What is an energy efficient TV? Trying to find the best TV in China and in Europe

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Abstract

Topten International launched a test project in order to find out whether there are large differences in energy efficiency between the TVs on the Chinese and the European market. For the test, the most energy efficient 46-inch TV models were selected from the lists of Topten Europe and Topten China. The TVs were tested and classified according to the Energy Labels and standards of Europe and China by three participating testing institutes. Apart from verifying the declarations and compliance with minimum efficiency requirements the main results support the initial theses: the On mode power of the European TV model is considerably lower than that of the Chinese model. The question which of the two TVs is more efficient however is not easy to answer: according to the European Union (EU) Energy Label, the EU TV is the more efficient of the two test TVs. On the Chinese Energy Label however, the Chinese TV reaches a better efficiency grade than the EU TV. Different efficiency definitions on the two Energy Labels make this possible: while an efficient TV in Europe is one with low power in On mode compared to a reference model of the same screen size, an efficient TV in China is bright relative to its power.

The results show that details of policy instruments can strongly influence product design. These instruments must therefore be carefully defined in line with their primary aim. The present project allows identifying aspects of the applied Labels and standards that could be improved.

Background

Topten[1] is an international program designed to create a dynamic benchmark for the most energy efficient products [1]. It addresses consumer's needs, but also manufacturers, retailers, researchers and policy makers to push them to produce more energy efficient products. There are currently 20 national Topten sites throughout Europe, China and the USA. Each site provides information on the most energy efficient products available in their local markets.

Toptens goal is to contribute their expertise to the worldwide distribution of the most energy efficient technologies. Due to different measurement standards and efficiency assessments in many countries is difficult to compare the Best Available Technology (BAT) from one region to another. This is also the main limitation to the benchmarking document on TVs from the 4E project [2], which found that the average Energy Efficiency Index in the countries considered improved by 8% from 2008 to 2009. Its global presence allows Topten to closely look at some products from different regions and compare their efficiency levels [3].

A comparison of the energy consumption of TV models on Topten websites in China, Europe and USA, based on declared power values, showed that Chinese TVs have a higher energy consumption than European and American models [4] (figure 1).

[1] www.topten.info

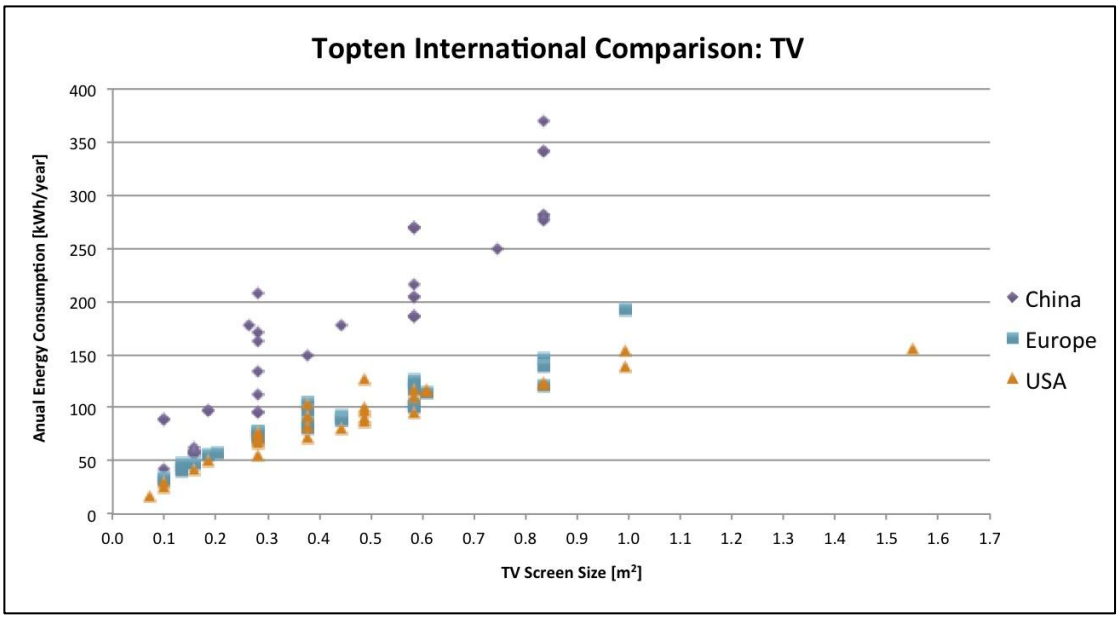


Figure 1: Annual Energy Consumption of Topten TVs

Source: [4]

Topten International wanted to look closer at the reasons for this finding: is it a fact that Chinese TVs are less energy efficient than European (and US-American) TVs? Or do different measurement standards lead to a higher power declaration in China? Topten International launched the testing project, which allows to better understand the details of the Chinese and the EU energy labels for TVs, and the measurement methods they are based on. The results are also used to verify the declared power and consumption values, and to determine the current level of the most efficient TVs on the market.

Also the Superefficient Equipment and Appliance Deployment (SEAD) Initiative[2] aims at determining the most efficient TVs of the world. Their results [6] are compared with the findings of the Topten test project in the final section.

Part of the project's findings have also been presented in [5] at eceee.

Methodology

The most energy efficient 46-inch TV models on the Chinese and European markets were both purchased and tested according to the Chinese and the European Energy Label and the relevant measurement standards by three participating testing institutes.

Product selection

The following requirements were defined, so that the two TV models do not provide different functionalities, which would make them not comparable:

- Screen diagonal: 46 inch / 117cm
- Resolution: 1920 x 1080
- No hard disk integration
- Automatic brightness function (or similar function) that can be switched off manually

[2] www.superefficient.org

At the end of June 2012 the TV models from the Topten China and Topten Europe lists with the lowest On mode power consumption - conforming to the above specifications - were selected for the test (figure 2). The technical specifications as declared by the manufacturers are presented in table 1.

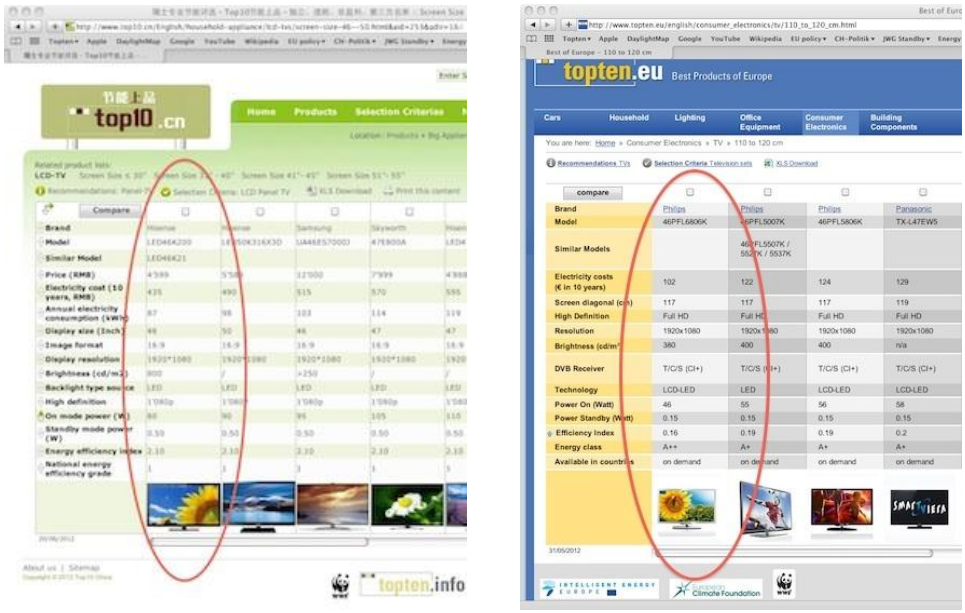


Figure 2: Topten China and Topten EU product lists with the selected TV models (June 2012)

Table 1: Selected TV models and technical specifications

Declarations according to	Chinese Energy Label	European Energy Label
Brand	Hisense	Philips
Model	LED46K200	46PFL6806K
Technology	LED-LCD	LED-LCD
Diagonale (Inches)	46	46
Resolution (Pixel)	1920x1080	1929x1080
On mode power (W)	80	46
Standby power (W)	0.5	0.15
Annual electricity consumption (kWh/year)	87	63
Energy Efficiency Index EEI	2.10	0.16
Energy label grade / class	1	A++

Product testing

Both TVs were tested by the three participating test institutes: CVC (Gunangzhou, China), NIM (Beijing, China) and VDE (Offenbach, Germany), according to the Chinese and the European measurement standards relevant for the respective Energy Labels and rated according to the Labels.

The Chinese and European Energy Labels for TVs

Figure 3: Chinese and European Energy Label for TVs

The Chinese Energy Label rates the TVs from grade 3 (least efficient) to 1 (most efficient). The grade 3 limit corresponds to the minimum energy performance standard (MEPS). For plasma TVs this is higher (less efficient) than for LCD TVs [7]. The European Energy Label ranges from A to G [8], even though TVs less efficient than class D are banned from the market [9]. TVs reaching better classes (A+ or A++) feature a label including these classes. From 2014 the scale will be A+ to F for all TVs [8].

The two Energy Labels are based on different definitions of TV efficiency: While in Europe an efficient TV is one with low power in On mode compared to the power of a reference model of the same screen size (P/P(dm^2)) [8], in China the most efficient TV is the one that is brightest relative to its power (high cd/W relation) [7]. European TVs are prevented from reaching low power simply by being very dark: the brightness in factory settings (this is how the TVs are measured) must be at least 65% of the maximum brightness.

According to both Energy Labels larger TVs can have higher power without getting a worse classification (EU: because larger reference TVs also have a higher power input; CN: because a larger TV has a higher luminous intensity (Cd = Cd/m^2 * m^2)). In Europe brighter TVs must be more efficient than darker ones in order to get an equal classification, while in China, in addition to larger TVs, brighter TVs can have a higher power without getting 'punished' with a bad grade.

The measurement of the On mode power consumption is based on the dynamic broadcast content of the IEC 62087 standard [10] for both energy labels, and both consider the average On mode power consumption over 10 minutes. However, the settings that are chosen for the On mode power and the luminance measurements are different for the two standards:

- Chinese energy label: brightness and contrast settings are adjusted to a 8-greylevel-signal, other image settings are set to 'factory setting'; Automatic Brightness Control (ABC) is switched off.
- EU energy label: factory settings ('out of the box'). ABC is switched off.

Apart from the different brightness and contrast settings, different signal input terminals are used (GB 24850: Rundfunk (RF, aerial broadcast); EU: High Definition Multimedia Interface (HDMI)) and different voltages are applied: 220V are used for the Chinese energy label, 230V for the EU energy label measurements.

Relevant regulations and standards

China: GB 24850: 2010 *Minimum allowable values of energy efficiency and energy efficiency grades for flat panel televisions* [7]. This paper contains the legal minimum efficiency requirements, the Energy Label details for TVs as well as the EEI calculation formulas and the measurement procedure. It is therefore referred to as 'standard' (as in Chinese). The

standard refers to the dynamic broadcast content of the IEC 62087:2008 [8] for the measurement of the On mode power. GB 24850 also includes a method for measuring the luminance and the Standby power of the TV.

Europe: *EU regulation No 1062/2010 on energy labelling of TVs* [8]. For the measurement of the On mode power IEC 62087: 2011 Methods of measurement for the power consumption of audio, video and related equipment [10] is applied (as recommended in a separate Communication [11]). For the Standby measurement [11] refers to the standard for measurement of low power consumption [12]. The EEI calculation formula and the labeling scale are contained in [8].

Results

Energy Efficiency Index (EEI) and Energy Class / Energy Grade

Table 2: Main results according to the EU Energy labelling regulation

EU Energy Label – 1062/2010						
	Philips 46PFL6806K			**Hisense LED46K200**		
Institute	**EEI**	**Class***	**Luminance ratio**	**EEI**	**Class**	**Luminance ratio**
CVC	0.161	A+	55%	0.302	B	54%
NIM	0.163	A+	53%	0.302	B	99%
VDE	0.169	A+	62%	0.301	B	99%

*Including the justified 5% On mode power reduction for the ABC to calculate the EEI, the results confirm the declared A++ class of the Philips TV.

All test institutes report the Philips 46PFL6806K to be of higher efficiency than the Hisense LED46K200 when measured and classified according to the European energy label. The institutes' results on EEI and efficiency class are in line, for the luminance ratio the institutes however reach different results.

For the Philips model all institutes calculated an EEI slightly above 0.16 and thus reported an energy class A+ for the Philips TV – while Philips declared it to be in class A++. According to the Labelling regulation, TVs which have the ABC activated receive a 5% reduction on the measured On mode power for the calculation of the EEI. The test institutes did not consider the 5% reduction, even though the Philips TV does have its ABC enabled at factory settings. When considering the 5% reduction, the declared A++ class of the TV can be confirmed (see table 5 for more details).

Table 3: Main results according to the Chinese energy labelling standard

Chinese Energy Label – GB 24850				
	Philips 46PFL6806K		**Hisense LED46K200**	
Institute	**EEI**	**Grade**	**EEI**	**Grade**
CVC	1.15 (1.34*)	2 (2*)	1.36 (1.50*)	2 (1*)
NIM	-	-	2.33	1
VDE	1.43*	1*	2.86*	1*

*Measured with HDMI input terminal, not RF as officially relevant for the Label

Contrary to the assessment of the European energy labelling regulation, all test institutes report the Hisense LED46K200 to be of higher efficiency than the Philips 46PFL6806K when measured according to the Chinese standard.

However, the three institutes reached different EEI results for both TV models, and even different energy grades on the Chinese Energy Label. (NIM did not report valid results for the test of the Philips TV according to the Chinese standard.)

Compliance check
Philips 46PFL6806K

Table 4: Compliance check for the Philips 46PFL6806K

Philips 46PFL6806K	On mode power (W)	Standby mode power (W)	Peak luminance ratio
Declared	45.5	0.15	65%
Incl. tolerance	48.7 (7%)	0.25 (0.1W)	60%
Result by CVC	44.25	0.12	55%
Result by NIM	44.59	0.16	53%
Result by VDE	46.11	0.12	62%
Compliance?	YES	YES	To be checked

The measurement tolerance for the On mode power of European TVs is 7%. The declared power of the Philips has been confirmed by the tests (table 4). The maximum allowed Standby power for TVs is 0.5W [9], the measurement tolerance is set at 0.1W. The Philips 46PFL6806K clearly meets this requirement. The brightness in factory settings or the home mode is required to be at least 65% of the maximum brightness. The institutes reached different results on the peak luminance ratio, but all are below 65%. How about the Energy Class? All institutes reported an A+ for the Philips TV instead of the declared A++. For the calculation of the EEI the institutes missed to include the 5% discount which is granted for TVs with an ABC: if the ABC is activated in the factory mode and the luminance of the TV is reduced at an ambient light intensity between 20 lux and 0 lux, the measured On mode power will be reduced for the calculation of the EEI and the annual energy consumption. This clause in [8] might not be obvious, and as the test reports show, it can easily be missed. Table 5 compares the relevant values with and without 5% ABC reduction.

Table 5: EEI calculation for the Philips model with reduction for ABC

Philips 46PFL6806K		CVC	NIM	VDE	Declared
without reduction	On mode power measured	44.3	44.6	46.1	45.5
	kWh/a	64.6	65.1	67.3	
	EEI	0.162	0.163	0.169	
	Class	A+	A+	A+	
with 5% reduction for enabled ABC	On mode power	42.0	42.4	43.8	43.2
	kWh/a	61.4	61.8	64.0	63.1
	EEI	0.154	0.155	0.161	0.159
	Class	A++	A++	A+	A++

The test institutes confirmed that the Philips TV has a light sensor with a brightness reduction function activated in the factory mode. Thus it deserves the 5% reduction. The On mode power measured by VDE is within the tolerance of 7% of the declared value. Therefore all results confirm the declared On mode power, EEI and Energy class of the Philips 46PFL6806K.

Hisense LED46K200

Also in China the maximum Standby power for TVs is 0.5W [7]. For the Hisense LED46K200 the declared standby power of 0.5W was confirmed by all three testing institutes (table 6). NIM and VDE also confirmed the declared grade 1 of the Hisense. CVC however reports an EEI of 1.36 (35% lower than what is declared) and grade 2.

Table 6: Compliance check for the Hisense LED46K200

Hisense LED46K200	Standby power	EEI	Grade
MEPS	0.5 W	0.6	3
Declared	0.5 W	2.1	1
Measured by CVC	0.42 W	1.36	2
Measured by NIM	0.35 W	2.33	1
Measured by VDE	0.41 W	2.86	1
Compliance?	YES	To be checked	

MEPS: Minimum Energy Performance Standard

Measured values

Standby power

The institutes' results for Standby power differ by up to 0.12W for the Hisense TV and 0.05W for the Philips TV (table 7). These deviations are larger than the measurement tolerance of the EU Ecodesign regulation of 0.01W [11]. The deviations between the institutes are larger than those between the two measurement standards, which are no more than 0.1W. The deviations between CVC and VDE are no higher than 0.02W (Hisense/EU).

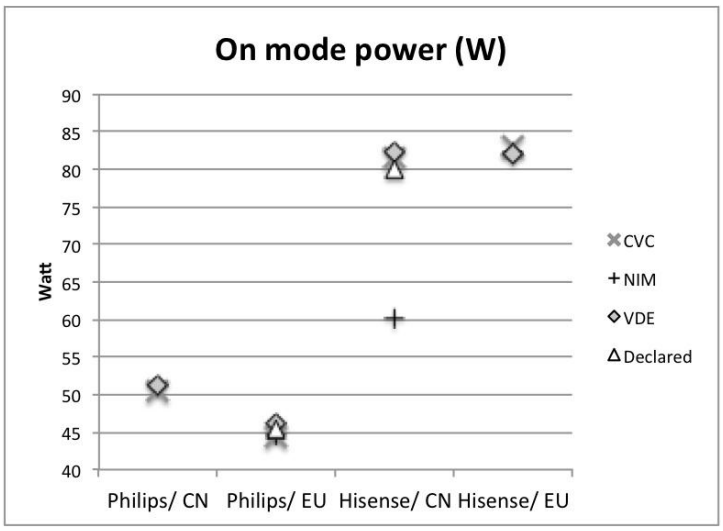
Table 7: Results of the Standby power measurements

Standby power (W)	Declared	CVC	NIM	VDE
Philips/ CN		0.11	0.16	0.12
Philips/ EU	0.15	0.12	0.16	0.12
Hisense/ CN	0.5	0.42	0.35	0.41
Hisense/ EU		0.43	0.35	0.41

CN: according to the [7], EU: according to [8]

On mode power

All institutes report the Hisense LED46K200 to have a higher On mode power than the Philips 46PFL6806K, for all measurements (figure 5). Results according to the EU labelling regulation are well aligned between the institutes, while for the measurement of the Hisense TV according to the Chinese standard NIM reports a lower value than the two other institutes.



On mode power (W)	Declared	CVC	NIM	VDE
Philips/ CN	-	50.44 (51.93*)	-	51.35*
Philips/ EU	45.5	44.25	44.59	46.11
Hisense/ CN	80	81.53 (82.28*)	60.11	82.32*
Hisense/ EU	-	82.93	82.28	81.93

Figure 5: of the On mode power results

*measured with HDMI input terminal instead of RF

On mode power measurements according to the EU standard:

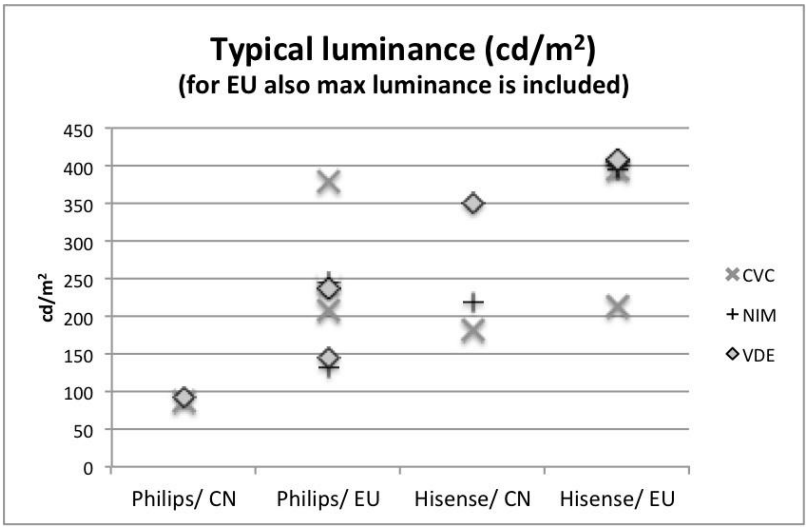
For the power measurements of the Philips according to the EU labelling regulation all institutes reached very similar results close to the declared 45.5W (despite different brightness settings and at different luminance levels, see below). The measured On mode power of the Chinese TV is around 80% higher than that of the EU TV.

On mode power measurement according to the Chinese standard:

CVC's and VDE's On mode power results for the Chinese TV according to the Chinese standard are close to the declared 80W; the deviation is below 3%. The result from NIM however is 25% lower. (For the luminance however CVC and NIM's results are closer to each other, while VDE measured at a much higher luminance – see below).

Also for the power measurement of the EU TV the results by VDE and CVC are very close (51W) (also the measured luminance does not differ too much, see below). NIM could not adjust the Philips model to the 8-greylevel-signal and did not report a valid result for this measurement. Also VDE reported problems to adjust the Philips TV to the 8-greylevel-signal of the Chinese standard, and finally chose the same settings as CVC. Using the HDMI input terminal instead of RF for the measurement by VDE does not seem to be leading to large differences in the results.

Luminance



Luminance (cd/m^2)	Typical luminance			Max. Luminance (EU)		
	CVC	NIM	VDE	CVC	NIM	VDE
Philips/ CN	87.62 (87.77*)		92.93*			
Philips/ EU	207.5	131.36	146	380.2	245.54	237.2
Hisense/ CN	182.95 (183.44*)	219.64	351.23*			
Hisense/ EU	213.8	395.9	405.1	394.5	401.08	407.6

Figure 6: Results of the luminance measurements

*measured with HDMI input terminal instead of RF

Figure 6 shows that for both TVs the luminance is higher at factory settings (EU standard) than when adjusted according to the Chinese 8-greylevel-signal. So, many Chinese TVs are measured at lower brightness than they are delivered with. The detail brightness and contrast setting chosen by the institutes for the luminance (and power) measurement are displayed in table 8.

Table 8: Brightness and contrast settings chosen for the luminance measurements

			Brightness setting	Contrast setting	Luminance (cd/m^2)
GB 24850	CVC	Philips	37	100	87.6
		Hisense	50	78	183.0
	NIM	Philips	-		-
		Hisense	54	73	219.6
	VDE	Philips	37	100	92.9
		Hisense	50 (48*)	78 (48*)	351.2 (303.2*)
EU 1062/2010	CVC	Philips	37	100	207.5
		Hisense	45	76	213.8
	NIM	Philips	Factory settings		131.4
		Hisense	Factory settings		395.9
	VDE	Philips	50	75	146.0
		Hisense	50	50	405.1

*settings chosen by VDE's interpretation of the translated standard

Luminance measured according to the EU Energy Label:

The luminance should be measured at factory settings. Once the settings have been changed, they can be regained by selecting 'factory settings' in the menu. Still the brightness and contrast settings chosen by the institutes and the luminance measured differ (table 8).

In the case of the Philips TV, CVC measured a considerably higher luminance than VDE and NIM. NIM's detail settings are not known. When looking at the factory brightness and contrast settings reported by the two other institutes, the difference in the measured luminance cannot be explained.

For measuring the maximum luminance all menu settings should be set to achieve the brightest image that can be obtained. Again, VDE and NIM report similar results for the Philips TV, while CVC measured a much higher maximum luminance (figure 6). Coincidentally, the peak luminance ratios calculated by CVC and NIM (table 2) end up to be very similar, even though they are based on different values.

For the Hisense it is the other way round: CVC measured around half the luminance of the other institutes when the TV is in the factory settings (table 8). Again, the brightness and contrast settings by VDE and CVC differ, but do not provide an explanation for the different results, while information on the settings chosen by NIM is missing. The Hisense's maximum luminance results obtained by the institutes differ by only around 3% (figure 6).

Luminance measured according to the Chinese standard:

Especially for the Hisense TV, the luminance results the institutes reached according to the Chinese standard also differ. VDE had doubts about their settings and finally chose the settings according to CVC. While the luminance results by CVC and VDE with identical settings are similar for the Philips TV, VDE's luminance result for the Hisense is much higher. NIM chose similar settings for the Hisense, but reached a different result. NIM could not adjust the Philips TV model to the 8-greylevel signal. The other two institutes obtained very low luminance results between 87 and 93 cd/m^2 for the Philips TV (figure 6).

Interpretation and limitations

The results according to both standards and for both TVs seem to show little correlation between:

- the brightness settings chosen by the institutes and the luminance measured
- and the luminance measured and the On mode power.

In discussions with the institutes explanations for the deviations were sought.

Part of the background is, that principally there are two ways to change the brightness in LCD TVs: either by the LCD layer, which works as a shutter and varies the amount of light that can get through,

or by changing the intensity of the backlight. The LCD layer has no effect on the power, but the brightness of the backlight does. The two tested TVs use different technologies: the Hisense TV, a relatively simple model, adjusts its brightness through the LCD layer, while the intensity of the backlight cannot be changed. Therefore the product always has the same power while in On mode, and, during the test by VDE, its power ranged from 81.8W to 82.4W only over the course of the dynamic broadcast content. The Philips TV on the other hand is more sophisticated: the 'dynamic backlight' setting leads to a lower power at dark scenes through dimming some LEDs of the backlight. Its power ranged from 37W to 57W during the test, depending on the brightness of the scenes. So, in the case of the Philips TV, a higher brightness can be associated with higher power, but is not necessarily so (when achieved uniquely by the LCD layer). The Philips also has an Automatic Brightness Control (ABC) adapting the brightness to the ambient light intensity, while the Hisense does not have such a function.

For the Hisense TV an explanation could not be found regarding the deviations between the institutes' test results. NIM's power result according to the Chinese standard (60W) cannot be explained. VDE could not achieve any modifications in On mode power in this model, and also CVC reports only values around 82W. The deviations between the luminance measured by the institutes according to the Chinese standard could partly be explained by the bad repeatability of the test. The Chinese institutes follow a methodology where several test engineers separately define the brightness settings according to the 8-greylevel-signal to obtain the best visibility, before discussing and agreeing on a certain procedure. CVC and NIM chose different settings, which could have lead to the different luminance results. Why VDE measured a higher brightness when choosing the settings according to CVC is not understood. Also not clear is why the institutes chose different 'factory' brightness and contrast settings for the measurement according to the EU standard, which may have lead to the lower luminance result CVC reports here.

In the case of the Philips model, the complexity of the product's setting possibilities offers some explanations for the different results obtained by the institutes. At first look it seems that the institutes did not choose identical brightness and contrast settings when measuring in the factory settings for the EU Energy Label– despite there being a 'factory settings' function in the menu. First it was found that the factory settings defined in the menu can be changed by software updates. Secondly, the 'factory settings' button in the Philips does not reset all possible settings: the 'colour temperature' for instance, which does influence the power by around 5% and the luminance by 30%, has to be reset manually.

Also different sound volume settings can have a faint influence on the power (Δ < 1W), and there is a contradiction between the EU Labelling regulation (asking for factory settings) and the IEC 62087, which defines a certain sound power level. Additionally, the ABC should be switched off for the test. CVC and NIM however both reported to have left the ABC on for the measurements according to the EU Energy Label, due to a misunderstanding. In the dark conditions of a test room, switching on the ABC can change the power by 15% and the luminance by 20%. It seems that when combining different setting options, the power and brightness differences of 5 to 20% can multiply and add up to around 30%. This can explain the luminance differences the institutes report for the EU Energy Label. The maximum luminance should be measured 'with the brightest picture which can be obtained by changing the menu settings'. This open formulation includes all menu settings affecting the brightness. But the very high maximum luminance CVC has reported could not be explained.

The Chinese Labelling Standard does not seem to be ready for TVs with complex menus as the Philips. The instruction as how to adjust the picture to the signal contains reference only to a few settings, such as 'contrast' and 'brightness'. It is not clear how to proceed with other settings affecting the brightness, e.g. the backlight.

Conclusions

The outcome shows three unambiguous results:

1. According to the EU Energy Label the most energy efficient European TV is more efficient than the best Chinese TV.

2. According to the Chinese Energy Label the most energy efficient Chinese TV is more efficient than the best European TV.

3. The Chinese TV has a higher On mode power than the European TV.

1 and 2 are possible because to the different definitions of 'TV efficiency' by the Chinese and the European Energy Labels: while in Europe an efficient TV is one that consumes little power relative to its screen size, the most efficient TV in China is the one that is brightest relative to its power.

The fact that the European TV performs better according to the EU Energy label, and the Chinese TV performs better according to the Chinese Energy Label shows that manufacturers adjust their products very much to the details of energy labels and standards; the energy label does have a strong influence on product design. The European Philips TV is even difficult to assess according to the Chinese standard (two of the institutes reported difficulties to adjust it according to the 8-greylevel-signal); the product was not designed to be measured with this standard. It is therefore crucial that an energy label (and other instruments such as MEPS) is well defined. If the label aims at saving energy, the label should indeed favour the most energy saving products by choosing an appropriate definition of energy efficiency. The measurement procedure should reflect real usage conditions and not leave room for interpretation.

The third result implies that the European Energy label does better when it comes to favouring energy saving TVs than the Chinese standard. The luminance results however also show that the European TV is darker than the Chinese TV for most of the measurements. The European standard favours dark factory settings (down to 60% of a – sometimes – low maximum brightness), which bears the risk that the brightness settings are tuned higher as soon as the product is installed at home and the effective energy consumption is higher than declared. Stiftung Warentest found that after improving the picture quality by changing the factory settings, the On mode power of (European) TVs could increase by 50% [13]. The Chinese standard on the other hand favours very bright TVs.

According to the EU standard, On mode power measurements deliver similar results, but the luminance results show bigger disparities. The differences in the results according to the Chinese standard are large - the results do not seem to be fully repeatable.

Comparison with SEAD results

SEAD awarded 'most efficient TVs' for four different regions of the world for three size ranges [6]. The two TV models tested in the present study were not among the awarded models. China was not a focus region of SEAD. In Europe and North America the awarded TV models were also on the Topten lists and are among the most efficient TVs. According to the Topten lists, which refer to regional or national standards and labels, the TVs awarded by SEAD are however not the most efficient models. A main reason for the different outcome can be the different selection methods: while Topten covers the entire market of interest, manufacturers had to apply for the SEAD award. TVs were tested for the SEAD award – for all regions according to the same measurement procedure. TVs that were awarded as efficient according to the SEAD method are not necessarily the most efficient TVs when assessed according to regional measurement standards and labels.

Main problems discovered in the standards

EU Energy Label

A major problem of the EU Energy Label for TVs is the staged introduction of the A+-classes, which is scheduled too late: in 2012, the best TVs already reached class A++ [14]. This class will however be displayed on all labels in 2017 only, and A+ in 2014 [7]. Before this, all TVs not reaching the A+ class feature labels where A is the top class – signalling to consumers that this is the BAT.

Another flaw is that the EEI and the energy class cannot be verified from the declared values. Apart from that, the minimum peak luminance ratio is not clearly defined. The standard favours dark factory settings with sometimes poor picture quality [13]. Consumers will in some cases have to change the settings to achieve a better picture and end up with a higher electricity consumption than declared. Other problematic aspects:

- The Pbasic for calculating the reference power depends on the number of tuners, but it is not clearly defined what an individual tuner is. The verification authorities from Germany and VDE assume that even a tuner which is capable of decoding DVB-T, -C and –S signals is only

accounted for as more than one tuner if more than one of these can be used in parallel. The Energy Labelling regulation however does not specify this interpretation, neither does the accompanying guideline [15]. Therefore the EEI and the energy class cannot easily be verified.

- TVs that have an ABC and/or a function that automatically reduces the luminance below at least 20 lux activated in the factory settings receive a 5% discount on the measured On mode power for the EEI calculation. From the technical datasheet nobody can tell if this is true or not. This also complicates the verification of the declared EEI and the energy class.

  For the revised Ecodesign regulation even a 10% reduction is recommended [16] – with however appropriate measurement and requirements for an ABC (progressive reduction of screen illuminance below 300 lux).
- The EU Energy Label asks for measurements in the factory settings, but due to complex menus, these are not easy to retrieve once the settings have been changed. Also the detail factory settings in one model can change over time through software updates. Several changed settings can lead to differences in power and luminance of around 30%.
- The peak luminance ratio is problematic: the ecodesign regulation requires it to be 65% at least. In the very same document however it is stated that 60% is sufficient (including measurement tolerances). So manufacturers set the luminance at 60% of the peak luminance and declare it to be 65% - all conform. Moreover luminance values are not declared, and therefore cannot be checked.
- A total of seven different documents are needed to define or to verify the declaration and compliance of TVs. Most documents and standards are not clearly referred to and not clearly defined (IEC 62087 is recommended to be used for assessing the On mode power; in a different document, two standards for the luminance measurement are recommended). Without insider knowledge it is not possible to measure a TV according to the energy label.

Chinese standard

The main problems are the lack of declaration and the settings for both the power and luminance measurement based on the 8-greylevel-signal, which do not seem to be fully repeatable.

- Nothing needs to be publicly declared by the manufacturers: neither the calculated EEI, nor the On mode power or the luminance. Instead manufacturers declare certain EEI and standby power values along the grade limit or subsidy line. It is not possible to compare the products within one label grade regarding their energy efficiency.
- The picture settings for measuring the On mode power do not seem to be distinct. The standard does not specify if the picture quality also needs be changed with the ‘backlight’ setting.
- The settings for a measurement over the HDMI input terminal are not defined in the standard. Accordingly HDMI is by now a trend on the market, but RF is still dominating.
- Different values for the signal processing power Ps are subtracted from the measured On mode power value, depending on the input terminal: Ps=10W for analogue RF input, but 17W for digital RF input. Manufacturers can thus achieve the best results by choosing the most convenient input terminal (with the largest Ps). Ps for the HDMI input terminal is not defined. The formula in the new draft standard GB 24850-201X [17] does not contain any Ps or other value to be subtracted from the measured power any more.

Recommendations for a harmonised Energy Label and standard

- An energy label should aim at reducing energy consumption by guiding consumers to the products that consume the least energy while still providing their function. As the results of this project imply, energy labels also strongly act on manufacturers and influence product design. Therefore it is important that a label is designed to label those products with good grades or classes that really help to lower the energy consumption.
- The usual approach however is to allow a higher energy consumption for products which offer ‘more’ function (larger screen, brighter image, higher capacity or volume, etc.) [18], and

usually for larger products it is easier to obtain good grades. This leads consumers to choose larger or brighter products than needed based on the good energy class or grade – which do not fulfill consumers' expectations to save energy, but actually consume more energy than needed.

- In order to contribute to energy savings, energy labels should make the higher energy consumption by larger, brighter or stronger products visible instead of rewarding increased size, brightness or capacity: grade and class limits should consequently be defined based on a degressive or even capped approach. This requires larger products to be of higher efficiency in order to reach good grades than smaller products.
- As for the brightness settings, the European approach seems reasonable: to measure at factory settings influences the way the products are delivered or the 'home' mode. TVs should be measured in those settings the consumer is most likely to choose in order to reflect real usage conditions – and the factory settings are quite probable to be used also after installation, as long as these settings are not too dark. Since consumers can change the settings in any case, it is good to also tackle the maximum brightness. If this is much brighter than how the TVs are measured, the real energy consumption can be much higher than declared. The min. 65% of maximum brightness in delivery state requirement leads manufacturers to renounce on unnecessary high maximum brightness settings. The wish for a bright 'Shop' mode should guarantee a certain minimum brightness. Still, it cannot be excluded that dark factory settings are preset which have to be changed by consumers, who then end up with a higher electricity consumption than what is declared.
- The Chinese standard does the opposite: it favours bright (and large) TVs, which acts against the energy label's main aim to save energy. With an energy label similar to the European one, where higher brightness is not rewarded, manufacturers have to find a midway between too low (bad visibility in shops) and too high (bad energy grading) brightness.
- The measurement at factory mode seems to be clearer than at a predefined brightness (which has to be obtained first by changing the settings with a test pattern). The problem that the factory settings are difficult to retrieve and can change over time should be solved – e.g. with a requirement for an easy reset possibility of all parameters.
- A harmonised standard should define test patterns to be used for the brightness measurement, which is distinct and leaves no room to adapt settings. A measurement standard should include advice as how to change the settings in order to obtain the brightest image (including 'backlight' setting, colour temperature, contrast etc.).
- ABC should be considered in an appropriate way (a discount that reflects the energy savings that are indeed achieved at real usage conditions).
- The relevant measurement standard instructions and broadcast signal materials should be clearly referred to, the procedure and broadcast content or test pattern should be distinctly defined, similar to the current Chinese standard.

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[9] European Commission: 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

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