWh	Task 2 section 1.5.2
H	Water rate		Euro/m3	
I	Aux. 1: None		Euro/kg	
J	Aux. 2 :None		Euro/kg	
K	Aux. 3: None		Euro/kg	
L	Repair & maintenance costs		Euro/ unit	
M	Discount rate (interest minus inflation)	4.0%	%	Commission rate used
N	Present Worth Factor (PWF) (calculated automatically)	5.24	(years)	
O	Overall Improvement Ratio STOCK vs. NEW, Use Phase	1.00		Stakeholder comment invited

Video recorder

Table 91: INPUTS FOR EU-Totals & economic Life Cycle Costs - Video recorder

nr	INPUTS FOR EU-Totals & economic Life Cycle Costs Description		unit	Reference
A	Product Life	6	years	Task 2 section 1.4
B	Annual sales	9.5	mln. Units/year	Task 2 section 1.3.3
C	EU Stock	34.5	mln. Units	Task 2 section 1.3.4
D	Product price	165	Euro/unit	Task 2 section 1.5.1
E	Installation/acquisition costs (if any)		Euro/ unit	
F	Fuel rate (gas, oil, wood)		Euro/GJ	
G	Electricity rate	0.16	Euro/kWh	Task 2 section 1.5.2
H	Water rate		Euro/m3	
I	Aux. 1: None		Euro/kg	
J	Aux. 2 :None		Euro/kg	
K	Aux. 3: None		Euro/kg	
L	Repair & maintenance costs		Euro/ unit	
M	Discount rate (interest minus inflation)	4.0%	%	Commission rate used
N	Present Worth Factor (PWF) (calculated automatically)	5.24	(years)	
O	Overall Improvement Ratio STOCK vs. NEW, Use Phase	1.00		Stakeholder comment invited

Projector

Table 92: INPUTS FOR EU-Totals & economic Life Cycle Costs

nr	INPUTS FOR EU-Totals & economic Life Cycle Costs Description		unit	Reference
A	Product Life	6	years	T2 report section 1.5.5
B	Annual sales	1.6	mln. Units/year	T2 report section 1.3.3
C	EU Stock	8	mln. Units	T2 report section 1.3.3
D	Product price	800	Euro/unit	T2 report section 1.4.4 and 1.5.1
E	Installation/acquisition costs (if any)	500	Euro/ unit	T2 report section 1.5.4 (25% of items at 2000 euros per item)
F	Fuel rate (gas, oil, wood)	0	Euro/GJ	
G	Electricity rate	0.16	Euro/kWh	T2 report section 1.5.2
H	Water rate		Euro/m3	
I	Aux. 1: None		Euro/kg	
J	Aux. 2 :None		Euro/kg	
K	Aux. 3: None		Euro/kg	
L	Repair & maintenance costs	425	Euro/ unit	T2 report section 1.5.6 (125 euro inspection plus2 lamps at 150 euros)
M	Discount rate (interest minus inflation)	4.0%	%	Commission rate used
N	Present Worth Factor (PWF) (calculated automatically)	5.24	(years)	
O	Overall Improvement Ratio STOCK vs. NEW, Use Phase	1.00		Stakeholder comment invited

Games console

Table 93: INPUTS FOR EU-Totals & economic Life Cycle Costs

nr	INPUTS FOR EU-Totals & economic Life Cycle Costs Description		unit	Reference
A	Product Life	5.5	years	Task 3 section 1.4
B	Annual sales	20.6	mln. Units/year	Task 2 section 1.3.3 Table 4
C	EU Stock	59.6	mln. Units	Task 2 section 1.3.4 Table 3
D	Product price	360	Euro/unit	Task2 section 1.5.1
E	Installation/acquisition costs (if any)		Euro/ unit	
F	Fuel rate (gas, oil, wood)		Euro/GJ	
G	Electricity rate	0.16	Euro/kWh	Task2 section 1.5.2 Table 8
H	Water rate		Euro/m3	
I	Aux. 1: None		Euro/kg	
J	Aux. 2 :None		Euro/kg	
K	Aux. 3: None		Euro/kg	
L	Repair & maintenance costs		Euro/ unit	
M	Discount rate (interest minus inflation)	4.0%	%	Commission rate used
N	Present Worth Factor (PWF) (calculated automatically)	4.85	(years)	Stakeholder comment invited
O	Overall Improvement Ratio STOCK vs. NEW, Use Phase	1.00		

Note: the input value for Overall Improvement Ratio (stock versus New, use phase) has been set at 1.00 in each of the EcoReports for video players/recorders, games consoles and projectors. The choice of ratio to use is to reflect whether the energy consumption of new products is likely to be lower than the average installed stock. Apart from improvements to standby power consumption (which will be brought about by another horizontal measure), it is difficult to speculate on the level of improvement new versus average installed stock. For example, a ratio of less than 1.00 could be used to reflect potential improvements in chip efficiencies in games consoles. However, the choice of ratio is subject to further discussion.

The study team received no stakeholder comment on this note.

Appendix 2

Base Case EcoReport Output Tables

Contents

Video player

Table 94: Life Cycle Impact (per unit) of Video player base case

Nr	Life cycle Impact per product:								Date	Author	
0	Video player base case								0	AEA/Intertek	
	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	**Total**	**BUTION**		Disposal	Recycl.	**Total**	
	Materials	**unit**									
1	Bulk Plastics	g			**430**			48	382	**430**	**0**
2	TecPlastics	g			**0**			0	0	**0**	**0**
3	Ferro	g			**570**			428	143	**570**	**0**
4	Non-ferro	g			**50**			38	13	**50**	**0**
5	Coating	g			**0**			0	0	**0**	**0**
6	Electronics	g			**215**			108	108	**215**	**0**
7	Misc.	g			**650**			488	163	**650**	**0**
	Total weight	g			**1915**			1108	807	**1915**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	232	56	**288**	**123**	**1110**	109	20	**89**	**1609**
9	of which, electricity (in primary MJ)	MJ	127	17	**144**	**0**	**1108**	0	12	**-12**	**1240**
10	Water (process)	ltr	77	3	**79**	**0**	**75**	0	11	**-11**	**143**
11	Water (cooling)	ltr	72	15	**87**	**0**	**2953**	0	2	**-2**	**3038**
12	Waste, non-haz./ landfill	g	2471	131	**2601**	**86**	**1309**	1761	36	**1725**	**5721**
13	Waste, hazardous/ incinerated	g	182	1	**183**	**2**	**27**	156	14	**142**	**354**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	12	3	**15**	**10**	**48**	8	1	**7**	**80**
15	Ozone Depletion, emissions	mg R-11 eq.	negligible								
16	Acidification, emissions	g SO2 eq.	119	17	**137**	**30**	**286**	16	10	**6**	**460**
17	Volatile Organic Compounds (VOC)	g	1	1	**1**	**1**	**0**	0	0	**0**	**3**
18	Persistent Organic Pollutants (POP)	ng i-Teq	16	2	**18**	**0**	**7**	12	0	**12**	**38**
19	Heavy Metals	mg Ni eq.	30	4	**33**	**4**	**19**	32	2	**30**	**87**
	PAHs	mg Ni eq.	15	1	**15**	**4**	**2**	0	1	**-1**	**20**
20	Particulate Matter (PM, dust)	g	7	4	**11**	**23**	**6**	141	0	**141**	**181**
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	15	0	**15**	**0**	**7**	9	7	**2**	**24**
22	Eutrophication	g PO4	2	0	**2**	**0**	**0**	1	0	**0**	**2**
23	Persistent Organic Pollutants (POP)	ng i-Teq	negligible								

***=Note: Recycling credits only relate to recycling of plastics and electronics (excl. LCD/CRT). Recycling credits for metals and other fractions are already taken into account in the production phase.**

Table 95: Life Cycle Costs per product and Total annual expenditure (2008) in the EU-27

	Video player base case *Item*	LCC new product		total annual consumer expenditure in EU25	
D	Product price	40	€	1300	mln.€
E	Installation/ acquisition costs (if any)	0	€	0	mln.€
F	Fuel (gas, oil, wood)	0	€	0	mln.€
F	Electricity	15	€	481	mln.€
G	Water	0	€	0	mln.€
H	Aux. 1: None	0	€	0	mln.€
I	Aux. 2 :None	0	€	0	mln.€
J	Aux. 3: None	0	€	0	mln.€
K	Repair & maintenance costs	0	€	0	mln.€
	Total	**55**	€	**1781**	mln.€

Table 96: EU Total Impact of NEW Video player base case produced in 2008 (over their lifetime)

Nr	EU Impact of New Models sold 2008 over their lifetime:							Date	Author		
0	Video player base case							0	AEA/Intertek		
	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	**Total**	**BUTION**		Disposal	Recycl.	**Total**	
	Materials	**unit**									
1	Bulk Plastics	kt			**14**			2	12	**14**	**0**
2	TecPlastics	kt			**0**			0	0	**0**	**0**
3	Ferro	kt			**19**			14	5	**19**	**0**
4	Non-ferro	kt			**2**			1	0	**2**	**0**
5	Coating	kt			**0**			0	0	**0**	**0**
6	Electronics	kt			**7**			3	3	**7**	**0**
7	Misc.	kt			**21**			16	5	**21**	**0**
	Total weight	kt			**62**			36	26	**62**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	PJ	8	2	**9**	**4**	**36**	4	1	**3**	**52**
9	of which, electricity (in primary PJ)	PJ	4	1	**5**	**0**	**36**	0	0	**0**	**40**
10	Water (process)	mln. m3	2	0	**3**	**0**	**2**	0	0	**0**	**5**
11	Water (cooling)	mln. m3	2	0	**3**	**0**	**96**	0	0	**0**	**99**
12	Waste, non-haz./ landfill	kt	80	4	**85**	**3**	**43**	57	1	**56**	**186**
13	Waste, hazardous/ incinerated	kt	6	0	**6**	**0**	**1**	5	0	**5**	**11**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	mt CO2 eq.	0	0	**0**	**0**	**2**	0	0	**0**	**3**
15	Ozone Depletion, emissions	t R-11 eq.	negligible								
16	Acidification, emissions	kt SO2 eq.	4	1	**4**	**1**	**9**	1	0	**0**	**15**
17	Volatile Organic Compounds (VOC)	kt	0	0	**0**	**0**	**0**	0	0	**0**	**0**
18	Persistent Organic Pollutants (POP)	g i-Teq	1	0	**1**	**0**	**0**	0	0	**0**	**1**
19	Heavy Metals	ton Ni eq.	1	0	**1**	**0**	**1**	1	0	**1**	**3**
	PAHs	ton Ni eq.	0	0	**0**	**0**	**0**	0	0	**0**	**1**
20	Particulate Matter (PM, dust)	kt	0	0	**0**	**1**	**0**	5	0	**5**	**6**
	Emissions (Water)										
21	Heavy Metals	ton Hg/20	0	0	**0**	**0**	**0**	0	0	**0**	**1**
22	Eutrophication	kt PO4	0	0	**0**	**0**	**0**	0	0	**0**	**0**
23	Persistent Organic Pollutants (POP)	g i-Teq	negligible								

***=Note: Recycling credits only relate to recycling of plastics and electronics (excl. LCD/CRT). Recycling credits for metals and other fractions are already taken into account in the production phase.**

***=Note: mt= megatonnes (metric)= 10^9 kg; kt= kilotonnes (metric)= 10^9 g; ton(metric)= 10^9 g; g=gram= 10^9 ng ; mln. M3 = million cubic metres= 10^9 litres; PJ= petaJoules= 10^9 MJ (megajoules) = 10^{15} Joules.**

Table 97: EU Total Impact of STOCK of Video player base case in 2008 (produced, in use, discarded)

Nr	EU Impact of Products in 2008 (produced, in use, discarded)***								Date	Author	
	Video player base case								0	AEA/Intertek	
	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	**Total**	**BUTION**		Disposal	Recycl.	**Total**	
	Materials	**unit**									
1	Bulk Plastics	kt			**14**			2	12	**14**	**0**
2	TecPlastics	kt			**0**			0	0	**0**	**0**
3	Ferro	kt			**19**			14	5	**19**	**0**
4	Non-ferro	kt			**2**			1	0	**2**	**0**
5	Coating	kt			**0**			0	0	**0**	**0**
6	Electronics	kt			**7**			3	3	**7**	**0**
7	Misc.	kt			**21**			16	5	**21**	**0**
	Total weight	kt			**62**			36	26	**62**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	PJ	8	2	**9**	**4**	**32**	4	1	**3**	**48**
9	of which, electricity (in primary PJ)	PJ	4	1	**5**	**0**	**32**	0	0	**0**	**36**
10	Water (process)	mln. m3	2	0	**3**	**0**	**2**	0	0	**0**	**4**
11	Water (cooling)	mln. m3	2	0	**3**	**0**	**84**	0	0	**0**	**87**
12	Waste, non-haz./ landfill	kt	80	4	**85**	**3**	**37**	57	1	**56**	**181**
13	Waste, hazardous/ incinerated	kt	6	0	**6**	**0**	**1**	5	0	**5**	**11**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	mt CO2 eq.	0	0	**0**	**0**	**1**	0	0	**0**	**2**
15	Ozone Depletion, emissions	t R-11 eq.	negligible								
16	Acidification, emissions	kt SO2 eq.	4	1	**4**	**1**	**8**	1	0	**0**	**14**
17	Volatile Organic Compounds (VOC)	kt	0	0	**0**	**0**	**0**	0	0	**0**	**0**
18	Persistent Organic Pollutants (POP)	g i-Teq	1	0	**1**	**0**	**0**	0	0	**0**	**1**
19	Heavy Metals	ton Ni eq.	1	0	**1**	**0**	**1**	1	0	**1**	**3**
	PAHs	ton Ni eq.	0	0	**0**	**0**	**0**	0	0	**0**	**1**
20	Particulate Matter (PM, dust)	kt	0	0	**0**	**1**	**0**	5	0	**5**	**6**
	Emissions (Water)										
21	Heavy Metals	ton Hg/20	0	0	**0**	**0**	**0**	0	0	**0**	**1**
22	Eutrophication	kt PO4	0	0	**0**	**0**	**0**	0	0	**0**	**0**
23	Persistent Organic Pollutants (POP)	g i-Teq	negligible								

***=Note: Recycling credits only relate to recycling of plastics and electronics (excl. LCD/CRT). Recycling credits for metals and other fractions are already taken into account in the production phase.**

****=mt= megatonnes (metric)= 10^9 kg; kt= kilotonnes (metric)= 10^9g; ton(metric)= 10^9g; g=gram= 10^9 ng ; mln. M3 = million cubic metres= 10^9 litres; PJ= petaJoules= 10^9 MJ (megajoules) = 10^{15} Joules.**

*****=simplified model assuming produced=EOL**

Video recorder

Table 98: Life Cycle Impact (per unit) of Video recorders

Nr	Life cycle Impact per product:							Date	Author		
0	Video recorder base case							0	AEA/Intertek		
	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	**Total**	**BUTION**		Disposal	Recycl.	**Total**	
	Materials	**unit**									
1	Bulk Plastics	g			**430**			48	382	**430**	**0**
2	TecPlastics	g			**0**			0	0	**0**	**0**
3	Ferro	g			**570**			428	143	**570**	**0**
4	Non-ferro	g			**50**			38	13	**50**	**0**
5	Coating	g			**0**			0	0	**0**	**0**
6	Electronics	g			**215**			108	108	**215**	**0**
7	Misc.	g			**650**			488	163	**650**	**0**
	Total weight	g			**1915**			1108	807	**1915**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	232	56	**288**	**123**	**2674**	109	20	**89**	**3173**
9	of which, electricity (in primary MJ)	MJ	127	17	**144**	**0**	**2672**	0	12	**-12**	**2804**
10	Water (process)	ltr	77	3	**79**	**0**	**179**	0	11	**-11**	**247**
11	Water (cooling)	ltr	72	15	**87**	**0**	**7123**	0	2	**-2**	**7208**
12	Waste, non-haz./ landfill	g	2471	131	**2601**	**86**	**3123**	1761	36	**1725**	**7534**
13	Waste, hazardous/ incinerated	g	182	1	**183**	**2**	**63**	156	14	**142**	**390**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	12	3	**15**	**10**	**117**	8	1	**7**	**149**
15	Ozone Depletion, emissions	mg R-11 eq.	negligible								
16	Acidification, emissions	g SO2 eq.	119	17	**137**	**30**	**689**	16	10	**6**	**862**
17	Volatile Organic Compounds (VOC)	g	1	1	**1**	**1**	**1**	0	0	**0**	**4**
18	Persistent Organic Pollutants (POP)	ng i-Teq	16	2	**18**	**0**	**18**	12	0	**12**	**48**
19	Heavy Metals	mg Ni eq.	30	4	**33**	**4**	**46**	32	2	**30**	**114**
	PAHs	mg Ni eq.	15	1	**15**	**4**	**5**	0	1	**-1**	**23**
20	Particulate Matter (PM, dust)	g	7	4	**11**	**23**	**15**	141	0	**141**	**190**
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	15	0	**15**	**0**	**17**	9	7	**2**	**34**
22	Eutrophication	g PO4	2	0	**2**	**0**	**0**	1	0	**0**	**3**
23	Persistent Organic Pollutants (POP)	ng i-Teq	negligible								

***=Note: Recycling credits only relate to recycling of plastics and electronics (excl. LCD/CRT). Recycling credits for metals and other fractions are already taken into account in the production phase.**

Table 99: Life Cycle Costs per product and Total annual expenditure (2008) in the EU-25

	Video recorder base case *Item*	LCC new product		total annual consumer expenditure in EU25	
D	Product price	165	€	1568	mln.€
E	Installation/ acquisition costs (if any)	0	€	0	mln.€
F	Fuel (gas, oil, wood)	0	€	0	mln.€
F	Electricity	36	€	234	mln.€
G	Water	0	€	0	mln.€
H	Aux. 1: None	0	€	0	mln.€
I	Aux. 2 :None	0	€	0	mln.€
J	Aux. 3: None	0	€	0	mln.€
K	Repair & maintenance costs	0	€	0	mln.€
	Total	**201**	€	**1802**	mln.€

Table 100: EU Total Impact of NEW Video recorder base case produced in 2008 (over their lifetime)

Nr	EU Impact of New Models sold 2008 over their lifetime:							Date	Author		
0	Video recorder base case							0	AEA/Intertek		
	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	**Total**	**BUTION**		Disposal	Recycl.	**Total**	
	Materials	**unit**									
1	Bulk Plastics	kt			**4**			0	4	**4**	**0**
2	TecPlastics	kt			**0**			0	0	**0**	**0**
3	Ferro	kt			**5**			4	1	**5**	**0**
4	Non-ferro	kt			**0**			0	0	**0**	**0**
5	Coating	kt			**0**			0	0	**0**	**0**
6	Electronics	kt			**2**			1	1	**2**	**0**
7	Misc.	kt			**6**			5	2	**6**	**0**
	Total weight	kt			**18**			11	8	**18**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	PJ	2	1	**3**	**1**	**25**	1	0	**1**	**30**
9	of which, electricity (in primary PJ)	PJ	1	0	**1**	**0**	**25**	0	0	**0**	**27**
10	Water (process)	mln. m3	1	0	**1**	**0**	**2**	0	0	**0**	**2**
11	Water (cooling)	mln. m3	1	0	**1**	**0**	**68**	0	0	**0**	**68**
12	Waste, non-haz./ landfill	kt	23	1	**25**	**1**	**30**	17	0	**16**	**72**
13	Waste, hazardous/ incinerated	kt	2	0	**2**	**0**	**1**	1	0	**1**	**4**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	mt CO2 eq.	0	0	**0**	**0**	**1**	0	0	**0**	**1**
15	Ozone Depletion, emissions	t R-11 eq.	negligible								
16	Acidification, emissions	kt SO2 eq.	1	0	**1**	**0**	**7**	0	0	**0**	**8**
17	Volatile Organic Compounds (VOC)	kt	0	0	**0**	**0**	**0**	0	0	**0**	**0**
18	Persistent Organic Pollutants (POP)	g i-Teq	0	0	**0**	**0**	**0**	0	0	**0**	**0**
19	Heavy Metals	ton Ni eq.	0	0	**0**	**0**	**0**	0	0	**0**	**1**
	PAHs	ton Ni eq.	0	0	**0**	**0**	**0**	0	0	**0**	**0**
20	Particulate Matter (PM, dust)	kt	0	0	**0**	**0**	**0**	1	0	**1**	**2**
	Emissions (Water)										
21	Heavy Metals	ton Hg/20	0	0	**0**	**0**	**0**	0	0	**0**	**0**
22	Eutrophication	kt PO4	0	0	**0**	**0**	**0**	0	0	**0**	**0**
23	Persistent Organic Pollutants (POP)	g i-Teq	negligible								

***=Note: Recycling credits only relate to recycling of plastics and electronics (excl. LCD/CRT). Recycling credits for metals and other fractions are already taken into account in the production phase.**

***=Note: mt= megatonnes (metric)= 109 kg; kt= kilotonnes (metric)= 109g; ton(metric)= 109g; g=gram= 109 ng ; mln. M3 = million cubic metres= 109 litres; PJ= petaJoules= 109 MJ (megajoules) = 1015 Joules.**

Table 101: EU Total Impact of STOCK of Video recorder base case in 2008 (produced, in use, discarded)

Nr	EU Impact of Products in 2008 (produced, in use, discarded)***								Date	Author		
	Video recorder base case								0	AEA/Intertek		
	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	**Total**	**BUTION**		Disposal	Recycl.	**Total**	
	Materials	**unit**									
1	Bulk Plastics	kt			**4**			0	4	**4**	**0**
2	TecPlastics	kt			**0**			0	0	**0**	**0**
3	Ferro	kt			**5**			4	1	**5**	**0**
4	Non-ferro	kt			**0**			0	0	**0**	**0**
5	Coating	kt			**0**			0	0	**0**	**0**
6	Electronics	kt			**2**			1	1	**2**	**0**
7	Misc.	kt			**6**			5	2	**6**	**0**
	Total weight	kt			**18**			11	8	**18**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	PJ	2	1	**3**	**1**	**15**	1	0	**1**	**20**
9	of which, electricity (in primary PJ)	PJ	1	0	**1**	**0**	**15**	0	0	**0**	**17**
10	Water (process)	mln. m3	1	0	**1**	**0**	**1**	0	0	**0**	**2**
11	Water (cooling)	mln. m3	1	0	**1**	**0**	**41**	0	0	**0**	**42**
12	Waste, non-haz./ landfill	kt	23	1	**25**	**1**	**18**	17	0	**16**	**60**
13	Waste, hazardous/ incinerated	kt	2	0	**2**	**0**	**0**	1	0	**1**	**3**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	mt CO2 eq.	0	0	**0**	**0**	**1**	0	0	**0**	**1**
15	Ozone Depletion, emissions	t R-11 eq.	negligible								
16	Acidification, emissions	kt SO2 eq.	1	0	**1**	**0**	**4**	0	0	**0**	**6**
17	Volatile Organic Compounds (VOC)	kt	0	0	**0**	**0**	**0**	0	0	**0**	**0**
18	Persistent Organic Pollutants (POP)	g i-Teq	0	0	**0**	**0**	**0**	0	0	**0**	**0**
19	Heavy Metals	ton Ni eq.	0	0	**0**	**0**	**0**	0	0	**0**	**1**
	PAHs	ton Ni eq.	0	0	**0**	**0**	**0**	0	0	**0**	**0**
20	Particulate Matter (PM, dust)	kt	0	0	**0**	**0**	**0**	1	0	**1**	**2**
	Emissions (Water)										
21	Heavy Metals	ton Hg/20	0	0	**0**	**0**	**0**	0	0	**0**	**0**
22	Eutrophication	kt PO4	0	0	**0**	**0**	**0**	0	0	**0**	**0**
23	Persistent Organic Pollutants (POP)	g i-Teq	negligible								

***=Note: Recycling credits only relate to recycling of plastics and electronics (excl. LCD/CRT). Recycling credits for metals and other fractions are already taken into account in the production phase.**

****=mt= megatonnes (metric)= 109 kg; kt= kilotonnes (metric)= 109g; ton(metric)= 109g; g=gram= 109 ng ; mln. M3 = million cubic metres= 109 litres; PJ= petaJoules= 109 MJ (megajoules) = 1015 Joules.**

*****=simplified model assuming produced=EOL**

Projectors

Table 102: Projectors - Life cycle impact (per unit) of Projectors – base case

Nr	Life cycle Impact per product:								Date	Author	
0	Projectors - base case								0	AEA/Intertek	
	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	**Total**	**BUTION**		Disposal	Recycl.	**Total**	
	Materials	**unit**									
1	Bulk Plastics	g			**757**			51	706	**757**	**0**
2	TecPlastics	g			**881**			59	822	**881**	**0**
3	Ferro	g			**259**			194	65	**259**	**0**
4	Non-ferro	g			**457**			343	114	**457**	**0**
5	Coating	g			**2**			2	1	**2**	**0**
6	Electronics	g			**596**			298	298	**596**	**0**
7	Misc.	g			**2214**			1661	553	**2214**	**0**
	Total weight	g			**5066**			2608	2459	**5066**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	422	153	**574**	**194**	**7920**	252	62	**190**	**8878**
9	of which, electricity (in primary MJ)	MJ	111	47	**158**	**0**	**7916**	0	35	**-35**	**8039**
10	Water (process)	ltr	154	8	**162**	**0**	**529**	0	32	**-32**	**660**
11	Water (cooling)	ltr	290	43	**332**	**0**	**21108**	0	10	**-10**	**21430**
12	Waste, non-haz./ landfill	g	6679	320	**6998**	**120**	**9246**	4003	103	**3900**	**20265**
13	Waste, hazardous/ incinerated	g	969	3	**971**	**2**	**192**	409	39	**369**	**1535**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	18	9	**27**	**15**	**346**	19	4	**15**	**403**
15	Ozone Depletion, emissions	mg R-11 eq.	negligible								
16	Acidification, emissions	g SO2 eq.	224	48	**271**	**49**	**2041**	37	27	**10**	**2370**
17	Volatile Organic Compounds (VOC)	g	1	2	**3**	**2**	**3**	1	0	**1**	**9**
18	Persistent Organic Pollutants (POP)	ng i-Teq	13	1	**14**	**1**	**52**	28	0	**27**	**94**
19	Heavy Metals	mg Ni eq.	38	4	**41**	**6**	**136**	73	4	**69**	**252**
	PAHs	mg Ni eq.	52	2	**54**	**5**	**16**	0	4	**-4**	**71**
20	Particulate Matter (PM, dust)	g	17	12	**28**	**46**	**44**	331	1	**329**	**447**
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	47	0	**48**	**0**	**52**	21	20	**1**	**100**
22	Eutrophication	g PO4	5	0	**6**	**0**	**0**	1	0	**1**	**7**
23	Persistent Organic Pollutants (POP)	ng i-Teq	negligible								

***=Note: Recycling credits only relate to recycling of plastics and electronics (excl. LCD/CRT). Recycling credits for metals and other fractions are already taken into account in the production phase.**

Table 103: Projectors - Life Cycle Costs per product and Total annual expenditure (2008) in the EU-27

	Projectors - base case *Item*	LCC new product		total annual consumer expenditure in EU25	
D	Product price	800	€	1280	mln.€
E	Installation/ acquisition costs (if any)	500	€	800	mln.€
F	Fuel (gas, oil, wood)	0	€	0	mln.€
F	Electricity	105	€	161	mln.€
G	Water	0	€	0	mln.€
H	Aux. 1: None	0	€	0	mln.€
I	Aux. 2 :None	0	€	0	mln.€
J	Aux. 3: None	0	€	0	mln.€
K	Repair & maintenance costs	371	€	567	mln.€
	Total	**1777**	€	**2807**	mln.€

Table 104: EU Total Impact of NEW Products produced in 2008 (over their lifetime)

Nr	EU Impact of New Models sold 2008 over their lifetime:							Date	Author		
0	Projectors - base case							0	AEA/Intertek		
	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	**Total**	**BUTION**		Disposal	Recycl.	**Total**	
	Materials	**unit**									
1	Bulk Plastics	kt			**1**			0	1	**1**	**0**
2	TecPlastics	kt			**1**			0	1	**1**	**0**
3	Ferro	kt			**0**			0	0	**0**	**0**
4	Non-ferro	kt			**1**			1	0	**1**	**0**
5	Coating	kt			**0**			0	0	**0**	**0**
6	Electronics	kt			**1**			0	0	**1**	**0**
7	Misc.	kt			**2**			2	1	**2**	**0**
	Total weight	kt			**7**			3	4	**7**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	PJ	1	0	**1**	**0**	**13**	0	0	**0**	**14**
9	of which, electricity (in primary PJ)	PJ	0	0	**0**	**0**	**13**	0	0	**0**	**13**
10	Water (process)	mln. m3	0	0	**0**	**0**	**1**	0	0	**0**	**1**
11	Water (cooling)	mln. m3	0	0	1	0	**34**	0	0	**0**	**34**
12	Waste, non-haz./ landfill	kt	11	1	**11**	**0**	**15**	6	0	**6**	**32**
13	Waste, hazardous/ incinerated	kt	2	0	**2**	**0**	**0**	1	0	**1**	**2**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	mt CO2 eq.	0	0	**0**	**0**	**1**	0	0	**0**	**1**
15	Ozone Depletion, emissions	t R-11 eq.	negligible								
16	Acidification, emissions	kt SO2 eq.	0	0	**0**	**0**	**3**	0	0	**0**	**4**
17	Volatile Organic Compounds (VOC)	kt	0	0	**0**	**0**	**0**	0	0	**0**	**0**
18	Persistent Organic Pollutants (POP)	g i-Teq	0	0	**0**	**0**	**0**	0	0	**0**	**0**
19	Heavy Metals	ton Ni eq.	0	0	**0**	**0**	**0**	0	0	**0**	**0**
	PAHs	ton Ni eq.	0	0	**0**	**0**	**0**	0	0	**0**	**0**
20	Particulate Matter (PM, dust)	kt	0	0	**0**	**0**	**0**	1	0	**1**	**1**
	Emissions (Water)										
21	Heavy Metals	ton Hg/20	0	0	**0**	**0**	**0**	0	0	**0**	**0**
22	Eutrophication	kt PO4	0	0	**0**	**0**	**0**	0	0	**0**	**0**
23	Persistent Organic Pollutants (POP)	g i-Teq	negligible								

***=Note: Recycling credits only relate to recycling of plastics and electronics (excl. LCD/CRT). Recycling credits for metals and other fractions are already taken into account in the production phase.**

***=Note: mt= megatonnes (metric)= 10^9 kg; kt= kilotonnes (metric)= 10^9g; ton(metric)= 10^9g; g=gram= 10^9 ng ; mln. M3 = million cubic metres= 10^9 litres; PJ= petaJoules= 10^9 MJ (megajoules) = 10^{15} Joules.**

Table 105: EU Total Impact of STOCK of Products in 2008 (produced, in use, discarded)

Nr	EU Impact of Products in 2008 (produced, in use, discarded)***								Date	Author		
	Projectors - base case								0	AEA/Intertek		
	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*				TOTAL
	Resources Use and Emissions		Material	Manuf.	**Total**	**BUTION**		Disposal	Recycl.	**Total**		
	Materials	**unit**										
1	Bulk Plastics	kt			**1**			0	1	**1**		**0**
2	TecPlastics	kt			**1**			0	1	**1**		**0**
3	Ferro	kt			**0**			0	0	**0**		**0**
4	Non-ferro	kt			**1**			1	0	**1**		**0**
5	Coating	kt			**0**			0	0	**0**		**0**
6	Electronics	kt			**1**			0	0	**1**		**0**
7	Misc.	kt			**2**			2	1	**2**		**0**
	Total weight	kt			**7**			3	4	**7**		**0**
									see note!			
	Other Resources & Waste							debet	credit			
8	Total Energy (GER)	PJ	1	0	**1**	**0**	**11**	0	0	**0**		**12**
9	of which, electricity (in primary PJ)	PJ	0	0	**0**	**0**	**11**	0	0	**0**		**11**
10	Water (process)	mln. m3	0	0	**0**	**0**	**1**	0	0	**0**		**1**
11	Water (cooling)	mln. m3	0	0	**1**	**0**	**28**	0	0	**0**		**29**
12	Waste, non-haz./ landfill	kt	11	1	**11**	**0**	**12**	6	0	**6**		**30**
13	Waste, hazardous/ incinerated	kt	2	0	**2**	**0**	**0**	1	0	**1**		**2**
	Emissions (Air)											
14	Greenhouse Gases in GWP100	mt CO2 eq.	0	0	**0**	**0**	**0**	0	0	**0**		**1**
15	Ozone Depletion, emissions	t R-11 eq.	negligible									
16	Acidification, emissions	kt SO2 eq.	0	0	**0**	**0**	**3**	0	0	**0**		**3**
17	Volatile Organic Compounds (VOC)	kt	0	0	**0**	**0**	**0**	0	0	**0**		**0**
18	Persistent Organic Pollutants (POP)	g i-Teq	0	0	**0**	**0**	**0**	0	0	**0**		**0**
19	Heavy Metals	ton Ni eq.	0	0	**0**	**0**	**0**	0	0	**0**		**0**
	PAHs	ton Ni eq.	0	0	**0**	**0**	**0**	0	0	**0**		**0**
20	Particulate Matter (PM, dust)	kt	0	0	**0**	**0**	**0**	1	0	**1**		**1**
	Emissions (Water)											
21	Heavy Metals	ton Hg/20	0	0	**0**	**0**	**0**	0	0	**0**		**0**
22	Eutrophication	kt PO4	0	0	**0**	**0**	**0**	0	0	**0**		**0**
23	Persistent Organic Pollutants (POP)	g i-Teq	negligible									

***=Note: Recycling credits only relate to recycling of plastics and electronics (excl. LCD/CRT). Recycling credits for metals and other fractions are already taken into account in the production phase.**

****=mt= megatonnes (metric)= 10^9 kg; kt= kilotonnes (metric)= 10^9 g; ton(metric)= 10^9 g; g=gram= 10^9 ng ; mln. M3 = million cubic metres= 10^9 litres; PJ= petaJoules= 10^9 MJ (megajoules) = 10^{15} Joules.**

*****=simplified model assuming produced=EOL**

Games consoles

Table 106: Life Cycle Impact (per unit) of Games consoles - base case

Nr	Life cycle Impact per product:							Date	Author		
0	Games consoles - base case							0	AEA/Intertek		
	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	**Total**	**BUTION**		Disposal	Recycl.	**Total**	
	Materials	**unit**									
1	Bulk Plastics	g			**1394**			125	1268	**1394**	**0**
2	TecPlastics	g			**13**			1	12	**13**	**0**
3	Ferro	g			**442**			332	111	**442**	**0**
4	Non-ferro	g			**382**			287	96	**382**	**0**
5	Coating	g			**0**			0	0	**0**	**0**
6	Electronics	g			**851**			441	410	**851**	**0**
7	Misc.	g			**1931**			1448	483	**1931**	**0**
	Total weight	g			**5013**			2634	2379	**5013**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	942	173	**1115**	**147**	**2392**	293	73	**220**	**3874**
9	of which, electricity (in primary MJ)	MJ	455	43	**498**	**0**	**2386**	0	48	**-48**	**2837**
10	Water (process)	ltr	415	10	**425**	**0**	**163**	0	43	**-43**	**545**
11	Water (cooling)	ltr	292	48	**341**	**0**	**6353**	0	9	**-9**	**6685**
12	Waste, non-haz./ landfill	g	7414	322	**7735**	**97**	**2838**	4609	138	**4472**	**15142**
13	Waste, hazardous/ incinerated	g	219	3	**222**	**2**	**57**	537	54	**483**	**764**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	54	11	**65**	**12**	**105**	22	5	**17**	**198**
15	Ozone Depletion, emissions	mg R-11 eq.	negligible								
16	Acidification, emissions	g SO2 eq.	478	57	**535**	**37**	**619**	43	37	**6**	**1196**
17	Volatile Organic Compounds (VOC)	g	4	3	**6**	**1**	**1**	1	1	**1**	**9**
18	Persistent Organic Pollutants (POP)	ng i-Teq	17	2	**19**	**1**	**16**	32	1	**31**	**66**
19	Heavy Metals	mg Ni eq.	86	4	**90**	**5**	**42**	85	6	**79**	**216**
	PAHs	mg Ni eq.	122	2	**124**	**4**	**6**	0	5	**-5**	**129**
20	Particulate Matter (PM, dust)	g	38	15	**53**	**30**	**14**	380	2	**378**	**475**
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	265	0	**266**	**0**	**18**	24	27	**-3**	**281**
22	Eutrophication	g PO4	5	1	**5**	**0**	**0**	1	0	**1**	**7**
23	Persistent Organic Pollutants (POP)	ng i-Teq	negligible								

***=Note: Recycling credits only relate to recycling of plastics and electronics (excl. LCD/CRT). Recycling credits for metals and other fractions are already taken into account in the production phase.**

Table 107: Life Cycle Costs per product and Total annual expenditure (2008) in the EU-27

	Games consoles - base case *Item*	LCC new product		total annual consumer expenditure in EU25	
D	Product price	360	€	7416	mln.€
E	Installation/ acquisition costs (if any)	0	€	0	mln.€
F	Fuel (gas, oil, wood)	0	€	0	mln.€
F	Electricity	32	€	393	mln.€
G	Water	0	€	0	mln.€
H	Aux. 1: None	0	€	0	mln.€
I	Aux. 2 :None	0	€	0	mln.€
J	Aux. 3: None	0	€	0	mln.€
K	Repair & maintenance costs	0	€	0	mln.€
	Total	**392**	€	**7809**	mln.€

Table 108: EU Total Impact of NEW Games consoles - base case produced in 2008 (over their lifetime)

Nr	EU Impact of New Models sold 2008 over their lifetime:							Date	Author		
0	Games consoles - base case							0	AEA/Intertek		
	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	**Total**	**BUTION**		Disposal	Recycl.	**Total**	
	Materials	**unit**									
1	Bulk Plastics	kt			**29**			3	26	**29**	**0**
2	TecPlastics	kt			**0**			0	0	**0**	**0**
3	Ferro	kt			**9**			7	2	**9**	**0**
4	Non-ferro	kt			**8**			6	2	**8**	**0**
5	Coating	kt			**0**			0	0	**0**	**0**
6	Electronics	kt			**18**			9	8	**18**	**0**
7	Misc.	kt			**40**			30	10	**40**	**0**
	Total weight	kt			**103**			54	49	**103**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	PJ	19	4	**23**	**3**	**49**	6	2	**5**	**80**
9	of which, electricity (in primary PJ)	PJ	9	1	**10**	**0**	**49**	0	1	**-1**	**58**
10	Water (process)	mln. m3	9	0	**9**	**0**	**3**	0	1	**-1**	**11**
11	Water (cooling)	mln. m3	6	1	**7**	**0**	**131**	0	0	**0**	**138**
12	Waste, non-haz./ landfill	kt	153	7	**159**	**2**	**58**	95	3	**92**	**312**
13	Waste, hazardous/ incinerated	kt	5	0	**5**	**0**	**1**	11	1	**10**	**16**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	mt CO2 eq.	1	0	**1**	**0**	**2**	0	0	**0**	**4**
15	Ozone Depletion, emissions	t R-11 eq.	negligible								
16	Acidification, emissions	kt SO2 eq.	10	1	**11**	**1**	**13**	1	1	**0**	**25**
17	Volatile Organic Compounds (VOC)	kt	0	0	**0**	**0**	**0**	0	0	**0**	**0**
18	Persistent Organic Pollutants (POP)	g i-Teq	0	0	**0**	**0**	**0**	1	0	**1**	**1**
19	Heavy Metals	ton Ni eq.	2	0	**2**	**0**	**1**	2	0	**2**	**4**
	PAHs	ton Ni eq.	3	0	**3**	**0**	**0**	0	0	**0**	**3**
20	Particulate Matter (PM, dust)	kt	1	0	**1**	**1**	**0**	8	0	**8**	**10**
	Emissions (Water)										
21	Heavy Metals	ton Hg/20	5	0	**5**	**0**	**0**	1	1	**0**	**6**
22	Eutrophication	kt PO4	0	0	**0**	**0**	**0**	0	0	**0**	**0**
23	Persistent Organic Pollutants (POP)	g i-Teq	negligible								

***=Note: Recycling credits only relate to recycling of plastics and electronics (excl. LCD/CRT). Recycling credits for metals and other fractions are already taken into account in the production phase.**

***=Note: mt= megatonnes (metric)= 10^9 kg; kt= kilotonnes (metric)= 10^9 g; ton(metric)= 10^9 g; g=gram= 10^9 ng ; mln. M3 = million cubic metres= 10^9 litres; PJ= petaJoules= 10^9 MJ (megajoules) = 10^{15} Joules.**

Table 109: EU Total Impact of STOCK of Games consoles - base case in 2008 (produced, in use, discarded)

Nr	EU Impact of Products in 2008 (produced, in use, discarded)***								Date	Author	
	Games consoles - base case								0	AEA/Intertek	
	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	**Total**	**BUTION**		Disposal	Recycl.	**Total**	
	Materials	**unit**									
1	Bulk Plastics	kt			**29**			3	26	**29**	**0**
2	TecPlastics	kt			**0**			0	0	**0**	**0**
3	Ferro	kt			**9**			7	2	**9**	**0**
4	Non-ferro	kt			**8**			6	2	**8**	**0**
5	Coating	kt			**0**			0	0	**0**	**0**
6	Electronics	kt			**18**			9	8	**18**	**0**
7	Misc.	kt			**40**			30	10	**40**	**0**
	Total weight	kt			**103**			54	49	**103**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	PJ	19	4	**23**	**3**	**26**	6	2	**5**	**56**
9	of which, electricity (in primary PJ)	PJ	9	1	**10**	**0**	**26**	0	1	**-1**	**35**
10	Water (process)	mln. m3	9	0	**9**	**0**	**2**	0	1	**-1**	**10**
11	Water (cooling)	mln. m3	6	1	**7**	**0**	**69**	0	0	**0**	**76**
12	Waste, non-haz./ landfill	kt	153	7	**159**	**2**	**31**	95	3	**92**	**284**
13	Waste, hazardous/ incinerated	kt	5	0	**5**	**0**	**1**	11	1	**10**	**15**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	mt CO2 eq.	1	0	**1**	**0**	**1**	0	0	**0**	**3**
15	Ozone Depletion, emissions	t R-11 eq.	negligible								
16	Acidification, emissions	kt SO2 eq.	10	1	**11**	**1**	**7**	1	1	**0**	**19**
17	Volatile Organic Compounds (VOC)	kt	0	0	**0**	**0**	**0**	0	0	**0**	**0**
18	Persistent Organic Pollutants (POP)	g i-Teq	0	0	**0**	**0**	**0**	1	0	**1**	**1**
19	Heavy Metals	ton Ni eq.	2	0	**2**	**0**	**0**	2	0	**2**	**4**
	PAHs	ton Ni eq.	3	0	**3**	**0**	**0**	0	0	**0**	**3**
20	Particulate Matter (PM, dust)	kt	1	0	**1**	**1**	**0**	8	0	**8**	**10**
	Emissions (Water)										
21	Heavy Metals	ton Hg/20	5	0	**5**	**0**	**0**	1	1	**0**	**6**
22	Eutrophication	kt PO4	0	0	**0**	**0**	**0**	0	0	**0**	**0**
23	Persistent Organic Pollutants (POP)	g i-Teq	negligible								

***=Note: Recycling credits only relate to recycling of plastics and electronics (excl. LCD/CRT). Recycling credits for metals and other fractions are already taken into account in the production phase.**

****=mt= megatonnes (metric)= 10^9 kg; kt= kilotonnes (metric)= 10^9g; ton(metric)= 10^9g; g=gram= 10^9 ng ; mln. M3 = million cubic metres= 10^9 litres; PJ= petaJoules= 10^9 MJ (megajoules) = 10^{15} Joules.**

*****=simplified model assuming produced=EOL**

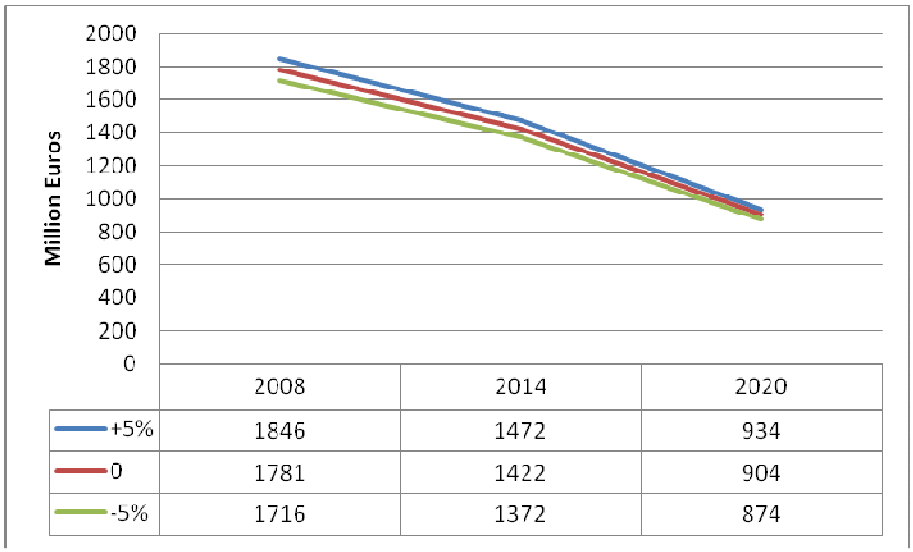
Appendix 3

Results of Sensitivity Analysis

Results of Sensitivity Analysis

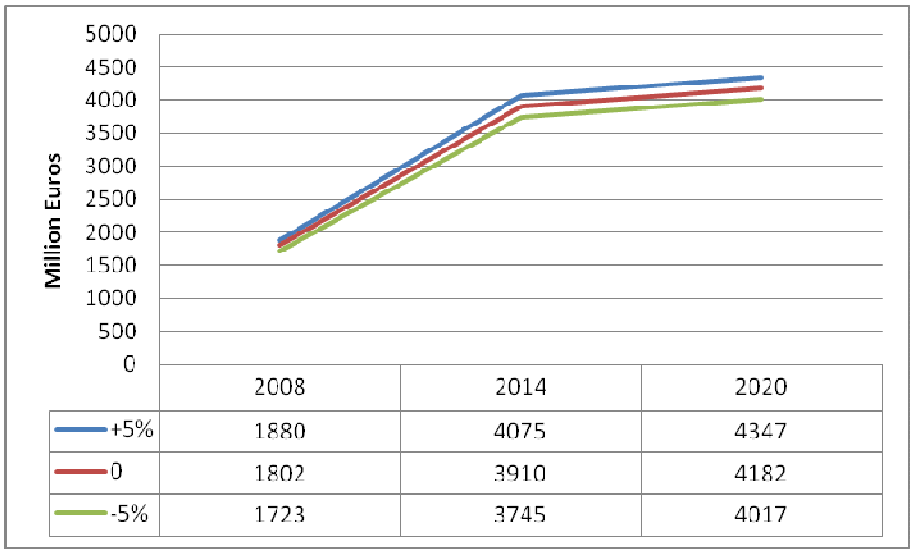
Sensitivity to Product Price

Video players – Total Consumer Expenditure (Million Euros)



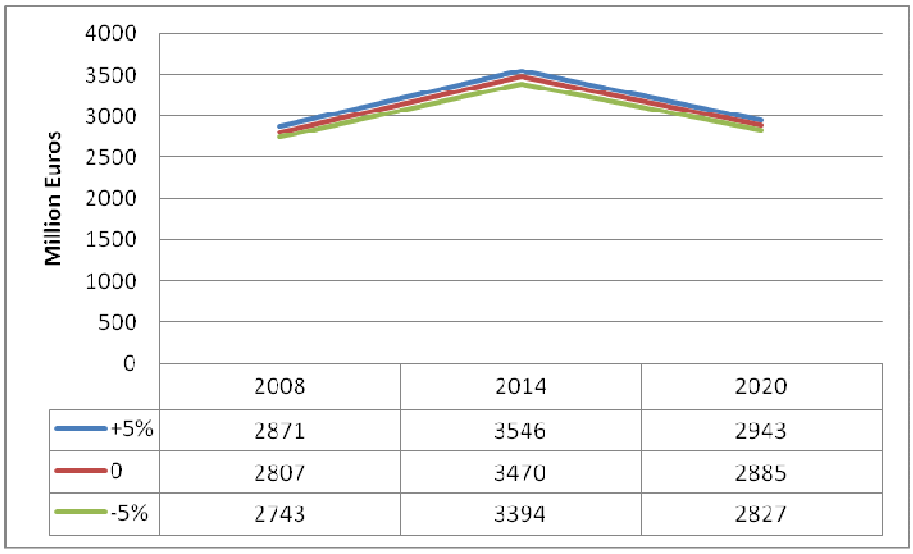
	2008	2014	2020
+5%	1846	1472	934
0	1781	1422	904
-5%	1716	1372	874

Video recorders – Total Consumer Expenditure (Million Euros)



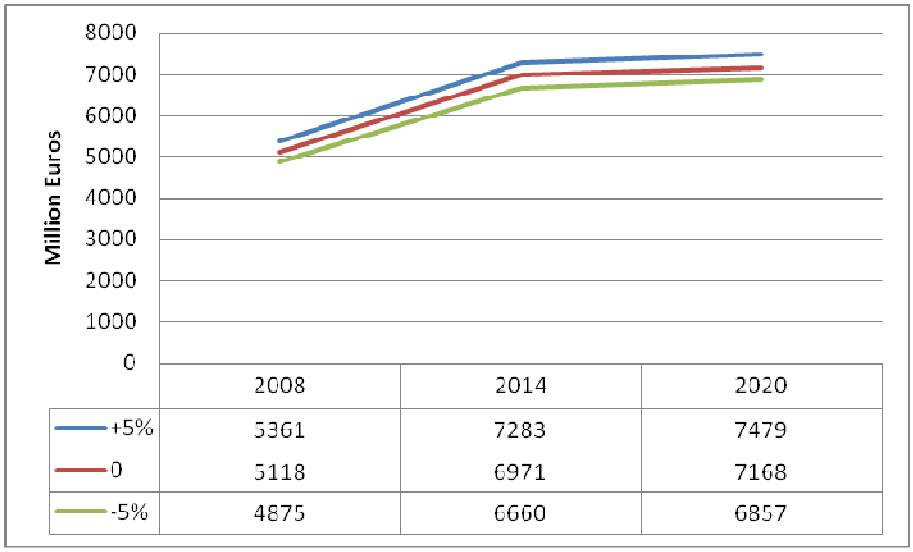
	2008	2014	2020
+5%	1880	4075	4347
0	1802	3910	4182
-5%	1723	3745	4017

Projectors – Total Consumer Expenditure (Million Euros)



	2008	2014	2020
+5%	2871	3546	2943
0	2807	3470	2885
-5%	2743	3394	2827

Games consoles – Total Consumer Expenditure (Million Euros)



	2008	2014	2020
+5%	5361	7283	7479
0	5118	6971	7168
-5%	4875	6660	6857

Sensitivity to Electricity price and Discount rate

Video Players – LCC per product Sensitivity Results

Optn No.	Base Case	Electr (+25%)	2% Disc rate	Electr (-25%)	6% Disc rate
0	54.74 €	58.42 €	55.75 €	51.05 €	53.82 €
1	52.84 €	56.05 €	53.85 €	49.63 €	51.94 €
2	52.50 €	55.62 €	53.35 €	49.37 €	51.72 €
3	54.20 €	56.74 €	54.89 €	51.65 €	53.56 €
4	48.52 €	51.64 €	49.25 €	45.39 €	47.84 €
5	54.74 €	58.42 €	55.75 €	51.05 €	53.82 €
6	54.74 €	58.42 €	55.75 €	51.05 €	53.82 €
7	54.74 €	58.42 €	55.75 €	51.05 €	53.82 €
8	64.90 €	70.13 €	66.95 €	59.68 €	63.12 €
9	54.23 €	57.92 €	55.48 €	50.55 €	53.10 €
10	54.74 €	58.42 €	55.75 €	51.05 €	53.82 €
11	48.04 €	51.04 €	48.92 €	45.03 €	47.24 €
12	49.43 €	51.79 €	50.04 €	47.08 €	48.89 €
13	46.71 €	49.51 €	47.72 €	43.91 €	45.80 €
14	54.21 €	56.64 €	55.07 €	51.79 €	53.43 €
15	48.71 €	51.51 €	49.72 €	45.91 €	47.80 €
16	55.69 €	58.24 €	56.63 €	53.14 €	54.84 €
17	49.73 €	52.16 €	50.40 €	47.30 €	49.13 €
18	46.61 €	49.27 €	47.24 €	43.96 €	46.04 €
19	50.18 €	52.83 €	51.01 €	47.52 €	49.41 €
20	47.82 €	50.47 €	48.64 €	45.18 €	47.05 €

Video recorders - LCC per product Sensitivity Results

Optn No.	LCC	Electr (+25%)	2% Disc rate	Electr (-25%)	6% Disc rate
0	201.00 €	209.45 €	202.99 €	191.67 €	198.35 €
1	198.51 €	206.89 €	201.13 €	190.13 €	196.17 €
2	188.60 €	194.50 €	190.22 €	182.70 €	187.14 €
3	196.00 €	202.86 €	197.94 €	189.31 €	194.41 €
4	178.00 €	185.75 €	179.97 €	170.65 €	176.57 €
5	201.00 €	209.45 €	202.99 €	191.67 €	198.35 €
6	201.00 €	209.45 €	202.99 €	191.67 €	198.35 €
7	201.00 €	209.45 €	202.99 €	191.67 €	198.35 €
8	232.00 €	245.04 €	237.36 €	219.82 €	228.13 €
9	199.00 €	208.31 €	202.40 €	190.53 €	196.73 €
10	201.00 €	209.45 €	202.99 €	191.67 €	198.35 €
11	177.27 €	184.58 €	179.27 €	169.95 €	175.45 €
12	177.06 €	183.33 €	178.66 €	170.80 €	175.61 €
13	180.13 €	187.45 €	182.67 €	172.81 €	177.83 €
14	181.98 €	188.50 €	184.23 €	175.46 €	179.94 €
15	180.13 €	187.45 €	182.67 €	172.81 €	177.83 €
16	182.45 €	189.09 €	184.76 €	175.81 €	180.35 €
17	187.34 €	192.93 €	188.87 €	181.76 €	185.96 €
18	185.04 €	190.05 €	186.22 €	180.03 €	183.96 €
19	201.05 €	206.06 €	202.70 €	196.04 €	199.55 €
20	182.99 €	187.98 €	184.63 €	178.01 €	181.50 €

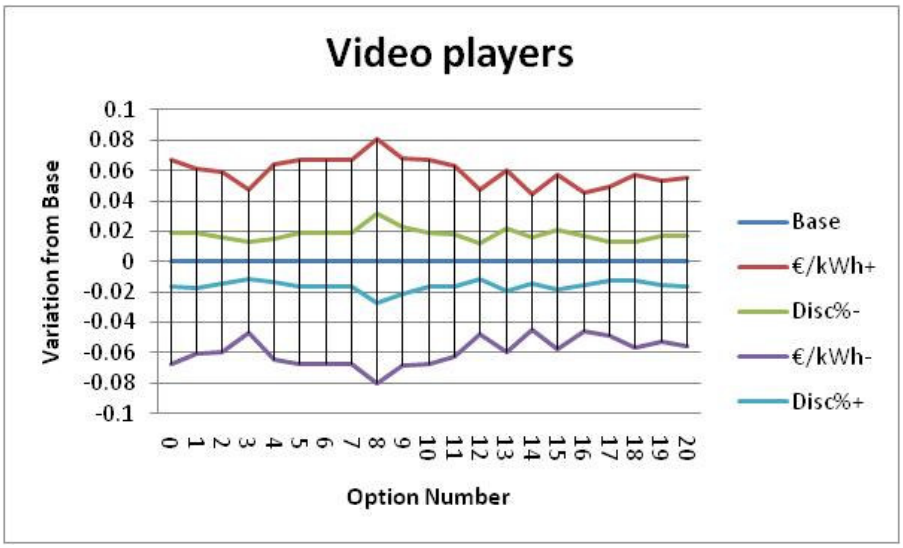
Projectors - LCC per product Sensitivity Results

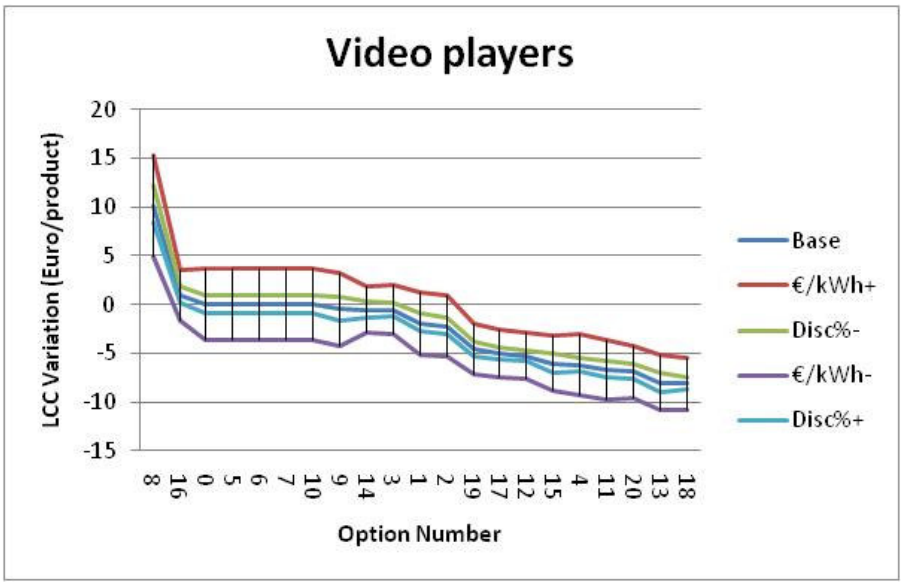
Optn No.	LCC	Electr (+25%)	2% Disc rate	Electr (-25%)	6% Disc rate
0	1,777 €	1,803 €	1,809 €	1,750 €	1,747 €
1	1,785 €	1,815 €	1,823 €	1,755 €	1,751 €
2	1,736 €	1,752 €	1,765 €	1,719 €	1,709 €
3	1,774 €	1,798 €	1,806 €	1,750 €	1,745 €
4	1,728 €	1,750 €	1,755 €	1,706 €	1,703 €
5	1,777 €	1,803 €	1,809 €	1,750 €	1,747 €
6	1,777 €	1,803 €	1,809 €	1,750 €	1,747 €
7	1,777 €	1,803 €	1,809 €	1,750 €	1,747 €
8	1,881 €	1,918 €	1,929 €	1,843 €	1,838 €
9	1,772 €	1,798 €	1,807 €	1,745 €	1,740 €
10	1,777 €	1,803 €	1,809 €	1,750 €	1,747 €
11	1,737 €	1,763 €	1,769 €	1,710 €	1,707 €
12	1,731 €	1,753 €	1,760 €	1,709 €	1,704 €
13	1,732 €	1,758 €	1,767 €	1,705 €	1,700 €
14	1,728 €	1,750 €	1,761 €	1,705 €	1,698 €
15	1,732 €	1,758 €	1,767 €	1,705 €	1,700 €
16	1,728 €	1,752 €	1,762 €	1,705 €	1,698 €
17	1,736 €	1,752 €	1,765 €	1,719 €	1,709 €
18	1,693 €	1,707 €	1,718 €	1,679 €	1,670 €
19	1,729 €	1,742 €	1,756 €	1,715 €	1,703 €
20	1,729 €	1,743 €	1,757 €	1,714 €	1,702 €

Games consoles - LCC per product Sensitivity Results

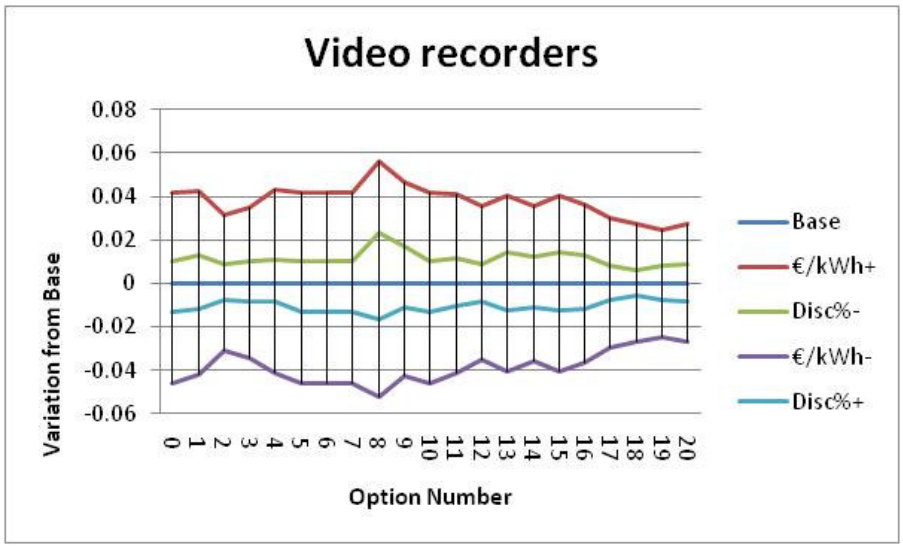
Optn No.	LCC	Electr (+25%)	2% Disc rate	Electr (-25%)	6% Disc rate
0	392.00 €	400.00 €	394.04 €	384.00 €	390.15 €
1	391.11 €	398.89 €	393.43 €	383.33 €	389.03 €
2	379.46 €	384.33 €	380.70 €	374.60 €	378.34 €
3	390.09 €	396.61 €	391.75 €	383.57 €	388.58 €
4	371.37 €	378.71 €	373.10 €	364.03 €	369.79 €
5	392.00 €	400.00 €	394.04 €	384.00 €	390.15 €
6	392.00 €	400.00 €	394.04 €	384.00 €	390.15 €
7	392.00 €	400.00 €	394.04 €	384.00 €	390.15 €
8	445.05 €	457.32 €	449.85 €	432.79 €	440.87 €
9	389.88 €	397.88 €	392.93 €	381.88 €	387.11 €
10	392.00 €	400.00 €	394.04 €	384.00 €	390.15 €
11	371.03 €	378.28 €	373.04 €	363.77 €	369.20 €
12	376.94 €	382.93 €	378.35 €	370.96 €	375.66 €
13	375.75 €	382.47 €	378.51 €	369.02 €	373.24 €
14	389.96 €	396.49 €	392.64 €	383.44 €	387.53 €
15	380.75 €	387.47 €	383.51 €	374.02 €	378.24 €
16	394.96 €	401.49 €	397.64 €	388.44 €	392.53 €
17	375.95 €	379.94 €	376.97 €	371.97 €	375.03 €
18	359.86 €	364.33 €	360.91 €	355.40 €	358.90 €
19	375.89 €	380.35 €	377.88 €	371.42 €	374.07 €
20	374.48 €	378.98 €	376.49 €	369.99 €	372.70 €

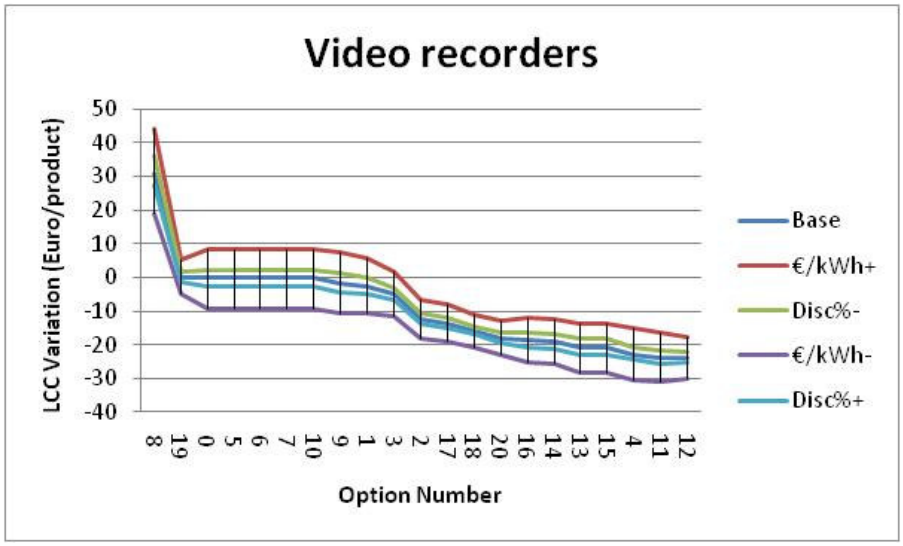
Video Players – sensitivity analysis



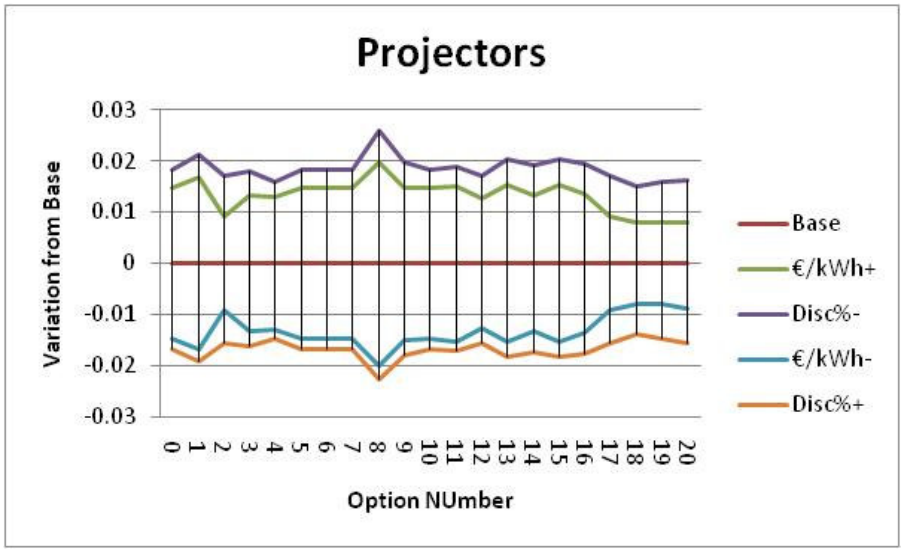


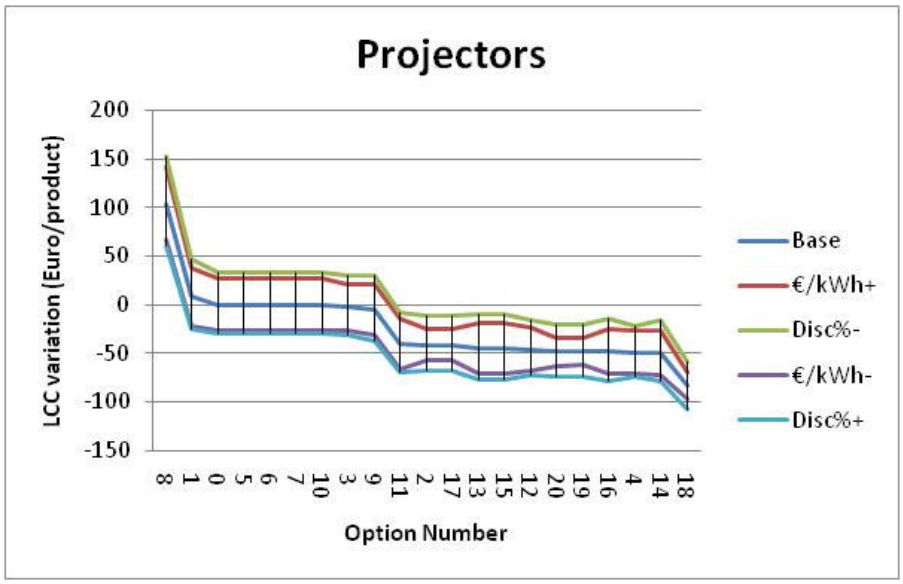
Video recorders – sensitivity analysis



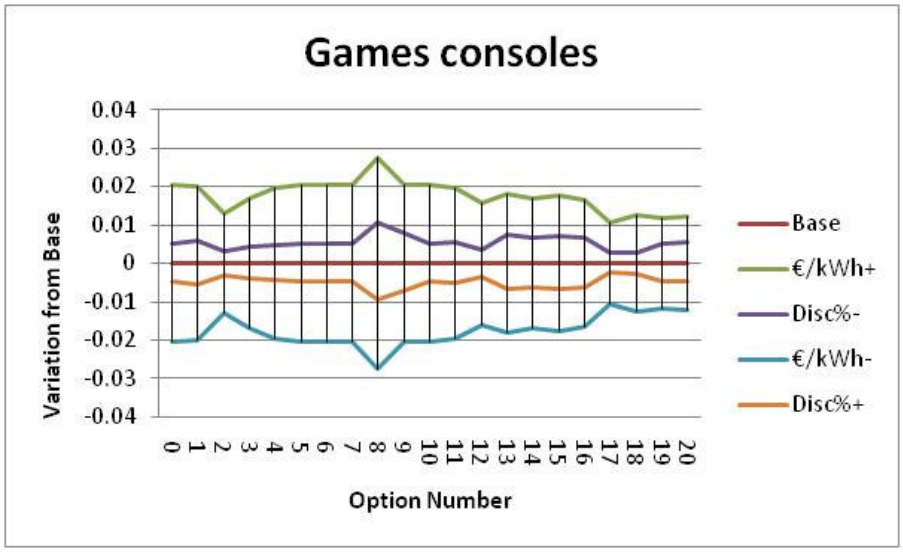


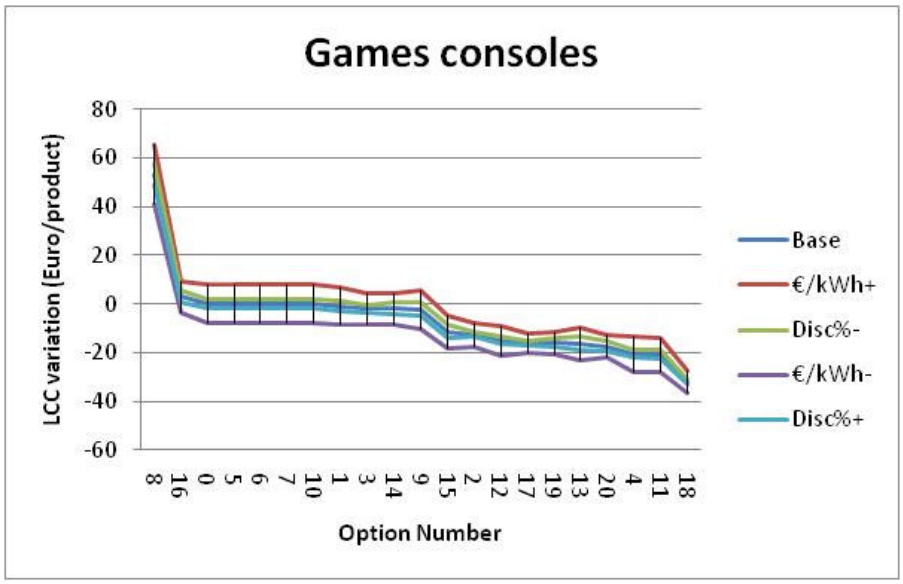
Projectors – sensitivity analysis



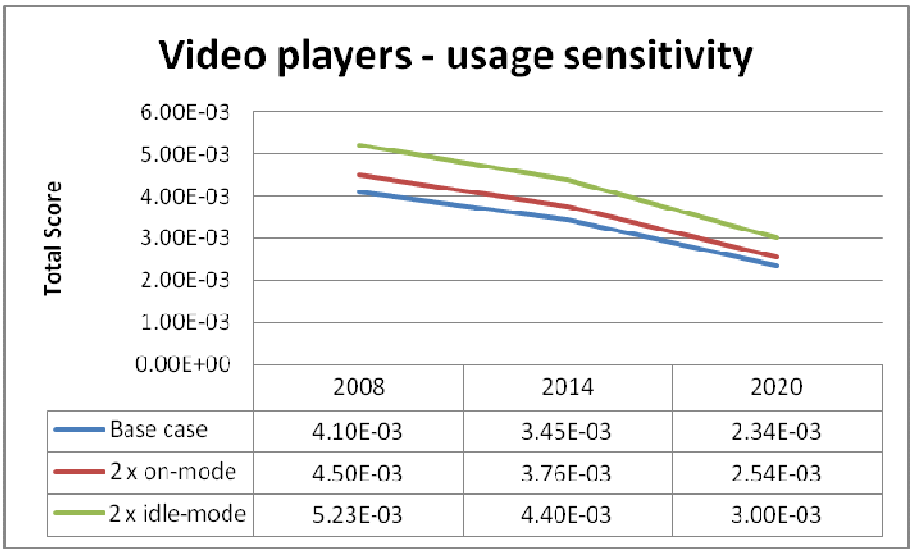


Games consoles – sensitivity analysis

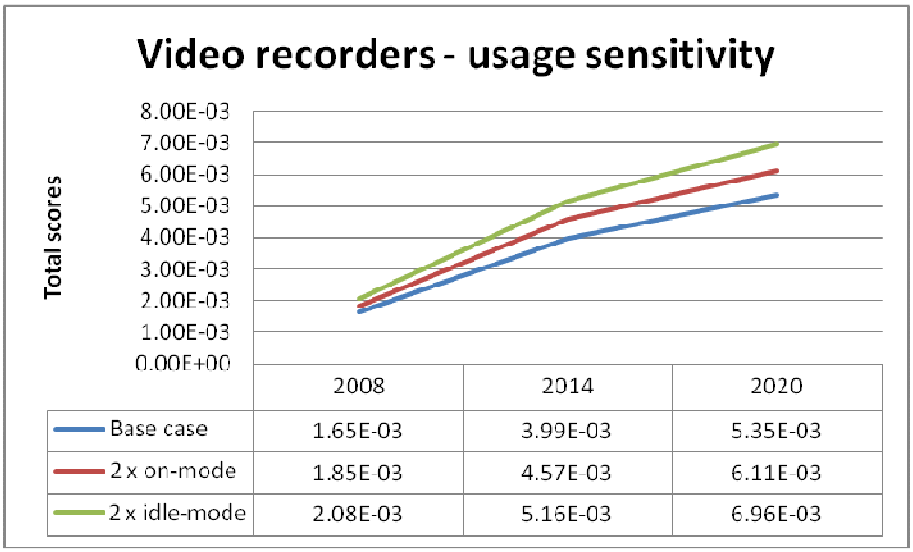




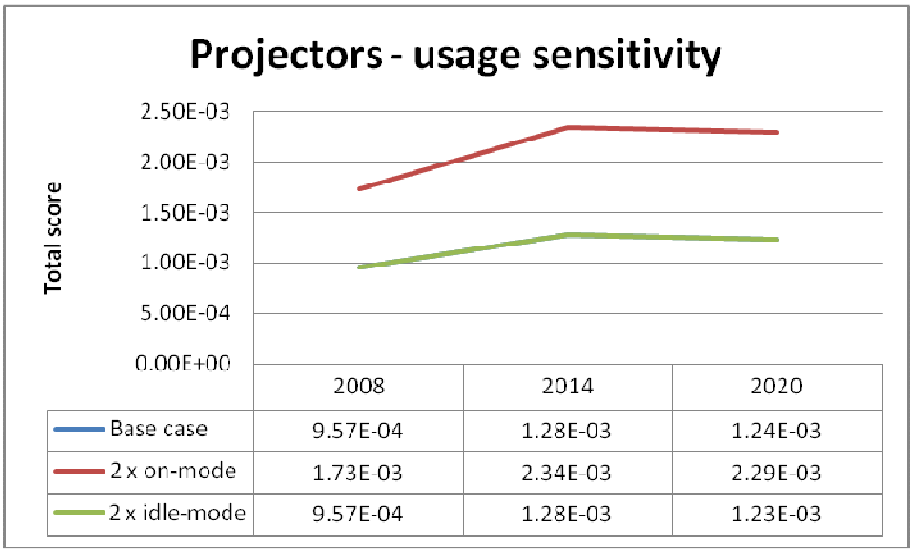
Sensitivity to Usage Pattern



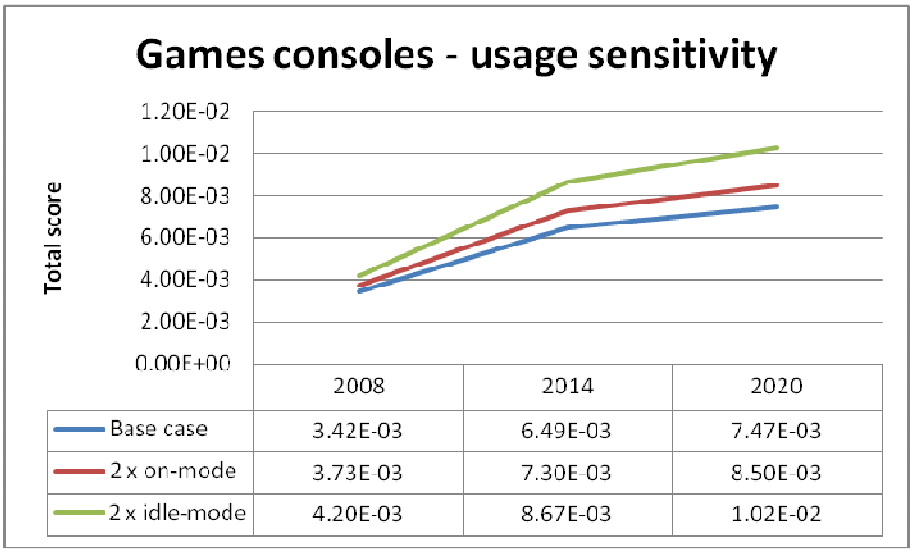
	2008	2008	2008	2014	2014	2014	2020	2020	2020
	BC	2 x on	2 x idle	BC	2 x on	2 x idle	BC	2 x on	2 x idle
Materials	1.75E-04	1.75E-04	1.75E-04	1.75E-04	1.35E-04	1.35E-04	1.35E-04	8.17E-05	8.17E-05
Total Energy (GER)	6.43E-04	7.16E-04	8.49E-04	5.40E-04	6.05E-04	7.21E-04	3.69E-04	4.15E-04	4.99E-04
of which, electricity	1.20E-03	1.38E-03	1.71E-03	1.04E-03	1.20E-03	1.49E-03	7.34E-04	8.50E-04	1.06E-03
Water (process)*	1.76E-05	1.90E-05	2.17E-05	1.44E-05	1.57E-05	1.81E-05	9.57E-06	1.05E-05	1.22E-05
Waste, non-haz./ landfill*	6.13E-05	6.35E-05	6.73E-05	4.85E-05	5.04E-05	5.38E-05	3.05E-05	3.18E-05	3.43E-05
Waste, hazardous/ incinerated*	1.28E-04	1.29E-04	1.32E-04	9.94E-05	1.01E-04	1.03E-04	6.05E-05	6.14E-05	6.31E-05
Emissions (Air)									
Greenhouse Gases in GWP100	4.79E-04	5.26E-04	6.11E-04	3.98E-04	4.39E-04	5.14E-04	2.68E-04	2.97E-04	3.51E-04
Acidifying agents (AP)	1.85E-03	2.04E-03	2.38E-03	1.54E-03	1.71E-03	2.01E-03	1.04E-03	1.16E-03	1.38E-03
Volatile Org. Compounds (VOC)	1.05E-05	1.08E-05	1.12E-05	8.26E-06	8.46E-06	8.83E-06	5.10E-06	5.25E-06	5.51E-06
Persistent Org. Pollutants (POP)	2.09E-04	2.15E-04	2.26E-04	1.64E-04	1.70E-04	1.80E-04	1.03E-04	1.07E-04	1.14E-04
Heavy Metals (HM)	2.27E-08	2.34E-08	2.48E-08	1.79E-08	1.86E-08	1.98E-08	1.12E-08	1.17E-08	1.26E-08
PAHs	2.08E-05	2.11E-05	2.18E-05	1.62E-05	1.65E-05	1.71E-05	9.96E-06	1.02E-05	1.06E-05
Particulate Matter (PM, dust)	3.20E-04	3.22E-04	3.25E-04	2.47E-04	2.49E-04	2.51E-04	1.49E-04	1.50E-04	1.52E-04
Emissions (Water)									
Heavy Metals (HM)	1.77E-05	1.85E-05	2.00E-05	1.42E-05	1.49E-05	1.62E-05	9.01E-06	9.53E-06	1.05E-05
Eutrophication (EP)	6.06E-12	6.07E-12	6.10E-12	4.67E-12	4.69E-12	4.71E-12	2.82E-12	2.83E-12	2.84E-12
Total scores:	4.10E-03	4.50E-03	5.23E-03	3.45E-03	3.76E-03	4.40E-03	2.34E-03	2.54E-03	3.00E-03
% of Base Case	100%	110%	127%	100%	109%	128%	100%	109%	128%



	2008	2008	2008	2014	2014	2014	2020	2020	2020
	BC	2 x on	2 x idle	BC	2 x on	2 x idle	BC	2 x on	2 x idle
Materials	5.07E-05	5.07E-05	5.07E-05	5.07E-05	1.07E-04	1.07E-04	1.07E-04	1.07E-04	1.07E-04
Total Energy (GER)	2.70E-04	3.07E-04	3.48E-04	6.73E-04	7.69E-04	8.77E-04	9.12E-04	1.05E-03	1.21E-03
of which, electricity	5.56E-04	6.49E-04	7.51E-04	1.43E-03	1.67E-03	1.94E-03	2.03E-03	2.37E-03	2.76E-03
Water (process)*	6.78E-06	7.52E-06	8.35E-06	1.64E-05	1.83E-05	2.05E-05	2.12E-05	2.40E-05	2.71E-05
Waste, non-haz./ landfill*	2.03E-05	2.14E-05	2.26E-05	4.58E-05	4.87E-05	5.18E-05	5.29E-05	5.70E-05	6.15E-05
Waste, hazardous/ incinerated*	3.89E-05	3.97E-05	4.04E-05	8.40E-05	8.59E-05	8.80E-05	8.88E-05	9.15E-05	9.45E-05
Emissions (Air)									
Greenhouse Gases in GWP100	1.93E-04	2.17E-04	2.43E-04	4.73E-04	5.35E-04	6.04E-04	6.27E-04	7.17E-04	8.17E-04
Acidifying agents (AP)	7.53E-04	8.49E-04	9.54E-04	1.85E-03	2.10E-03	2.38E-03	2.47E-03	2.83E-03	3.23E-03
Volatile Org. Compounds (VOC)	3.34E-06	3.45E-06	3.58E-06	7.36E-06	7.66E-06	7.99E-06	8.11E-06	8.55E-06	9.04E-06
Persistent Org. Pollutants (POP)	6.79E-05	7.11E-05	7.46E-05	1.52E-04	1.60E-04	1.69E-04	1.73E-04	1.84E-04	1.98E-04
Heavy Metals (HM)	7.48E-09	7.87E-09	8.30E-09	1.69E-08	1.79E-08	1.90E-08	1.94E-08	2.09E-08	2.25E-08
PAHs	6.46E-06	6.63E-06	6.83E-06	1.41E-05	1.46E-05	1.51E-05	1.53E-05	1.59E-05	1.67E-05
Particulate Matter (PM, dust)	9.53E-05	9.62E-05	9.71E-05	2.03E-04	2.05E-04	2.08E-04	2.08E-04	2.12E-04	2.15E-04
Emissions (Water)									
Heavy Metals (HM)	6.10E-06	6.51E-06	6.97E-06	1.40E-05	1.51E-05	1.63E-05	1.67E-05	1.83E-05	2.00E-05
Eutrophication (EP)	1.78E-12	1.79E-12	1.80E-12	3.77E-12	3.79E-12	3.81E-12	3.83E-12	3.85E-12	3.88E-12
Score:	**1.65E-03**	**1.85E-03**	**2.08E-03**	**3.99E-03**	**4.57E-03**	**5.16E-03**	**5.35E-03**	**6.11E-03**	**6.96E-03**
% of Base case	**100%**	**112%**	**126%**	**100%**	**115%**	**129%**	**100%**	**114%**	**130%**



	2008	2008	2008	2014	2014	2014	2020	2020	2020
	BC	2 x on	2 x idle	BC	2 x on	2 x idle	BC	2 x on	2 x idle
Materials	1.97E-05	1.97E-05	1.97E-05	1.97E-05	2.25E-05	2.25E-05	2.25E-05	1.69E-05	1.69E-05
Total Energy (GER)	1.62E-04	3.04E-04	1.62E-04	2.20E-04	4.13E-04	2.20E-04	2.14E-04	4.08E-04	2.14E-04
of which, electricity	3.60E-04	7.12E-04	3.60E-04	4.94E-04	9.78E-04	4.94E-04	4.92E-04	9.76E-04	4.92E-04
Water (process)*	3.70E-06	6.54E-06	3.70E-06	4.93E-06	8.83E-06	4.93E-06	4.69E-06	8.59E-06	4.69E-06
Waste, non-haz./ landfill*	1.02E-05	1.43E-05	1.02E-05	1.29E-05	1.85E-05	1.29E-05	1.12E-05	1.69E-05	1.12E-05
Waste, hazardous/ incinerated*	2.70E-05	2.97E-05	2.70E-05	3.26E-05	3.64E-05	3.26E-05	2.58E-05	2.96E-05	2.58E-05
Emissions (Air)									
Greenhouse Gases in GWP100	1.10E-04	2.00E-04	1.10E-04	1.47E-04	2.72E-04	1.47E-04	1.42E-04	2.67E-04	1.42E-04
Acidifying agents (AP)	4.36E-04	8.00E-04	4.36E-04	5.87E-04	1.09E-03	5.87E-04	5.67E-04	1.07E-03	5.67E-04
Volatile Org. Compounds (VOC)	1.47E-06	1.91E-06	1.47E-06	1.83E-06	2.44E-06	1.83E-06	1.54E-06	2.15E-06	1.54E-06
Persistent Org. Pollutants (POP)	2.39E-05	3.59E-05	2.39E-05	3.07E-05	4.72E-05	3.07E-05	2.74E-05	4.39E-05	2.74E-05
Heavy Metals (HM)	3.02E-09	4.51E-09	3.02E-09	3.87E-09	5.91E-09	3.87E-09	3.44E-09	5.48E-09	3.44E-09
PAHs	3.58E-06	4.26E-06	3.58E-06	4.39E-06	5.32E-06	4.39E-06	3.58E-06	4.51E-06	3.58E-06
Particulate Matter (PM, dust)	3.84E-05	4.16E-05	3.84E-05	4.62E-05	5.06E-05	4.62E-05	3.63E-05	4.07E-05	3.63E-05
Emissions (Water)									
Heavy Metals (HM)	3.43E-06	5.01E-06	3.43E-06	4.37E-06	6.55E-06	4.37E-06	3.86E-06	6.03E-06	3.86E-06
Eutrophication (EP)	8.27E-13	8.52E-13	8.27E-13	9.88E-13	1.02E-12	9.88E-13	7.64E-13	7.98E-13	7.64E-13
Score:	**9.57E-04**	**1.73E-03**	**9.57E-04**	**1.28E-03**	**2.34E-03**	**1.28E-03**	**1.24E-03**	**2.29E-03**	**1.23E-03**
% of Base Case	**100%**	**181%**	**100%**	**100%**	**183%**	**100%**	**100%**	**185%**	**100%**



	2008	2008	2008	2014	2014	2014	2020	2020	2020
	BC	2 x on	2 x idle	BC	2 x on	2 x idle	BC	2 x on	2 x idle
Materials	1.90E-04	1.90E-04	1.90E-04	3.72E-04	2.45E-04	2.45E-04	3.90E-04	2.47E-04	2.47E-04
Total Energy (GER)	4.97E-04	5.56E-04	6.43E-04	1.00E-03	1.17E-03	1.42E-03	1.18E-03	1.39E-03	1.71E-03
of which, electricity	7.71E-04	9.19E-04	1.14E-03	1.90E-03	2.32E-03	2.95E-03	2.33E-03	2.87E-03	3.66E-03
Water (process)*	2.56E-05	2.68E-05	2.85E-05	4.03E-05	4.38E-05	4.88E-05	4.39E-05	4.82E-05	5.46E-05
Waste, non-haz./ landfill*	6.32E-05	6.02E-05	6.27E-05	8.58E-05	9.08E-05	9.82E-05	9.10E-05	9.74E-05	1.07E-04
Waste, hazardous/ incinerated*	1.12E-04	1.14E-04	1.15E-04	1.52E-04	1.55E-04	1.60E-04	1.55E-04	1.59E-04	1.65E-04
Emissions (Air)									
Greenhouse Gases in GWP100	3.97E-04	4.35E-04	4.91E-04	7.44E-04	8.54E-04	1.02E-03	8.57E-04	9.96E-04	1.20E-03
Acidifying agents (AP)	7.26E-04	7.82E-04	8.81E-04	1.33E-03	1.53E-03	1.81E-03	1.53E-03	1.78E-03	2.14E-03
Volatile Org. Compounds (VOC)	1.32E-05	1.34E-05	1.37E-05	1.82E-05	1.87E-05	1.95E-05	1.87E-05	1.94E-05	2.04E-05
Persistent Org. Pollutants (POP)	1.39E-04	1.43E-04	1.51E-04	2.09E-04	2.23E-04	2.44E-04	2.24E-04	2.42E-04	2.69E-04
Heavy Metals (HM)	2.18E-08	2.21E-08	2.30E-08	3.14E-08	3.32E-08	3.58E-08	3.33E-08	3.55E-08	3.89E-08
PAHs	5.56E-05	5.58E-05	5.62E-05	7.33E-05	7.42E-05	7.54E-05	7.44E-05	7.54E-05	7.70E-05
Particulate Matter (PM, dust)	3.46E-04	3.47E-04	3.49E-04	4.52E-04	4.56E-04	4.61E-04	4.56E-04	4.61E-04	4.68E-04
Emissions (Water)									
Heavy Metals (HM)	8.59E-05	8.51E-05	8.61E-05	1.13E-04	1.15E-04	1.18E-04	1.15E-04	1.18E-04	1.21E-04
Eutrophication (EP)	6.65E-12	6.68E-12	6.69E-12	8.65E-12	8.68E-12	8.72E-12	8.70E-12	8.74E-12	8.80E-12
Score:	3.42E-03	3.73E-03	4.20E-03	6.49E-03	7.30E-03	8.67E-03	7.47E-03	8.50E-03	1.02E-02
% of Base Case	100%	109%	123%	100%	112%	134%	100%	114%	137%

Appendix 4

ECMA The Environment Declaration Pro-Forma

ECMA-370-Annex-B.pdf

Appendix 5

Japanese ECO MARK English Translation.


145ec1.pdf

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