

Topten Product Criteria Paper on

DVD-Recorder, DVD-Player and Blu-ray Disc-Player

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The Project in brief

Topten is part of the international Euro-Topten initiative supported by the European programme Intelligent Energy Europe and several national institutions (energy agencies, WWF, consumer associations, research institutes). On global level Topten is coordinated by TIG, the Topten International Group. The organisation adheres to the Topten Charter, TIG statutes and TIG Rules of Procedure (www.topten.info).

Topten is a service that supports the market for energy efficient products. It aims at making energy efficient products the first choice for consumers, by offering them a user friendly tool for product comparison and selection. The key element is an online information platform for consumers presenting the most energy efficient appliances currently available in various product categories, including household appliances, office equipment, consumer electronics and cars. Information on energy consumption and performance of products as well as several other characteristics (i.e. brand, model, price, picture) is provided. Product data is based on labels and standardized declarations as well as tests from accepted well known institutions. The service is independent of manufacturers and retailers.

Consortium

The project is co-ordinated by the Agence de l'Environnement et de la Maitrise de l'Energie (ADEME). The 19 project partners are:

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Austria: Austrian Energy Agency (A.E.A.)	AT
Belgium: World Wide Fund for Nature – vzw/asbl	BE
Belgium: WWF European Policy Office	BE
Czech Republic: SEVEn, o.p.s	CZ
Finland: Motiva Oy	FI
France: WWF Fonds Mondial pour la Nature	FR
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Portugal: Quercus	PT
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Criteria Paper for DVD-Recorder, DVD-Player and Blu-ray Disc-Player

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1 Introduction

The criteria papers provide a central tool for the Euro-Topten partners to collect and analyse product data and establish a national Topten selection. Appropriate selection criteria and respective technical specifications are a crucial precondition for meaningful and well-accepted Topten websites. The purpose of this criteria paper is to provide a common basis for the definition of technical specifications. Obviously, the range of products differs significantly in terms of price level, configuration and energy consumption. Furthermore, differences also exist in purchasing power and behavioural aspects of people across European countries. .

Within the European wide Topten project, the aim is to develop an aligned approach for technical specifications for all national Topten websites. A high level of uniformity and congruency of the different national websites will enhance the awareness amongst manufacturers. Good quality data at national level furthermore allows to analyse the situation at European level and make policy recommendations, which are shown on www.topten.info.

This paper contains the product specification for Topten DVD-Recorder, DVD-Player and Blu-ray Disc-Player. Across Europe, a stock of about 174 million DVD and Blu-ray players and recorders existed in the private households 2008 (IVF 2009). If the energy consumption requirements, as listed in the Topten project, are followed and the stock of 174 million DVD and blu-ray products is replaced with Topten products, annual energy savings of about 60 to 70% could be achieved. In absolute terms, it would mean annual energy savings of about 50 kWh per product and about 8.6 billion kWh (8.6 TWh) across Europe. This implies a reduction potential of about 4.4 billion kg CO₂ eq. per year¹.

A product should meet all criteria described in Chapter 4 in order to be listed on www.topten.info as a Best Available Technology. In an ideal situation, criteria are based on international or European standards. However, in some cases, widely accepted and strictly defined standards are missing – (e.g. for products in the segment consumer electronics). Within the methodology of WP3, it was intended to use the implementation measures of the Ecodesign directive as a basis for the criteria definition. Currently, the preparatory study for Lot 3 Sound and Imaging Equipment, which includes DVD-Recorder, DVD-Player and Blu-ray Disc-Player, is being conducted. However, at the time of the inception of this report, the preparatory study has not been completed. Therefore, the information in this criteria paper is only partially availed from the ongoing preparatory study. This criteria paper is largely based on the study of the Öko-Institut (2009) “PROSA – DVD-Recorder, DVD-Player and Blu-ray Disc-Player -

¹ Calculations based on the energy consumption data presented in Prakash et al. (2009): PROSA – DVD-Recorder, DVD-Player and Blu-ray Disc Player – Developing the award criteria for a climate label, Öko-Institut, Freiburg 2009.

Data on electricity mix in EU-27 is based on GEMIS 4.5.

Developing the award criteria for a climate label². This study was done within the framework of developing award criteria for the German Blue Angel Label.

² Prakash, S.; Brommer, E.; Griebhammer, R.; Lüders, B. (2009). PROSA DVD-Recorders / Blu-ray-Players – Developing the award criteria for a climate label. Freiburg 2009. Commissioned by: German Environment Ministry (BMU), Berlin / Project Management Jülich

2 Product Specification

This chapter provides an overview of DVD-Recorder, DVD-Player and Blu-ray Disc-Player. It also gives a technical analysis of the product and explains EU and national relevant product and test standards.

2.1 Product Definition

The California Energy Commission³ uses three definitions to describe DVD-devices meant to decode, produce and record (digitized) video signals:

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 function⁴.
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.

In this classification, the recent development in the optical format towards Blu-ray technology is missing. Blu-ray is a rather recent optical format with a storage capacity (27 GB) which is 6 times higher than that of a DVD, and 34 times higher than that of a CD. Such a storage capacity is sufficient to record 2 hours of film in HDTV-format. Blu-ray Discs can only be used with the Blu-ray Disc-Players. In order to write and read the data, Blu-ray Disc-Players make use of a blue-violet laser (Blu-ray). It has a shorter wavelength (405 nm) than that of a red laser (650 nm) used in standard DVDs. Furthermore, Blu-ray burners also possess an extra red laser in order to read and burn CDs and DVDs. A big advantage of Blu-ray Discs lies in its ability to show finer picture details and provide a larger number of sound formats that generally available in DVDs. Thus, in line with the definitions above, a Blu-ray Disc-Player can be defined as follows:

³ CEC reference [(2007) 2007 Appliance efficiency regulations (revised) <http://www.energy.ca.gov/2007publications/CEC-400-2007-016/CEC-400-2007-016-REV1.PDF>

⁴ “Electronic programming guide (EPG)” means an application that provides an interactive, onscreen menu of TV listings, and that downloads programme information from the vertical blanking interval of a regular TV signal.

4. “Blu-ray Disc-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 Blu-ray or a DVD”.

However, this approach could create a very large number of definitions as new products enter the market with new features or combine existing features. Thus, it is important to differentiate the products under focus of this criteria paper from similar products, such as Set-Top Boxes, Home Cinema System (with speakers) and Portable DVD Player. In line with the recent development of ENERGY STAR Version 2.0 Program Requirements for Audio/Video⁵, following products should be excluded from the scope of this criteria paper:

- 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

Furthermore, home cinema systems can be identified by the ability to be connected directly to speakers because they have an integrated amplifier. This can greatly increase the power consumption and has more in common with other types of audio

⁵ <https://www.energystar.gov/ia/downloads/AV%20Final%20Draft%20v2%20Specification.pdf>

amplifiers and receivers. Therefore, devices with an integrated audio amplifier are excluded from the scope of this criteria paper.

Thus, this criteria paper defines DVD-Recorder, DVD-Player and Blu-ray Disc-Player as stand-alone devices which:

- a) decode 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
- b) have no tuner unless it records on a removable media in a standard library format
- c) are primarily mains powered
- d) do not have a display for viewing video
- e) lack an integrated audio amplifier
- f) are not designed for a broad range of home or office applications

2.2 Product Types

As mentioned in the previous chapter, the video devices can be differentiated according to their ability to decode, produce and record digitized video signals. Devices whose sole purpose is decryption and decoding of digitized video signals on a removable media are covered by DVD-Player and Blu-ray Disc-Player, depending upon which removable media is used. Devices whose sole purpose is the production or recording of digitized video signals on a DVD are covered by DVD-Recorders without Hard Disc Drive (HDD). And finally, devices which can record video signals onto a hard disk drive, are covered by DVD-Recorders with HDD.

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.

In the following, a list of features and functions defining a DVD/ Blu-ray Player/ Recorder are presented:

- 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 eg 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)
- Battery (optional)
- Switching and distribution (optional)
- Input (optional)
- (Tuner to decode broadcast video signals, including IPTV if there is also recording to removable library media)

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. Furthermore, DVD-Recorders (with HDD) have the ability to edit / delete advertisements from the recordings. In some recorders, the so called capital marks can be set at the end of each recording to facilitate the skipping of advertisements while watching the recording later on. Additionally, the recorders have a function with which recorded programmes can be brought exactly to their true start and true end, while deleting the unnecessary extended recording. Some DVD-Recorders (with HDD) record a programme automatically after being switched-on. The automatic recording is, however, not saved automatically on HDD, and has to be archived with the help of an extra command before switching-off the device. In some recorders, it is possible to deactivate the function of automatic recording.

The storage capacity of DVD recorders (with HDD) depends on the quality of recordings. In larger HDDs (400 GB), the storage capacity lies at 90 hours for high quality recordings, and 710 hours for low quality recordings (test 2/2008). In medium-sized HDDs (250 GB), the storage capacity for high quality recordings lies between 36 – 67 hours, and for low quality recordings between 355 – 729 hours (test 2/2008). Small-sized HDDs (160 GB) have storage capacity of 35 – 40 hours for high quality recordings, and 280 hours for low quality recordings (test 2/2008). Some DVD-Recorders have the ability to adapt the quality of the recordings and with it the storage requirement according to the available storage capacity.

Furthermore, there is an increasing number of DVD-Recorders (with HDD) in the market with integrated Tuner. Apart from analogue tuners for cable and antennae TV, DVD-Recorders are also equipped with digital tuners. With the help of an integrated digital tuner, it is possible to receive digital terrestrial TV (DVB-T). Thus, consumers do not have to buy an extra tuner in order to receive DVB-T. Furthermore, there is until now only one DVD-Recorder in the market which is equipped with digital satellite receiver (DVB-S) (Prakash et al. 2009). Finally, some DVD-Recorders possess two HD digital tuners, which helps in recording two different programmes in HD quality at the same time.

DVD-Recorders, DVD-Player and Blu-ray Disc-Player possess, apart from an analogue scart connection, also HDMI⁶-connection points. With this, digital data stored on DVDs/ Blu-ray Disks can be transferred directly to projectors, LCD and Plasma TV without leading to a loss in picture quality related to the transformation in analogue signal. Alternatively, there are also DVI-connection points (Digital Visual Interface), which can transfer analogue as well as digital data. DVI-connection points can be differentiated into DVI-D (only digital data is transferred), DVI-I (both analogue and digital data is transferred) and DVI-A (only analogue data is transferred, rare to find). DVI and HDMI are compatible with each other, so that, for example, to connect a TV with DVI-connection point with a DVD-Player with a HDMI-connection point.

DVD-Recorders, DVD-Player and Blu-ray Disc-Player can also be used to show photographs, and to listen to music (traditionally possible only with CD-Players). Furthermore, many devices have a so called MP3 ripping function that enables to record the music data in MP3-format on an USB-stick, while simultaneously listening to a music CD. The devices can also be used to play music or data from an USB-stick or SD-cards.

The recent technological development in the form of Blu-ray Disc-Players provides more features and functions, such as Video-On-Demand and BD Live (downloading trailers, sub-titles etc from the internet). Some High-end Blu-ray Disc-Players possess two HDMI-output sources in order to transfer picture and sound data separately. The

⁶ High Definition Multimedia Interface

two output sources can also be used, for instance, to connect to a TV and a projector at the same time.

2.3 Best Available Technology

Apart from several aspects discussed in the previous chapter, it is important to perceive the role of Best Available Technology in terms of lower energy consumption. One of the most important points in this context is the ability of a device to auto power down (APD)⁷ to standby-mode with low power consumption. In the current version of ENERGY STAR Version 2.0 Program Requirements for Audio/ Video, the requirement for an Auto Power Down function is mandatory.

The aspect of Auto Power Down in terms of reducing the total time spent in high energy consumption modes, is not only related to the ON-Mode, but also to the so called “Quick Start Mode” which is available in DVD-Recorders and Blu-ray Disc-Players. The basic purpose of the “Quick Start Mode” is to reduce the reactivation time of the device. Generally, DVD-Recorders and Blu-ray Disc-Player require between 30-60 seconds reactivation time, which is considered to be too long by consumers. Therefore, it is assumed that a majority of consumers would prefer to select “Quick Start Mode” for comfort as the reactivation times is reduced to mere 3 – 5 seconds. However, power consumption in a “Quick Start Mode” is extremely high if compared to normal low power standby. The power consumption of DVD-Recorders and Blu-ray Disc-Players in this mode ranges between 7 to 14 watts (Prakash et al. 2009). Prakash et al. (2009) calculated that in absence of an Auto Power Down function, energy consumption of DVD-Recorders and Blu-ray Disc-Players increases almost two to three times if “Quick Start Mode” is used instead to low power standby.

In few devices, the customer is informed during the first configuration after the purchase that selection of the “Quick Start Mode” implies a much higher energy

⁷ According to the ENERGY STAR Version 2.0 Program Requirements for Audio/ Video, Auto Power Down can be defined as: „the capability to automatically switch a device from On mode to Sleep mode after a predetermined period of time (APD timing) has elapsed. APD timing begins when the following criteria have been met: (1) the device has ceased performance of all primary functions, or (2) the last user input has been received (e.g., remote control signal, volume adjustment).

Primary function is defined by the same ENERGY STAR document as: „a primary function is any discrete, dynamic device function that can be perceived by an end-user. The delivery of active audio/video content to an end user is considered a primary function.

1) Continuous device functions (e.g. clocks, status displays, indicator lamps) are not primary functions.

2) Static device functions are not considered to be primary functions. Static functions include, but are not limited to:

- i) No active audio or video processing or output
- ii) Playback paused or stopped
- iii) No optical disc media in disc drive
- iv) System waiting in disc menu or other menu for user input

consumption than normal standby. In the specifications of the German Blue Angel Label (www.blauer-engel.de), the manufacturers have to fulfill not only the requirement of Auto Power Down (after 4 hours of user inactivity) and provision of energy consumption information while selecting “Quick Start Mode”, but they are also required to provide exact power consumption values in wattss for “Quick Start Mode” and normal low power standby during first configuration. This requirement is, however, only valid for DVD-Recorders. Blu-ray Disc-Players with the function of “Quick Start Mode” have been left out of the scope of the German Blue Angel Label.

2.4 Current Energy Efficiency Criteria

At the EU level, the development of ecodesign requirements for different types of sound and imaging equipment are under progress (Lot 3, Sound & Imaging Equipment: www.ecomultimedia.org). The category sound and imaging equipment is seperated into four product groups: (1) Video players/ recorders, (2) Projector/ beamer, (3) Games machines, and (4) Digital picture frames. The product group video players/ recorders encompasses DVD-Recorder, DVD-Player and Blu-ray Disc-Player.

2.5 Legislations and Labels

2.5.1 European legislation

The following four European legislations are relevant for DVD-Recorders, DVD Players and Blu-ray Disc-Players.

- Directive 2002/96EC (WEEE) - Waste Electrical and Electronic Equipment Directive
- Directive 2002/95/EC (RoHS) - Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment
- Low Voltage Directive (LVD) 2006/95/EC
- Electromagnetic (EMC) Directive 2004/108/EC
- Commission Regulation 278/2009 implementing Directive 2005/32/EC. Ecodesign requirements for external power supplies (EPS)
- Commission Regulation 1275/2008 implementing Directive 2005/32/EC. Ecodesign requirements for standby and off mode electric power consumption of electrical and electronic household and office equipment.

The last regulation applies to the standby and off mode power consumption of electrical and electronic household and office equipment. It sets maximum power consump-

tion allowances depending on the functions enabled while in standby and off-mode. The regulation will come into effect in 2010, and is made stricter 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:
 - conditions providing only an indication of off-mode condition;
 - 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 table below shows the power consumption requirements of Commission Regulation 1275/2008 implementing Directive 2005/32/EC for standby and off mode:

Table 1 Requirements for 2010 and 2013

	Off-mode [W]	Standby mode [W]	Standby mode with information display [W]
2010	1,00	1,00	2,00
2013	0,50	0,50	1,00

2.5.2 International Labelling Programs

The following table illustrates the international label programmes for energy efficient DVD Players/Recorders and Blu-ray Players with their scope and respective requirements.

Table 2 National programmes for DVD Players, DVD Recorders and Blu-ray Players

Country	Program	Scope	Type	Requirements				
				On [W]	Standby [W]	Auto Power Down	Off Switch	other
Korea	Ecolabel	DVD player/recorder	voluntary	15	3		Has to be attached if consumption power is maintained with more than 1 W or standby mode is continued more than 30 min	Chemical substances
Scandinavia	Nordic Swan	DVD / Blu-ray players	voluntary	15	2		Hard or soft on-off-switch	Hazardous substances
Germany	Blue Angel	DVD recoder with HDD	voluntary	25	0,5; 2 with Timer programming	Yes, 4 hours after user inactivity		Quickstart mamimum 5 sec; maximum power consumption in Quick Start 9 W
Germany	Blue Angel	DVD recorder without HDD	voluntary	22	0,5; 2 with Timer programming	Yes, 4 hours after user inactivity		Quickstart mamimum 5 sec; maximum power consumption in Quick Start 9 W
Germany	Blue Angel	DVD player	voluntary	8	0,5	Yes, 4 hours after user inactivity		
Germany	Blue Angel	Blu-ray player	voluntary	20	0,5	Yes, 4 hours after user inactivity		Quickstart mamimum 5 sec; maximum power consumption in Quick Start 9 W
California	California Energy Commission (CEC)	DVD players and recorders	mandatory		3			

The final version of ENERGY STAR Version 2.0 Program Requirements for Audio/Video specifies following threshold values for ON and sleep modes⁸:

Product Function	Sleep Mode Power Consumption Limits (W)			
	Tier 1 Consumer AV Products	Tier 1 All Other Products	Tier 2 All Products	Tier 3 All Products
Base (All Products)	N/A	1.0		
In-use Networking / Control Protocol (Wake / Sleep Capability Only)	N/A	2.0	1.0	

Figure 1 ENERGY STAR v2.0 Sleep mode power consumption limits⁹

Product Function	On Mode Power Consumption Limits (W)			
	Tier 1 Consumer AV Products	Tier 1 All Other Products	Tier 2 All Products	Tier 3 All Products
High Resolution Display (> 480x234 pixel resolution and 5 inches diagonal screen size)	N/A	$P = 6*(R) + 0.05*(A) + 3$ Where: <i>R</i> = Display resolution (x * y) in megapixels <i>A</i> = Viewable screen area in square inches		
In-use Networking / Control Protocol	N/A	2.0	1.0	
Standard Definition (SD) Source Optical Disc Player/Recorder	N/A	6.0 (Playback) 16 (Recording)	TBD	

⁸ Sleep mode according to Energy Star v2.0: The common term “standby” may also describe this mode, where the product is connected to a mains power source, is not providing a primary function, and offers one or more of the following user oriented or protective functions which may persist for an indefinite time.: i) to facilitate the activation of other modes (including activation or deactivation of On mode) by remote switch (including remote control), internal sensor, timer; ii) continuous function: information or status displays including clocks; iii) continuous function: sensor-based functions.

For purposes of this specification, Sleep Mode is defined as the time when the product is connected to a power source, produces neither sound nor picture, neither transmits nor receives program information and/or data (excluding data transmitted to change the unit’s condition from Sleep Mode to On Mode), and is waiting to be switched to On Mode by a direct or indirect signal from the consumer (e.g., with the remote control).

⁹ Tier 1 requirements are applicable until July 2010. From July 2010 onwards, Tier 2 requirements will be valid. The term „tier“ implies different (temporal) stages of Energy Star requirements. Generally, the requirements get stricter while passing from one tier to another.

Product Function	On Mode Power Consumption Limits (W)			
	Tier 1 Consumer AV Products	Tier 1 All Other Products	Tier 2 All Products	Tier 3 All Products
SD Source to HD Output "Upconversion" Optical Disc Player/Recorder	N/A	10 (Playback) 16 (Recording)		TBD
High Definition (HD) Source Optical Disc Player/Recorder	N/A	15 (Playback) 25 (Recording)		TBD

Figure 2 ENERGY STAR v2.0 On mode power consumption limits

Furthermore, all products must offer Auto Power Down (APD) functionality that is enabled by default to qualify for ENERGY STAR. The ENERGY STAR document states:

"[...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) and when the product ceases performance of all primary functions...]

1) $APD \leq 30$ minutes: This timing option is acceptable for use as a default setting. If APD timing is set to less than or equal to 30 minutes, products do not have to meet Idle state power consumption requirements.

2) $30 \text{ minutes} < APD < 2 \text{ hours}$: This timing option is acceptable for use as a default setting. If APD can be disabled, or if APD timing can be set to greater than 30 minutes, products must meet Idle state power consumption requirements.

3) $APD \geq 2 \text{ hours}$: 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".

The Top Runner programme in Japan does not set threshold values for power consumption in wattss, but rather sets limit in terms of annual energy consumption, which is based on a well-defined user behaviour over the year. The target values for annual energy consumption within the Top Runner programme are displayed in the figure below:

Non-DTB [Digital Terrestrial Broadcasting]-capable DVD recorders (Ones without built-in digital broadcasting receivers)

Category				Standard energy consumption efficiency or calculation formula
Attached recording device	Tuner and signal conversion function	Additional terminal	Category name	
Having HDD only	Basic specifications	Without digital network terminal	A	$E=0.02C+45$
		With digital network terminal	B	$E=0.02C+49$
	Having multiple tuners	Without digital network terminal	C	$E=0.02C+55$
		With digital network terminal	D	$E=0.02C+60$
	Having multiple MPEG encoders	Without digital network terminal	E	$E=0.02C+63$
		With digital network terminal	F	$E=0.02C+68$
Having VCR only	Basic specifications	Without digital network terminal	G	$E=39$
		With digital network terminal	H	$E=44$
	Having multiple tuners	Without digital network terminal	I	$E=39$
		With digital network terminal	J	$E=54$
	Basic specifications	Without digital network terminal	K	$E=0.02C+58$
		With digital network terminal	L	$E=0.02C+63$
Having both HDD and VCR	Having multiple tuners	Without digital network terminal	M	$E=0.02C+68$
		With digital network terminal	N	$E=0.02C+73$
	Having multiple MPEG encoders	Without digital network terminal	O	$E=0.02C+76$
		With digital network terminal	P	$E=0.02C+81$

Remarks

1. "Digital network terminal" means iLink, USB, LAN, and HDMI.
2. "E" and "C" represent the following numeric values.
 E: Standard energy consumption efficiency (kWh per year)
 C: HDD storage capacity (gigabytes)

DTB-Capable DVD Recorders (Ones with built-in digital broadcasting receivers)

Category				Standard energy consumption efficiency
Integrated Recording Device	HDD Recording Capacity	Additional Function(s)	Category name	
With HDD only	HDD recording capacity of below 500 GB	No additional function	a	58.1
		With one additional function	b	64.4
		With two or more additional functions	c	71.2
	HDD recording capacity of 500 GB or greater	No additional function	d	65.3
		With one additional function	e	71.7
		With two or more additional functions	f	78.4
With HDD and VCR	HDD recording capacity of below 500 GB	No additional function	g	65.0
		With one additional function	h	71.9
		With two or more additional functions	i	79.3
	HDD recording capacity of 500 GB or greater	No additional function	j	72.9
		With one additional function	k	79.8
		With two or more additional functions	l	87.2

Note : "Additional function" refers to simultaneous dual program recording function, iLink (DV terminal) or simultaneous encoding function.

Figure 3 Target values for Non-DTB-capable and DTB-capable DVD-recorders in Top Runner

2.6 Test Standards

The following standards are relevant for the assessment of the energy consumption of DVD-Recorders, DVD Player and Blu-ray Disc-Players.

EN/IEC 62301:2005. "Household Electrical Appliances - Measurement of Standby Power". This standard specifies methods of measurement of electrical power consumption in standby modes and other low power modes as applicable.

IEC 62087: 2008 / EN 62087:2003 “Methods of measurement for the power consumption of audio, video and related equipment”. This standard specifies methods of measurement for the power consumption of television sets, video recording equipment, Set Top Boxes, audio equipment and multi-function equipment.

It is suggested, as also proposed in the German Blue Angel label, that the test measurement methodology and conditions comply with the international standard IEC 62087.

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.

The product should be tested with the manufacturers default settings.

3 Economic and Market Analysis

3.1 Market and Stock data

According to the International Video Federation, the average DVD penetration in Western Europe¹⁰ rose from 78 % in 2007 to 81.3 % in 2008. In Central / Eastern Europe¹¹ the average penetration is rising as well, but on a lower level. It reached 54.3 % in 2008, up from 47.3 % in 2007 (Figure 4).

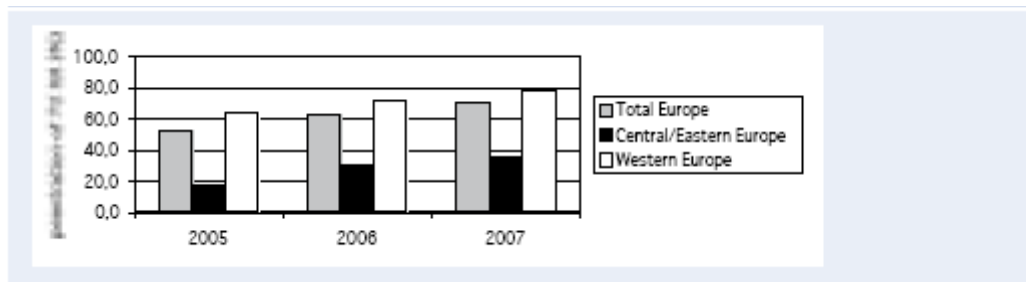


Figure 4 Penetration of DVD Video Players / Recorders in Europe 2005-2007 [IVF 2009]

Considering whole Europe, the DVD penetration reached 73.3 % in 2008 that can be translated into 173.2 million DVD households. This number represents 36 % of DVD households worldwide (Table 3).

Table 3 Video Market Europe [IVF 2009]

	2003	2004	2005	2006	2007	2008
Population [Mio]	488.15	486.60	491.58	493.22	494.79	496.33
Households [Mio]	197.77	199.22	200.57	201.78	203.00	204.13
TV households [Mio]	228.5	230.3	232.0	233.8	235.2	236.3
DVD Player/recorder HHs [Mio]	59.0	90.3	121.9	145.7	161.9	173.2
Blu-ray Disc stand-alone player HHs [Mio]	-	-	-	-	0.06	0.82

¹⁰ West Europe covers Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, UK.

¹¹ Central/Eastern Europe covers Croatia, Czech Republic, Hungary, Poland, Russia.

3.2 Growth and Trends

As visible in Figure 5, the share of the product segment DVD Player/Recorder decreased constantly from 11.9 to 8.7 % between 2004 and 2006 [Boyny 2006].

Share of Product Segments Total (Value %)

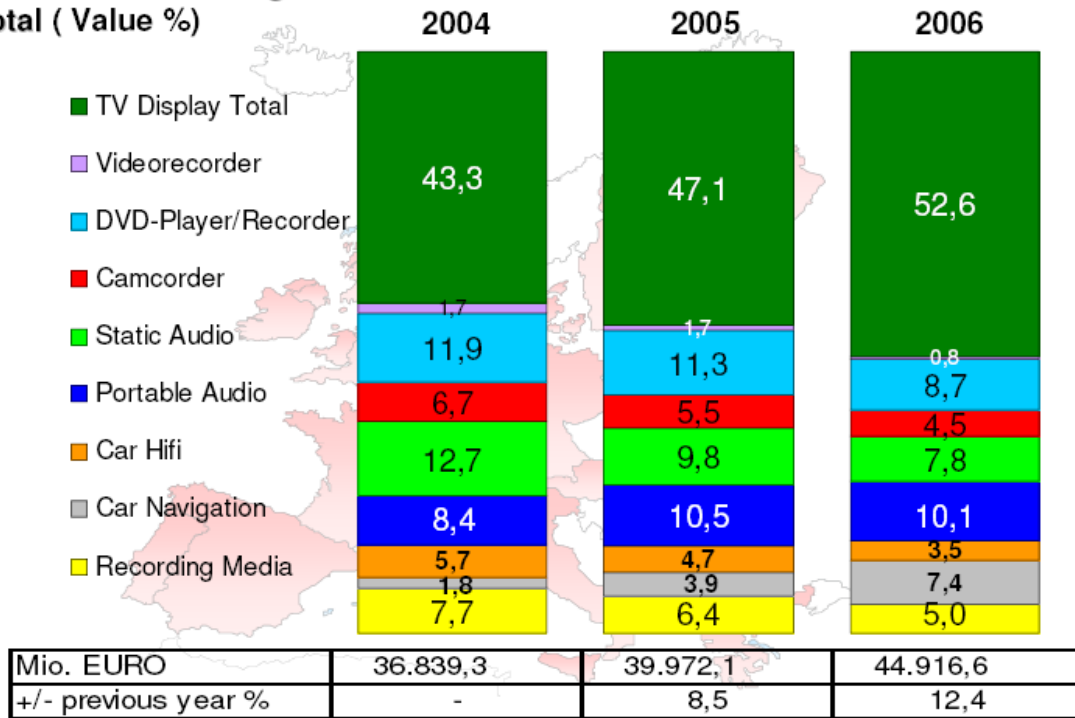


Figure 5 Share of DVD-Player/ Recorder [Boyny 2006]

In the following two years, i.e. 2007 and 2008, the downward trend continued. However, considering the whole consumer electronic market, the development was quite positive till 2007 (Figure 6).

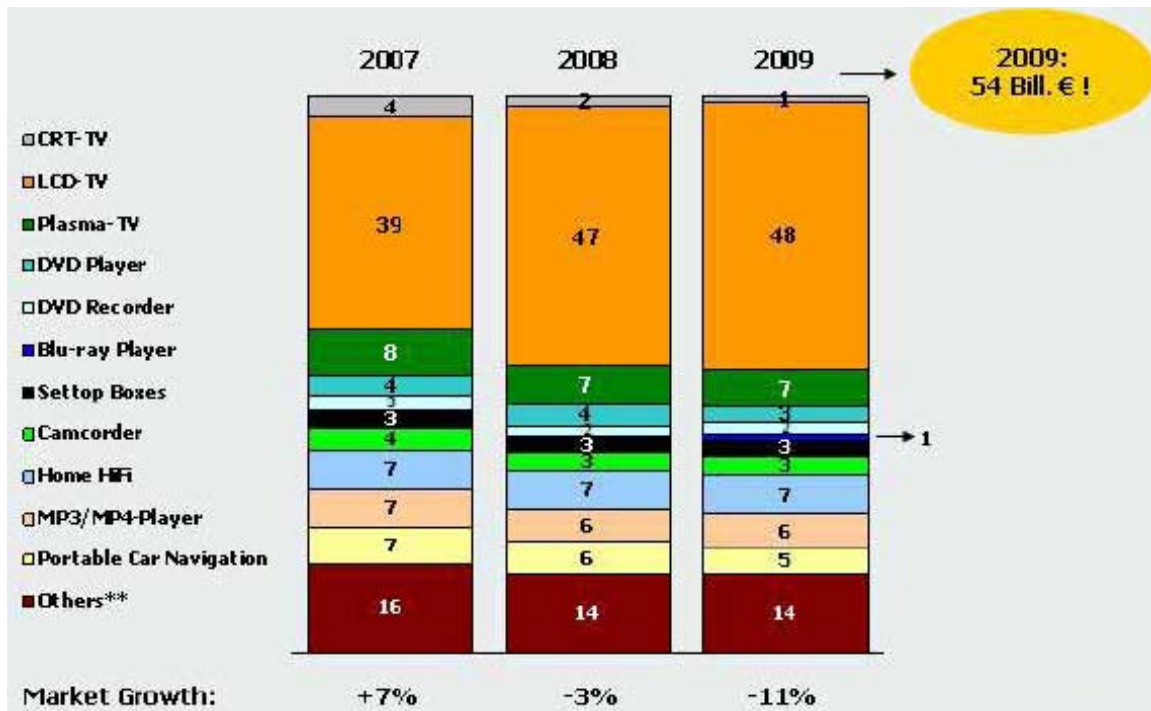


Figure 6 Share of the product segments of consumer electronics [GfK 2009]

However, EITO, the European Information Technology Observatory, assumes that in 2009 the market for consumer electronics will decrease by 8.7 % and in 2010 by 6.2 %. As illustrated in Figure 6, GfK forecasts a decrease of 11 % in market growth in 2009. However, EITO forecasts that Blu-ray Disc-Players will be one of the few growing segments: a growth of three-digit percentage in turnover is expected for 2009.

Figure 7 shows the product segment VIDEO which is composed of DVD and VCR-DVD Recorders, DVD and VCR-DVD Players and VCR. Between 2004 and 2006 the sales volume decreased from 4.989 to 4.075 Mio. Euro, whereas the percentage of the DVD Recorders expanded from 26.1 % to 48.4 %. In 2008 Blu-ray Players penetrated the market for the first time with a sales value of estimated 2.1 million pieces [Boyny 2006].

**Share of Product Segments
Video (Value %)**

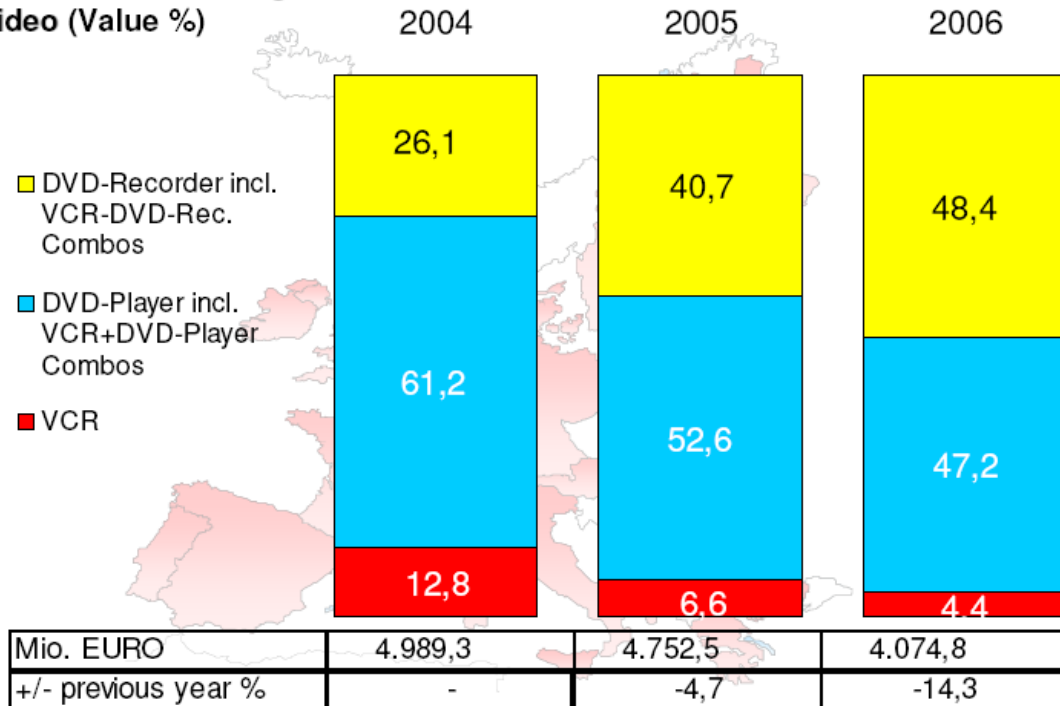


Figure 7 Share of the product segment Video [Boyny 2006]

Since 2005 DVD Recorders became increasingly popular in the European market. Their market share (DVD Recorders and VCR-DVD-Recorder Combos) increased from 26.1 % to 48.4 % between 2004 and 2006 as shown in

Figure 7. The sales volume of DVD-Recorders (Table 4) increased, especially between 2004 and 2006, from 2.9 million sold units to 6.5 million sold units. At the same time, the DVD Players became less significant as their annual sales decreased from 23.7 million units in 2005 to (estimated) 14.6 million units in 2008.

Table 4 Sales of DVD Players, DVD Recorders and Blu-ray Disc-Players in West Europe [Römerscheidt 2008]

Sales in West Europe [Thds. units]	2004	2005	2006	2007	2008 (estimated)
DVD Player	23,765	23,773	20,088	17,368	14,646
DVD Recorder	2,871	5,349	6,517	6,080	6,380
Blu-ray Player	0	0	4	98	553

The development of Blu-ray Disc-Players has been very positive. After market entry in 2006, the segment increased enormously. In 2006, the segment started with 4 thousand sold units, reaching 98,000 in 2007, and 553,000 in 2008.

In the first half of 2009, the Blu-ray Disc-Player segment was able to quadruple the number of sold units in comparison with the same period of the previous year [GfK 9/2009]. For 2009, the GfK retail and technology forecasts sales of 2.1 million Blu-ray Disc-Players.

In a paper called “Home Video : Status quo” the market research company SNL Kagan forecasts a rapid growth of Blu-ray Disc-Players after 2010. For 2014, they expect a global market share of 60 %. In Australia, more than 5 % of the households are already equipped with a Blu-ray Disc-Player. According to GfK, 3,000 Blu-ray Disc-Players were sold in Australia in September 2008, and in December 2008 20,000 units.

In the USA, 10.7 million Blu-ray devices can be found in private households, capturing about 10% of total market share. According to SNL Kagan, the turnover with Blu-ray Disc-Players was expected to increase from 255 million US-Dollar in 2008 to 1.3 billion US-Dollar in 2010.

3.3 Prices

Market research done in Germany shows that the average consumer price of DVD-Recorder, DVD-Player and and Blu-ray Disc-Player has decreased constantly (Figure 8).



Figure 8 Development of the average prices of DVD Players and Recorders

This downward trend reflects the situation in the whole of Europe. Also in the Blu-ray Disc-Player segment the prices are falling constantly. Between January 2009 and June 2009, the price of a Blu-ray Disc-Player fell to an average of EUR 252 [GfK 9/2009]. This downward trend is expected to continue. Digitimes assumes that the prices of Blu-ray Disc-Players could decrease to 77 US-Dollar till 2012 [<http://www.digitimes.com/news/a20091120PD202.html>].

DVD-Recorder

The first two DVD-Recorders that were available on the market had costs between 1,500 and 2,000 Euros. Not even a half year later, the prices for DVD Recorders fell more than 50%. Today, DVD Recorders can be bought for 200 Euros (Prakash et al. 2009). However, Stiftung Warentest doesn't recommend DVD Recorders at a price of less than 300 Euros due to their bad video quality and their cheap components. The upward price movement is diversified: a high-end device can cost up to 2,000 Euros. The majority of the DVD-Recorders can be found in the medium price range from 150 to 300 Euros. In the price range from 300 to 450 Euros, there are 20 to 25 % of the devices. Low-prices DVD-Recorders with a maximum purchase price of 150 Euros have a market share of 6-8 %. The same applies to high price devices with a selling price of minimum 600 Euros. In 2008, Stiftung Warentest tested DVD Recorders with Hard Drive Disc (HDD) twice. In the issue of Mach 2009 Stiftung Warentest tested again ten DVD Recorders. In these tests, the prices ranged between 194 and 700 Euros. GfK quotes the following average prices: in 2007 311 Euros and in 2008 282 Euros for a DVD recorder with HDD. That implies a price reduction of nearly 10 % [GfK 2008].

DVD Player

In the DVD-Player segment there is a wide range of products with different features in nearly all price levels. Cheap no name devices cost around 30 Euros. DVD-Players in the price range between 70 and 150 Euros have lower standards in terms of sound and image quality. Nevertheless, these devices meet the expectations of ordinary DVD customers. DVD-Player with a selling price between 150 and 400 Euros are characterized by a high standard of sound and image quality. According to GfK the average price for DVD-Player increased from 74 to 82 Euros between 2007 and 2008.

Blu-ray Disc-Player

The price range for Blu-ray Disc-Players, tested by Stiftung Warentest in 2007, was between 385 and 1,450 Euros. According to BVV, the average selling price in 2007 was 536 Euros. In 2008, the average price decreased by 45 % to 289 Euros. HD/Blu-ray Combo devices are comparatively expensive: in 2007 they had an average price of 1,249 Euros. Even for the Combo devices a downward trend in prices is obvious. In 2008 the typical selling price decreased by 51 % to 617 Euros [BVV 2009].

3.4 Energy Consumption

The majority of the DVD-Players, DVD-Recorders and Blu-ray Disc-Players do not have a power (On/Off) switch. This implies that the devices are left in the standby mode even when they are not used. The reactivation from standby to On mode leads, in most of the cases, to long waiting times. Devices tested by Stiftung Warentest in 2008 had a reactivation time of 18 to 30 seconds. Blu-ray Disc-Player, tested by chip 02/09 in September 2008 had a reactivation time that ranged between 46 and 64 seconds.

Some devices have an additional Eco-Mode. In the Eco-Mode, the energy consumption can be reduced by the deactivation of some functions (e.g. display) or by increasing the reactivation time. Consequently, the energy consumption in the eco-mode is lower than in the standby mode. The difference in reactivation time of some devices ranged between 4 and 12 seconds in test 09/2007. The difference in reactivation time in test 02/2008 was 1 or 2 seconds, with one exception: reactivation from eco-mode was three times higher than reactivation from the standby mode (45 versus 17 seconds). The main problem with the eco-mode is that it is not easily visible in the user's guide, or the explanation to utilize is often quite confusing.

In addition, DVD-Recorder and Blu-ray Disc-Player have a so-called Quick Start Mode to shorten the reactivation time. The quick start can be adjusted or activated by the user. Two DVD-Recorders tested by Stiftung Warentest in September 2008 had a reactivation time of only 3 seconds while using the quick start function. However, the energy consumption of the devices with quick start is considerably higher than the energy consumption in standby mode. It can be assumed that the majority of the customers won't accept the long reactivation time in the standby mode. Consequently, they will prefer the quick start mode despite the high energy consumption. To inform the customers about the difference in energy consumption, it would be recommendable to displays these values (in watt) already at the initial configuration of the devices.

Additionally, there is another kind of standby mode for a DVD-Recorder: standby mode with timer programming. In this mode, the timer is activated to record a broadcast. Thereby, DVD-Recorders consume much more power (2 – 5 watts) than in a standby mode.

Some devices have the capability to switch automatically into the standby mode after a certain period of user inactivity. As specified by manufacturers, this feature is also called Auto Power Down. However, it is not available in many devices. The role of auto power down in reducing the energy consumption is very important. Prakash et al. (2009) calculated that introduction of the function of Auto Power Down in DVD-recorder with HDD reduces the energy consumption by 51%, in Blu-ray Disc-Players by almost 61%.

As already mentioned in the introduction of this criteria paper, replacement of the current stock of DVD and Blu-ray products in EU-27 with Topten products would enable energy savings of about 8.6 billion kWh (8.6 TWh). This implies a reduction potential of about 4.4 billion kg CO₂ eq. per year. On a household basis, it would mean annual energy savings of about 50 kWh per product per household.

DVD-Recorder

The power consumption in On mode ranges between 20 and 30 watts. DVD-Recorders with HDD, tested by Stiftung Warentest in 2008 had an average power consumption in On mode of 26.5 watts. In 2009 the average value was 26.7 watts. Devices listed at No-Energy¹² had an average power consumption of 27.9 watts. According to tests of Topten Switzerland, DVD-Recorder with HDD had a higher power consumption than DVD-Recorder without HDD. Here, high quality devices with HDD need between 28 and 30 watts in On mode, low quality devices up to 60 watts. The average of these devices was 40 watts.

Efficient devices have a power consumption of only about 17 watts. An essential part of the operating costs is caused by the standby consumption which differs from device to device. The range of the standby power consumption of tested DVD-Recorders by Stiftung Warentest varied from efficient 0.9 to high 7.9 watts. The average standby consumption of the tested devices was 3,2 watts in 2008. The average value of the DVD-Recorders, tested by Chip (chip 8/2008) was 3.2 watts as well. The range varied from 0.0 watt (devices with on/off switch) to 20 watts. In Topten Switzerland, the standby power consumption of the most efficient DVD-Recorder with HDD was 0.67 watt. The majority of the devices had a standby power consumption of 2 watts. The standby power consumption is higher while using the timer (between 2 and 5 watts, one Recorder even 7.4 watts) (test 2/2008). In addition the standby power consumption with quick start is much higher ranging from 7 to 14 watts.

DVD-Players

The best ten DVD-Players presented by Topten Austria have an On mode power consumption between 7 and 10 watts. Even the rest of the 25 Players on Topten Austria, only few devices had an On mode power consumption of more than 20 watts. The standby consumption of these 25 DVD-Players varies from 0.3 to 3.0 watts. The standby power consumption of the majority of the DVD-Players was below 1.0 watt. There are only few devices offering an on/off switch.

Blu-ray Disc-Player

There is a huge difference between the On mode power consumption of traditional DVD-Players and Blu-ray Disc-Players: DVD-Players are between 7 and 9 watts, Blu-

¹² <http://www.no-energy.com/index.html>

ray Disc-Players tested in 2008 between 22 and 27 watts (test 7/2008). One Blu-ray Disc-Player even had a power consumption of 48.5 watts (test 06/2007).

The Blu-ray Disc-Players presented by Chip (Chip 2/2009) had an average power consumption of 31.8 watts in On mode. The standby consumption ranged between 0,3 and 1.2 watts. The average value was 0.5 watts. However, the reactivation time from standby mode to On Mode was found to be quite long. Some Blu-ray Disc-Players need a couple of minutes for booting and loading. The reason for this is that a Blu-ray Disc-Player has to be booted in an operational mode before loading the disc (similar to a computer). The fastest Blu-Ray Disc-Player tested by chip 02/2009 started to play the Blu-ray Disc after 46 seconds. By using the quick start feature, the receptivity can be reduced to only a couple of seconds, however the energy consumption increases enormously. One of the tested devices had an energy consumption of 9 watts in quick start mode, in the conventional stanby mode the power consumption was 0.1 watt.

3.5 Manufacturers and Distributors

Key players in the section consumer electronics with focus on DVD Players, recorders and Blu-ray Players are listed below:

- LG Electronics Inc.,
- Panasonic Corporation,
- Pioneer Electronics NV,
- Royal Philips Electronics N.V,
- Samsung Electronics Co. Ltd,
- SANYO Electric Co. Ltd.,
- Sharp Corporation,
- Sony Corporation,
- Toshiba Corporation.

4 Selection Criteria

The recommended selection criteria are based mainly on the specifications of the German Blue Angel Label (www.blauer-engel.de). Since January 2010, all electrical and electronic household and office equipment must conform to the Commission Regulation 1275/2008 of the Directive 2005/32/EC for standby and off mode electric power consumption. The German Blue Angel label specifies threshold values that are stricter than the one specified in the above mentioned Directive. Market analysis conducted for the development of the Blue Angel specifications reveals that the threshold values can be fulfilled by a small number of existing efficient products.

4.1 Energy Efficiency Criteria

The recommended efficiency criteria are:

- DVD-Recorders
 - Power consumption in standby mode
 - Power consumption in ON mode
 - Power consumption in Quick Start mode
 - Power consumption in standby mode with timer programming
 - Auto Power Down to low power standby mode

- DVD-Players
 - Power consumption in standby mode
 - Power consumption in ON mode
 - Auto Power Down to low power standby mode

- Blu-ray Disc-Players
 - Power consumption in standby mode
 - Power consumption in ON mode
 - Power consumption in Quick Start mode
 - Auto Power Down to low power standby mode

4.2 Quality related product features

Quality related product feature:

- Reactivation time (DVD-Recorder and Blu-ray Disc-Players)

Further information to be provided:

- Annual energy consumption (kWh/ year)
- Price and annual costs of energy consumption (based on current electricity prices, €/ kWh)

Based on the study Prakash et al. (2009), which builds the basis for the specifications defined in the German Blue Angel criteria, we suggest the following daily usage pattern: 2 hours ON-mode, 4 hours Quick Start mode and 18 hours standby mode for DVD-Recorders and Blu-ray Disc-Players, and 2 hours ON-mode and 22 hours Standby mode for DVD-Players

4.3 Recommendation for value setting

The recommended values are:

	Auto Power Down*	Standby (W)	Standby with information display (W)	Quick Start (W)**	Standby with Timer (W)	ON-Mode	Reactivation time (s)
DVD-Recorder	Yes	0.5	1.0	9.0	2.0	25	5.0
DVD-Player	Yes	0.5	1.0	-	-	8.0	-
Blu-ray Disc-Player	Yes	0.5	1.0	9.0	-	20	5.0

* Latest after 4 hours user inactivity. APD enabled by default. APD should bring the device in low power standby mode.

** Customers are informed in customer information that Quick Start mode is related to much higher power consumption than normal low power standby mode.

Evaluation:

There have been some deviations in the scope of the product group and value setting in this criteria paper when compared to the specifications of the German Blue Angel Label:

- Inclusion of Blu-ray Disc-Players with Quick Start functionality
- Reactivation time of maximum 5 seconds for the Blu-ray Disc-Players
- Threshold value of 9 W in Quick Start mode for Blu-ray Disc-Players

- Inclusion of a separate threshold value for standby mode with information display
- In this criteria paper, manufacturers have been asked to provide the information on high energy/ power consumption in Quick Start mode in customer information. In the specifications of the German Blue Angel Label, this information has to be provided also when customer selects the option of Quick Start mode during configuration.

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