Topten Product Criteria Paper on

Television and television sets

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The Project in brief

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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.

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1 Introduction

The criteria presented in this paper cover the most important TV technologies currently available on the European market, focusing on LCD and plasma TV displays.

TVs belong to most and widely used appliances in Europe: On average households use a TV for about 2,25 hours per day, this relates to more than 4 hours listening period per day for all persons actually watching TV. In 2003 1,48 TVs virtually were in use in every European (E 25) household. The annual electricity consumption of TVs for EU-27 in 2007 approx. corresponds to the electricity consumption of the Czech Republic (60 TWh). The volume of sales in the EU is estimated of approx 32 million units per year. It is expected that the annual sales will increase to approx. 45 million units by 2020.[1]

Quite obviously well known CRT TVs (cathode ray tube TVs) have diminished from the market. LCD (liquid crystal display) and plasmas are dominating the sales. New LCD backlighting technologies based on LED (light emitting diode) are contributing to higher energy efficiency as well as better picture quality. A trend to higher screen sizes is still ongoing.

Huge efforts in decreasing overall energy consumption of TVs therefore are highly worth to be made. The new EC regulation No 642/2009 has set limits on off and standby mode consumption as of January 7, 2010. From August 20, 2010 limits regarding on mode consumption will be in place. In one year an EU energy efficiency label for TVs will enhance further energy efficiency.

The new regulation regarding eco design requirements for TVs as well as the upcoming labelling delegated regulation for TVs (currently available as a draft version) will serve as perfect background for setting up Topten criteria. From August 20, 2010 manufacturers will be obliged to publish information on TV power consumption on free access websites. This will support Topten site managers in establishing TV Top-lists to a great extent. However some challenges regarding reliability and comparability may remain. These issues are discussed in detail in chapters 2.3 and 3.2 of this paper.

The paper starts with an overview on the major TV technologies including some aspects regarding efficiency and quality. It continues with a summary on current legislation and standards relevant for Topten as basis and finally concludes with recommendation on product categorisation and criteria to be used within Topten.

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[1] SEC(2009) 1012 final COMMISSION STAFF WORKING DOCUMENT Accompanying document to the Commission Regulation implementing Directive 2005/32/EC with regard to ecodesign requirements for televisions IMPACT ASSESSMENT SUMMARY

2 Product Definition

This chapter provides an overview of television technologies covered in this criteria paper. It also gives a technical analysis of the product type and explains relevant EU and international legislation, labels as well as test standards.

2.1 Product Definition

Television means a television set or a television monitor, referring to Definitions outlined in Commission Regulation (EC) No 642/2009[2]:

“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

(b) one or more tuner(s)/receiver(s) and optional additional functions for data storage and/or display such as digital versatile discs (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 sound device, which is linked through standardised video signal paths including cinch (component, composite), SCART, HDMI, and future wireless standards (but excluding non-standardised video signals paths like DVI and SDI), but cannot receive and process broadcast signals.

2.2 Product Types

A few established TV technologies are currently widely available on the market: CRT, Plasma and LCD-Panels as well as Rear projection TVs and projectors well known from office application. While Plasma and LCD dominate the TV sales, CRT is obviously diminishing. Rear projection TVs and projectors represent a niche market segment only and therefore are not laying in the focus of this paper.

2.2.1 CRT – Cathode Ray Tube

CRT at a glance:

The cathode ray tube (CRT) system was, until the late 1980s, virtually the only television display technology in common circulation; it still dominates the stock (!) in EU 25.[3]

[2] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:191:0042:0052:EN:PDF

The heart of a CRT system is the cathode ray tube itself, which consists of an evacuated and sealed glass tube similar in appearance to a large domestic funnel. The analogue nature of the CRT system has both strengths and weaknesses. While capable of producing extremely high quality and precise television pictures, the size of the electronics and the length of the tube required means that the scope to reduce the size of the CRT cabinet is limited. Unfortunately, bigger screen sizes in excess of 36 inches require cabinets of sizes not deemed acceptable by consumers.

Typical screen size range: < 36 “	
Pros	cons
High quality picture for still common PAL signals Moderate efficiency Low energy consumption due to smaller size screens in average	No new models on the market Not suited for HDTV Contain lead in the tube Relation volume : screen size less good than for LCD and Plasma

CRT in detail:

The cathode ray tube (CRT) uses heat to create light by striking large numbers of electrons against glass. Once the light hits the glass, extra electrodes deflect the light beams onto the television screen. An image is produced by modulating the intensity of the electron beam with a received video signal (or another signal derived from it). Cathode rays exist in the form of streams of high-speed electrons emitted from the heating of a cathode inside a vacuum tube, at its rear end. The emitted electrons form a beam within the tube due to the voltage difference applied across the two electrodes (the CRT screen typically forms the anode). The beam is then perturbed (deflected), either by a magnetic or an electric field (magnetic yoke), to scan systematically in a fixed pattern (raster) the inside surface of the screen (anode).

[3] Description for CRT, LCD and PDP taken from “EuP Preparatory Study “Television” (Lot 5), Fraunhofer IZM, Germany, August 2007

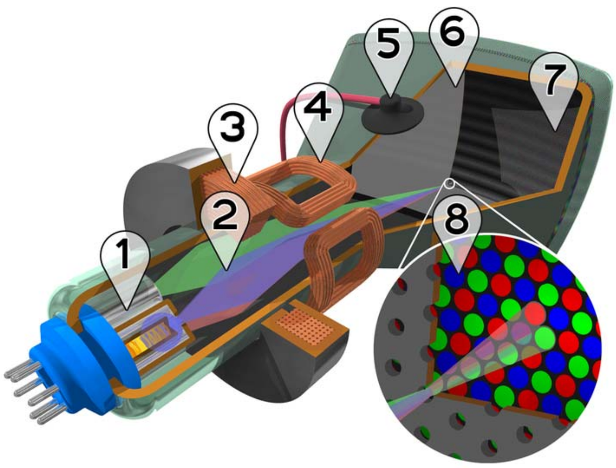


Figure 1: Cutaway rendering of a color CRT (Source: Wikipedia)

1. Three Electron guns (for red, green, and blue phosphor dots)
2. Electron beams
3. Focusing coils
4. Deflection coils
5. Anode connection
6. Mask for separating beams for red, green, and blue part of displayed image
7. Phosphor layer with red, green, and blue zones
8. Close-up of the phosphor-coated inner side of the screen

The screen is covered with a phosphorescent coating (often transition metals or rare earth elements), which emits visible light when excited by the electrons. The outer glass allows the light generated by the phosphor out of the monitor, but (for colour tubes) it must block dangerous X-rays generated by high energy electrons impacting the inside of the CRT face. For this reason, the glass is leaded (sometimes called "lead crystal"). Colour tubes require significantly higher anode voltages than monochrome tubes (as high as 32,000 volts in large tubes), partly to compensate for the blockage of some electrons by the aperture mask or grille; the amount of X-rays produced increases with voltage. Because of leaded glass, other shielding, and protective circuits designed to prevent the anode voltage from rising too high in case of malfunction, the X-ray emission of modern CRTs is well within approved safety limits.

2.2.2 PDP Plasma Display Panel

PDP at a glance:

Plasma (PDP - Plasma Display Panel) screens consist of a matrix of cells sandwiched between two glass panels, containing a mixture of xenon and neon gas. Electrodes in front of and behind the cells convert the gases into a plasma which excites a layer of phosphor material, displaying a picture on the screen.

Typical Screen size range: 37 - … “	
Pros	cons
Natural colour representation in darker rooms Larger viewing angle than LCD	Screen size not available below 37 “ Higher energy consumption compared to LCD

PDP in detail:

Although the technological principle was invented already in 1964 by Donald L. Bitzer and H. Gene Slottow of University of Illinois, the first colour PDP television was sold in 1997 by Pioneer. Today only five plasma display panel manufacturers are competing in the market. These are LG and Samsung of Korea, and Panasonic, Pioneer and Fujitsu-Hitachi-Plasma of Japan. Plasma television’s high brightness, high-speed response, and wide viewing angle show some advantages for motion pictures and large screens. However, LCD and other technologies (OLED, SED) are closing in and competition will be harsh in future. PDP is currently competing in screen size segment of 37 Inch and larger. Plasma Display Panel (PDP) is a self-emissive flat panel display where light is created in a cell by phosphors excited by a plasma discharge between two flat panels of glass. Each cell is filled with a gas and sandwiched between layers of electrodes. The illuminate effectiveness (brightness) is reduced if cell size is smaller as gas volume is also reduced. A voltage of 100 to 200V is required to ignite the plasma for individual pixels, and display heating as well as radio frequency emission has to be carefully controlled. The following Figure 2 and Figure 3 show the principle PDP design.

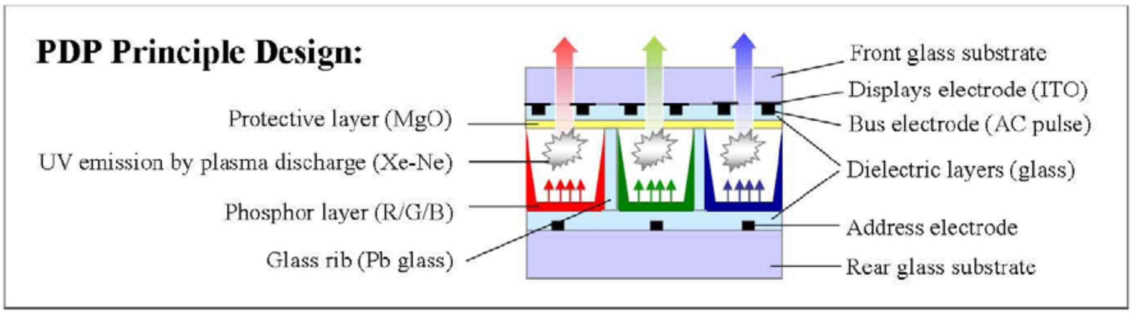


Figure 2: Principle Design of Plasma Display Panel (PDP) (Source: EuP Preparatory Study “Television” (Lot5), Fraunhofer IZM)

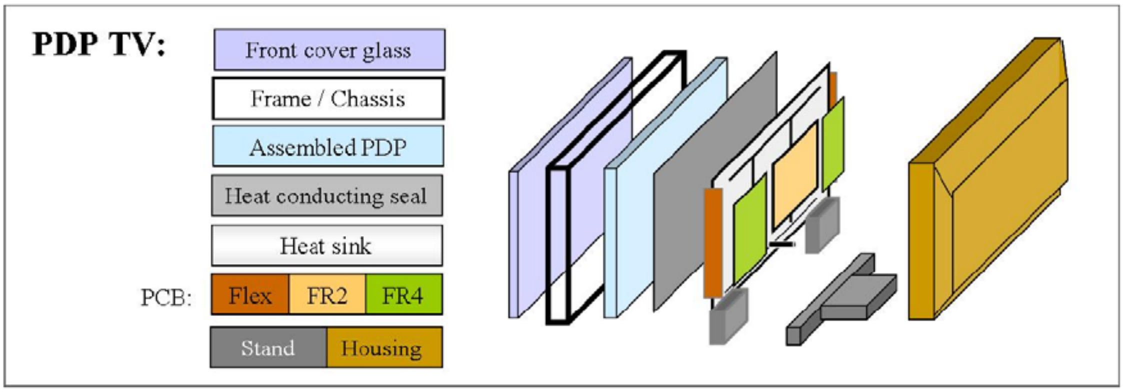


Figure 3: Principle Design of a PDP-TV (Source: EuP Preparatory Study "Television" (Lot5), Fraunhofer IZM)

2.2.3 LCD Liquid Crystal Displays

LCD at a glance:

Liquid Crystal Displays (LCD) screens exploit the ability of some materials to alter their crystalline structure when a voltage is applied, changing from being transparent to opaque.

Typical Screen size range: 20 – 55 "	
Pros	Cons
Lower energy consumption Best suitable for lighter rooms	Weak colour representation of black image elements Viewing angle might be a problem

LCD in detail:

Liquid Crystal Displays (LCD) are the most mature and commercially successful flat panel display technology (FDP) today. More lightweight than conventional CRTs and with an increasing picture quality, the LCD technology has the capability of realizing the full range of screen sizes for a reasonable price. LCD and other FPDs are incorporating fixed matrix technologies, but create the images using different methods. LCD – in contrast to PDP or SED[4] – is a non-emissive technology using a backlight (CCFL[5], HCFL[6] or LED[7]) as a light source. LCD is made up of any number of pixels consisting of materials (liquid crystals) that can alter

[4] SED – Surface-Conduction Electron-Emitter Display

[5] CCFL – Cold-Cathode Fluorescent Lamp (standard technology for LCD backlighting)

[6] HCFL – Hot Cathode Fluorescent Lamp (backlighting technology only used by Sony, more efficient than CCFL)

[7] LED – Light Emitting Diode (new rapidly emerging backlighting technology, highest efficiency compared to CCFL and HCFL)

their crystalline structure or orientation when voltage is applied. The transparency is changing through this principle. The light from the light source first passes through a polarization filter, gets then modulated by the liquid crystals, and creates a blue, red or green pixel after passing through another polarization and colour filter. Thin Film Transistor (TFT) technology on glass is used to drive or control the orientation of the liquid crystals (pixels). The display is protected on the front side with an antireflective hard coating. LCD technology is continuously improving. This improvement revolves around the miniaturization and optimization of the functional layers by keeping transparency of the layers very high. The Figure 4 shows the principle design of a liquid crystal display.

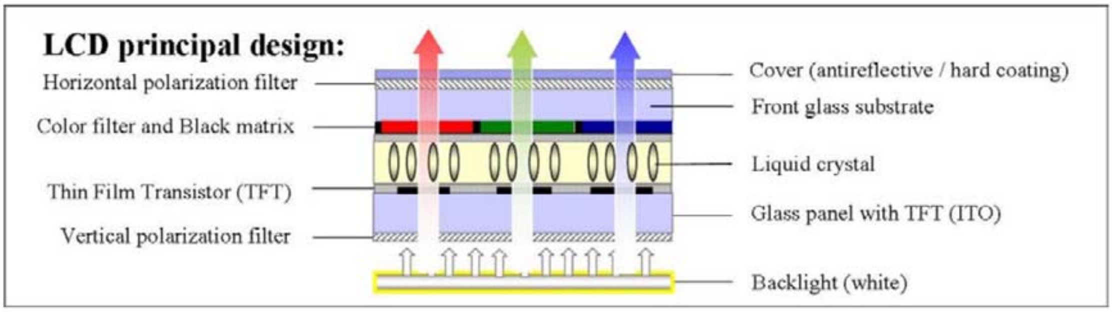


Figure 4: Principle Design of a Liquid Crystal Display (Source: EuP Preparatory Study “Television” (Lot5), Fraunhofer IZM)

Figure 5 shows the principle design of a LCD-TV in exploded view.

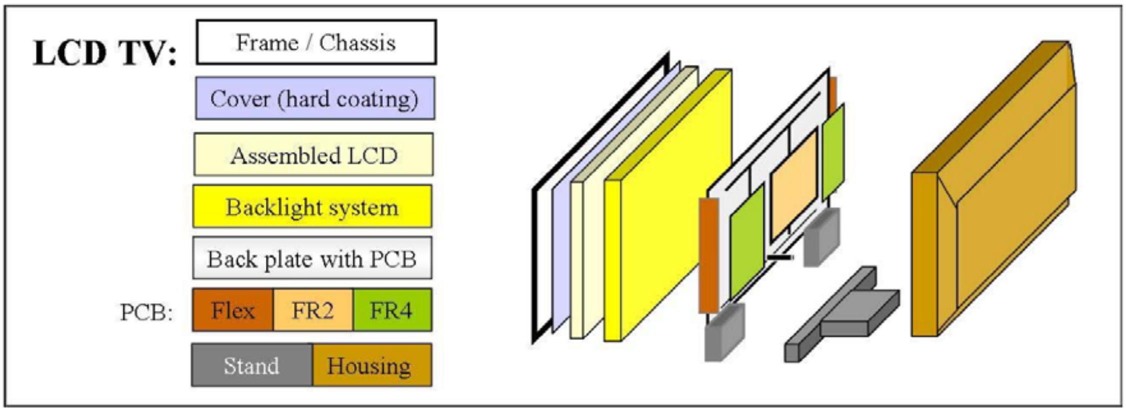


Figure 5: Principle Design of LCD-TV (Source: EuP Preparatory Study “Television” (Lot5), Fraunhofer IZM)

A new technology for backlighting of LCD-panels was brought to the market mid 2009. The so-called LED TVs use LED instead of CCFL or HCFL for backlighting purposes. However, the picture itself is generated similarly to common LCDs (therefore, the denomination "LED TV" is rather a communication term). Figure 6 shows a simplified scheme for both concepts:

CCFL Backlight LED Backlight

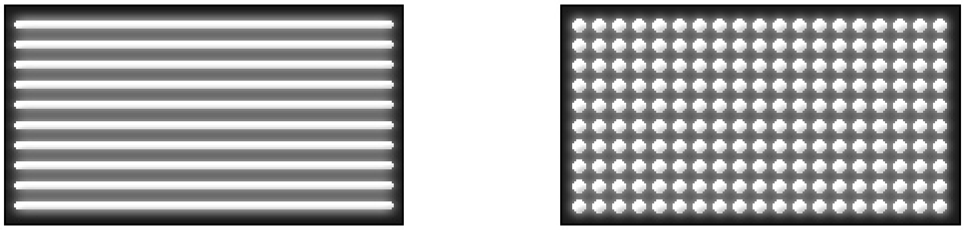


Figure 6: CCFL vs. LED-Backlighting of LCD-TVs (Source: tvfacts.de, 2010)

Up to now three different types for LED backlighting have been developed for marketability:

- edge LED backlight
- full LED backlight
- full RGB LED (red, green, blue) backlight

Figure 7 show the principles of edge and full LED backlight.

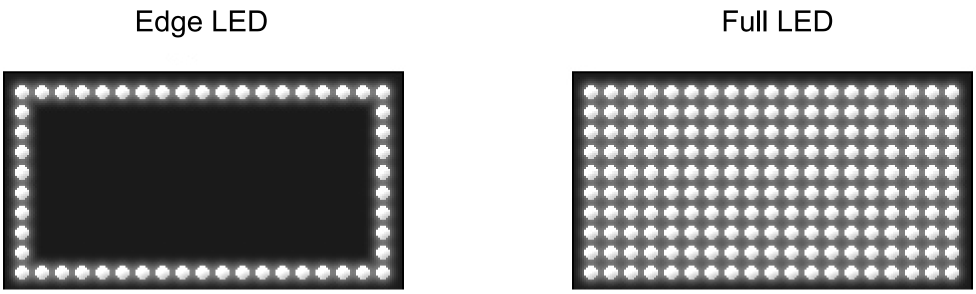


Figure 7: Two different types of LED-Backlighting: Edge LED resp. Full LED (Source: tvfacts.de, 2010)

Main advantage of edge resp. full LED backlighting is a more constant illumination level througout the image and the ability to adapt the backlighting level according to specific parts of the image shown. Given the example, a picture showing a complete dark night sky with full moon, the lighter parts will then be backlighted with full intensity, the darker parts only with very low or no backlighting. This technique – often called local dimming – results in enhanced contrast and significantly increased energy consumption.

For this purpose white LED are used most commonly. A more performing (and expensive) approach is using RGB LEDs (a LED each for the colors red, green, blue). RGB LED backlighting yield a better color representing additional to the benefits mentioned above.

2.2.4 Rear projection TV

For the very biggest screen size, a television projector projects pictures across a room onto a screen. These projectors are often based on LCD or DLP (Digital Light Projection) technologies and are capable of displaying images several meters wide. Unlike plasma and LCD televisions, there is no direct relationship between screen size and energy consumption. Large or small, they use about the same amount of electricity, so the largest are relatively very efficient in terms of watts per centimetre of screen.

2.3 Overview on basic terms and aspects regarding efficiency criteria for TVs

2.3.1 Glossary

Ambient Lighting Control (ALC)

Ambient lighting control automatically reduces the overall brightness of the whole screen when the light level of the room (ambient light) is low. This is more comfortable for the viewer and can also reduce power consumption.

Average picture level (APL)

APL represents the video signal level, i.e. it is a metric for the brightness of a “video image”. Giving an example, the APL of a ski race is quite higher than the APL of video sequence of a night sky. APL is defined as a percentage of the range between reference black and reference white level and is mathematically averaged over the period of a frame to come up with APL. Television programme material is said to have a 15% average picture level over a long period of time.

Forced menu

A set of televisions settings pre-defined by the manufacturer, of which the user of the television must select a particular setting upon initial start-up of the television.

Full HD resolution

Full HD resolution means a screen resolution with physical pixel count of at least 1920 x 1080 pixels. The number 1080 represents 1,080 lines of vertical resolution (1080 horizontal scan lines), while the letter p stands for progressive scan (meaning the image is not interlaced).

Only 1080p (progressive) can be referred to as full HD or full high definition although 1080i (interlaced) is also 1920x1080 pixels. The term usually assumes a widescreen aspect ratio of 16:9, implying a horizontal resolution of 1920 pixels. This creates a frame resolution of 1920×1080. “HD” or “HD ready” is widely used for TVs which can process HD 1080p signal but feature a resolution below 1920×1080. Please see Section 2.3.2 for further details.

Home Mode

“Home mode” means the television setting which is recommended by the manufacturer for normal use.

Peak luminance ratio

Ratio of the peak luminance of the home-mode condition or of the on-mode condition of the television as set by the supplier over the peak luminance of the brightest on-mode condition. According to CR 642/2009 measurements of peak luminance shall be made with a luminance meter, detecting that portion of the screen exhibiting a full (100 %) white image, which is part of a ‘full screen test’ test pattern that does not exceed the average picture level (APL) point where any power limiting occurs in the display luminance drive system.

Shop Mode

“Shop mode” means the television setting which is recommended by the manufacturer to be used on point of sale with usually much higher brightness and contrast levels compared to the home mode setting.

2.3.2 Established industry Labels for High definition Television (HDTV)[8]

	HD Ready Designed for display devices - including integrated digital TVs, monitors and projectors - that can accept, process and display High Definition 720p and 1080i (interlaced) (but not 1080p - progressive) signals. To enjoy HDTV broadcasts, these devices will need to be used in conjunction with an ("HD TV") device that can receive and decode the signals.
	HD TV Designed for television receivers - including set-top boxes and integrated digital TVs - that can receive and decode HD (720p, 1080i) satellite, cable or terrestrial broadcast transmissions.
	HD ready 1080p Designed for display devices - including integrated digital TVs, monitors and projectors - that can in addition to 720p and 1080i also accept, process and display High Definition 1080p signals. Display devices bearing the "HD ready 1080p" logo feature a 1920 x 1080 screen resolution. To enjoy HDTV broadcasts, these devices will need to be used in conjunction with an "HD TV" device that can receive and decode the signals.

[8] Definitions established by DIGITALEUROPE (former EICTA - European Information, Communications and Consumer Electronics Industry Technology Association

	HD TV 1080p Designed for "HD ready 1080p" display devices that can also receive and decode HD (720p, 1080i) Satellite, Cable or Terrestrial broadcast transmissions. Display devices bearing the "HD TV 1080p" logo feature a 1920 x 1080 screen resolution.

2.3.3 Technical aspects regarding power consumption in on mode

For long time power consumption of TVs was measured using static test patterns (full white display, color bars, etc.) . The main purpose for the declaration of on mode power values was for security reasons (thus quoting maximum values) not for actual comparability of different models in terms of energy efficiency. However state of the art measurements are based on dynamic test patterns (video sequences) facilitating “real world” tests. For strict comparability it has to be provided that the influencing factors for power consumption in on mode

- brightness setting and
- the characteristics of the broadcast signals

have to be specified properly. In the following these aspects are discussed in detail since they define the basis for the appropriate declaration of on mode power consumption data by manufacturers.

Beyond brightness setting and the characteristics of the broadcast signals the type of technology used (CRT, PDP, LCD), the screen size and the duration of usage self-evidently determine the actual energy consumption of a certain TV.

Characteristics of broadcast signals

The power consumption profile of television devices applying different display technologies varies according to their technical principles in which a picture is reproduced on the screen. As an example, the power consumption of a plasma display depends on the Average Picture Level (APL) of the image because the average energy drawn by a pixel depends on its brightness.

There are two definitions of APL:[9]

- Type 1 (Pre-Gamma) is the time average of a video signal input voltage to a TV set, which is usually expressed as a percentage of the full (100%) white signal level voltage.

[9] Description for CRT, LCD and PDP taken from “EuP Preparatory Study “Television” (Lot 5), Fraunhofer IZM, Germany, August 2007

- Type 2 (Post-Gamma) is the time average of the average luminance of all pixels in the TV set, which is usually expressed as a percentage of the peak white luminance level.

PDP as a phosphor-based self-emission technology shows a power consumption profile in correlation to APL more similar to CRT. LCDs with constant backlighting show a constant (not changing) power profile in correlation to the Average Picture Level (APL). For low APL the power consumption of a plasma display can fall by more than 50 percent from its peak value at high APL, and may be less than a comparable size LCD panel (because its power consumption doesn't vary with APL). However, the current development of dynamic backlighting in LCD television also suggests that in the future power consumption of LCD may vary according to APL.

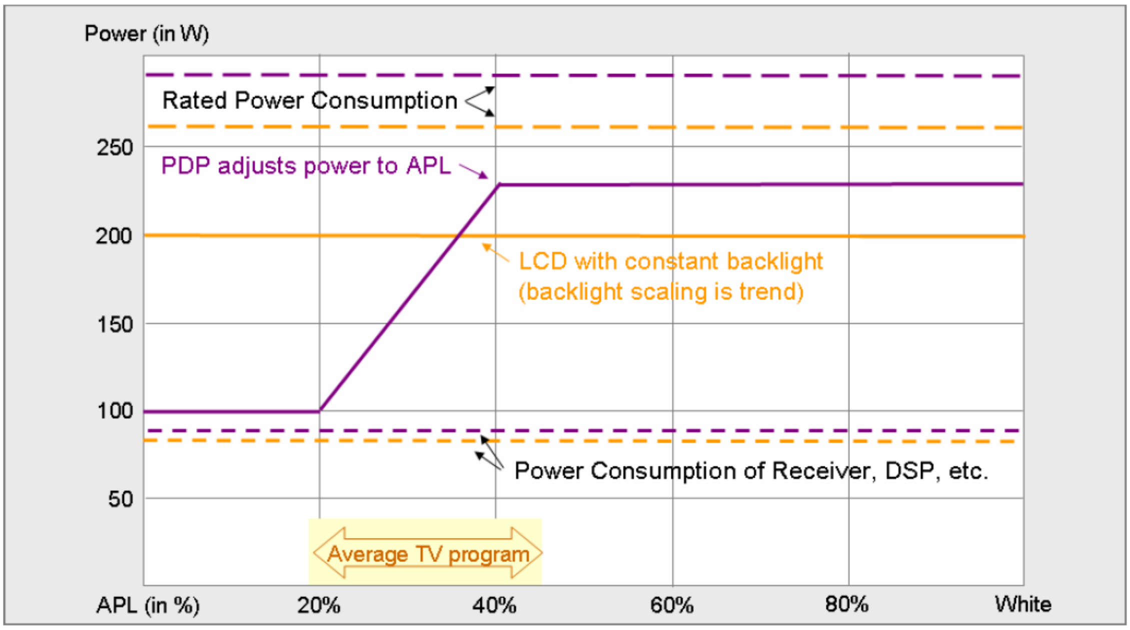
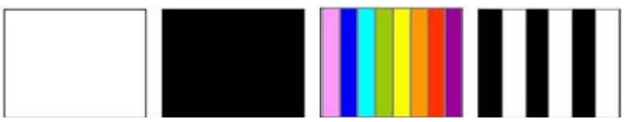


Figure 8: Power consumption profiles of LCD and PDP are different (Source: EuP Preparatory Study “Television” (Lot5), Fraunhofer IZM)

Static Video signal test pattern (sub-optimal, previously used)



White, black, color bars, white black bars

Dynamic video signal sequence

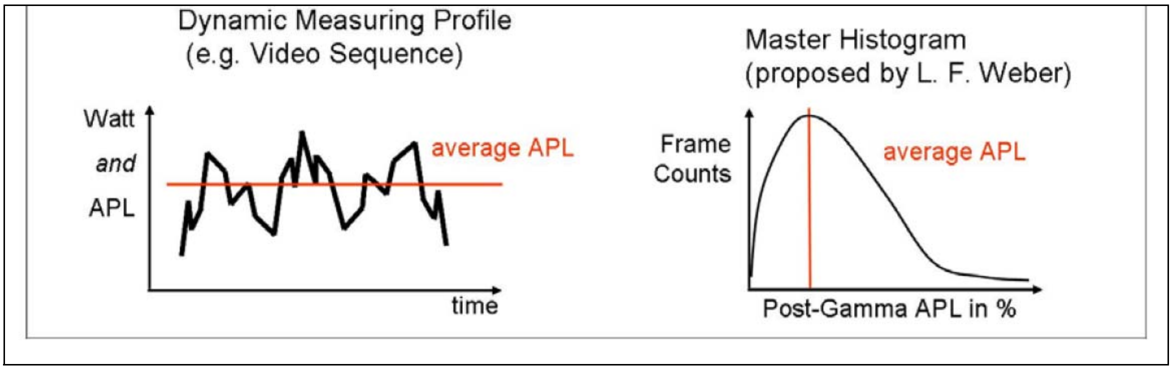


Figure 9: Different approaches for power consumption test methods (Source: EuP Preparatory Study “Television” (Lot5), Fraunhofer IZM)

The revised IEC 62087 dynamic broadcast-content test video signal has a 38% APL on average. This means that self-emitting displays such as CRT and PDP will show somewhat lower (and more realistic) power consumption values that with the conventional three-black-and-white-bar test video signal.

Figure 10 illustrates the APL dependent power draw of a PDP, derived from a measurement with a standardised test signal sequence.

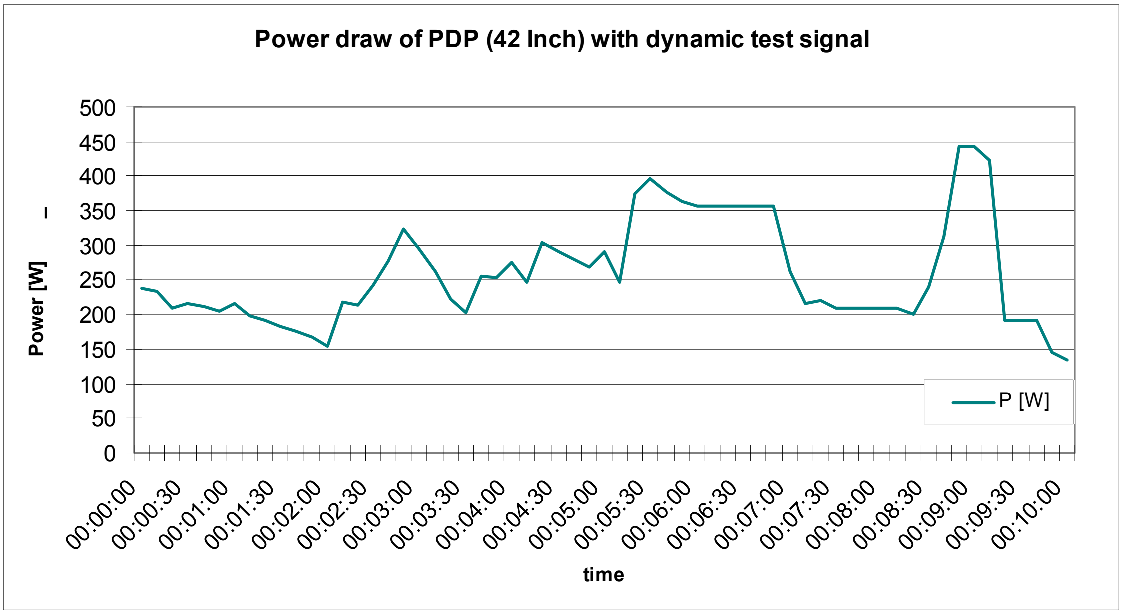


Figure 10: Power draw of a 42 Inch PDP with a dynamic test signal sequence (10 minutes) (Source: Austrian Energy Agency, 2008)

Most presumably LCD displays with LED-backlight and local dimming will have power draw characteristics similar to PDP displays as already explained earlier.

Brightness setting

Quite self evident the second main factor affecting power consumption is the setting of the TV's brightness level.

UK observations [10] have shown that the standard ("home mode") viewing mode is between 55% and 90% of maximum luminance mode with the majority of models falling between 60% and 70% of maximum luminance mode. IEC 62087 requirements state that testing should be carried out at the default luminance setting recommended by the manufacturers for the home use of the TV.

This survey also highlighted that TV on-mode power savings moving from an average bright room to a dark room with ALC enabled could be between 18 to 30% of the average power without ALC.

This gives a clear indication that different levels of brightness (related to different default settings and/or different ambient light levels) will lead to significant differences in power consumption in on mode. Concluding: this framework conditions will challenge the comparability of power values declared by manufacturers.

Keeping this in mind in the context of accomplishing own tests or operating with declared power values will be crucial.

2.4 Best Available Technology

Best available technology is currently represented by LCD displays with full LED-backlighting, reaching an Energy Efficiency Index below 0,27 (Source: topten.info, 2010) corresponding to an Efficiency Class of A according to draft delegated regulation[11].

The new technology OLED (Organic LED) is announced to be very efficient and high performing. By now OLED TVs are not available on the broad market, but have been presented as prototypes and high price niche products. A broad commercial launch of OLED TVs affordable for wide consumer segments is still pending.

[10] MTProg Briefing Note BNCE7: 2008 testing of TV luminance and ambient lighting control, http://efficient-products.defra.gov.uk/spm/download/document/id/780; 14.01.2010

[11] Draft commission delegated regulation implementing Directive 2010/…/EU of the European Parliament and of the Council with regard to energy labelling of televisions, circulated on 30. April 2010

2.5 Legislation and Labelling

2.5.1 Regulation (EC) No 642/2009

The current implementing measure Commission regulation (EC) No 642/2009 of 22 July 2009 with regard to eco design requirements for televisions stipulates the following requirements, setting values for maximum energy consumption in different modes.

Criteria "On mode power consumption"

Due date	Product type	Full HD resolution	All other resolutions
From 20 August 2010	TV sets	20 W + A x 1,12 x 4,3224 W/dm²	20 W + A x 4,3224 W/dm²
	TV monitors	15 W + A x 1,12 x 4,3224 W/dm²	20 W + A x 4,3224 W/dm²
From 1 April 2012	TV sets	16 W + A x 3,4579 W/dm²	
	TV monitors	12 W + A x 3,4579 W/dm²	

Visible screen area A expressed in dm²

Criteria "standby / off mode power consumption"

	Off mode	Standby mode
From 7 January 2010	1 W	1* / 2** W
From 20 August 2011	0,3 (0,5) W ***	0,5* / 1** W

** power consumption in any condition providing only a reactivation function, or providing only a reactivation function and a mere indication of enabled reactivation function*

*** power consumption in any condition providing only information or status display, or providing only a combination of reactivation function and information or status display*

**** Power consumption of any off-mode condition shall not exceed 0.30 watts, unless the following condition is fulfilled: For televisions with an easily visible switch putting the television in a condition with power consumption not exceeding 0,01 Watt when operated to the off position, the power consumption of any other off-mode condition shall not exceed 0,5 Watt*

Requirement regarding peak Luminance ratio from 20 August 2010:

The peak luminance of the home mode condition for televisions with forced menu shall not be less than 65% of the peak luminance of the brightest on-mode condition provided by the television. (TVs without forced menu: peak luminance of the on mode condition of the TV as delivered by the manufacturer not less than 65 % ….)

Information requirements from 20 August 2010

Information to be made publicly available on free-access website from 20 August 210

Data	Specification
On mode power consumption	Data in watts [Format XX,X W for values up to 100 W, format XXX W for values above 100 W]
Standby / off mode	Data in watts (Format X,XX W)
Ratio of peak luminance	%
In the case the TV contains mercury and lead	Content as X,X mg and the presence of lead

“On mode average” vs. “on mode maximum”

Please note that the term “On mode power consumption” used in the Regulation means i.a. a certain test sequence applied (IEC 62087, Edition 2.0.) and a specific brightness setting in “home mode” condition (defined relative to brightest on mode condition). Very often a maximum on mode value is declared in product documentation. This data reflects the maximum power draw of a TV set if all brightness and contrast levels are set to the maximum. In contrary to the “On mode power consumption” defined as a real life average value the maximum value has no relevance for everyday usage but for security reasons (are wiring and fuses strong enough?).

As long as the labelling requirements for TV have not entered into force, it will be not 100% clear if data declared in catalogues, product data sheets and other marketing resources corresponds to Regulation’s requirements or is maximum power value or manufacturer defined “average” on mode value.

Eco design requirement Automatic power down from 20 August 2011:

TVs after no more than 4 hours in on mode following the last user interaction and/or channel change shall be switched automatically from on mode to standby mode or off mode.

DRAFT Commission communication in the framework of the implementation of Commission Regulation (EC) No 642/2009 of 22 July 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for televisions

Accompanying to the Regulation No 642/2009 the Commission is planning to publish titles and references of transitional methods of measurement12 for the implementation of this Regulation:

[12] It is intended that these transitional methods will ultimately be replaced by harmonised standard(s). When available, reference(s) to the harmonised standard(s) will be published in the Official Journal of the European Union in accordance with Articles 9 and 10 of Directive 2009/125/EC.

Measured parameter	Reference	Title
On-mode power consumption – terms, definitions and abbreviations – General method of measurement – Measuring conditions for television sets in On (average) mode	IEC 62087, Edition 2.0.	Methods of measurement for the power consumption of audio, video and related equipment
Standby/off-mode power consumption – terms and definitions – General conditions for measurements – Measurements	EN 62301, First Edition	Household electrical appliances – Measurement of standby power

The Regulation (EC) No 642/2009 stipulates in Annex II (Measurements) that:

"Measurement shall be made using a reliable, accurate and reproducible measurement procedure, which takes into account the generally recognised state of the art measurement methods. […] Measurements shall be made using a dynamic broadcast-content signal representing typical broadcast TV content. The measurement shall be the average power consumed over 10 consecutive minutes.

This Commission communication will hence now close the gap, which was brought by the Regulation regarding the measurement requirements. The only specification missing is the one for peak luminance ratio. For the moment there is still a lack of clarity how the peak performance ratio has to be measured. As discussed in section 2.3.3 the brightness level is directly affecting the power consumption.

2.5.2 Draft Commission Delegated Regulation with regard to energy labelling of televisions

The Draft Commission Delegated Regulation with regard to energy labelling of television[13] comprising a labelling scheme for televisions will be binding 12 months after the publication of the delegated regulation in the Official Journal.

Table 1 gives an overview on the Energy Efficiency Classes corresponding to the Energy Efficiency Index. The calculation of the Index is presented right below.

Table 1: Energy efficiency class of a television

Energy Efficiency Class	Energy Efficiency Index
A +++	EEI < 0.10

[13] Draft commission delegated regulation implementing Directive 2010/…/EU of the European Parliament and of the Council with regard to energy labelling of televisions, circulated on 30. April 2010

A ++	0.10 ≤ EEI < 0.16
A +	0.16 ≤ EEI < 0.23
A	0.23 ≤ EEI < 0.30
B	0.30 ≤ EEI < 0.40
C	0.40 ≤ EEI < 0.50
D	0.50 ≤ EEI < 0.64
E	0.64 ≤ EEI < 0.80
F	0.8 ≤ EEI < 1..00
G (least efficient)	1.00 ≤ EEI

The Energy Efficiency Index (EEI) is calculated as EEI = P/P_{ref} (A), where:

P_{ref} (A) = P_{basic} + A · 4.3224 watts/dm²;

- P_{basic} = 20 Watts for television sets;
- P_{basic} = 15 Watts for television monitors;
- A is the visible screen area expressed in dm2;
  for screen aspect 4:3 use formula A = 0,480 * d²
  for screen aspect 16:9 use formula A = 0,427 * d²
  (where d is the diameter in [dm])
- P is the on-mode power consumption of the television in watts

The annual on-mode energy consumption E in kWh is calculated as E = 1.46 x P.

For the purposes of calculating the Energy Efficiency Index and the annual on-mode energy consumption respectively, the on-mode power consumption is reduced by 5% if all of the following conditions are fulfilled:

- “the luminance of the television in the home-mode or the on-mode condition as set by the supplier, as applicable, is automatically reduced between an ambient light intensity of at least below 20 lux,
- the automatic brightness control is activated in the home-mode condition or the on-mode condition of the television as set by the supplier, as applicable (i.e. if the TV is equipped with automatic brightness control feature), when the television is placed on the market.”

The new label layout and the timetable is presented in Figure 11 and Figure 12. The new label will entry into force 12 months after publication of the Regulation in the EU Official Journal (most presumably in July 2010 according to tentative planning of the Commission). New label forms may come even earlier if manufacturer deem appropriate.

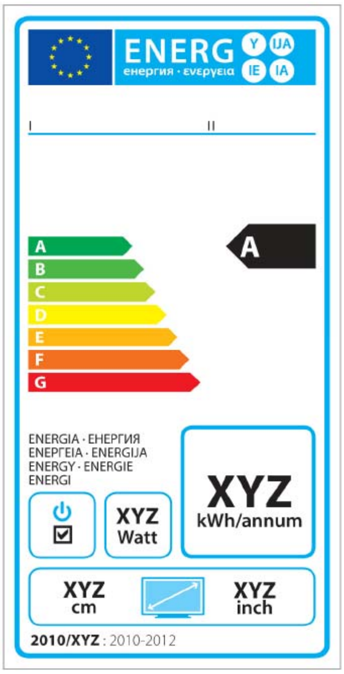


Figure 11: Layout of Energy Efficiency Labelling for TVs (Source: EC, 2010)

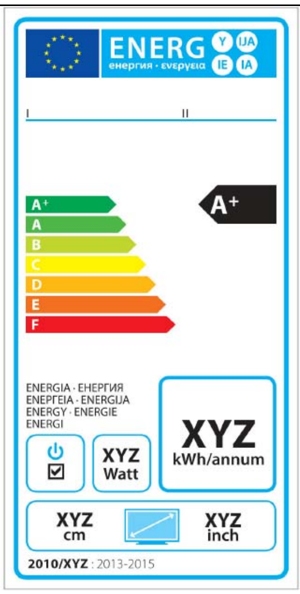
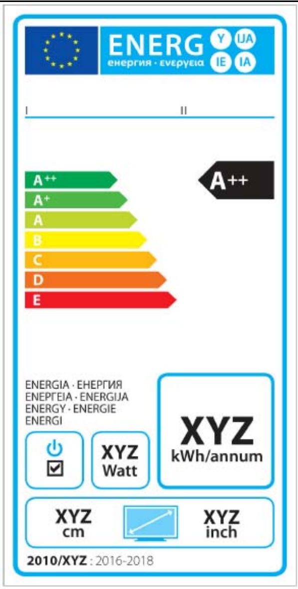
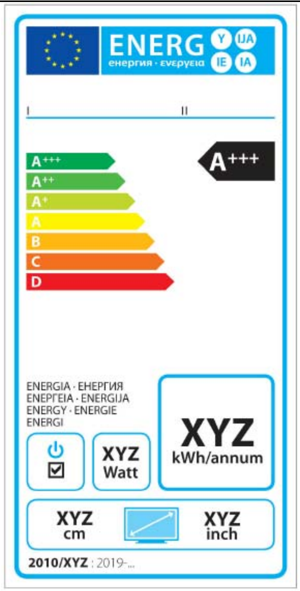
From 1st January 2013	From 1st January 2016	From 1st January 2019
		

Figure 12: further versions and timetable of Energy Efficiency Labelling for TVs (Source: EC, 2010)

The following information shall be included in the label:

I. supplier's name or trade mark.

II. supplier's model identifier
III. the energy efficiency class
IV. on-mode power consumption in Watt
V. annual on-mode energy consumption
VI. visible screen diagonal in inches and centimetres.
VII. for televisions with an easily visible switch, which puts the television in a condition with power consumption not exceeding 0.01 watts when operated to the off position, the symbol (marked in figure 13 below) may be added.

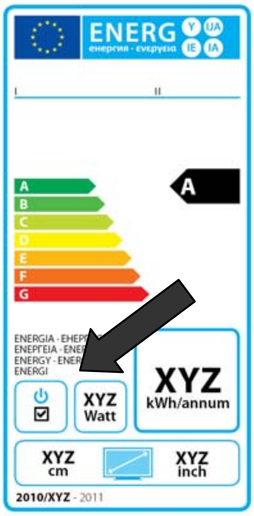


Figure 13: Switch logo on the label (Source: EC, 2010)

2.5.3 EU Eco-Label for televisions (C(2009) 1830)

The Commission decision of 12 March 2009 establishing the revised ecological criteria for the award of the Community Eco-label to televisions has been applied since 1 November 2009 (and shall be valid until 31 October 2013). Eco-labelled TVs are by 114 % (till the end of 2010, 70 % 1 from January 2011 until December 2012, 36 % from 2013) less efficient than recent A labelled models.

Figure 14: Logo EU-Ecolabel (Source: European Comission, 2010)

The criteria stipulated in the specification for this eco label on a voluntary basis aim at:

- reducing environmental damage or risks related to the use of energy (global warming, acidification, depletion of non-renewable energy sources) by reducing energy consumption,
- reducing environmental damage related to the use of natural resources,
- reducing environmental damage related to the use of hazardous substances by reducing the use of such substances

Eco Label Criteria regarding Energy consumption

Passive Standby

i. The passive standby consumption of the television shall be ≤ 0,30 W except where the condition in part ii is fulfilled.

ii. For televisions with an easily visible hard off-switch, such that when the switch is operated to the off position, the television's energy consumption is < 0,01 W, the passive standby consumption of the television shall be ≤ 0,50 W.

Maximum energy consumption

Televisions shall have energy consumption in on-mode of ≤ 200 W.

Energy Efficiency

Validity period	Energy Efficiency Index	Corresponding to Class
Until 31 December 2010	EER <= 0,64	Minimum D
1 January 2011, until 31 December 2012	EER <= 0,51	Approx. Minimum C
From 1 January 2013	EER <= 0,41	Approx. Minimum B

Beyond these criteria the following aspects are also defined:

- mercury content of fluorescent lamps
- design for disassembly
- heavy metals and flame retardants
- user instructions
- information appearing on the Ecolabel

Currently the brands Sony, Sharp and Samsung have claimed the EU Ecoflower for several of their products.

2.6 International Legislation and Labelling

2.6.1 Energy Star Programme Requirements for TVs

The US labelling programme Energy Star defines qualification criteria for a broad range of product categories (contrarily to the EU based Energy Star programme in which only office equipment is covered), amongst other home electronic products also televisions[14].

Requirements are in place for on mode power consumption setting specifications for effective date May 1, 2010 (Version 4.0) resp. May 1, 2012 (Version 5.0). From May 1, 2012 there also will be a fixed power limit for diameters above 127 cm (50 inches).

It is worth considering that the power values for on mode consumption derived from the Energy Star specifications are not comparable to values based on the EU regulation No 642/2009 as definitions for luminance differ:

Energy Star Definition:	Specification in EU regulation
the peak luminance of the product in the “home” mode, or in the default mode as shipped, shall not be less than 65% of the peak luminance of the “retail” mode, or the **brightest selectable preset (!) mode**, of the product. “	peak luminance of the home mode condition […] shall not be less than 65% of the peak luminance of the **brightest on-mode condition provided by the television (!)**

Hence a more thorough discussion of specific criteria is not done in this paper.

2.7 Test Standards

2.7.1 IEC 62087 Ed 2.0

The IEC Standard 62087, Ed 2.0: “Methods of Measurement for the Power Consumption of Audio, Video and Related Equipment” is the state of the art test standard for determining on mode power consumption of TVs. Conditions relevant for measurement are defined in section 11, “Measuring conditions of television sets for On (average) mode. This standard also includes dynamic broadcast-content video signal sequence (mean APL’ histogram is 34%).

[14] ENERGY STAR Program Requirements for TVs: Versions 4.0 and 5.0

http://www.energystar.gov/ia/partners/prod_development/revisions/downloads/television/Final_Version%204_5_TV_Program_Requirements.pdf

3 Economic and Market Analysis

3.1 Stock, Sales and Market Trends

The volume of sales in the EU is estimated of approx 32 million units per year. It is expected that the annual sales will increase to approx. 45 million units by 2020.[15]

The annual electricity consumption of TVs for EU-27 in 2007 is estimated at 60 TWh, approx. corresponding to the electricity consumption of the Czech Republic, and the expected electricity consumption by 2020 corresponds approx. to the electricity consumption of Sweden (130 TWh).

Up to date data on more detailed level regarding market and stock data as well as for growth and trends is not available.

According to the EuP preparatory study ‘Televisions’ 31 million TVs were sold in the EU in 2005, with sales increasing by 2% per year. The penetration rate per household was 1.4 in 2005, and is expected to have reached 2.0 by 2010 (Fraunhofer Institute, 2007). CRT-TVs (CRT= cathode ray tube) and small screen sizes are yet dominating the stock of installed TVs in European households (Bertoldi, Atanasiu, 2009):

Table 2: Penetration rate of TV display technologies in EU households (Bertoldi, Atanasiu, 2009)

CRT	LCD	PDP
60%	30%	10 %

Table 3: Penetration rate of TV screen sizes in EU households (Bertoldi, Atanasiu, 2009)

Small (35-66 cm)	Medium (67-99 cm)	Large (> 100cm)
50%	33%	12 %

Forecasts based on market trends indicate a shift in TV sales towards a higher share of LCDs and larger screen sizes: on the EU market in 2007 for the first time more LCD-TVs (53%) were sold than CRTs (35%) (Fraunhofer Institute, 2007) and screens larger than 66cm reached an estimate market share of 56%. For market sales of TVs by display type and screen size of units see also Figs. 15 and 16.

[15] SEC(2009) 1012 final COMMISSION STAFF WORKING DOCUMENT Accompanying document to the Commission Regulation implementing Directive 2005/32/EC with regard to ecodesign requirements for televisions IMPACT ASSESSMENT SUMMARY

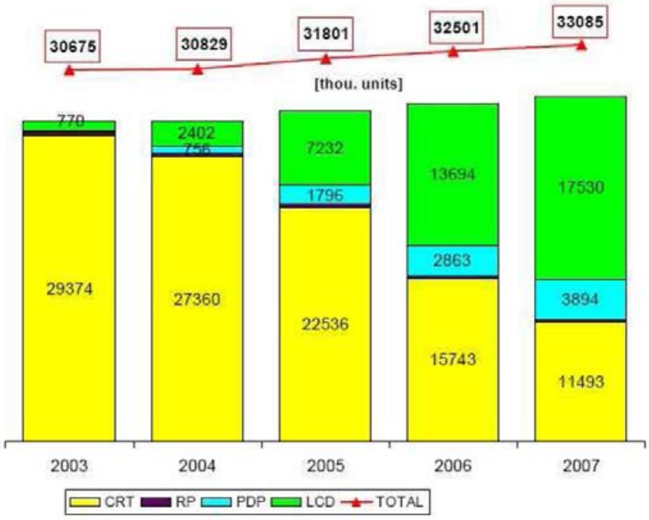


Figure 15: Market sales by type of of TVs (Source: Boyny, 2008)

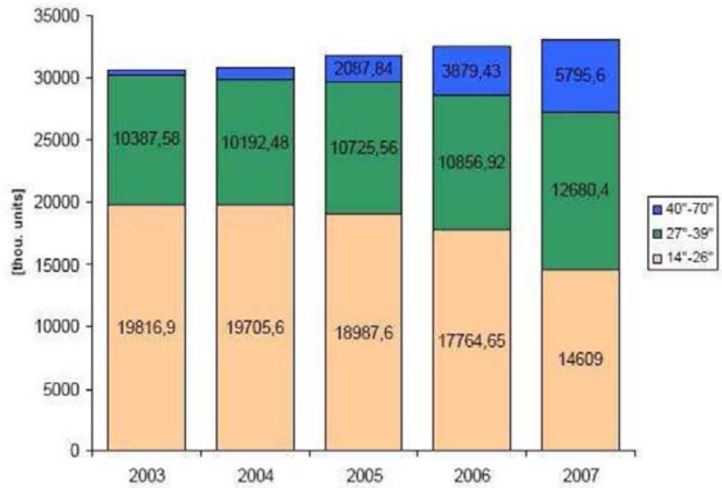


Figure 16: Market sales by screen size of TVs (Source: Boyny, 2008)

The EuP preparatory study (Fraunhofer Institute, 2007) identified four main factors influencing the market development:

- Flat panel displays (flat TVs)
- Larger screen sizes
- Digital television broadcasting
- High-resolution television (HDTV)

The European Commission proposes that by 2012 all member states complete the transition from analogue to digital TV broadcasting (Commission Communication, May 2005). TV sets without integrated digital receiver need a set-top box to decode the digital signals. Thus the development towards digital TV is expected to lead to a considerable increase of set-top boxes.

3.2 Manufacturers and Distributors

3.2.1 List of Manufacturers

List of manufacturers relevant for the entire EU market

Brand	Website	EU-Headquarter
BANG & OLUFSEN	www.bang-olufsen.com	Denmark
JVC	www.jvc-europe.com	United Kingdom
LG Electronics	www.lge.com	Netherlands
LOEWE	www.loewe.de	Germany
PANASONIC	www.panasonic-europe.com/home.aspx	Belgium
PHILIPS	www.philips.com	Netherlands
PIONEER	www.pioneer.eu	Belgium
SAMSUNG	www.samsung.com	United Kingdom
SANYO	www.sanyo.co.uk	United Kingdom
SHARP Electronics	www.sharp-eu.com	Belgium
SONY	www.sony-europe.com	Belgium
TOSHIBA Information Systems	www.toshiba.co.jp/worldwide/europe.html	United Kingdom

3.3 Data sources and Databases

According to Regulation (EC) No 642/2009 manufacturers will be obliged to provide information for the purpose of consumer information. The following information is to be made publicly available on free-access website from 20 August 2010:

Power consumption in On mode, Standby / off mode, Ratio of peak luminance

Thus search on manufacturers' websites will be sufficient for data gathering even just starting from now, as manufacturers declare power consumption data based on IEC Standard 62087, Ed 2.0 . Not all but several manufacturers will send product information on request (most of them are already sending information requested by the Topten.info team). GfK also sells TV product information but there are still uncertainties about certain values provided by manufacturers to GfK (which is not yet systematically checking) on which type of power consumption data is available.

We also will have to cope with poor data quality sometimes, as manufacturers (most likely distributors) may provide incorrect data, even if we highlighted that we had asked for power consumption data based on IEC Standard 62087. Please note that it has been common for manufacturers for a very long term to declare maximum on mode power values (especially for security reasons).

4 Selection Criteria

The proposed Topten selection criteria are basically based on the EU Regulation (EC) No 642/2009 and the Draft Labelling Delegated Regulation for TVs as described in chapter 2.5.2

4.1 Energy Efficiency Criteria

The energy efficiency criteria shall include:

- Energy Efficiency Index (covering On mode power consumption)
- Energy Consumption in Standby and off mode

4.2 Quality related product features

The following product specification may qualify for additional quality criteria or are recommended for additional user information

Product specification	Qualifies for quality criterion	Only for user information
DVB-T Tuner integrated	✓	
Full HD	✓	
Ambient Lighting Control (ALC)	✓	
Viewing Angle	✓	
Format		✓
Response time		✓
Equipped with interconnect Common Interface (CI+)		✓
Contrast (Dynamic)		✓
Max Brightness		✓
Interfaces (including Numbers) HDMI Input Component Video Input PC Input Audio Input 21-Pin Input/Output LAN Port		✓
Presence Sensor		✓
Content of hazardous substances: Mercury, Lead (if applicable)		✓
Certified for EU Eco Label (EU flower)		✓

4.3 Recommendation for value setting

Criterion "Energy Efficiency Index (covering On mode energy consumption)"

As a starting point we suggest to stick to following value settings for on mode energy consumption

Energy Efficiency Index (EEI)	≤ 0.50

Criterion "Energy Consumption in Standby and off mode"

This setting should be based on eco design requirements valid from 20 August 2011 that Topten could recommend select already from now on:

Off mode	Standby mode
0,3 (0,5) Watt ***	0,5* / 1** Watt

** power consumption in any condition providing only a reactivation function, or providing only a reactivation function and a mere indication of enabled reactivation function*

*** power consumption in any condition providing only information or status display, or providing only a combination of reactivation function and information or status display*

**** Power consumption of any off-mode condition shall not exceed 0.30 watts, unless the following condition is fulfilled: For televisions with an easily visible switch putting the television in a condition with power consumption not exceeding 0,01 Watt when operated to the off position, the power consumption of any other off-mode condition shall not exceed 0,5 Watt*

5 Additional Considerations

Optimal distance for viewing

Manufacturers' recommendation regarding suitable distance for viewing high definition images on a Full HDTV is about two to three times the diagonal measurement of the TV. Conventional standard definition images required a viewing distance of about four to five times the diagonal measurement of the screen. This rule of thumb seems to be for a minimum distance avoiding pixellated images.

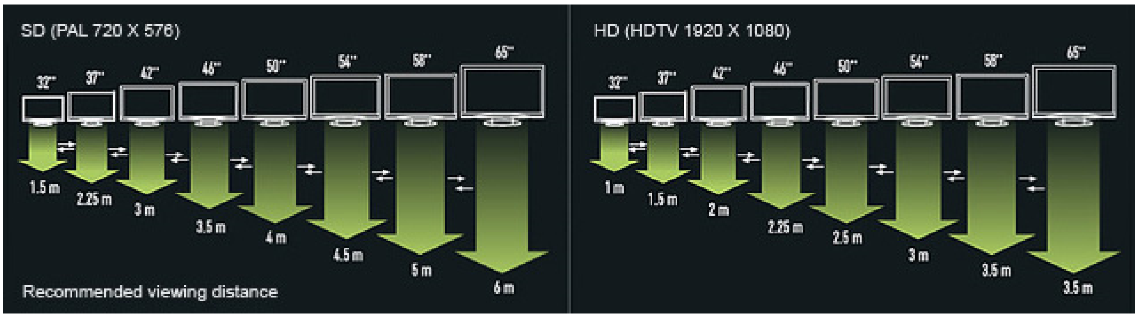


Figure 17: suitable distance for viewing (Source: Panasonic, 2009)