Finding the most energy efficient TV in China and in Europe: not such an easy job…

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Abstract

Judging from the declared On-mode power found on Topten China and Topten Europe, the most energy efficient TVs on the European market seem to be far more efficient than those on the Chinese market. Topten International wanted to find out whether this finding is a fact or whether different measurement protocols and methods caused the difference.

An international testing project was launched: three testing institutes, CVC and NIM from China and VDE from Germany, each tested the most efficient 46-inch-TV from Topten China and from Topten Europe according to the Chinese and the European Energy labels and the relevant measurement procedures. The TV models selected for the test were the A++-Philips 46PFL6806K (Europe) and the Hisense LED46K200 (China). The results were used to verify the values declared by the manufacturers and to check the products' compliance with relevant minimum requirements.

The results show that the On-mode power of the European TV model is indeed considerably lower than that of the Chinese model. Whether this makes the European model a more energy efficient TV than the Chinese model however depends on the perspective: while according to the EU Energy Label the European TV model is more energy efficient than the Chinese model, on the Chinese Energy Label the latter reaches a better grade than the EU-TV. The reason is to be found in the different definitions of TV energy efficiency: the EU Energy Label defines TV efficiency as a low power input for a given screen size, while in China the most energy efficient TVs are those with the highest brightness for a given power input.

This testing project provides detail insights of strengths and weaknesses of the different measurement standards, which can be used to conclude on specific improvements. The results show that the definition of efficiency and the specificities of measurement methods obviously have a very strong influence on product design.

Introduction

Topten is a tool to promote the most energy efficient products with producers and retailers, to raise consumer awareness, and to inform policy makers. 19 national Topten sites provide information on the most energy efficient products available on their local markets. Products on Topten are selected according to official regional or national Labels and standards.

Topten aims at achieving a wide distribution of the most energy efficient technologies. Usually only little is know about the Best Available Technology (BAT) and it is especially hard to compare the efficiency of similar products across continents, because different definitions of efficiency and different measurement standards are applied (Attali et al., 2011 and Bush et al. 2011).

A comparison of the energy consumption of TV models on Topten China, Europe and USA by Sun Wei, Topten International Services (TIS), showed - based on data published on Topten lists - that Chinese TVs have a higher energy consumption than European and American models (Sun Wei, 2011).

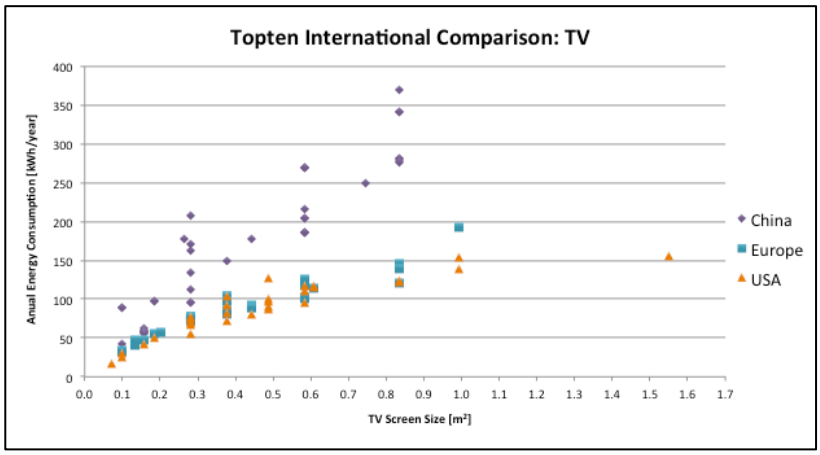


Figure 1: Annual Energy Consumption of Topten TVs. Source: Sun Wei, 2011.

Topten International[1] questioned whether TVs on the Chinese market are indeed less efficient than on the European (and the US) markets. In order to investigate this question, a testing project was launched: a highly efficient TV model from China and from Europe were both tested according to the Chinese and the European Energy Label. Key questions of the project:

- are TVs on the Chinese market indeed less efficient than European TVs?
- If yes, why and to what extent?
- If not: why do manufacturers declare a higher energy consumption in China?

An additional aim of the project was to understand the measurement methods and their differences, with the long term goal of achieving improved standards and global standard harmonisation. A main difference were certainly the definitions of TV efficiency. While in Europe an efficient TV is one that uses little power relative to its screen size (European Commission, 2010), in China, the most efficient TV is the one that is brightest relative to its power (CNIS, 2010). The measurement project also contributes to the verification of the declared power and efficiency values, and to find out to what degree different testing institutes reach different results.

At the same time the very best available TV technology from China and Europe shall be determined: what is the highest efficiency a TV model can reach today? The results help to distribute high efficiency technology worldwide.

Also the Superefficient Equipment and Appliance Deployment (SEAD) Initiative[2] aimed at determining the most efficient TVs of the world and in four regions of the world, through a competition, which also took place in 2012. SEAD aimed at finding and awarding the most efficient TV models by testing the nominated models. The results (SEAD 2012) and methodology are compared with the Topten test project in the 'Conclusions' chapter of this paper.

Methodology

The most efficient TV model on the Chinese and the European markets were purchased and the products' energy efficiency was tested according to the Chinese and the European measurement standard by three participating testing institutes. The standards relevant for the energy labels were applied.

Product selection

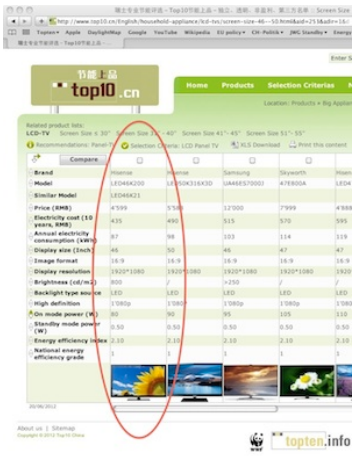
[1] www.topten.info
[2] www.superefficient.org

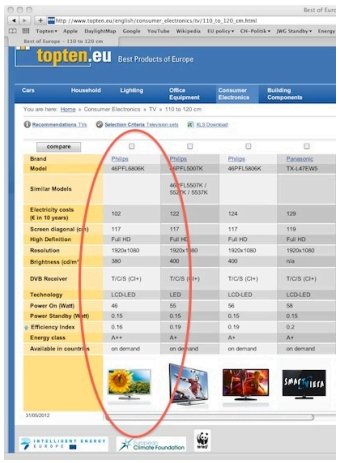
The most energy efficient TV models on the Chinese and on the European market were selected from the product lists from Topten China and Topten Europe, respectively. In order to be comparable, both TV models were required to be of the same size and to have similar features:

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

The best TV models on Topten China and Topten Europe were selected for the test end of June 2012. From the TVs in the scope, those two models with the lowest On mode power were chosen:

- Topten China: Hisense LED46K200
- Topten Europe: Philips 46PFL6806K





Figures 2, 3: Topten China and Topten EU product lists with the selected TV models (June 2012)

Table 1: Specifications (declared by manufacturers) of the two selected TV models

Declarations according to	Chinese standard	European standard
Brand	Hisense	Philips
Model	LED46K200	46PFL6806K
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	2.10	0.16
Energy label grade / class	1	A++

Product testing

Three testing institutes participated in the project:

CVC: Guangzhou Vkan Certification & Testing Institute, China National Center for Quality Supervision & Test of Electrical Appliances. Guangzhou, China.

NIM: National Institute of Metrology. Beijing, China.

VDE: Association for Electrical, Electronic and Information Technologies VDE. Offenbach, Germany.

Both TVs were tested by the institutes according to the Chinese and the European measurement standards relevant for the respective Energy Labels:

- China: GB 24850: 2010 Minimum allowable values of energy efficiency and energy efficiency grades for flat panel televisions. The standard refers to the dynamic broadcast content of the IEC 62087:2008 standard for the measurement of the On mode power. GB 24850 also includes a method for measuring the luminance and the Standby power.
- Europe: EU regulation No 1062/2010 on energy labelling of TVs (EC, 2010). For the measurement of the On mode power the IEC standard for the measurement for the power consumption of audio, video and related equipment is applied (IEC 2011). For the Standby measurement the regulation refers to the standard for measurement of low power consumption (CENELEC 2011).

Main differences between the Energy Labels and measurement standards

European TVs are classified according to their energy efficiency on a labelling scale from class A++ (Best Available Technology) to D (tier 2 of the Ecodesign regulation (EC, 2009)) (EC, 2010). The Chinese energy label classifies TVs on a scale from grade 1 (most efficient) to 3 (just above the minimum allowed efficiency level) (CNIS, 2010). The grade 1 limit is higher (less efficient) for plasma TVs than for LCD TVs.

The EU energy label is based on a definition of TV efficiency as On mode power relative to the power of a reference TV of the same screen area ($P/P(dm^2)$). For the efficiency measurement, the TV's screen area and its On mode power are relevant; the luminance is not considered for the assessment of the efficiency. However, it is required to be at least 65% of the maximum luminance in factory settings.

The Chinese energy efficiency standard and label defines TV efficiency as luminous intensity relative to the power (cd/W): the most efficient TV is the one that is brightest relative to its power. To assess the efficiency of a Chinese TV the luminance, the screen area and the On mode power are considered.

In both Energy Labels larger TVs can use more power (EU: because the larger reference TV also has a higher power input; CN: because a larger TV has a higher luminous intensity ($Cd = Cd/m^2 * m^2$)) without getting a worse classification. In Europe brighter TVs need to be more efficient than darker ones in order not to get a worse classification (because higher brightness usually requires higher power input), while in China, additionally to larger TVs, also brighter TVs can use higher power without getting 'punished' with a bad grade.

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

- Chinese energy label: brightness and contrast settings are adjusted to a 8-greylevel-signal; Automatic Brightness Control (ABC) is switched off.
- EU energy label: factory settings ('out of the box') or in 'home mode' if a forced menu is applicable. ABC is switched off.

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

Results

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

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

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%

All test institutes report the Philips TV to be of higher efficiency than the Hisense TV when assessed according to the European energy label. The results on EEI and efficiency class are well comparable, for the luminance ratio the institutes however reach different results.

For the Philips 46PFL680K all institutes calculated an EEI slightly above 0.16 and thus report an energy efficiency class A+ for the Philips TV – while Philips declares it to be in class A++. According to the Labelling regulation TVs which have the Automatic Brightness Control (ABC) activated receive a 5% reduction on the measured On mode power for the calculation of the EEI. The Philips TV does have its ABC enabled at factory settings. The test institutes did not consider the 5% reduction. If it is considered, the declared A++ class of the TV is however 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 according to the European energy labelling regulation, all test institutes report the Hisense TV to be of higher efficiency than the Philips TV when measured according to the Chinese standard.

For both TVs the three testing institutes reached different EEI results, which even lead to different classifications on the Chinese Energy Label. For the test of the Philips TV according to the Chinese standard, NIM did not report valid results.

Compliance check

The maximum allowed Standby power for TVs is 0.5W (EC, 2009). The Philips 46PFL6806K clearly meets this requirement.

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

How about the Energy Efficiency Class? All institutes reported an A+ for the Philips 46PFL6806K instead of the declared A++. For the calculation of the EEI the institutes missed to include the 5%-discount to the On mode power value, 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 of at least 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 the Energy labelling regulation might not be obvious, and as the test reports show, it can

easily be missed. The table below compares the relevant values without and with 5%-ABC-reduction.

Table 5: EEI calculation for the Philips 46PFL6806K without and with ABC reduction

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 does have a brightness reduction function fulfilling the needed requirements in the factory mode, and it thus deserves the 5% reduction. Since also the On mode power measured by VDE is clearly within the tolerance of 7% for the declared value, the tests have confirmed the declared On mode power, EEI and Energy Efficiency class declaration of the Philips 46PFL6806K.

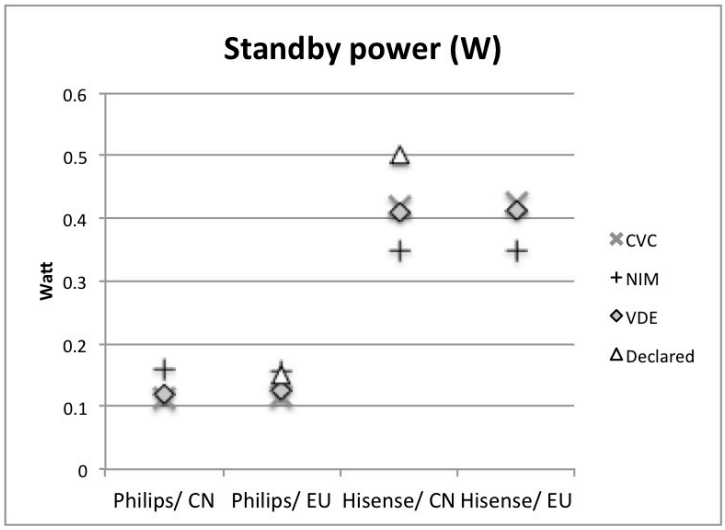
Hisense

The declared standby power of 0.5 W was confirmed by all three testing institutes. 0.5W is the maximum allowed Standby power for TVs (CNIS, 2010). NIM and VDE both 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 and	Grade
Max. required	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	

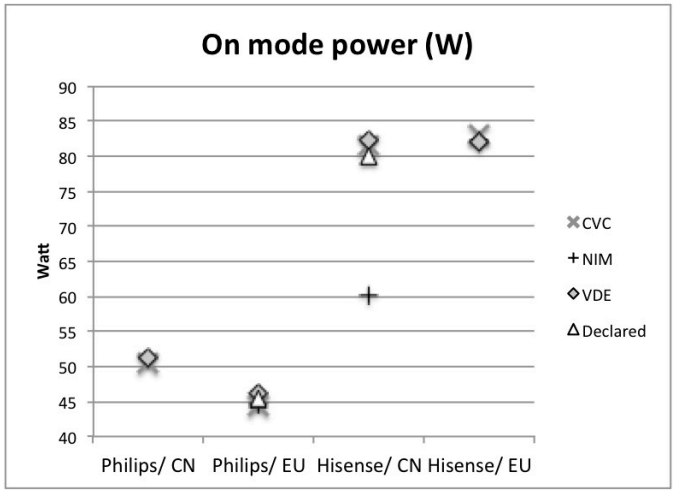
Measured values



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

Figure 4: Results of the Standby power measurements. CN: according to the Chinese Labelling standard. EU: according to the European Energy Label

The deviations in the results for the Standby power are up to 0.12W for the Hisense TV and 0.05W for the Philips. These deviations are larger than the measurement tolerance of the EU Ecodesign regulation (EC, 2009), which is defined as 0.01W. The deviations between the institutes are larger than those between measurement standards, which are no more than 0.1W. The deviations between CVC and VDE are only up to 0.02W (Hisense/EU).



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: Results of the On mode power measurements. *measured with HDMI input terminal instead of RF*

All institutes report the Hisense TV to have a higher On mode power than the Philips TV, for all measurements. Results according to the EU labelling regulation are well aligned between the institutes, while for the measurements according to GB 24850 (CN) NIM reports lower values than the two other institutes for both TV models.

On mode power measurements according to the EU standard

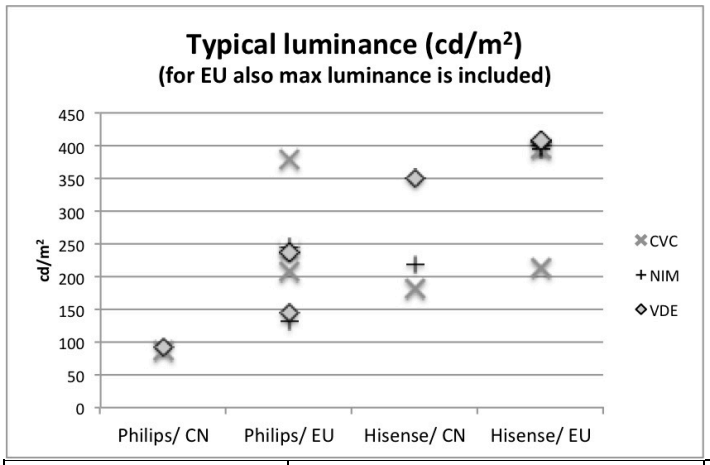
At the power measurements of the Philips TV according to the EU labelling regulation, all institutes reached very similar results very close to the declared value of 45.5W (despite different brightness settings and at different luminance levels, see below). The measured On mode power of the Chinese TV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

On mode power measurement according to the CN standard

CVC's and VDE's On mode power results for the Chinese TV according to the Chinese standard are close to the declared value of 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, 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 (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 instead of RF*

Image 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.

Table 6: Brightness and contrast settings chosen for the luminance measurements

			Brightness setting	Contrast setting	Typical 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 typical luminance should be measured at factory settings. After having changed the settings, these can be regained by choosing 'factory settings' in the menu. Still the luminance settings and the luminance the institutes measured differ.

In the case of the Philips CVC measured a considerable higher luminance than VDE and NIM. NIM's detail settings are not known. Also 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 as to achieve the possibly brightest image. Again, VDE and NIM obtained similar results for the Philips TV, while CVC measured a much higher maximum luminance. Coincidentally, the peak luminance ratio calculated by CVC and NIM (table 2) end up to be very similar, even though it is based on very different values.

For the Hisense it is the other way round: CVC measures only around half the luminance of the other institutes when the TV is in the factory settings. 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%.

Luminance measured according to the Chinese standard

Typical luminance measured according to the Chinese standard differs also, especially for the Hisense TV. VDE had doubts about their settings and 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 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.

Interpretation and limitations

For the results according to both standards and for both TVs there seems to be little correlation between:

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

Explanations for the deviations were looked for in discussion with the institutes.

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 keeps the same power while in On mode, and its power ranges only from 81.8W to 82.4W over the course of the dynamic broadcast content. The Philips on the other hand is more sophisticated: the 'dynamic backlight' setting leads to a lower power at dark scenes through switching off some LEDs of the backlight. Its power ranges 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 by the LCD layer). The Philips also has an Automatic Brightness Control adapting the brightness to the ambient light intensity, while the Hisense does not have such a function.

Not for all deviations between the test results for the Hisense an explanation could be found. NIM's power result according to the Chinese standard (60W) cannot be explained. The other

institutes could not achieve any modifications in On mode power in this model. The deviations in the luminance measured 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 can have lead to the different luminance. 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 sight strikes 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 'factors settings' function in the menu. It was found that, firstly, 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 additionally.

Also different sound volume settings can have a faint influence on the power ($\wedge$ < 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.

Then the ABC should be switched off for the test. CVC however reported to have left the ABC on for the measurements according to the EU 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.

Neither the Chinese Labelling Standard seems 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 'contrast' and 'brightness' settings. It is not clear whether also other settings affecting the brightness, such as 'backlight' or 'colour temperature' should be changed.

Conclusions

The results show 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 thanks 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 possibly

little power relative to its screen size, the most efficient TV in China is the one that is brightest relative to the power input.

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 has not been 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 provide any 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 low declared energy consumption might not be realised. Stiftung Warentest (2011) found that after improving the picture quality by changing the factory settings, the On mode power of (European) TVs could increase by 50%. 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 don't seem to be fully repeatable.

Comparison with SEAD results

SEAD awarded 'most efficient TVs' of four different regions and the world of three size ranges (SEAD, 2012). The two TV models tested in the present study were not among the awarded models. China was no focus region of SEAD. In Europe and North America the awarded TV models are also on the Topten lists and are among the most efficient TVs also according to Topten. 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

The 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++ (Topten. 2012). This class will however be displayed on all labels in 2017 only, and A+ in 2014 (EC, 2010). 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 thus 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 (Stiftung Warentest, 2011). Consumers will in most cases change the settings to achieve a better picture and end up with a higher electricity consumption than declared. Other problematic aspects:

- The number of tuners is not clearly defined. 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 specifiy this interpretation, neither does the guideline. Therefore the EEI and the energy class is not easy to be verified (the P_{basic} for calculating the reference power depends on the number of tuners).
- TVs that have an Automatic Brightness Function (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 (EC 2012) – 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 (or in "home mode" if a forced menu is applicable), 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 minimum peak luminance ratio is not clear: 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 is 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 (the 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

Main problems are the lack of declaration and the settings for the power and the luminance measurement based on the 8-greylevel-signal, which don't seem to be fully repeatable.

- Nothing needs to be publicly declared by the manufacturers: neither the calculated EEI, nor the On mode power nor the luminance. Instead manufacturers declare certain EEI and standby power values along the grade limit or subsidy line, which are supposed to be on the lower and thus 'safe' side of the real value. It is not possible to compare the products within one label grade regarding their energy efficiency.
- The brightness settings for measuring the On mode power don't seem to be distinct. The standard does not specify, if the picture quality shall also be changed with the 'backlight' setting; it mentions only 'brightness' and 'contrast'.
- 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 does not contain any Ps or other value to be subtracted from the measured power any longer.

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 those products that help to really lower the energy consumption are labelled with good energy grades.

  The usual approach however is to grant a higher energy consumption to products which offer 'more' function (larger screen, brighter image, higher capacity or volume, etc.) (Calwell, 2009), and usually for larger products it is easier to obtain good grades. This leads to consumers to choose larger or brighter products than needed based on the good energy class or grade – which don't fulfil consumers' expectations to save energy, but consume more energy than needed.

  In order to contribute to energy savings, energy labels should therefore 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 does not seem to be so bad: to measure at factory settings influences the way the products are delivered or the 'home' mode. They 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 at, 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, there is the danger that dark factory settings are preset which consumers have to change, who then end up with a higher electricity consumption than 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, 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 should however 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 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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