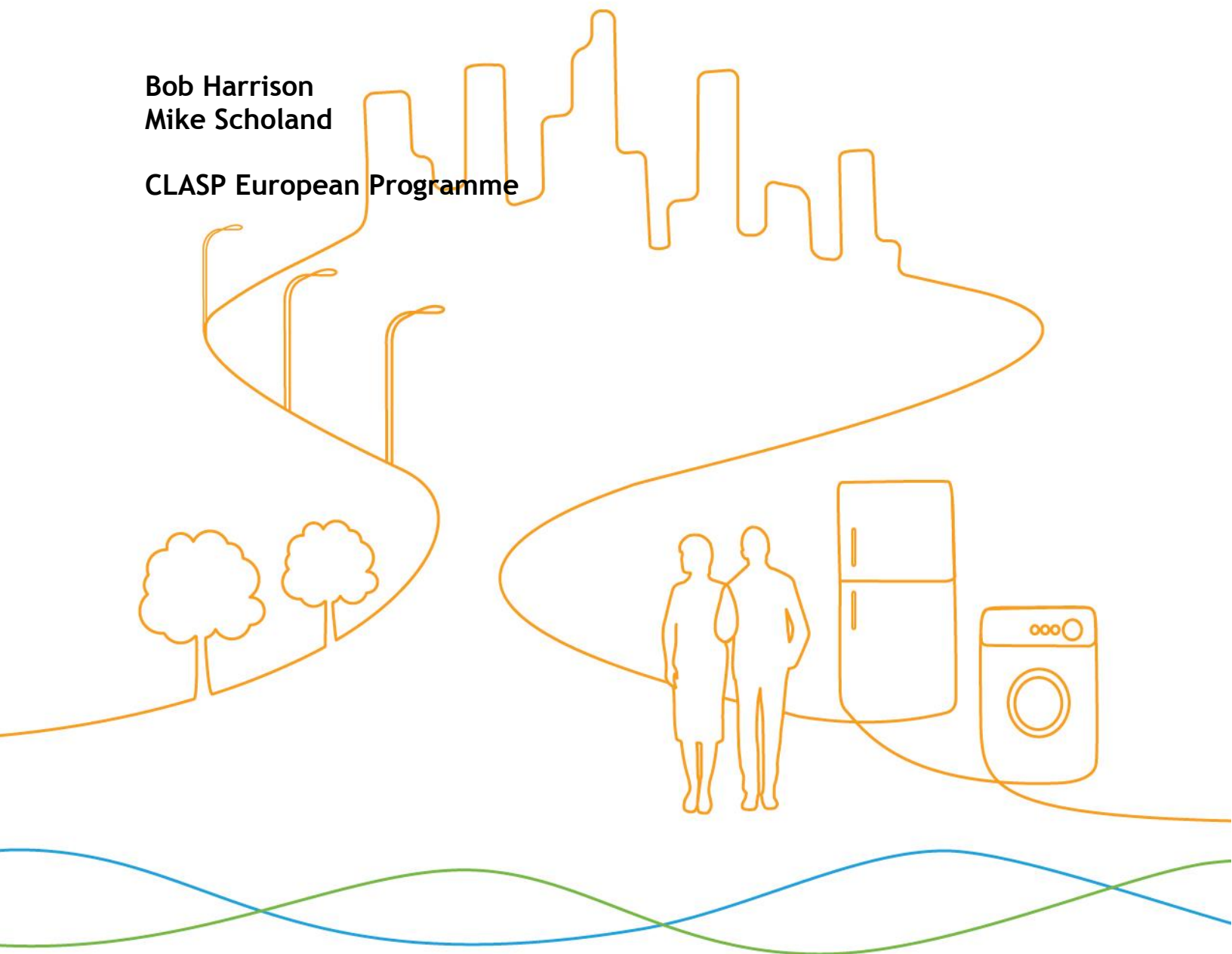


Review of Ecodesign and Energy Labelling Regulations for Televisions and Draft Regulation for Electronic Displays: Discussion Paper

10 November 2014

**Bob Harrison
Mike Scholand**

CLASP European Programme



Contents

1. INTRODUCTION	1
1.1. EUROPEAN REGULATIONS AND DECISIONS FOR DISPLAYS.....	2
1.1.1. <i>Television Ecodesign Regulation 642/2009</i>	2
1.1.2. <i>Television Energy Labelling Regulation 1062/2010</i>	3
1.1.3. <i>Television Eco-label (2009/300/EC)</i>	6
1.2. ENERGY STAR LABELLING IN THE US	7
1.2.1. <i>Television ENERGY STAR labelling (v.6.1)</i>	7
1.2.2. <i>Computer monitor Eco-label (2011/337/EU)</i>	8
1.2.3. <i>Television ENERGY STAR labelling (v.6.1) Computer monitor ENERGY STAR labelling (version 6.0 and EU Decision 202/2014)</i>	9
2. EUROPEAN MARKET OVERVIEW	12
2.1. SHIPMENTS AND SCREEN SIZE	12
2.2. RELATIONSHIP BETWEEN COST AND ENERGY EFFICIENCY LEVEL	14
2.3. AVERAGE ENERGY CONSUMPTION	15
2.4. CHANGING TV TECHNOLOGIES	16
2.5. IMPACT OF THE COMMISSION REGULATIONS	17
3. ISSUES TO BE ADDRESSED IN A REVISION OF THE REGULATIONS	20
3.1. TECHNOLOGY EFFICIENCY TRENDS	20
3.1.1. <i>Organic Light Emitting Diode Televisions</i>	21
3.1.2. <i>Quantum-dot LED TVs</i>	21
3.2. PRODUCT FEATURES	23
3.2.1. <i>Three Dimensional (3D) Screens</i>	23
3.2.2. <i>Internet-connected televisions</i>	24
3.2.3. <i>Automatic Brightness Control</i>	25
3.2.4. <i>Enhanced Reactivation and Mode Control Options</i>	26
3.2.5. <i>Ultra High Definition TVs</i>	27
4. REGULATORY REQUIREMENTS	30
4.1. DATABASE PROVIDED BY DIGITALEUROPE.....	30
4.2. PROPOSAL FOR ECODESIGN REQUIREMENTS	32
4.2.1. <i>Auxiliary Functions</i>	43
4.2.2. <i>Power management and other modes</i>	44
4.2.3. <i>Peak luminance ratio</i>	44
4.2.4. <i>Other (non-energy) requirements</i>	45
4.3. ENERGY LABELLING	45
4.4. CENELEC HARMONISED EUROPEAN MEASUREMENT STANDARD	48
ANNEX A. DIGITALEUROPE COMMENTS ON THE DISPLAY REGULATION REVISION	49
REFERENCES.....	63

Tables

TABLE 1-1. TELEVISION ECODESIGN ON-MODE POWER REQUIREMENTS FROM REGULATION 642/2009.....	3
TABLE 1-2. TELEVISION ENERGY EFFICIENCY CLASSES FROM EU No 1062/2010.....	5
TABLE 1-3. ENERGY STAR V.5.0 REQUIREMENTS FOR ON-MODE POWER CONSUMPTION.....	9
TABLE 1-4. ENERGY STAR LABELLING REQUIREMENTS FOR MAXIMUM ON-MODE POWER CONSUMPTION (P_{ON_MAX}).....	10
TABLE 3-1. EFFICIENCY IMPROVEMENT OPTIONS IN LCD TELEVISIONS AND DIGITAL DISPLAYS.....	20
TABLE 3-2. COMPARISON OF HD AND NEW UHD DISPLAYS.....	28
TABLE 3-3. 4K UHD RESOLUTIONS, ASPECT RATIOS AND NUMBER OF PIXELS.....	29
TABLE 4-1. ELECTRONIC DISPLAY RESOLUTIONS IN DIGITALEUROPE DATABASE.....	30
TABLE 4-2. VARIABLES IN THE MAXIMUM ON POWER EQUATION – DRAFT EUROPEAN CURVES.....	34
TABLE 4-3. MODELS FROM THE 2014 DATABASE THAT PASS THE THREE TIER LEVELS, GROUPED BY SCREEN SIZE.....	36
TABLE 4-4. DIGITAL EUROPE’S PROPOSAL FOR EEI VALUES AND FUNCTIONS.....	38
TABLE 4-5. MODELS FROM THE 2014 DATABASE THAT PASS THE DIGITAL EUROPE PROPOSED THREE TIER LEVELS.....	39
TABLE 4-6. HYPOTHETICAL PASS-RATE PROJECTING PERFORMANCE IMPROVEMENT FOR DISPLAYS TO 2020.....	43
TABLE 4-7. EXISTING AND SUGGESTED NEW ENERGY LABEL CLASSES AND DISTRIBUTION OF 2014 MODEL DATABASE.....	46

Figures

FIGURE 1-1. EUROPEAN ECODESIGN REQUIREMENTS, TIER 1 AND 2 (EC No 642/2009) FOR FULL HD TVs.....	3
FIGURE 1-2. EUROPEAN ENERGY LABEL CLASSES F THROUGH A+++ FOR TELEVISIONS, EU No 1062/2010.....	5
FIGURE 1-3. EUROPEAN ECO-LABEL FOR TELEVISIONS (2009/300/EC).....	6
FIGURE 1-4. COMPARISON OF US ENERGY STAR MAXIMUM ON-MODE POWER FOR V.6 AND (DRAFT) V.7.....	8
FIGURE 1-5. ENERGY STAR LABELLING REQUIREMENTS FOR MAXIMUM ON-MODE POWER CONSUMPTION (P_{ON_MAX}).....	11
FIGURE 2-1. INCREASING SCREEN SIZE IN EU-24, SALES OF TELEVISIONS FROM 2007 – 2013. DATA: GfK, PUBLISHED IN TOPTEN, 2014.	13
FIGURE 2-2. AVERAGE SALES PRICES OF TV BY ENERGY LABEL CLASS, HOLDING SCREEN SIZE CONSTANT. DATA: GfK, PUBLISHED IN TOPTEN, 2014.....	14
FIGURE 2-3. AVERAGE SALES PRICES OF TVs BY SCREEN SIZE, FOR A-CLASS ONLY AND ALL ENERGY LABEL CLASSES. DATA: GfK, PUBLISHED IN TOPTEN, 2014.....	15
FIGURE 2-4. SALES-WEIGHTED AVERAGE TV ENERGY CONSUMPTION IN EU-24, 2007 – 2013. DATA: GfK, PUBLISHED IN TOPTEN, 2014.....	16
FIGURE 2-5. TV TECHNOLOGY CHANGES IN EU-24, 2007 – 2013. DATA: GfK, PUBLISHED IN TOPTEN, 2014.....	17
FIGURE 2-6. AVERAGE POWER CONSUMPTION OF MODELS SOLD IN EU-24 COMPARED TO ECODESIGN TIERS. DATA: GfK, PUBLISHED IN TOPTEN, 2014.....	18
FIGURE 2-7. EFFICIENT TELEVISION MODELS ON THE EUROPEAN MARKET, JAN 2010 – MAY 2014. SOURCE: TOPTEN.....	19
FIGURE 3-1. QUANTUM-DOT SIZE RELATES TO EMISSION WAVELENGTH.....	22
FIGURE 3-2. EXAMPLE OF POSSIBLE SMART TELEVISION SCREEN SIZE CHANGE.....	25
FIGURE 3-3. COMPARISON OF RELATIVE DISPLAY RESOLUTIONS.....	27
FIGURE 4-1. SCATTER PLOT OF 2014 EUROPEAN MODEL DATA AND 642/2009 MEPS LEVELS.....	31
FIGURE 4-2. ENERGY LABEL CLASS PROGRESSION BETWEEN 2012 AND 2014, MODEL DATABASE (NOT SALES).....	32
FIGURE 4-3. PROPOSED MEPS CURVES AND 2014 DATA, DIFFERENTIATING BETWEEN UHD AND NON-UHD MODELS.....	35
FIGURE 4-4. PROPOSED MEPS CURVES AND 2014 DATA, FOCUS ON SMALL SCREEN SIZES.....	36
FIGURE 4-5. PROPOSED MEPS CURVES AND 2014 DATA, WITH US ENERGY STAR CURVES.....	37

FIGURE 4-6. PROPOSED MEPS CURVES AND 2014 DATA, WITH ENERGY STAR CURVES; SMALL SCREEN SIZE	38
FIGURE 4-7. PROPOSED MEPS CURVES AND 2014 HD ONLY DATA WITH DIGITALEUROPE PROPOSED MEPS	39
FIGURE 4-8. PROPOSED MEPS CURVES AND 2014 HD ONLY DATA WITH DIGITALEUROPE 4K PROPOSED MEPS	40
FIGURE 4-9. COMPARISON OF THE PROPOSED 2014 MEPS LEVELS WITH THE DRAFT 2012 MEPS CURVES.....	41
FIGURE 4-10. COMPARISON OF THE PROPOSED 2014 MEPS LEVELS AND 2012 LEVELS, SMALLER SCREEN SIZES	42
FIGURE 4-11. EXISTING ENERGY LABEL CLASSES WITH PROPOSED MEPS AND 2014 DATABASE	47
FIGURE 4-12. PROPOSED NEW ENERGY LABEL CLASSES WITH PROPOSED MEPS AND 2014 DATABASE	47

Abbreviations

3D	Three Dimensions	EU	European Union
4K	4000 pixels in horizontal dimension (a high resolution digital video format)	GfK	Gesellschaft für Konsumforschung
A	Area	HD	High Definition
ABC	Automatic Brightness Control	HDD	Hard Disk Drive
APD	Auto Power Down	HDMI	High-Definition Multimedia Interface
APL	Average Picture Level	IEC	International Electrotechnical Commission
BRD	Blu-RayDisc	IEEE	Institute for Electrical and Electronics Engineers
CCFL	Cold Cathode Fluorescent Lamp	JRC	Joint Research Council (EC)
CDV	Committee Draft for Voting	kWh	kilowatt-hour
CF	Consultation Forum established under Article 18 of the Ecodesign Directive	LBNL	Lawrence Berkeley National Laboratory (USA)
CEN	European Committee for Standardisation	LED	Light Emitting Diode
CENELEC	European Committee for Electrotechnical Standardisation	LCD	Liquid Crystal Display
CRT	Cathode Ray Tube	MEPS	Minimum Energy Performance Standards
DBEF	Dual Brightness Enhancement Film	MOCVD	Metal Organic Chemical Vapour Deposition
dm	decimetre	MP	Megapixel
DOE	US Department of Energy	NVRAM	Non-Volatile Random-Access Memory
DPF	Digital Picture Frame	OLED	Organic Light Emitting Diode
DVD	Digital Versatile Disc	OJ	Official Journal of the European Union
DVI	Digital Visual Interface	PDP	Plasma Display Panel
EC	European Commission	PO	Power On-mode
EEA	European Economic Area	SCART	Syndicat des Constructeurs d'Appareils Radiorécepteurs et Téléviseurs
EEL	Energy Efficiency Index	TV	Television
EN	European Norm	USB	Universal Serial Bus
ENTR	Directorate-General for Enterprise and Industry (European Commission)	VCR	Video Cassette Recorder
EPA	Environmental Protection Agency (USA)	VGA	Video Graphics Array
ErP	Energy related Products	W	Watt

1. Introduction

According to Article 6 of the 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 televisions¹, the Commission shall review this Regulation in the light of technological progress and shall present the results of this reviews to the Ecodesign Consultation Forum.

Furthermore, according to Article 7 of the Commission Delegated Regulation (EU) No 1062/2010 of 28 September 2010 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of televisions², the Commission shall review this Regulation in the light of technological progress.

- The main objective of this discussion paper is to present to the Commission the results of the evaluation of the application of the above mentioned Ecodesign and Energy Labelling Regulations on televisions.

Furthermore, for displays other than televisions and television monitors (ENER Lot 3), a draft of the ecodesign Working Document on displays was discussed at a Consultation Forum meeting in October 2009. Designing a separate measure for displays, has proven to be difficult because the convergence of products has made it difficult to clearly define separate product categories. Traditional product category definitions relied on different input signals and the presence of a tuner for televisions. But today, any display can be designed to accept a variety of input signals, including broadcast signals for which a tuner (even an external tuner) is required. Also, the amount of energy consumed by the tuner/receiver has decreased significantly. Furthermore, the experience with the current definitions on televisions and television monitors in the Regulations does not provide a sufficiently clear distinction for products on the market.

Therefore, the European Commission is envisaging to merge the review work on the television regulations with the work on the draft regulation on display products and to prepare one set of ecodesign and energy labelling requirements for all electronic displays, including televisions, computer monitors and digital photo frames.

- The second objective of this discussion paper is to present proposals in view of the review of Regulations on Televisions and television monitors that will lay down ecodesign and energy labelling requirements for electronic displays for the consumer market, including televisions, computer monitors and digital photo frames.

This report has been prepared by CLASP with input from stakeholders (including industry) and is presented to the European Commission and the Consultation Forum as an independent contribution to the development of ecodesign and energy labelling criteria for electronic displays.

¹ OJ L 191, 23.07.2009, p. 42

² OJ L314, 30.11.2010, p.64

This discussion paper is structured as follows:

- Chapter 1 provides an introduction to this report, including a statement of the objectives and a summary of the European regulatory and voluntary measures that apply to electronic displays. It also includes some discussion on the United States' Energy Star programme for televisions.
- Chapter 2 provides an overview of the European market, including information on models and trends around screen size and average energy consumption. This chapter also addresses changes in television technologies and assesses the impact of the Commission regulation.
- Chapter 3 discusses the issues for consideration in the revision of the Regulation. This includes trends in energy efficiency and product features such as 3D screens, internet-connected TVs, automatic brightness control, ultra-high definition displays and more.
- Chapter 4 presents the proposed Ecodesign requirements for electronic displays. This includes a presentation of the database provided by DigitalEurope and our analysis of three different potential minimum energy performance standards. The rationale for this proposal is provided.
- Annex A provides the DigitalEurope proposal provided to CLASP in July 2014.

In addition to this discussion paper, an Excel spreadsheet is also available which contains the anonymous database that was used for this analysis (with no manufacturer names). This spreadsheet is available for download on the CLASP website.

1.1. European Regulations and Decisions for displays

This section provides a summary of energy-related requirements of each of the currently applicable Commission Regulations and Decisions, as well as an overview of the United States' ENERGY STAR programme for televisions – both current (v. 6.1) and draft proposed (v. 7.0). For each regulation or programme, a table is included summarising the energy requirements of these policy initiatives.

1.1.1. Television Ecodesign Regulation 642/2009

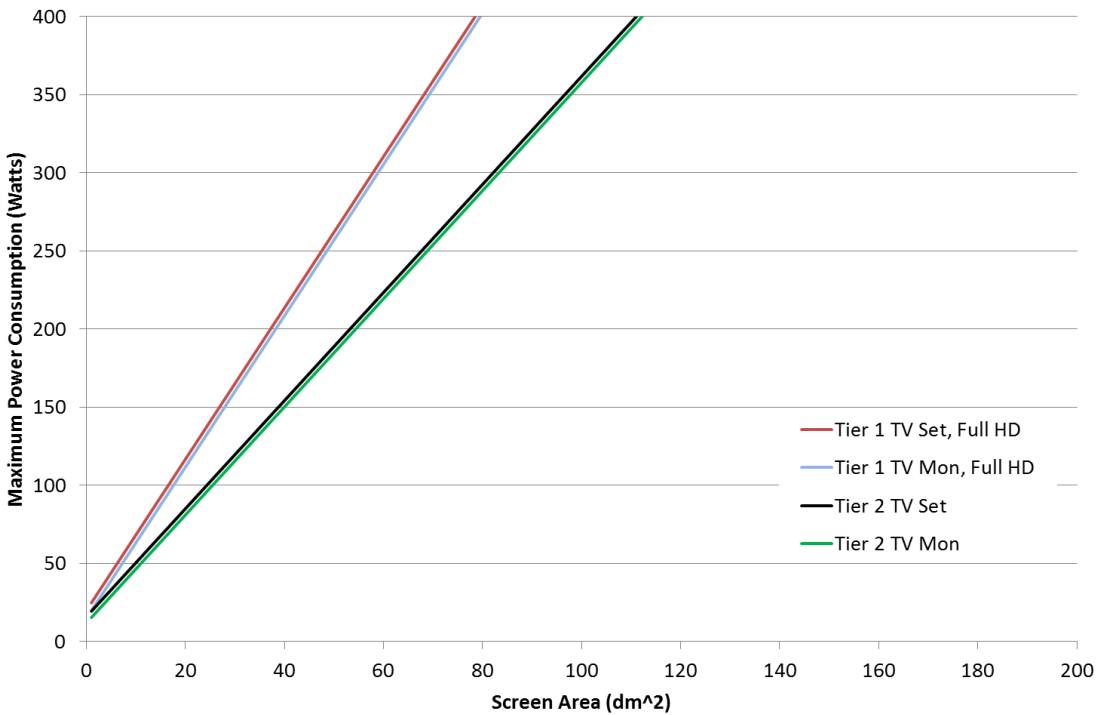
The maximum on-mode energy consumption levels for televisions under the ecodesign requirements are presented below. The Regulation includes two minimum energy performance requirement (MEPS) levels, one that took effect in 2010 and one that took effect in 2012.

Starting on 20 August 2010, the on-mode power consumption of a television with visible screen area A (expressed in square decimetres, dm²) shall not exceed the levels shown as Tier 1 in Table 1-1. Starting on 1 April 2012, the on-mode power consumption shall not exceed the levels shown as Tier 2 in Table 1-1.

Table 1-1. Television Ecodesign on-mode power requirements from Regulation 642/2009

Regulatory Tier	Product	Full HD resolution	All other resolutions
Tier 1 (20 Aug 2010)	Television sets	$20 + A \times 1.12 \times 4.3224$	$20 + A \times 4.3224$
	Television monitors	$15 + A \times 1.12 \times 4.3224$	$15 + A \times 4.3224$
Tier 2 (1 April 2012)	Television sets	$16 + A \times 3.4579$	
	Television monitors	$12 + A \times 3.4579$	

The basic formula established at Tier 1 for television sets at “All other resolutions” represents an EEI of 1.00, which was the 2007 market average. The Tier 2 efficiency level for television sets at Full HD and all other resolutions is equivalent to an EEI of 0.8 because $0.8 \times (20 + A \cdot 4.3224) = 16 + A \times 3.4579$.


Figure 1-1. European ecodesign requirements, Tier 1 and 2 (EC No 642/2009) for full HD TVs

1.1.2. Television Energy Labelling Regulation 1062/2010

The Energy Labelling Regulation for Televisions (EU No 1062/2010) uses a similar equation to the Tier 1 requirements for television ecodesign requirements. There is one general equation for television energy labelling that varies slightly with some of the features incorporated into a television set. For example, slightly higher energy consumption is allowed for television sets with a hard disc or more than one tuner/receiver.

The equation and various input constants below are used for calculating the EEI in the television Energy Labelling Regulation are given below. The EEI is calculated as $EEI = P/P_{ref(A)}$, where:

$$P_{\text{ref (A)}} = P_{\text{basic}} + A \times 4.3224$$

where:

$P_{\text{basic}} = 20$ W for television sets with one tuner/receiver and no hard disc,

$P_{\text{basic}} = 24$ W for television sets with hard disc(s),

$P_{\text{basic}} = 24$ W for television sets with two or more tuners/receivers,

$P_{\text{basic}} = 28$ W for television sets with hard disc(s) and two or more tuners/receivers,

$P_{\text{basic}} = 15$ W for television monitors, and

A is the visible screen area expressed in dm^2 ; and

P is the on-mode power consumption of the television in W measured in accordance with Annex VII, rounded to one decimal place.

The annual on-mode energy consumption “E” which is calculated in kWh of electricity consumption is defined in the energy labelling regulation as:

$$E = 1.46 \times P$$

where:

1.46 is the multiplier used to represent annual energy consumption based on an assumption of four hours of use per day; i.e., $(365 \text{ days/year} \times 4 \text{ hours/day}) \times (1 \text{ kilo} / 1000) = 1.46$ kilohours/year for televisions in on-mode.

P is the on-mode power consumption of the television in W measured in accordance with Annex VII, rounded to one decimal place.

For televisions with automatic brightness control, the EEI and the annual on-mode energy consumption is reduced by 5% if the following conditions are fulfilled when the television is placed on the market:

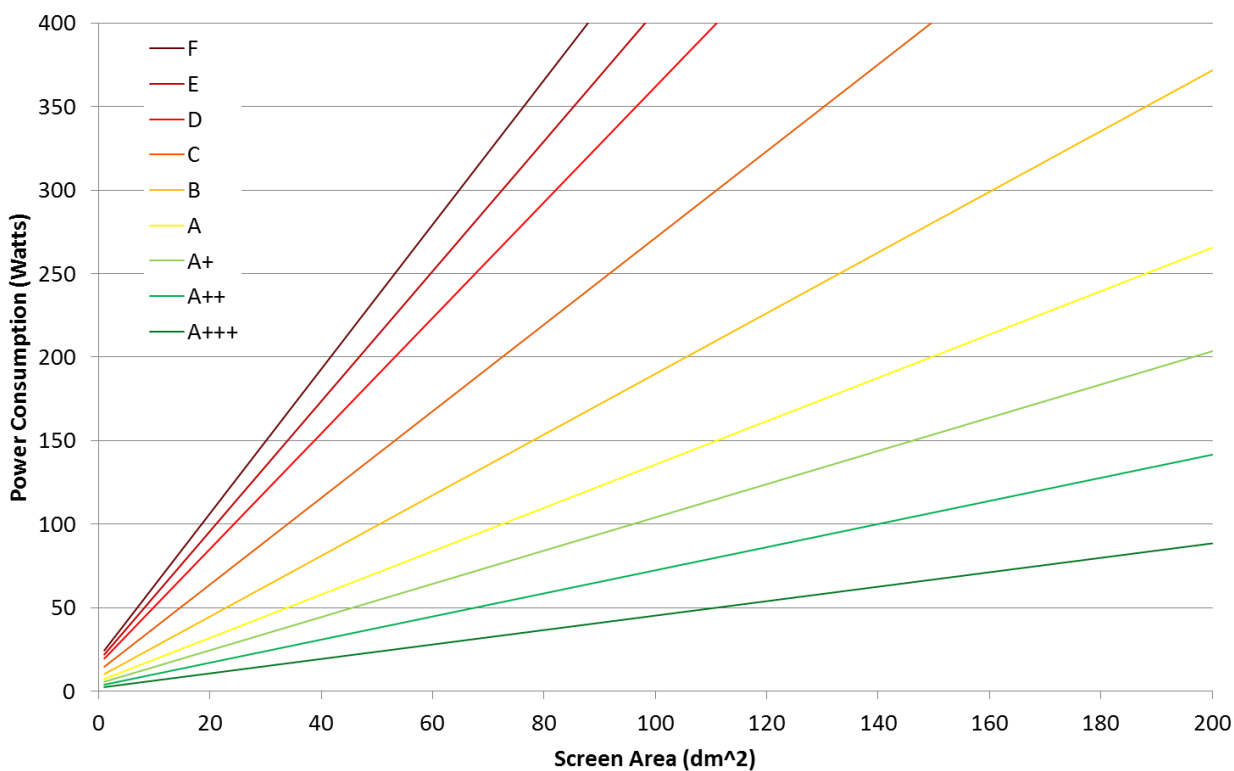
- (a) television luminance in the home-mode or the on-mode condition as set by the supplier is automatically reduced between an ambient light intensity of at least 20 lux and 0 lux;
- (b) the automatic brightness control is activated in the home-mode condition or the on-mode condition of the television as set by the supplier.

Table 1-2 presents the energy-efficiency classes for televisions, as adopted by the Television Energy Labelling Regulation 1062/2010. The regulation presents four label designs, each with a different range of energy efficiency classes, because only seven classes may appear at any one time. Thus, original label is from A to G (from 30 November 2011), followed by a scale of A+ to F (from 1 January 2014), followed by A++ to E (from 1 January 2017) and finally A+++ to D (1 January 2020).

Table 1-2. Television energy efficiency classes from EU No 1062/2010

Energy efficiency class	Energy Efficiency Index
A+++ (most efficient)	$EEI < 0.10$
A++	$0.10 \leq EEI < 0.16$
A+	$0.16 \leq EEI < 0.23$
A	$0.23 \leq EEI < 0.30$
B	$0.30 \leq EEI < 0.42$
C	$0.42 \leq EEI < 0.60$
D	$0.60 \leq EEI < 0.80$
E	$0.80 \leq EEI < 0.90$
F	$0.90 \leq EEI < 1.00$
G (least efficient)	$1.00 \leq EEI$

The graph below presents the plot of the energy label classes presented in the table above, with each line representing the maximum energy consumption or threshold-value for that labelling class.


Figure 1-2. European energy label classes F through A+++ for televisions, EU No 1062/2010

1.1.3. Television Eco-label (2009/300/EC)

The Eco-label is a voluntary programme intended to recognise products meeting ambitious levels of environmental performance, and to inform consumers that these products are among the best in their class. The Eco-label for televisions³ has seven requirements that must be met to qualify for the label. The criteria related to power consumption increase in stringency over time and use the visible screen area (A, expressed in dm²) as the key variable in calculating the maximum power consumption.

The requirements concerning energy consumption are as follows:

- Until 31 December 2010, televisions placed on the market bearing the Eco-label shall have an on-mode power consumption equal to or lower than $0,64 \times (20 + A \times 4.3224 \text{ W/dm}^2)$.
- From 1 January 2011, until 31 December 2012 televisions placed on the market bearing the Eco-label shall have an on-mode power consumption equal to or lower than $0,51 \times (20 + A \times 4.3224 \text{ W/dm}^2)$.
- From 1 January 2013, televisions placed on the market bearing the Eco-label shall have an on-mode power consumption equal to or lower than $0,41 \times (20 + A \times 4.3224 \text{ W/dm}^2)$.

Because these three equations given for the Eco-label are all based on the same basic formula of $(20 + A \times 4.3224 \text{ W/dm}^2)$ which itself represents a 2007 market average EEI of 1.00, the Eco-label threshold values are equivalent to an EEI of 0.64 in 2010, an EEI of 0.51 in 2011 and 2012, and an EEI of 0.41 from 2013 onwards.

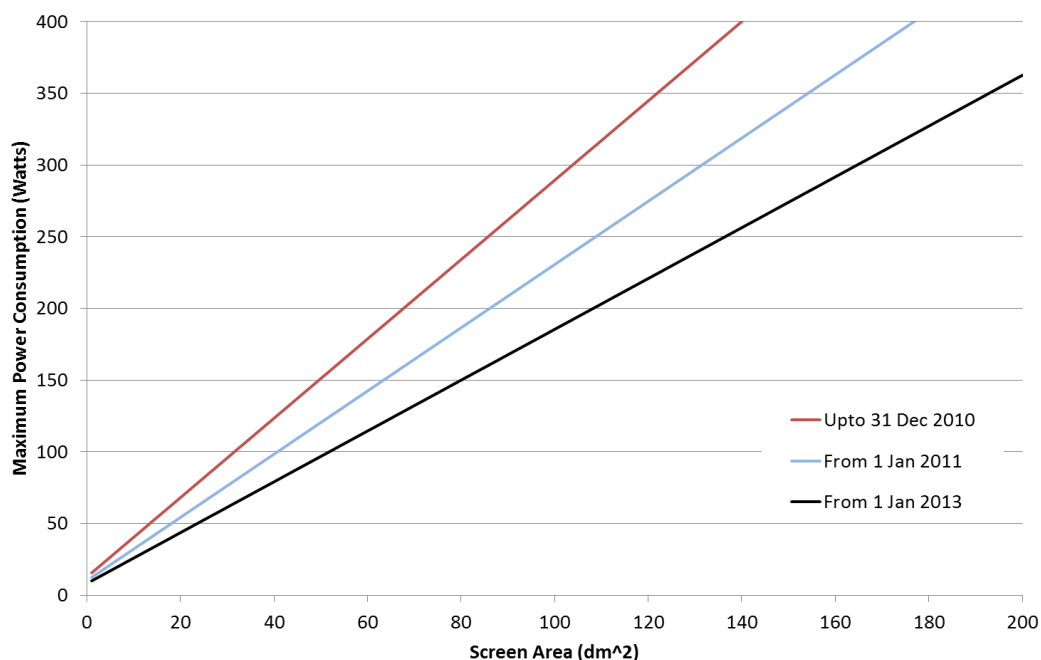


Figure 1-3. European eco-label for televisions (2009/300/EC)

³ Commission Decision of 12 March 2009 establishing the revised ecological criteria for the award of the Community Eco-label to televisions (notified under document number C(2009) 1830) (Text with EEA relevance) (2009/300/EC)

1.2. ENERGY STAR labelling in the US

The ENERGY STAR programme is a voluntary labelling scheme for manufacturers of energy-efficient products to obtain recognition for those products that meet specific performance requirements. The US Environmental Protection Agency (EPA) has offered the market an ENERGY STAR labelling scheme for televisions since 2001.

1.2.1. Television ENERGY STAR labelling (v.6.1)

The current specification for ENERGY STAR Televisions is version 6.1, which was issued on 22 January 2014. Version 6.0 became effective on 1 June 2013, and was slightly revised on 22 January 2014, but this revision did not change the energy-efficiency requirements shown above.

Revision 6.1 is built upon the previous version (6.0), but had a few changes including:

- incorporates the US Department of Energy's (DOE's) Test Procedure Final Rule for Television Sets (78 FR 63823), published on Oct. 25, 2013,⁴
- requires the measurement for on-mode testing with ABC enabled by default, and
- changed the required sample size for testing.

The following italicised text provides the energy-efficiency requirements of ENERGY STAR version 6.1.⁵

On Mode Power Consumption Requirements:

$$P_{ON_MAX} = 100 \times \tanh(0.00085 \times (A - 140) + 0.052) + 14.1$$

Where:

P_{ON_MAX} is the maximum allowable On Mode Power consumption in W

A is the viewable screen area of the product in square inches, calculated by multiplying the viewable image width by the viewable image height

***tanh** is the hyperbolic tangent function.*

However, the EPA's ENERGY STAR programme for televisions is currently under review, with a draft specification (version 7.0) that was issued in September 2014. The requirements are presented below, and curves that correspond to these requirements are shown in the figure that follows.

Maximum On Mode Power Requirement

$$P_{ON_MAX} = 71 \times \tanh(0.0005 \times (A - 140) + 0.045) + 14$$

Where:

P_{ON_MAX} is the maximum allowable On Mode Power consumption in watts;

A is the viewable Screen Area of the product in square inches; and

***tanh** is the hyperbolic tangent function.*

⁴ Appendix H to Subpart B of 10 CFR Part 430 along with 10 CFR Part 429.25; the Final Rule for which can be found here: <http://www.regulations.gov/#!documentDetail;D=EERE-2010-BT-TP-0026-0076>

⁵ Taken from the EPA's website: http://www.energystar.gov/index.cfm?c=tv_vcr.pr_crit_tv_vcr

The figure below presents a comparison of the on-mod power requirements of EPA Energy Star version 6.0 and (draft) 7.0. There is less ambition at the very small screen sizes (<12" diagonal), but there is a reduction of approximately 40% of the power consumption for the larger screen sizes.

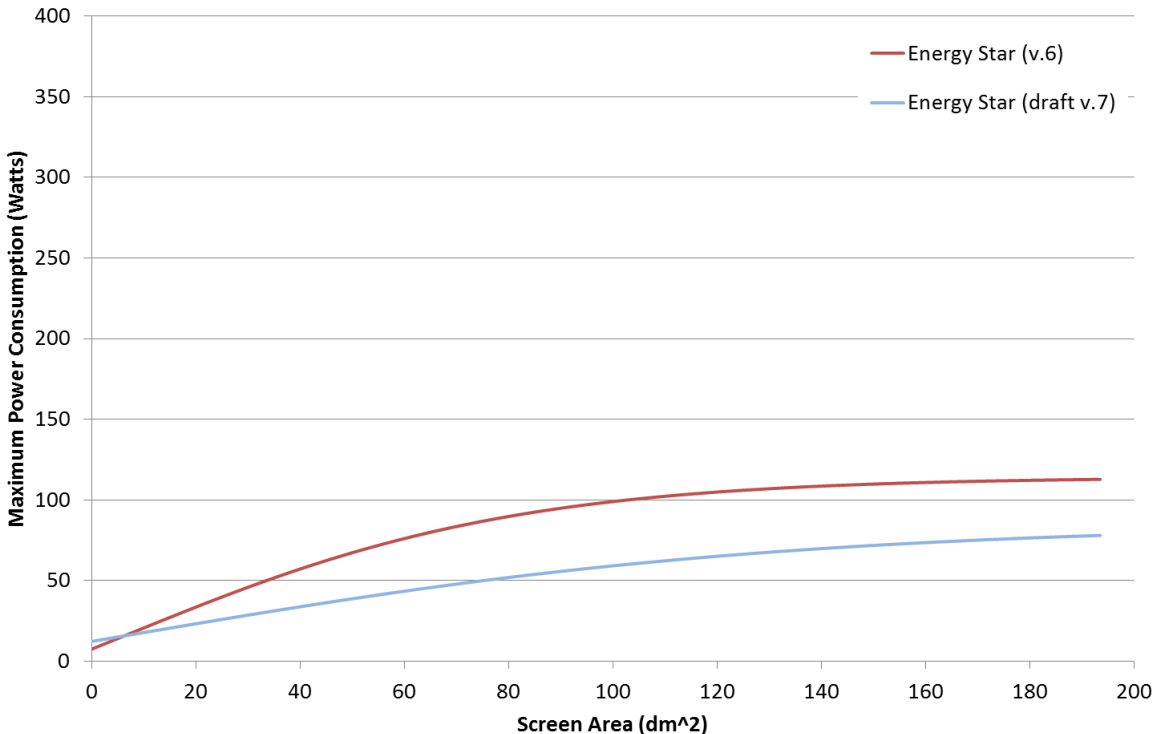


Figure 1-4. Comparison of US ENERGY STAR Maximum On-Mode Power for v.6 and (draft) v.7

1.2.2. Computer monitor Eco-label (2011/337/EU)

The Eco-label Decision No 337/2011 is primarily about desktop computers, integrated desk top computers and thin clients. But it also includes some requirements for computer monitors.⁶ There are 15 different criteria contained in the document, however just the energy-efficiency criteria related to computer monitors are reproduced here.

Energy savings are listed under criterion 1, and energy savings for computer displays are presented under letter (b). The requirements are as follows:

- (i) The computer display's energy efficiency performance in active mode shall exceed the energy efficiency requirements set out in ENERGY STAR v5.0 by at least 30%;
- (ii) computer display sleep mode power must not exceed 1 W;
- (iii) computer displays shall have an energy consumption in on-mode of ≤ 100 W measured when set to maximum brightness;

⁶ Commission Decision of 9 June 2011 on establishing the ecological criteria for the award of the EU Ecolabel for personal computers (notified under document C(2011) 3737) (Text with EEA relevance) (2011/337/EU)

- (iv) computer monitor off mode power shall not exceed 0,5 W.

The Energy Star v5.0 energy performance requirements state that when operating, the display must not exceed the maximum on-mode power consumption (PO or PO1). The maximum on-mode power consumption is expressed in watts and calculated based on the megapixel (MP) display resolution and the viewable screen area (A), and rounded to the nearest tenth of a watt.

Table 1-3. ENERGY STAR v.5.0 requirements for on-mode power consumption

Display category	Maximum on-mode power consumption (W)
Diagonal screen size < 30 inches Screen resolution ≤ 1.1 megapixel	$PO = 6 \times MP + 0.05 \times A + 3$
Diagonal screen size < 30 inches Screen resolution > 1.1 megapixel	$PO = 9 \times MP + 0.05 \times A + 3$
Diagonal screen size 30 – 60 inches ⁷ All screen resolutions	$PO = 0.27 \times A + 8$

For displays shipped with automatic brightness control (ABC) enabled by default, an alternate calculation is used that assumes the display will be in low ambient lighting conditions 20% of the time. To calculate maximum on-mode power consumption in W rounded to the nearest tenth of a Watt (PO1):

$$PO1 = (0.8 \times P_H) + (0.2 \times P_L)$$

Where:

P_H is the on-mode power consumption in high ambient lighting conditions, and
 P_L is the on-mode power consumption in low ambient lighting conditions.

1.2.3. Television ENERGY STAR labelling (v.6.1) Computer monitor ENERGY STAR labelling (version 6.0 and EU Decision 202/2014)

The typical products that would be eligible for qualification under this scheme include the following: (a) Computer Monitors, (b) Digital Picture Frames, (c) Signage Displays, and, (d) Additional products including monitors with keyboard, video and mouse (KVM) switch functionality, and other industry-specific displays that meet the definitions and qualification criteria in this specification. Certain products are excluded from participation in this programme, including for example products with a viewable diagonal screen size greater than 61 inches; products with an integrated television tuner; and products that are marketed and sold as televisions, including products with a computer input port (e.g., VGA) that are marketed and sold primarily as televisions (other exclusions apply).

The maximum on-mode power consumption is defined according to the resolution of the display, as presented in the table below. The products are divided by diagonal screen size (given in inches), and

⁷ Monitors with a diagonal screen size > 60 inches do not qualify for ENERGY STAR.

have P_{ON_MAX} requirements for normal and high-resolution displays. The resolution density, D_p is defined in pixels / in², and is equal to $(r \times 10^6) / A$ where r is the screen resolution in megapixels and A is the viewable screen area in inches square. If D_p exceeds 20,000 pixels per square inch, then the High Resolution column is used where two terms are calculated for the P_{ON_MAX} equation – r_1 and r_2 . The term r_1 is calculated as $(20,000 \times A) / 10^6$ and r_2 is calculated as $((D_p - 20,000) \times A) / 10^6$. These two terms are then plugged into the High Resolution equations to calculate the P_{ON_MAX} for those displays.

Table 1-4. ENERGY STAR labelling requirements for Maximum on-mode power consumption (P_{ON_MAX})

Product Type ¹	P_{ON_MAX} for Normal Resolution ²	P_{ON_MAX} for High Resolution ³
$d < 12,0$	$(6,0 \times r) + (0,05 \times A) + 3,0$	$(6,0 \times r_1) + (3,0 \times r_2) + (0,05 \times A) + 3,0$
$12,0 \leq d < 17,0$	$(6,0 \times r) + (0,01 \times A) + 5,5$	$(6,0 \times r_1) + (3,0 \times r_2) + (0,01 \times A) + 5,5$
$17,0 \leq d < 23,0$	$(6,0 \times r) + (0,025 \times A) + 3,7$	$(6,0 \times r_1) + (3,0 \times r_2) + (0,025 \times A) + 3,7$
$23,0 \leq d < 25,0$	$(6,0 \times r) + (0,06 \times A) - 4,0$	$(6,0 \times r_1) + (3,0 \times r_2) + (0,06 \times A) - 4,0$
$25,0 \leq d \leq 61,0$	$(6,0 \times r) + (0,1 \times A) - 14,5$	$(6,0 \times r_1) + (3,0 \times r_2) + (0,1 \times A) - 14,5$
$25,0 \leq d \leq 61,0$ for Signage Displays Only	$(0,27 \times A) + 8,0$	$(0,27 \times A) + 8,0$

¹ d is the diagonal screen size in inches

²Normal resolution is $D_p \leq 20,000$ pixels/in² where r is screen resolution in megapixels, A is viewable area in square inches and the result is rounded to the nearest tenth of a watt (W)

³High resolution is $D_p > 20,000$ pixels/in² where r is screen resolution in megapixels, A is viewable area in square inches and the result is rounded to the nearest tenth of a watt (W)

Note: the numbers appearing in red have been corrected from the original OJEU notice, which when compared to the original source document for this table – US EPA Energy Star Program Requirements for Displays, version 6.0 revision January 2013⁸ has typographical errors for two categories of product.⁹

For example, consider a 19-inch diagonal screen with a viewable area of 162 square inches (10.45 dm²). This display has a resolution of 1440 x 900, or 1,296,000 pixels, thus having a D_p value of 8000, so it would fall into the normal resolution column. Applying the equation for a 19 inch diagonal display $((6,0 \times r) + (0,025 \times A) + 3,7)$ and plugging into that equation, the P_{ON_MAX} is 15.5 Watts, when rounded to the nearest tenth of a Watt.¹⁰

The above equations are presented graphically below, assuming an aspect ratio of 16:9. All sizes were converted into dm² for clarity and comparison to other graphs in this section. The normal resolution curve is based on the maximum resolution of a D_p value equal to 20,000 pixels per in². For a 19 inch computer monitor, that equates to 3.1 megapixels. The high resolution curve is based on a resolution of 30,000 pixels per in², which for a 19 inch computer monitor corresponds to 4.7 megapixels.

⁸ http://www.energystar.gov/sites/default/files/specs//private/Final_Version_6%200_Displays_Program_Requirements.pdf

⁹ OJ L 114, 16.04.2014, p.75

¹⁰ If the television equation were applied to this computer monitor example, it would be: $EEl = 15.5 / (15 + 10.45 \times 4.3224) = 0.26$, which would correspond to a television Energy Class rating of A.

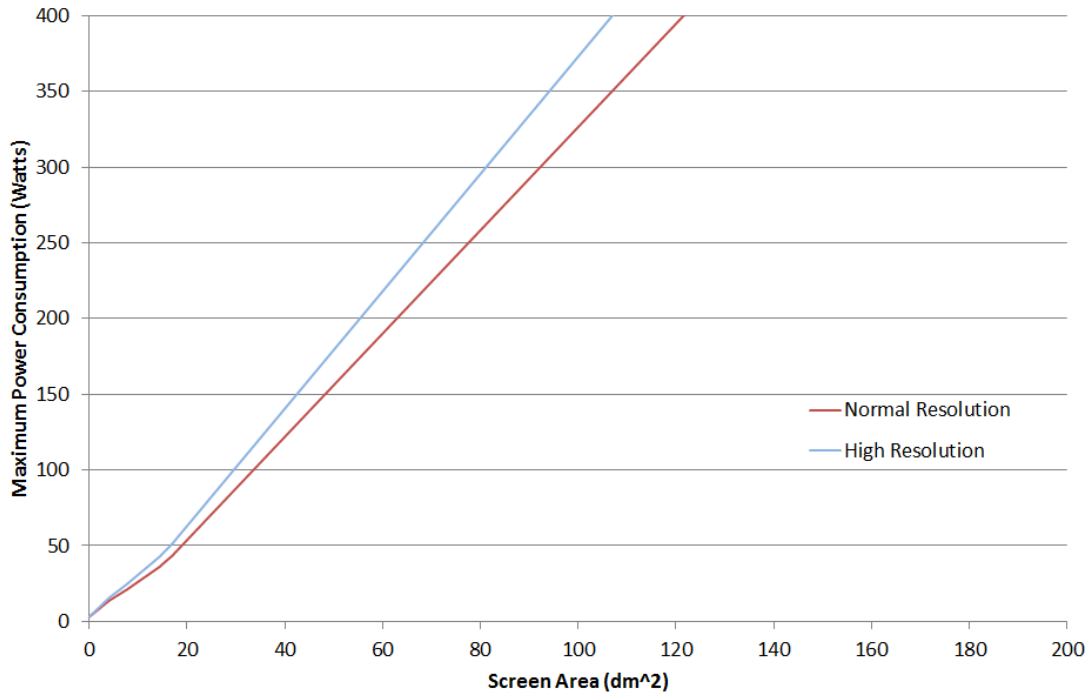


Figure 1-5. ENERGY STAR labelling requirements for Maximum on-mode power consumption (P_{ON_MAX})

For products that meet the definition of an Enhanced-Performance Display, an extra power allowance (P_{EP}) is calculated and added to P_{ON_MAX} as calculated in Table 1-4. The sum of the P_{EP} and P_{ON_MAX} represents the maximum allowable power under this scheme for enhanced performance displays. There are two extra power allowance equations, one for screens with a diagonal screen size less than 27 inches and one for screens with a diagonal measurement of 27 inches and greater.

$$P_{EP<27"} = 0,30 \times P_{ON_MAX}$$

$$P_{EP\geq 27"} = 0.75 \times P_{ON_MAX}$$

For products with Automatic Brightness Control (ABC) enabled by default, a power allowance (P_{ABC}) as calculated per the equation below shall be added to P_{ON_MAX} , as calculated in d in Table 1-4, if the on mode power reduction (R_{ABC}) as calculated by equation 4 is greater than or equal to 20%. R_{ABC} is calculated as follows:

$$R_{ABC} = 100 \times ((P_{300} - P_{10}) / P_{300})$$

Where P_{300} is the measured on-mode power, in Watts, when tested with an ambient light level of 300 lux and P_{10} is the measured on-mode power, in watts, when tested with an ambient light level of 10 lux. If R_{ABC} is found to be greater than or equal to 20% of P_{ABC} , then the extra power allowance P_{ABC} shall be added P_{ON_MAX} .

$$P_{ABC} = 0,10 \times P_{ON_MAX}$$

2. European Market Overview

The Lot 5 Preparatory Study on televisions was completed and published in August 2007, just prior to a technological revolution in television technology. At the time when the preparatory study was conducted, LCD televisions with LED backlighting were considered an expanding niche market. Since that time, the rapid development and market adoption of this technology and other energy saving technologies resulted in industry-led energy efficiency improvements that were faster than had been originally anticipated.

A market monitoring report published in July 2014¹¹ concluded that “these improvements [in efficiency] were not mainly caused by the Ecodesign and Labelling regulations” (Topten, 2014). They concluded that the improvements were a result of natural technology development which happened much faster than the Commission had anticipated when setting the regulation in 2009. However they point out that the discussions surrounding the energy-efficiency measures in combination with the energy label may have put this aspect of the design into focus and accelerated the introduction of more efficient models.

The total energy consumption of televisions (and to a large extent computer monitors) in Europe has been affected by a number of parameters, including:

- a higher number of display devices per household (i.e., higher market penetration rates),
- longer daily use of the display devices (N.B., not only for watching programmes but also playing games, web browsing, etc.),
- an overall increase in the average size of television screens and computer monitors,
- the adoption of new features (e.g., Internet access, tuners, storage devices),
- the development of more energy efficient technologies for televisions and computer monitors.

While these would be excellent data to fully understand, in order to have a better assessment of the actual installed energy use of electronic displays across Europe, these data are difficult to estimate and in some cases are unknown or proprietary. For the purposes of this discussion paper, the market assessment will instead concentrate on understanding the changes and evolution of the European television market as this is the most prevalent of the products covered in regulation EC No 642/2009.

2.1. Shipments and Screen Size

According to the Topten European Market study, the annual sales of televisions in the EU-24 grew from 41 million units in 2007 to a peak of 56 million units in 2010 (Topten, 2014). Shipments then gradually declined to 54 million units in 2011, 47 million units in 2012 and 41 million units in 2013. The 2013 level of shipments is equal to the estimated shipments for 2007 of 41 million. Two factors that contributed to this significant (37%) increase in sales in 2010 relative to 2007 were (1) the gradual switch across Europe

¹¹ European TV market 2007-2013; Energy efficiency before and during the implementation of the Ecodesign and Energy Labelling regulation; Second report with 2013 sales data; Anette Michel, Sophie Attali, Eric Bush, Topten International Services, Zurich, Switzerland, 7 July 2014. http://www.topten.eu/uploads/File/European_TV_market_2007-2013_July14.pdf

from analogue to digital broadcast and (2) the introduction of flat-screen, smaller-footprint and better performing televisions.

In contrast to the rise and fall of television sales between 2007 and 2013, over this same time period, there was a steady increase in the demand for larger screen-sizes in televisions. Consumers were purchasing increasingly large television screens as shown through the sales data for the EU-24 presented in the Topten market report. Figure 2-1 shows the relative proportion of the market by screen size changing over a seven year time period for the EU-24 (Topten, 2014). In 2007, for example, televisions sized 40-50" (i.e., 102 cm – 127 cm diagonal) were approximately 15% of the market; but by 2013, their market share had more than doubled to 32%. And in contrast with that, televisions <20" diagonal constituted 20% of the market in 2007 but dropped to only 5% in 2013. This reduction in the smaller screen sizes may be reflective of consumers shifting to watch smaller-screen (streamed) content on portable devices and laptop computers.

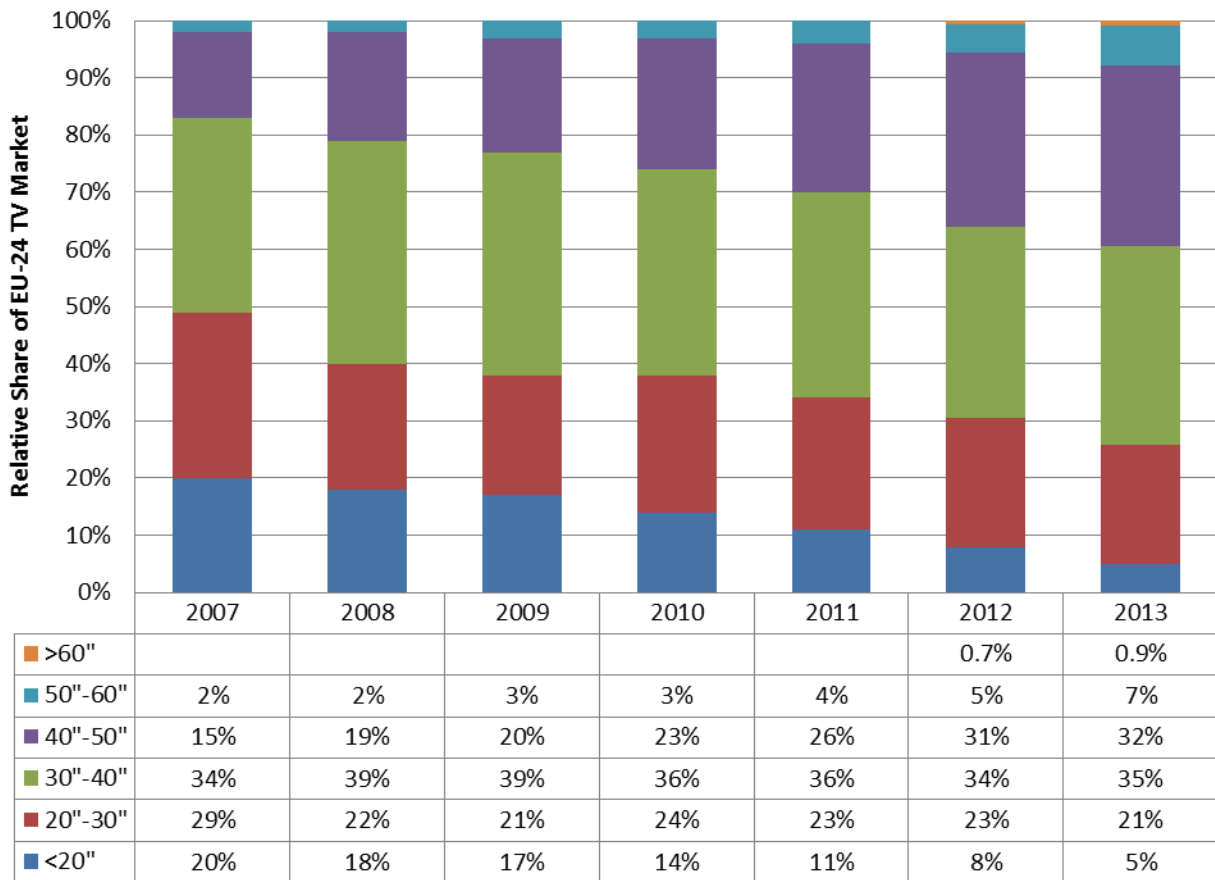


Figure 2-1. Increasing Screen Size in EU-24, Sales of Televisions from 2007 – 2013. Data: GfK, published in Topten, 2014.

2.2. Relationship Between Cost and Energy Efficiency Level

The Topten market report also assessed whether the market trends and consumer choices were having an impact on the price of televisions in the European Market (Topten, 2014). The report analysed the GfK sales and price data for 2012 and 2013 and compared the trends across screen-size categories and across energy label class categories. In other product groups regulated under ecodesign like refrigerators and electric motors, products typically become more expensive as they increase in efficiency. However the data showed that this was not the case for televisions. Instead, it was found that there was no relationship between cost and efficiency, thus indicating that there is a negative life-cycle cost (i.e., financial savings to consumers) associated with purchasing more energy-efficient models.

There are two sets of graphs reproduced here from the Topten market report which clearly illustrate the lack of any relationship between cost and efficiency. Figure 2-2 shows the average sales prices across the EU-24 in 2012 and 2013 for all televisions between 30" and 40" diagonal, and between 40" and 50" diagonal (please note a different Y-axis scale in these two figures) (Topten, 2014). The efficiency of the television in the sample increases as the models move from D class to A++ class. The average price paid (Euros) for each label class of the two size categories is shown underneath the bars. In both figures, there is no discernible correlation between price and efficiency (as connoted by energy label class). Thus the data seem to indicate that efficiency gains incorporated into new television models are being achieved without having a clear or measurable impact on price.

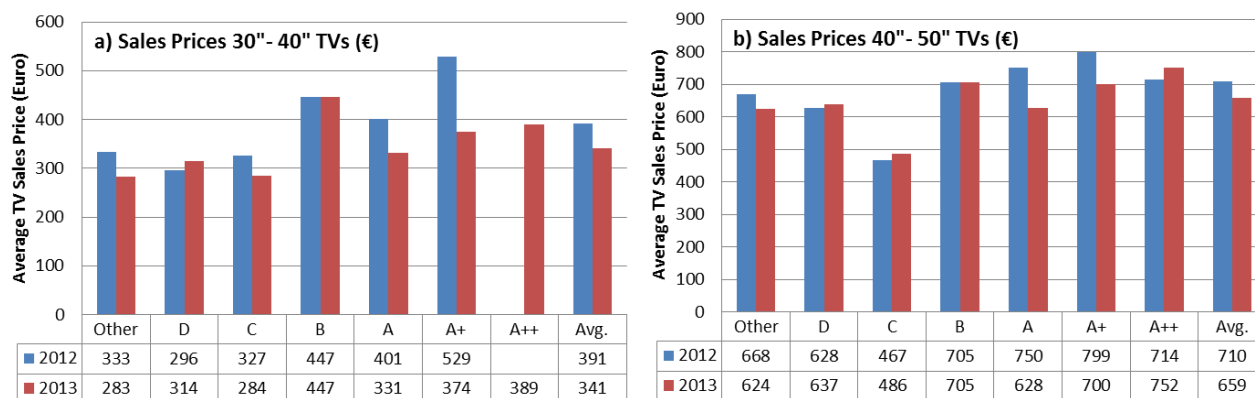


Figure 2-2. Average Sales Prices of TV by Energy Label Class, Holding Screen Size Constant. Data: GfK, published in Topten, 2014.

In stark contrast to the above figures, the Topten market report analysed the impact on price that is associated with screen size. Figure 2-3 illustrates the price trend in 2012 and 2013 where the energy label class is held constant (i.e., all A-class TVs in figure (a)) and where all energy label classes are combined and the database is only differentiated on screen size (b) (Topten, 2014). These two figures show a very clear trend in increasing price correlated with television screen size – the larger the screen, the more expensive the television. Please note that there are different Y-axis scales used in figures (a) and (b) below.

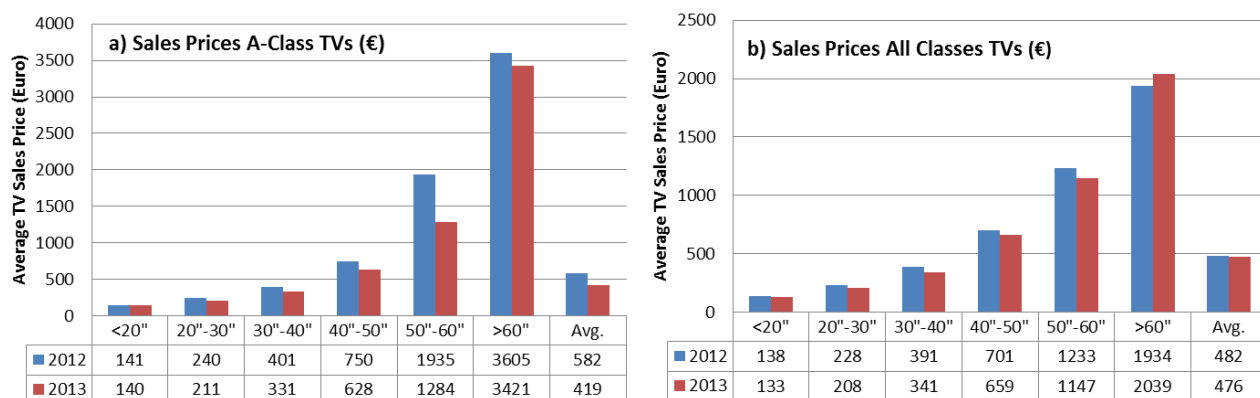


Figure 2-3. Average Sales Prices of TVs by Screen Size, for A-Class Only and All Energy Label Classes.
 Data: GfK, published in Topten, 2014.

From a policy-making perspective, it is very relevant to understand that in the European television market, higher efficiency does not involve higher cost for the consumer. Television screen size has a much larger influence on price, as will other aspects related to the television performance such as resolution or colour quality.

The data show, however, that energy label class which is a surrogate for energy-efficiency does not have an impact on price, and thus moving the market to higher efficiency televisions has a negative life-cycle cost benefit for consumers. This finding means that moving to higher efficiency models of electronic displays will bring immediate benefits (i.e., financial savings) to consumers. For this reason, no life-cycle cost assessment was conducted as part of this review.

2.3. Average Energy Consumption

For many other products, a trend of increasing average size would tend to increase energy consumption, but the technological improvements being incorporated into electronic displays have been found to more than off-set the increase in size. The graph below depicts the sales-weighted average on-mode power consumption of televisions in the EU-24 and for a 40-43 inch (101-109 cm) television. These 2007 to 2013 values represent sales-weighted averages for the EU-24 based on GfK data (Topten, 2014).

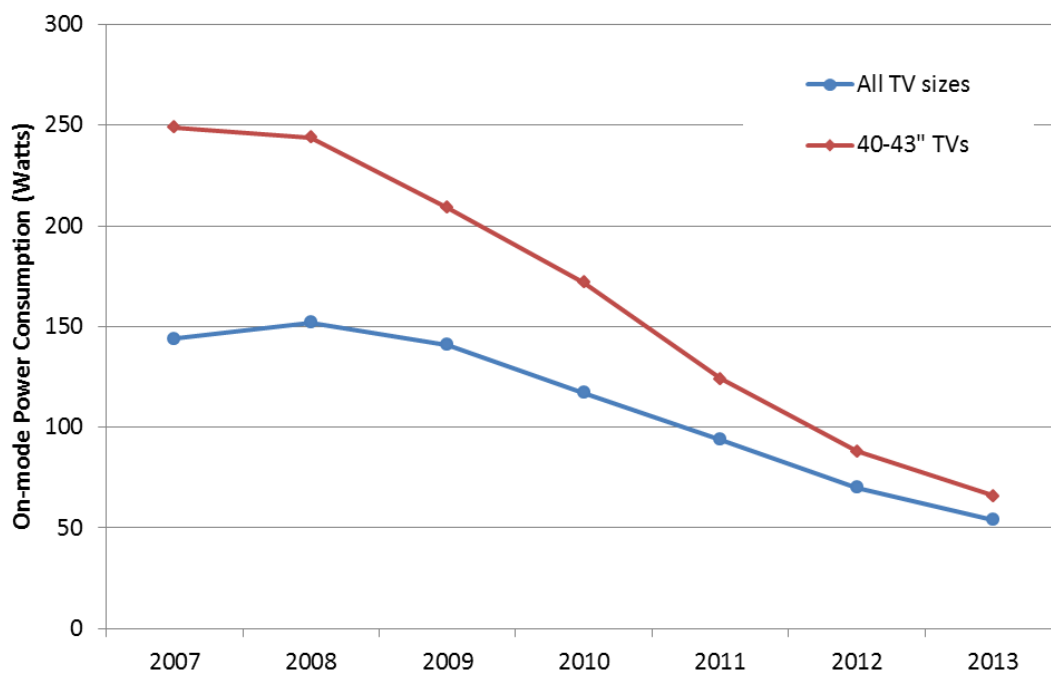


Figure 2-4. Sales-Weighted Average TV energy consumption in EU-24, 2007 – 2013. Data: GfK, published in Topten, 2014.

The red line in the above figure shows the reduction in power consumption for a 40-43 inch television between 2007 and 2013. Over that time period, the power consumption for the same size screen drops from 250 Watts to around 70 Watts, which represents a reduction of approximately 72%. Across all televisions sold over that same time period (the blue line in Figure 2-4), the reduction in power consumption is approximately 63%. One of the reasons that the reduction in all sizes is not as large as the reduction for one specific size category is due to the trend toward larger screen sizes in the sales mix.

2.4. Changing TV Technologies

The principal driver behind the improvement in energy-efficiency of televisions has been the change in the underlying technologies being incorporated into these products. Once the dominant technology in televisions, between 2007 to 2013 cathode ray tube (CRT) technology experienced rapidly declining sales and is now virtually non-existent in the EU market. The new technologies that entered the market, replacing CRTs are flat-screen technologies such as plasma and liquid-crystal display (LCD). The first generation of LCD technology incorporated cold cathode fluorescent lamps (CCFL), and these have now been all but replaced by light emitting diodes (LED) lamps for backlighting the LCD screen.

CRT TVs were 89% of the market in 2004, and only seven years later their shipments had dropped to nearly zero (Topten, 2014). LCD TV's, in contrast went from 8% of sales in 2004 to 87% in 2009. LCD TV's were originally illuminated with CCFL technology, which was eventually replaced with LED back-lit units. By 2013, LCD TVs with CCFL back-lighting had dropped to 4% of sales, with LED being the dominant technology. Plasma technology was considered to have a promising future in the large TV sizes, such as

36" and greater. However this technology never achieved greater than 10% of sales; and in 2013 Panasonic announced it would stop producing plasma TVs from March 2014, Samsung announced that it would stop of production from the end of 2014 and LG is reported as moving in the same direction. Rear projection TVs had been on the European market as early as 2000, but by 2012 the last manufacturer (Mitsubishi) announced it would stop production. Rear projection TVs were for large screen formats and have never really achieved more than 1% of market share.

Figure 2-5 shows how the television technologies have been changing over time in Europe (EU-24), with relative proportions of sales of the total market in each year. These data are GfK sales data for the EU-24 (Topten, 2014).

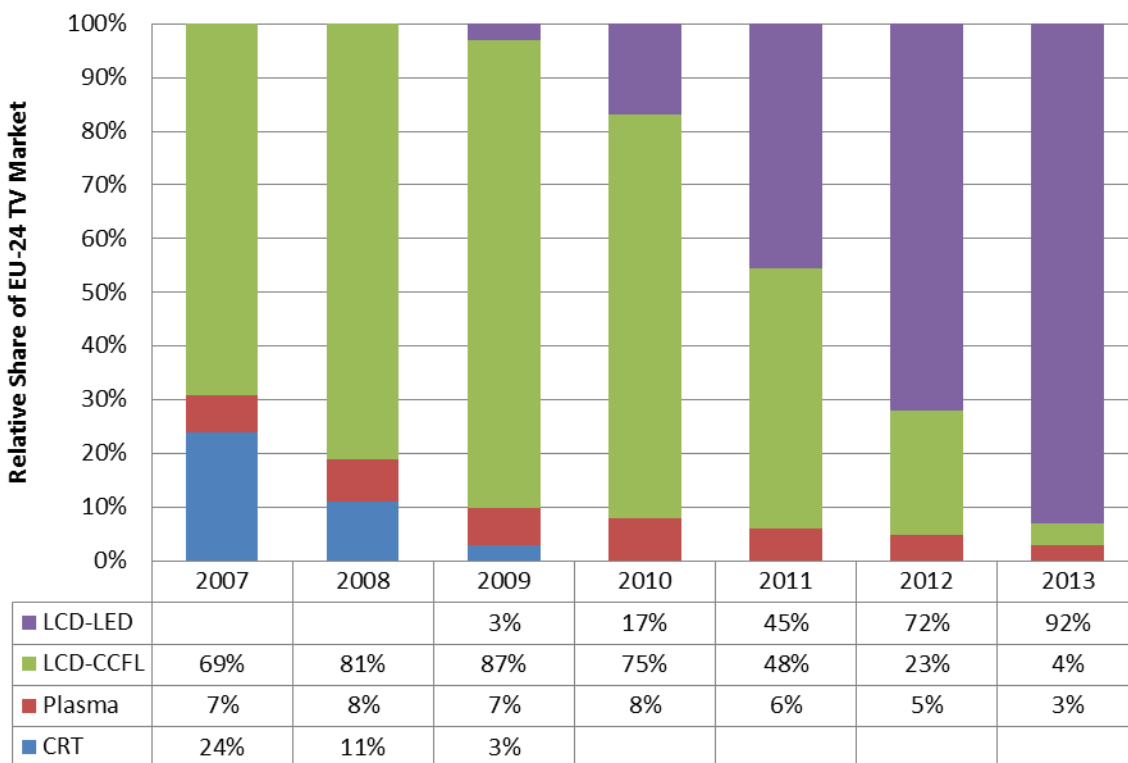


Figure 2-5. TV Technology Changes in EU-24, 2007 – 2013. Data: GfK, published in Topten, 2014.

2.5. Impact of the Commission Regulations

Different studies (Coolproducts for a Cool Planet¹²; Topten 2014; CSES, 2012) indicate that the energy-efficiency improvements in televisions are due in large part to the unanticipated rapid pace of technological change. The ecodesign mandatory efficiency requirements are thought to have had little impact on the market. Figure 2-6 shows how the sales-weighted market average for specific size categories was well ahead of the requirements in EC No 642/2009 (Topten, 2014). The figures present data for the two most popular size categories in Europe – 32 inch and 40-43 inch screens.

¹² Link to the Coolproducts for a Cool Planet homepage: <http://www.coolproducts.eu/>

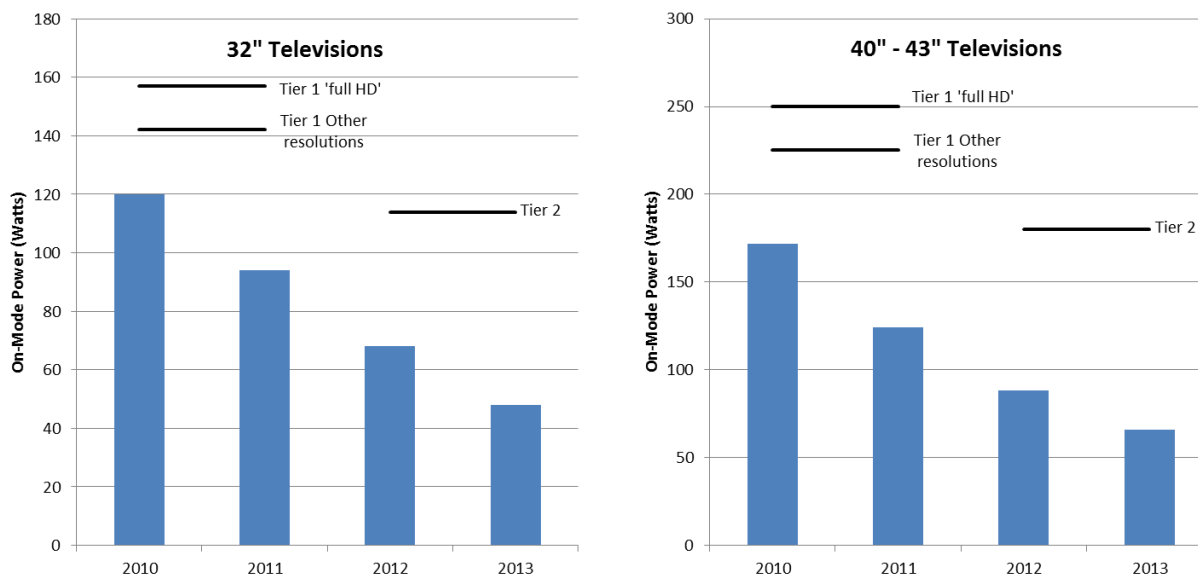


Figure 2-6. Average Power Consumption of Models Sold in EU-24 Compared to Ecodesign Tiers. Data: GfK, published in Topten, 2014.

For the 32 inch television, when the regulation was introduced in August 2010, the market average was already 15-24% below the maximum allowable on-mode power consumption. Similarly, when Tier 2 took effect in April 2012, the market average for 32 inch TVs was 40% below the maximum allowable level. For the popular 40-43 inch televisions, the market average was already more efficient than the maximum allowable on-mode power – the average was 24-31% more efficient than Tier 1 in 2010 and 51% more efficient than Tier 2 in 2012.

The rapid evolution of television technology also exceeded the expectations on the Energy Labelling Regulation. Figure 2-7 below shows the energy class trend over time of the televisions offered on the EU Market (Topten, 2012). Energy class A++ products (defined as $0.10 \leq EEI < 0.16$) had been planned to be introduced to the European market in 2017, but it had already started to appear on the European market in 2012, and reached 68 models by May 2014 (Topten, 2014).

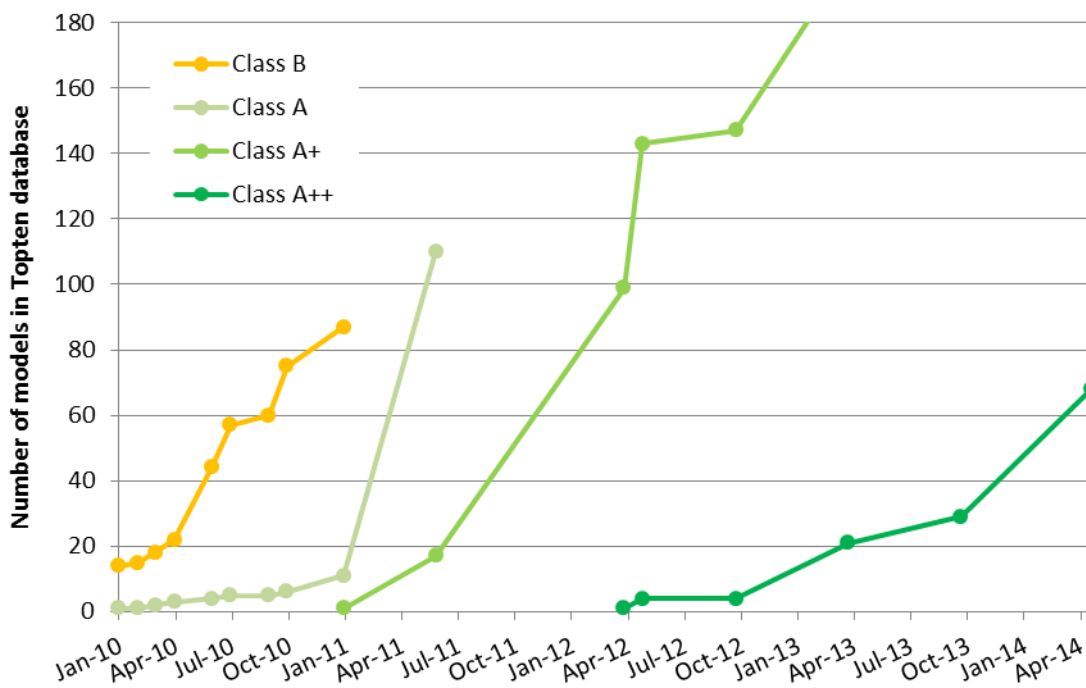


Figure 2-7. Efficient television models on the European market, Jan 2010 – May 2014¹³. Source: Topten

¹³ European TV market 2007-2013; Energy efficiency before and during the implementation of the Ecodesign and Energy Labelling regulation; Second report with 2013 sales data; Anette Michel, Sophie Attali, Eric Bush, Topten International Services, Zurich, Switzerland, 7 July 2014. http://www.topten.eu/uploads/File/European_TV_market_2007-2013_July14.pdf

3. Issues to be addressed in a revision of the Regulations

This chapter discusses some of the key issues that relate to digital displays, specifically (1) technology efficiency trends; and (2) product features (e.g., 3D screens, Internet-connected displays, automatic brightness control, enhanced reactivation and mode control options, ultra-high definition). Each of these issues is discussed in more detail in the subsequent subsections.

3.1. Technology efficiency trends

Although very significant gains in energy-efficiency have been achieved for televisions in the last 5-10 years, there are technologies that can be employed that will further improve their performance in the coming 5-10 years.

Table 3-1. Efficiency improvement options in LCD televisions and digital displays

Components		Expected improvement options	Cost / Effect on efficiency / availability
Backlight Unit	Backlight Source	• CCFL to LED	• Cost increase but adopted by manufacturers due to improved quality
		• High LED efficacy	• Overall cost reduction in the longer term • Thermal management challenge; and near term higher cost of better LEDs
	Optical films	• Optimized combination of films • Multi-function film e.g., prism + diffuser	• Trade-offs in material cost, ease of manufacture, and efficiency
		• Reflective polarizer (e.g., Dual Brightness Enhancement Film)	• Cost increase, proprietary technology
LCD Panel		• Improvement in transmittance by optimizing pixel design, functional layers, e.g., polarizer, colour filter, and data line	• Proprietary technology • R&D investment required but driven by total cost reduction.
Power management		• Backlight dimming in relation to picture content, i.e. black colours	• Cost increase, but can save up to 50% of backlight power (Shiga et al 2008) • Backlight structure, input images, and algorithm but with direct LED backlight and 2-edge LED backlight
		• Backlight dimming in relation to ambient light, i.e., Auto Brightness Control (ABC) Presence detectors	• Cost increase • The effect varies with default manufacturer settings and ambient light levels.
Other		• Power Supply Unit (PSU) Efficiency	• Trade-off in cost and efficiency and already operating at over 80% efficiency in volume production products
		• Colour gamut (by colour filter or light source)	• Trade off with efficiency using filters but now through Quantum-dot LED technology providing an efficiency gain of potentially 20%

Source: LBNL, 2012 with some minor modifications.

3.1.1. Organic Light Emitting Diode Televisions

Organic Light Emitting Diodes (OLEDs) are made from carbon-based organic materials that emit light when electricity is applied. Due to the fact that OLEDs produce their own coloured light directly, OLED displays do not require a backlight and filters (unlike LCD displays), thus they can achieve gains in efficiency as well as be being simpler to manufacture and much thinner. OLEDs offer great picture quality, high contrast ratios, vibrant colours, fast response rates and a wide viewing angle.

The OLED is structured around a cathode (that injects the electrons), an emissive layer and an anode (that removes the electrons). Research in OLED displays is on-going as this technology is being commercialised. For instance, there are small-molecule OLED displays and large-molecule (or polymer) OLED displays. Another technology division is between fluorescent and phosphorescent materials. The fluorescent materials last longer but are much less efficient than phosphorescent materials, although there are still some research and development challenges, such as developing a stable blue phosphorescent OLED.

In terms of commercialised OLED displays, are Passive-Matrix (PMOLED) and Active-Matrix (AMOLED) designs, based on a difference in the driving electronics, either passive matrix or active matrix. A PMOLED uses a simple control scheme that addresses each row (or line) in a display sequentially. This circuit does not contain a storage capacitor, so the pixels in each line are off most of the time. To compensate for this, more voltage is needed to make them brighter which affects their efficiency and there are restrictions on resolution and size. PMOLED displays are usually small and can be found in products like MP3 players, mobile phones and car radios. AMOLED displays, on the other hand, are driven by a thin-film transistor (TFT) which contains a storage capacitor that maintains the line pixel states, enabling large screens and higher resolution displays. AMOLED displays were first introduced to the market in 2007/08 and have been used on digital cameras, mobile phones and OLED TVs.

Global shipments of OLED televisions are expected to reach 2.7 million units in 2015¹⁴ compared with 260 million LED-LCD televisions. LCD televisions are expected to dominate world shipments of televisions from 2012 until OLED televisions become price competitive (earliest predicted date 2016). There will be a subsequent two to three year transition period before OLED televisions dominate large screen shipments.

3.1.2. Quantum-dot LED TVs

One of the new technologies that the industry is developing to differentiate and improve energy-efficiency of displays are quantum dots, which promise high colour gamut performance, enabling LCD displays to offer similar colour gamut performance to AMOLED displays.

LCD televisions consist of two major components - a backlight unit which provides light and a liquid-crystal module which creates the image. The liquid-crystal module contains millions of pixels, each of which contains three subpixels, one each for blue, green and red light. By controlling the amount of light each subpixel allows to pass through the pixel, a broad range of colours is created. The quality of the

¹⁴ "AMOLED Televisions Presented at CES, but Volume Remains Limited", IHS Technology; January 21, 2013" See: <https://technology.ihs.com/419547/amoled-televisions-presented-at-ces-but-volume-remains-limited>

colours produced by the LCD television is then a function of the spectral energy of the white light in the backlight unit and the effectiveness of the colour filter at the subpixel level.

Quantum dots are a new material class that can be tuned to emit light very efficiently at precise red, green and blue wavelengths, thus creating an ideal light spectrum for LCD displays. Quantum dots can be fabricated to convert short-wavelength light (e.g., blue light) to nearly any colour in the visible spectrum. The spectral output of the quantum dot is based on its size, with smaller dots producing shorter wavelengths (i.e., blue light) and larger dots producing longer wavelengths (i.e., red light); and medium-sized dots covering the wavelengths in between. The best quantum dots available today emit light with over 90% efficiency, within a very narrow spectral distribution. Ranging in size from 2 to 6 nanometers, quantum dots manufactured from the same material emit different colours of light just due to their differences in size, as shown in the figure below.¹⁵

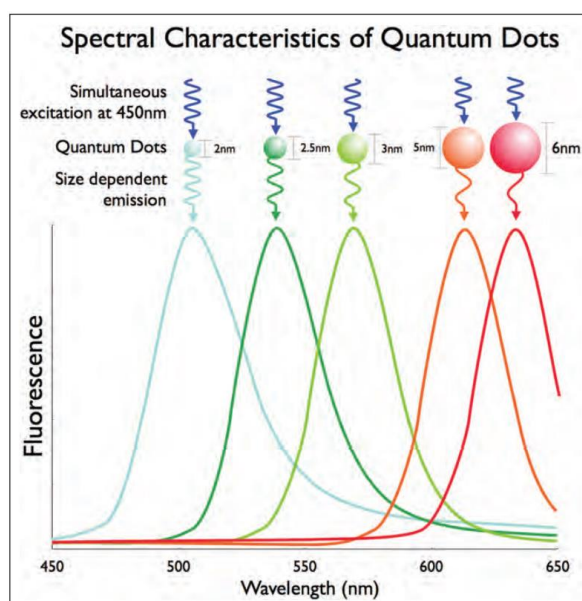


Figure 3-1. Quantum-dot size relates to emission wavelength

Some early adopters of quantum dot technology include Amazon’s Kindle Fire HDX tablet PC and Sony’s Triluminos TV in 2013.¹⁶ However, quantum dots to date have had issues that prevented faster market penetration. One problem is Cadmium which most of the dots contain and the other is the high price of the materials, driven in part by the high R&D investment that was necessary to commercialise them. Quantum dot manufacturers are working to address these barriers, for example Nanoco has produced Cadmium-free quantum dot materials, and while other manufacturers obtained a temporary exemption in Europe for Cadmium in products with quantum dot-based displays. Regarding the cost of materials, many manufacturers are entering the market, especially from Korea including Samsung, LG, Sangbo, LMS, Hanwha and SKC-Haas. Increased competition is expected to lower prices in the near future and accelerate the market adoption.

¹⁵ “Quantum-Dot Displays: Giving LCDs a Competitive Edge through Color”, by Jian Chen, Veeral Hardev, and Jeff Yurek from Nanosys. Information Display, January 2013.

¹⁶ Source: <http://www.displaysearchblog.com/2014/08/is-quantum-dot-the-next-step-in-lcd-tv-evolution/#more-5707>

DisplaySearch estimates that on a global basis, quantum dot penetration in LCD TVs will be less than 1% in 2015, but will approach 10% in 2020, meaning 2 million and over 26 million sets, respectively. Korean manufacturers are potentially thinking of repeating their experience with LED TV, when they led in both technology and volume. If quantum dot TV is as successful as LED TV, it could extend the LCD TV making it competitive with OLED TV. The key issue will be how the brands position and market quantum dot technology, and whether wide colour gamut is attractive enough to consumers to enable a price premium.

Furthermore, according to Nanosys, when quantum dot films are incorporated into the backlight of LCD displays, it can bring about a 20% improvement in efficiency.¹⁷ (Chen et al, 2014)

3.2. Product Features

From a functionality point of view, there are several trends in the electronic display markets that warrant discussion and consideration in the context of a review of the Ecodesign and Energy Labelling Regulations. These are:

- 3D, with or without special viewing equipment,
- Internet connectivity,
- automatic brightness control,
- enhanced reactivation and mode control options and
- ultra high definition TVs.

In general, without any stimulus to take energy efficiency into account, these new features and technologies could result in increasing the power consumption of the electronic display. The following subsections discuss each of these six technology trends in the context of this regulatory review.

3.2.1. Three Dimensional (3D) Screens

Three dimensional (3D) displays commonly found on the market in Europe today use static filtering through polarised glasses or polarised screen filters or they use active shuttering through glasses to produce the sequential left and right eye images required for 3D viewing. Polarised imaging introduces a luminance loss of around 40% of the basic, pre-polarisation display luminance. On the other hand, shuttered glasses lose approximately 60% of the display luminance. Thus to reproduce 3D, in normal 2D viewing room illuminance conditions, both technological approaches require that displays are operated at close to their maximum brightness, to accommodate perceived image brightness losses from filters or shutters.

Operating at their maximum brightness, the screens require a significant increase in power that is far greater than the additional processing power required for converting basic video data into 3D display

¹⁷ For more information on how quantum dots work, see this presentation from Dr. Chen at Nanosys: http://www.avusergroups.org/tfug_pdfs/2014_7chen_NANOSYS.pdf

drive data. Experts estimate that the power requirement of current reduced instruction set computer (RISC) processors required to convert video data into 3D display drive data is, for display products in the scope of this Regulation, less than 1% of the screen power requirement. Thus, the processing side consumes very little power compared to the power requirements of the display luminance drive. The increased power consumption in 3D mode will vary by 3D technology and by manufacturer, but generally would be approximately 30 to 40% higher than in 2D mode. It should be noted, however, that there is currently no 3D dynamic test loop for measuring power consumption in 3D mode. Industry experts are working on developing a test loop, to be published with the 2D test loop associated with the IEC 62087 test method covering television on-mode power measurement. This is likely to be made available in a harmonised standard mandated to support the review of regulation 642/2009.

Finally, at this very transitional stage from 2D to 3D entertainment, there is considerable uncertainty about the viewing time allocated by the consumer to 3D content for the purposes of related regulation metrics. In 2009, there was an expectation that by 2012 most medium to large screen televisions would carry 3D capability and that many programmes and films would be available in 3D – both from optical Blu-RayDisc (BRD) and broadcast media. But the growth of 3D content has not been realised as quickly as originally thought and the use of 3D enabled televisions has been slower than projected in part because of the limited availability of 3D content. Thus, while 3D capability is built into over 30% of large screen (i.e., 40+ inches) and high-end televisions today, these units are primarily used for 2D viewing. This slower than expected growth in 3D televisions is not unique to Europe. In Australia, forecasts developed in early 2010 projected that by 2012 nearly all televisions sold would have 3D capability and lots of content in both broadcast and BRD format would be available. However in the current Australian market, 3D televisions represent only 25-30% of the market.

3.2.2. Internet-connected televisions

As with other products, displays are becoming networked products, offering consumers the opportunity to check email and social networking sites, browse the Internet, and watch programmes via the Internet. To meet these functions, televisions require new hardware including additional or enhanced processors, and memory chips. Until recently, images from web browsing displayed by networked televisions generally had a higher average picture level (APL) than standard broadcast images. This combined with poor power management in networked standby mode and potentially larger/wider screens for picture-in-picture viewing, led the LBNL to report that a smart (i.e., networked) TV could consume approximately 10% more power in its drive circuit than a conventional TV. However this estimate has already been reduced through the use of low-power 'system-on-a-chip' configurations, better power management and the trend to popular web-based image sources (e.g. Facebook and YouTube) with the same APL as normal broadcast material. Thus, it does not seem that it would be necessary to have additional allowances for the on-mode power of these products, since the purpose of the regulation in the past has been to encourage the use of low power processors and power management for networked televisions.

The rate of market adoption of networked televisions will rely on the user interface technology and high performance operating systems rather than on the screen technology itself. Large and innovative producers of consumer electronics and providers of Internet-related products and services are expected to influence this market, as well as computer hardware manufacturers because of the system processing requirements.

Finally, it is worth noting that smart televisions could encourage the development of larger and wider screen sizes as consumers want to do multiple activities on one screen. As shown in the figure below, having one programme that is watched on the main screen while one or more small embedded screens are overlaid on the side (e.g., email, social networking pages or other content channels) could encourage a migration from the standard 16:9 ratio to a 20:9 ratio because of the need to maintain multiple embedded screens. As shown in the figure below, the demand for smart televisions could accelerate the demand for larger screens that would increase energy consumption.

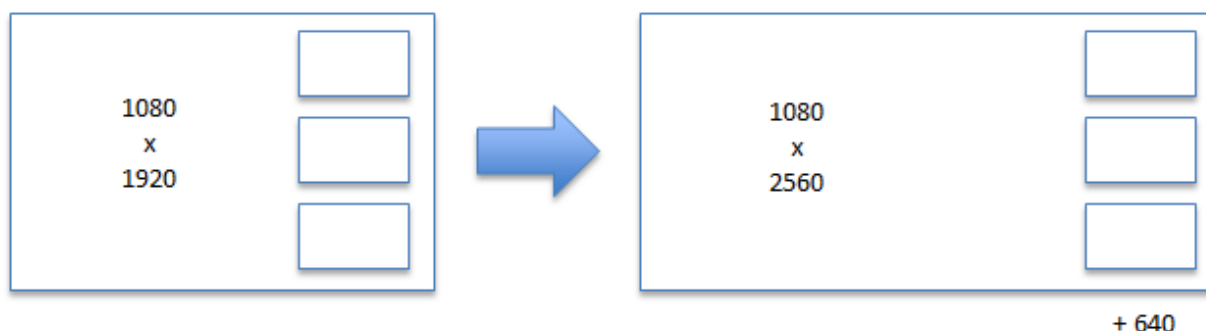


Figure 3-2. Example of possible smart television screen size change

3.2.3. Automatic Brightness Control

According to a study published in 2011, the magnitude of the effect of ABC on power consumption is significant (LBNL, 2011). However, the study noted that measurement methods that allow for crediting estimated energy savings to televisions with ABC must be written carefully in order to avoid creating counterproductive incentives where picture brightness settings are set too low for viewer comfort. Such settings could result in manufacturers designing products that obtain energy savings during testing that are never realised in practice. The study concluded that to ensure that ABC is properly used as an efficiency improvement option, the following must be met:

- ABC settings must be activated by default, rather than shipped with the feature disabled;
- ABC settings should be easier to adjust than to deactivate completely; and
- Test methods that take into account the energy savings benefits of ABC need to be revised to have more realistic ambient lighting levels.

The CENELEC and IEC working groups dealing with television performance measurement are, as of October 2014, currently working on display measurement methods that will address ABC issues to provide a scientific basis for measuring the ABC control characteristic¹⁸. It is intended that this measurement method should be standardised for all displays incorporating ABC. In the meantime the ABC testing methodology adopted by ENERGY STAR and the US Department of Energy (DOE) and in the soon to be published revision of IEC 62087 will be used in an EN harmonised standard mirroring the IEC standard. The only variable would be the room illumination levels, measured at the display, around

¹⁸ IEC 62087 will set a method of measuring ABC and will make no comment on what the ABC characteristic should be. This will be left to the policy makers and programme developers.

which a regulatory body or voluntary agreement would set its ABC control regime. The actual characteristics of that control should ideally follow the sensitivity curve of the human eye to luminance change in an observed display area.

Drawing on available current data assembled on room illumination for TV viewing, ENERGY STAR and the US DOE will require that ABC display luminance control characteristics should start to reduce display luminance from a room illumination level, measured at the ABC sensor; of below 300 lux (300 lux is recommended as a saturation illuminance point that disables ABC control). Four measurement points are prescribed, 100 lux, 35 lux, 12 lux and 3 lux. The on-mode power measured at these illuminance levels (P_{100} , P_{35} , P_{12} and P_3) is used in the following metric to calculate the declared on-mode power (P_{on}) for prescribed conformance criteria, for a TV with ABC enabled by default.

$$P_{on} \text{ (declared)} = (0.25 * P_{100} + 0.25 * P_{35} + 0.25 * P_{12} + 0.25 * P_3)$$

At a room illumination of 300 lux and above, the ABC should have no impact on the display luminance. Below 300 lux, typically starting at 100 lux, there should be a progressive reduction in screen luminance. Ideally following a luminance control characteristic standardised for all displays. Thus, it is proposed that the amended Commission Regulation should synchronise with the ENERGY STAR / DOE illuminance measurement point criteria for ABC to reduce the burden on manufacturers' technical declaration testing. An energy label bonus is recommended for display products with ABC enabled to prescribed limits in the delivered condition of the display product.

The ENERGY STAR / DOE ABC allowance metric is not recommended since no luminance or power change limits are prescribed and in the absence of a "standardised" ABC control characteristic, excessive luminance reduction of the display to maximise ABC allowances could lead to users disabling the ABC control function.

3.2.4. Enhanced Reactivation and Mode Control Options

An issue for televisions that can be frustrating for consumers is the booting (or reactivating) time for a model that can vary from a few seconds to 45 seconds. To overcome slow starting times, some televisions incorporate "fast play" or "quick start" standby modes that allow the television system to start within a few seconds. According to a report from ECCJ (ECCJ, 2009), these fast start options can consume significant power – e.g., 25 W on average to standby power consumption. Slow start times may prompt consumers to regularly use the fast start mode, even though this mode consumes significantly more power than the default standby mode. It is noted, from 2013-2014 television testing conducted by a consumer organisation¹⁹ in Europe, that principal manufacturers have moved away from keeping processing circuitry active for fast start and now incorporate the use of NVRAM memory chips. This latter solution allows fast start with no adverse qualification of the current television Regulation standby requirement. Thus, consideration should be given to the qualification of the revised Regulation to clearly state that no extra allowance should be provided for the "fast start" option. Any fast-start mode provided as a user-option for a TV should not exceed the maximum standby allowance given in the Regulation for that product.

¹⁹ Testing was conducted in 2011 and 2012 for WHICH? Magazine, a UK consumer association publication.

Other reactivation or control features include room presence detection, facial recognition, voice recognition and gesture detection. Where these features are associated with reactivation of the display product, the power allowance should be up to 1.5W more than the standby power allowance for a combination of two or more enhanced reactivation and control features or 1W more than the standby allowance for voice recognition only. It is recommended that the availability of a room presence detection enhanced reactivation feature that reduces on-mode power requirement in the absence of a display viewer is rewarded with an energy label bonus.

3.2.5. Ultra High Definition TVs

Another important aspect that requires a proper assessment is ultra high definition (UHD) televisions (also known as UHD, Ultra-HD, 4K-2K, 4K, 8K and RETINA). UHD displays have started to enter the market, both in large screen televisions as well as for small screen applications (e.g., “New i-Pad” RETINA display). The figure below shows the relative resolutions of the standard definition (SD), Full High Definition (FHD) and the 4K and 8K UHD displays.²⁰

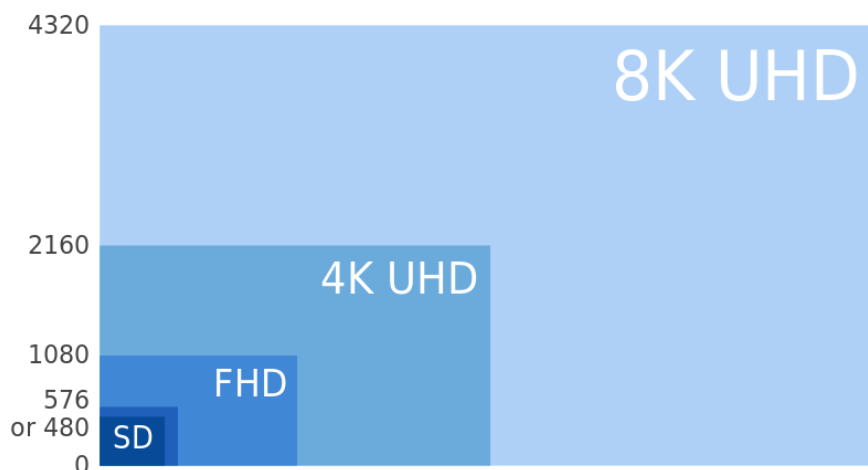


Figure 3-3. Comparison of Relative Display Resolutions

UHD content is starting to be made available, such as the recent World Cup in Brazil²¹ and the Commonwealth Games in Glasgow.²² This is an important innovation because although the human eye is unable to detect an improvement in image quality of screens over 125 cm diagonal (50 inches) at the recommended viewing distance between a UHD and a full HD display, a dramatic improvement in colour presentation will be clearly evident. As UHD displays start to become a volume product, any increase in processing power required for UHD video data conversion to display driver data will tend to be masked by the screen luminance power and is already proven to be insignificant in a major manufacturer’s products. The processing power is expected to remain comparatively low because the rate of progress of energy efficient processor development is rapid. The processor power will also be the same as, or less than, that required by HD displays when UHD displays become the volume product. In this context it should be noted, for example, that the new processor for the “New iPad” RETINA display, providing four

²⁰ Source: Wikipedia http://en.wikipedia.org/wiki/8K_resolution

²¹ <http://www.techienews.co.uk/9713052/bbc-announces-live-4k-uhd-streaming-of-2014-world-cup-matches/>

²² <http://www.bbc.co.uk/mediacentre/latestnews/2014/ultra-hd-cwg>

times the pixel resolution of the previous generation iPad 2 display, requires no more power than the earlier iPad2 processor.

The data provided by DigitalEurope for the 2014 European market already shows that UHD does not necessarily require more energy (see Figure 4-3). A display manufacturer going to launch a UHD or 5k display will use a new generation of RISC processors which offer higher performance and lower energy consumption.²³ The innovation of processors over the last few years illustrates this track-record; that is going from 32 nanometre (nm) processors in 2010 to 22nm in 2012. These were followed by 14nm in 2014 with 10nm expected in the next 2-3 years. In contrast with any new UHD display, any new HD electronic display will probably use a consolidated, cheaper processor of the previous generation.

An empirical examination of the new 4k UHD displays with similar models from those same manufacturers indicates that the UHD displays have the possibility of even lower consumption than the HD versions they're replacing. The following table provides two examples from Samsung and Acer obtained from the Internet with manufacturer reported performance values. For the Samsung model, the screen is approximately the same size, but the UHD model is 23% brighter (370 cd/m²) and yet consumes 36% less energy. For the Acer model, the screen is the same size and brightness, but the UHD model consumes 5% less electricity than the HD model.

Table 3-2. Comparison of HD and new UHD Displays

Manufacturer	Model	Resolution	Size (inches)	Brightness	Power
Samsung	T28D310NH	1366 x 768 (HD)	27.5	300 cd/m ²	50 W
Samsung	U28D590D	3840 x 2160 (UHD)	28	370 cd/m ²	32 W
Acer	B296CL	2560 x 1080 (HD)	29	300 cd/m ²	45 W
Acer	XB280HK	3840 x 2160 (UHD)	29	300 cd/m ²	42.5W

Given the above findings, it does not appear to be necessary to have any extra power allowances for UHD displays, as the rate of technology evolution is so rapid these are already entering the market and proving they are also energy-efficient.

The following table provides an overview of some of the common UHD formats, their respective resolutions, the display aspect ratio and the number of pixels associated with the display.²⁴

²³ An example of this would be the processors used in mobile phones. Compared to the A7 processor (28 nanometre), the A8 processor (20 nm) is 13 percent smaller, 25 percent faster and 50 percent more power efficient. The new A9 processor (14 nm) being introduced by Samsung is 15 percent smaller, 20 percent faster, and 35 percent more power efficient than the A8 processor. See Daily Tech, 2014.

²⁴ Source: Wikipedia, http://en.wikipedia.org/wiki/4K_resolution

Table 3-3. 4K UHD Resolutions, Aspect Ratios and Number of Pixels

Format	Resolution	Display aspect ratio	Pixels
8K	7680 × 4320	16:9	33,177,600
Ultra high definition television	3840 × 2160	1.78:1 (16:9)	8,294,400
Ultra wide television	5120 × 2160	2.37:1 (21:9)	11,059,200
WHXGA	5120 × 3200	1.60:1 (16:10, 8:5)	16,384,000
DCI 4K (native resolution)	4096 × 2160	1.90:1 (19:10)	8,847,360
DCI 4K (Cinema Scope cropped)	4096 × 1716	2.39:1	7,028,736
DCI 4K (flat cropped)	3996 × 2160	1.85:1	8,631,360

From the data provided by DigitalEurope in 2014, it is clear that there are energy-efficient UHD displays already available on the European Market in the top classes ($\geq A$), thus it does not seem necessary to exclude these products from the efficiency requirements or to postpone their coverage.

In addition, there are some non-standard / ultra-wide resolution formats that have been observed, such as a 5K UHD monitor. This is also a very efficient product, and is in line with the performance of 4K UHD displays. Although it is theoretically possible to create 6K and 7K UHD displays, the next current “standardised” higher resolution after the 5K UHD monitors is an 8K UHD display. However, displays at 8K UHD are only available in prototype at this time, and there is no 8K content planned for broadcast transmission in the next few years.

From the data already observed in the market place, UHD displays have demonstrated their ability to reach the same high efficiency levels of lower resolution displays.

4. Regulatory requirements

This chapter describes the approach followed in developing a set of mandatory performance tiers for electronic displays.

4.1. Database provided by DigitalEurope

The proposed ecodesign requirements developed in this paper are based on a set of anonymised model data provided by DigitalEurope in August 2014 and supplemented with some additional models in October 2014. The additional models came from DigitalEurope and one manufacturer who is not a DigitalEurope member but who is active in the European market. In total, this 2014 dataset contains 1010 models available on the European market and includes televisions, television monitors, computer monitors, hospitality televisions and other products in a wide range of sizes. The technologies represented are almost exclusively LED-illuminated LCD displays, but there are a few plasma models (n=13) that are still on offer and a few OLED models (n=19) that have been introduced. LED-LCD displays include UHD models (n=45).

In studying the data, it became clear that some of the viewable area values provided in the spreadsheet were not calculated precisely based on the resolution of the screens. Therefore, the first step involved calculating the viewable area of the display using the known resolutions and the following equation:

$$\text{Viewable Area} = \frac{H \times W \times D}{(H^2 + W^2) \times 100}$$

Where H and W represent the pixel count in the height and width of the display respectively or that count resolved to the components of an aspect ratio and D is the diagonal measurement in centimetres (cm) of the viewable part of the display. The table below shows all the resolutions found in the DigitalEurope database that were then used to calculate the viewable area for the analysis. For those models which did not declare their resolution, a format of 16:9 was assumed.

Table 4-1. Electronic Display Resolutions in DigitalEurope database

Display Width Resolution (W)	Display Height Resolution (H)	Notes
1366	768	16:9
1280	1024	
1440	900	16:10
1600	900	16:9
1680	1050	16:10
1920	1080	HD, 16:9
1920	1200	16:10
2560	1080	
2560	1440	16:9
3440	1440	
2560	1600	16:10
3840	2160	1.78:1 (16:9) UHD
5000	3000	1.60:1 (16:10, 8:5) UHD

The on-mode power consumption levels provided by the manufacturers in the datasets are assumed to be accurate. It is understood that the power consumption level is an out-of-the-box measurement of average power with a dynamic test loop signal following IEC 62087 (Methods of measurement for the power consumption of audio, video and related equipment).

The figure below presents a scatter plot of the calculated screen size vs. power consumption for the European 2014 models database. The Commission's existing two ecodesign MEPS levels for television sets – Tier 1 (2010) and Tier 2 (2012) are included for reference. There appears to be one model that is out of compliance, however this particular model is a computer monitor rather than a television, so the MEPS curve does not apply.

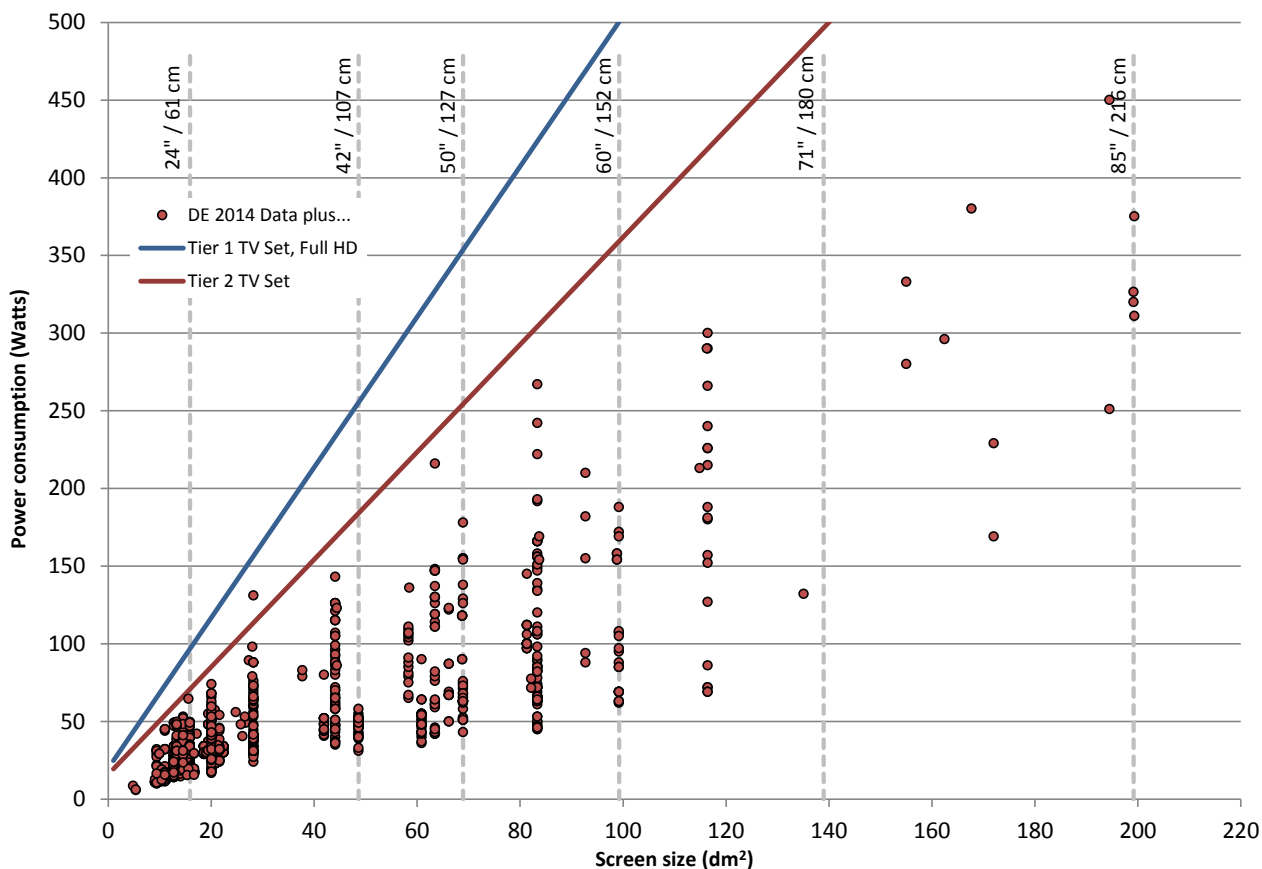


Figure 4-1. Scatter Plot of 2014 European Model Data and 642/2009 MEPS Levels

The new 2014 database provided by manufacturers was compared to the 2012 database provided by DigitalEurope when the Commission first initiated its review of EC No 642/2009. The first comparison made looked at the changes in label class, as shown in the figure below. There has been a trend in improving efficiency over the intervening two years, with A+ energy label class having the highest number of models. The number of models in the A+ class grew from 82 to 286 models. The A++ energy

class, scheduled for introduction in 2017, had no models in 2012 but now has 41 models or 4.2% of the model database.²⁵

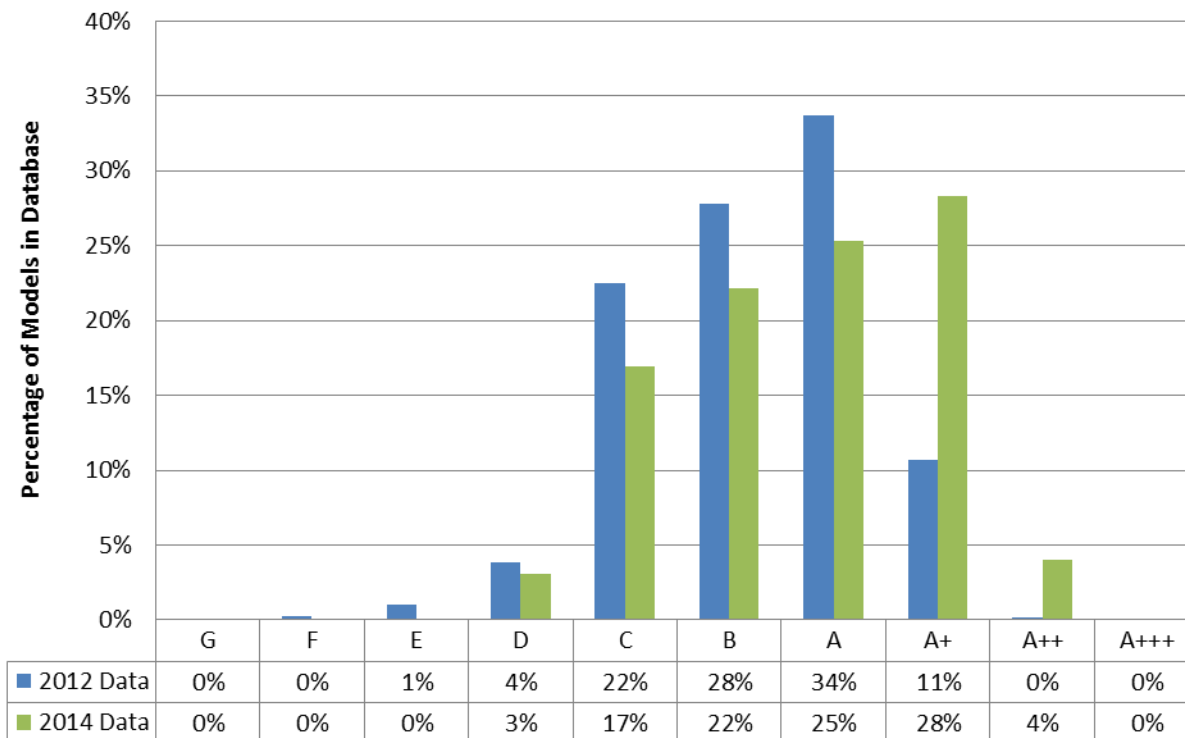


Figure 4-2. Energy Label Class Progression between 2012 and 2014, Model Database (not Sales)

The weighted-average EEI was calculated for the two databases, using the energy labelling EEI equation from EU No 1062/2010. The averages are weighted by model and by screen-area of those models – thus, these are indicative of the market, but they do not necessarily represent the sales-weighted averages for the years shown. The 2012 database contained 756 models and had an average EEI of 0.383. The 2014 database contains 1022 models and has an average EEI of 0.300. Thus, in those two years, the available models on the market have experienced an improvement of 22% in their weighted-average EEI (energy labelling) value. At this rate of improvement, A+++ models are expected to be placed on the European market in 2016, four years ahead of the scheduled introduction of the A+++ label in 2020.

4.2. Proposal for Ecodesign Requirements

One of the problems with the 2012 proposal by the Commission was the discontinuity experienced between the “small” and “large” displays, and how to define that product characteristic. The Commission’s 2012 proposal had applied a best-fit linear curve of performance for the small displays and then a natural log function for the large displays. Applying that same approach with the new 2014

²⁵ Note: Topten Europe found there to be 68 A++ models in the market as of May 2014 (Topten, 2014). The reason for this discrepancy is that not all electronic display companies selling product in Europe are members of DigitalEurope, who were the primary source of model data for this review.

dataset was not an ideal solution as the small and large lines did not align well to the new database and adjustments or trade-offs would have been required.

To resolve this issue, we considered MEPS levels and requirements of a few different programmes around the world, including the recent Super-efficient Equipment and Appliance Deployment (SEAD) work in the Asia-Pacific Economic Community (APEC) region. The approach published by SEAD was based on that used by the US ENERGY STAR programme, namely a tangent hyperbole [TANH ()] function. The Tanh function provides a curve shape that correlates well with the data and policy objectives. This approach offers a good fit for the European 2014 dataset, and was used as the basis of the recommendation in this study.

The equation is based originally on the draft United States Energy Star version 7.0, which establishes a maximum power using a tan hyperbole function and screen area defined in square inches:

$$\text{Power} = 65 \times \tanh(0.02 + 0.0005 \times (\text{Area} - 140)) + 15$$

This equation was converted by the SEAD experts to square centimetres, and a variable called Z_{class} was added to shift the curve in order to create different threshold values. In addition to that, the term adding watts for baseload was broken into two components, a fixed and a variable component. Thus, the modified (draft) US Energy Star equation presented in the APEC report is:

$$\text{Power} = Z_{\text{class}} \times (65 \times \tanh(0.02 + 0.0000775 \times (\text{Area} - 900)) + 5) + 7$$

Where:

Z_{class} is the multiplication factor used to establish separate reference threshold values (i.e., different Tier levels in the SEAD report);

Tanh is the hyperbolic tan mathematical function used to define the curve;

Area is the visible screen area measured in cm^2 ;

'7' is the watts of fixed baseload which does not change with efficiency class; and

'5' is the variable part of the baseload which changes with efficiency class.

The other factors (65, 0.02, 0.0000775, 900) are used in the equation to define the curvature of the tanh function.

For the proposal presented in the current ecodesign working document, these constants were adjusted to convert the screen area term from square centimetres to square decimetres, and some of the constants were adjusted slightly to better match the 2014 European model dataset, distributing the efficiency requirements evenly across the screen sizes.

The equation that is used as the basis for these three maximum wattage power consumption curves is given below, where the *Area* term is the screen area of the display in dm^2 :

$$\text{Power}_{\text{max}} = A \times [B \times \tanh(C + D \times (\text{Area} - E)) + F] + G$$

And the variables plugged into the equation are given in the table below:

Table 4-2. Variables in the Maximum On Power Equation – Draft European Curves

Variable	Tier 1	Tier 2	Tier 3
A	3.0	2.0	1.0
B	100	99	98
C	0.02	0.02	0.02
D	0.006	0.0065	0.007
E	11	11	11
F	4	4	4
G	6	6	6

The function still applies ambitious requirements on large screens, but it is not as stringent as the natural log function used in the Commission’s 2012 ecodesign working draft document. This function is an improvement over the 2012 proposal because it sets reasonable pressure on the regulation of a diminishing market of smaller screens and avoids the discontinuity problem observed between small and large screens. This equation offers the benefit of having one equation that applies to all display sizes. In the figure below, the displays from the European 2014 model database are presented with the three proposed tier levels based on the tanh function. The models in the database have been colour-coded to differentiate between UHD and non-UHD displays, in order to show the range of efficiencies available the market at the different screen resolutions and sizes.

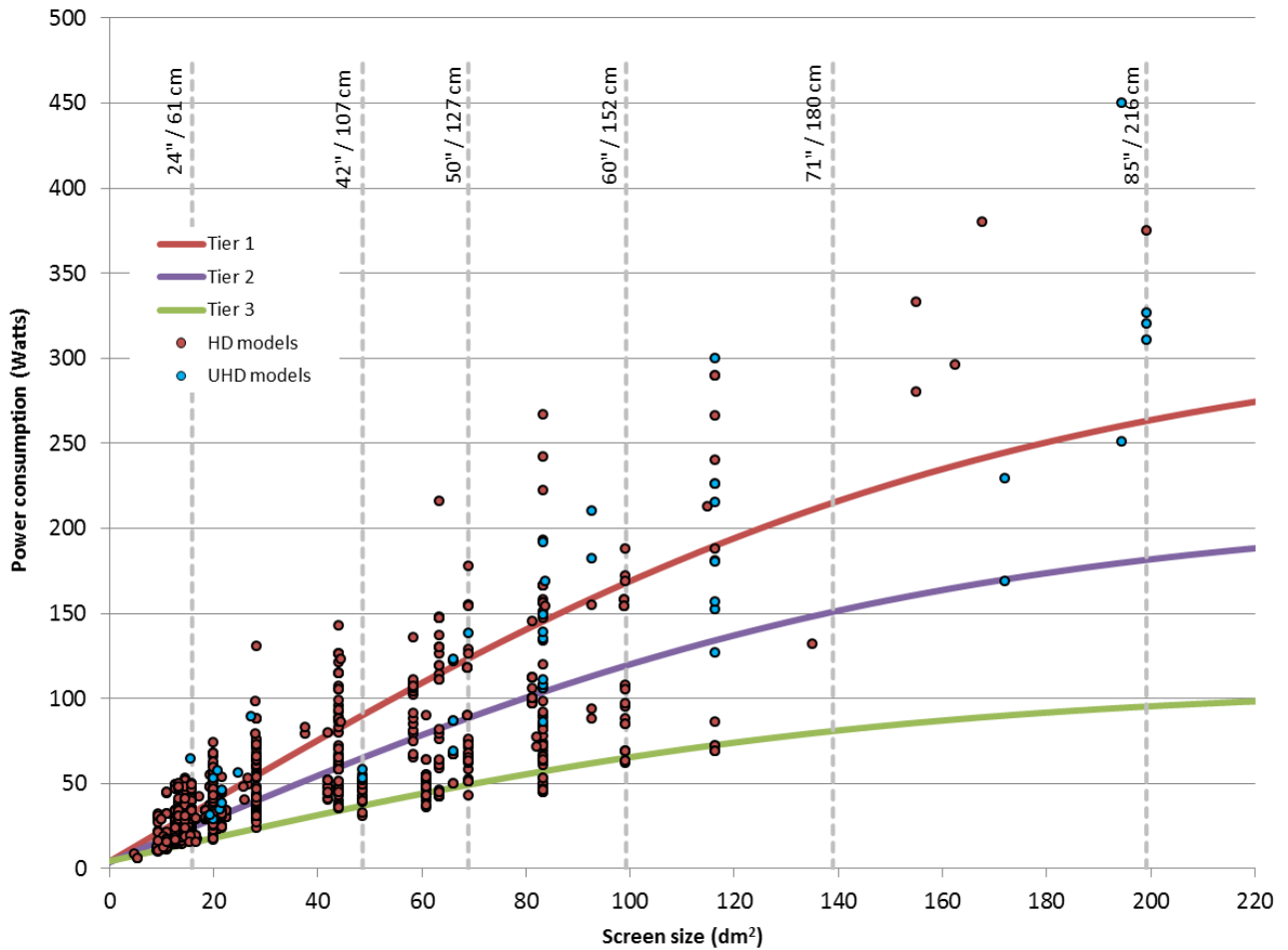


Figure 4-3. Proposed MEPS Curves and 2014 Data, differentiating between UHD and non-UHD models

The following figure provides a close-up of the smaller screen sizes with the proposed three tiers based on the tanh function.

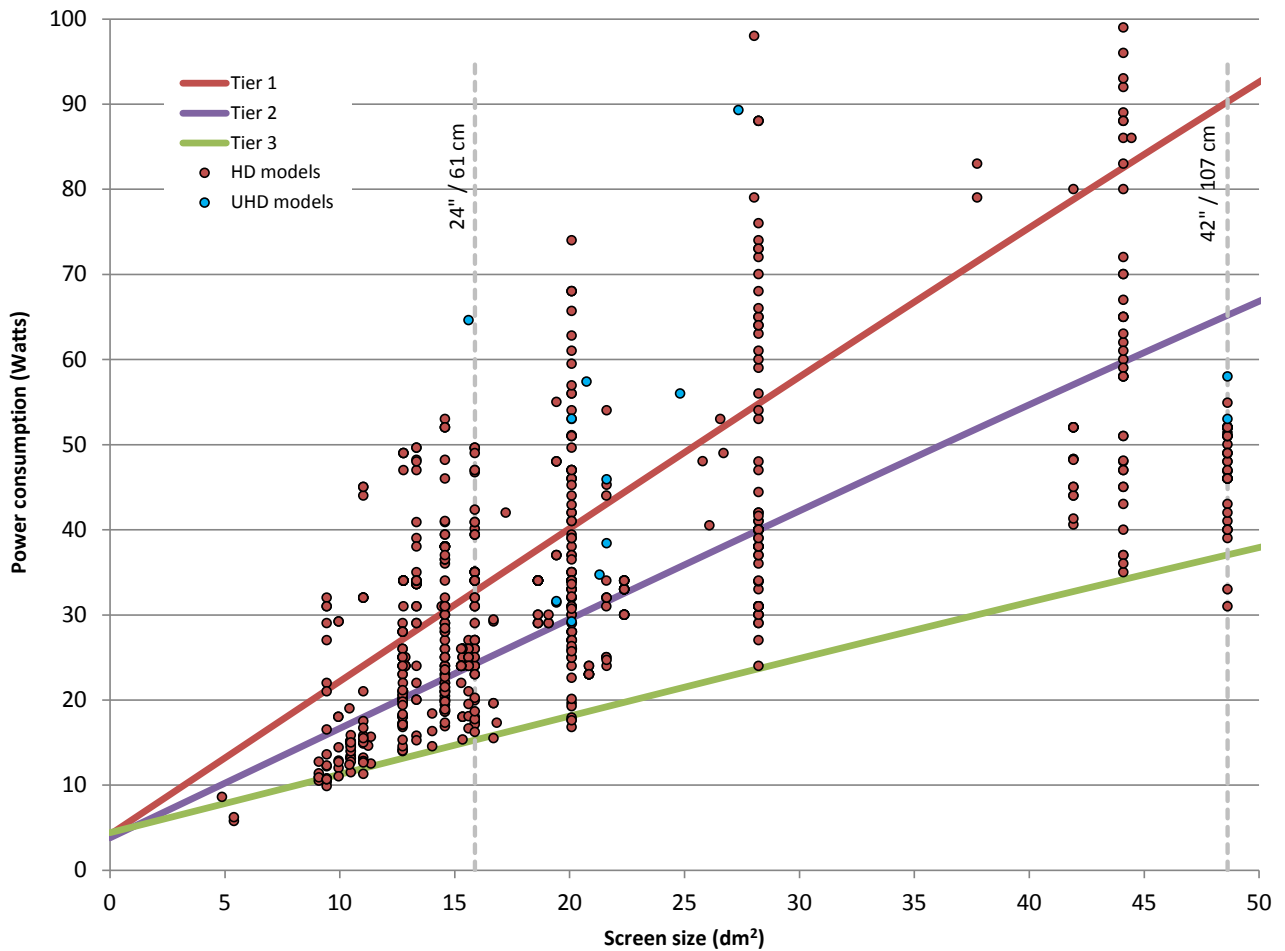


Figure 4-4. Proposed MEPS Curves and 2014 Data, Focus on Small Screen Sizes

When applying these three curves to the European 2014 model database, we have the following progression of pass/fail of units at the different screen sizes.

Table 4-3. Models from the 2014 Database that Pass the Three Tier Levels, grouped by Screen Size

Size (inch)	<24"	24" to <42"	42" to <50"	50" to <60"	60" to <71"	>71"	Total
Size (cm)	<61	61 to <107	107 to <127	127 to <152	152 to <180	>180	
Area (dm ²)	<16	16 to <49	49 to <69	69 to <99	99 to <139	>139	
Count	301	384	137	136	39	13	1010
Tier 1	71%	68%	86%	79%	69%	23%	72%
Tier 2	43%	33%	72%	65%	56%	8%	46%
Tier 3	4%	1%	11%	9%	18%	0%	5%

Looking specifically at the number of UHD models in the dataset (n=45 models) and these three tiers, 51% of the UHD models in the 2014 database pass the Tier 1 level and 16% of the 2014 models pass the Tier 2 level which would take effect around 2018.

The figures below present a comparison of these three curves with the US ENERGY STAR curves, both the current version 6.0 and the proposed revision for version 7.0.

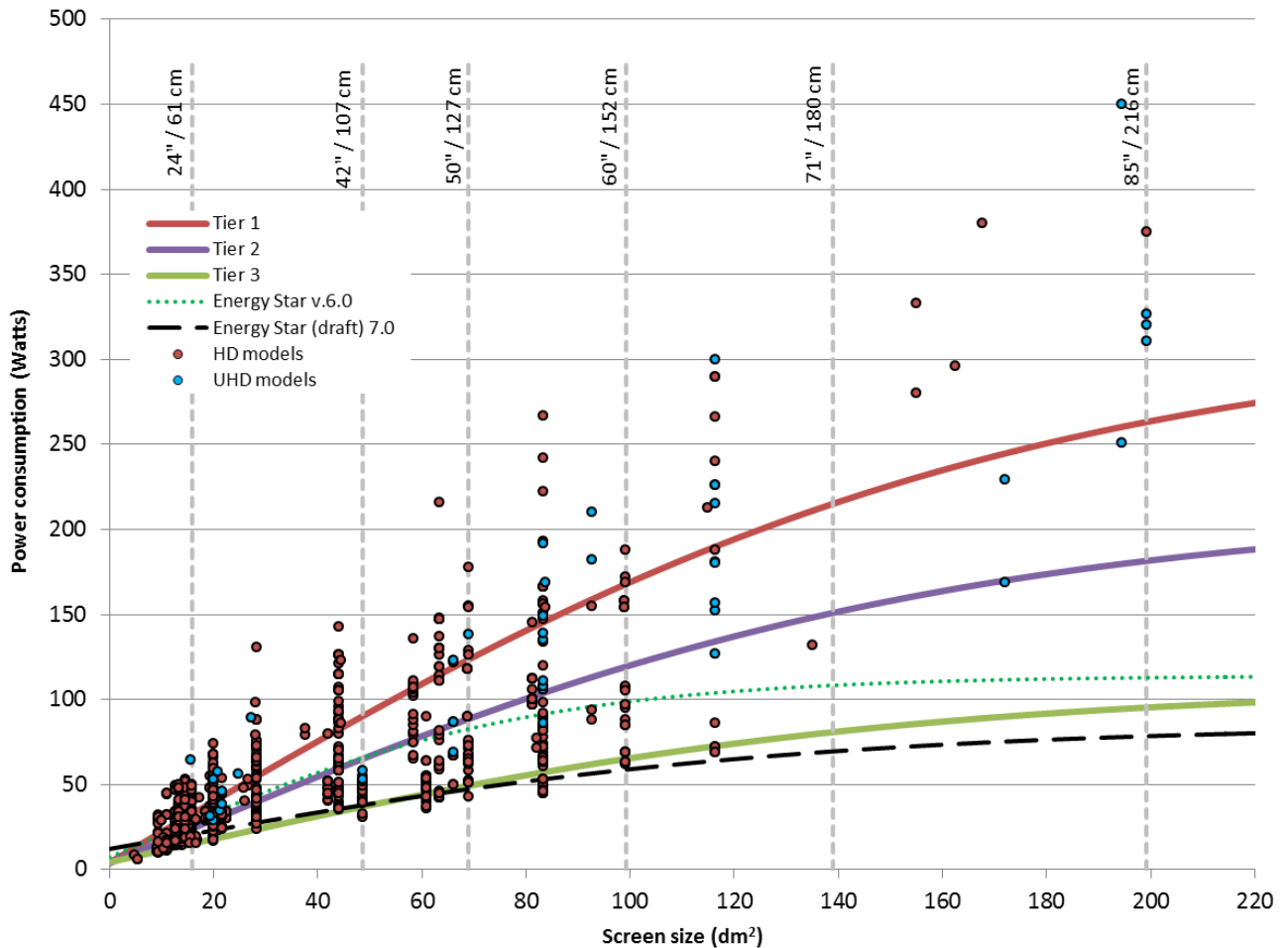


Figure 4-5. Proposed MEPS Curves and 2014 Data, with US ENERGY STAR Curves

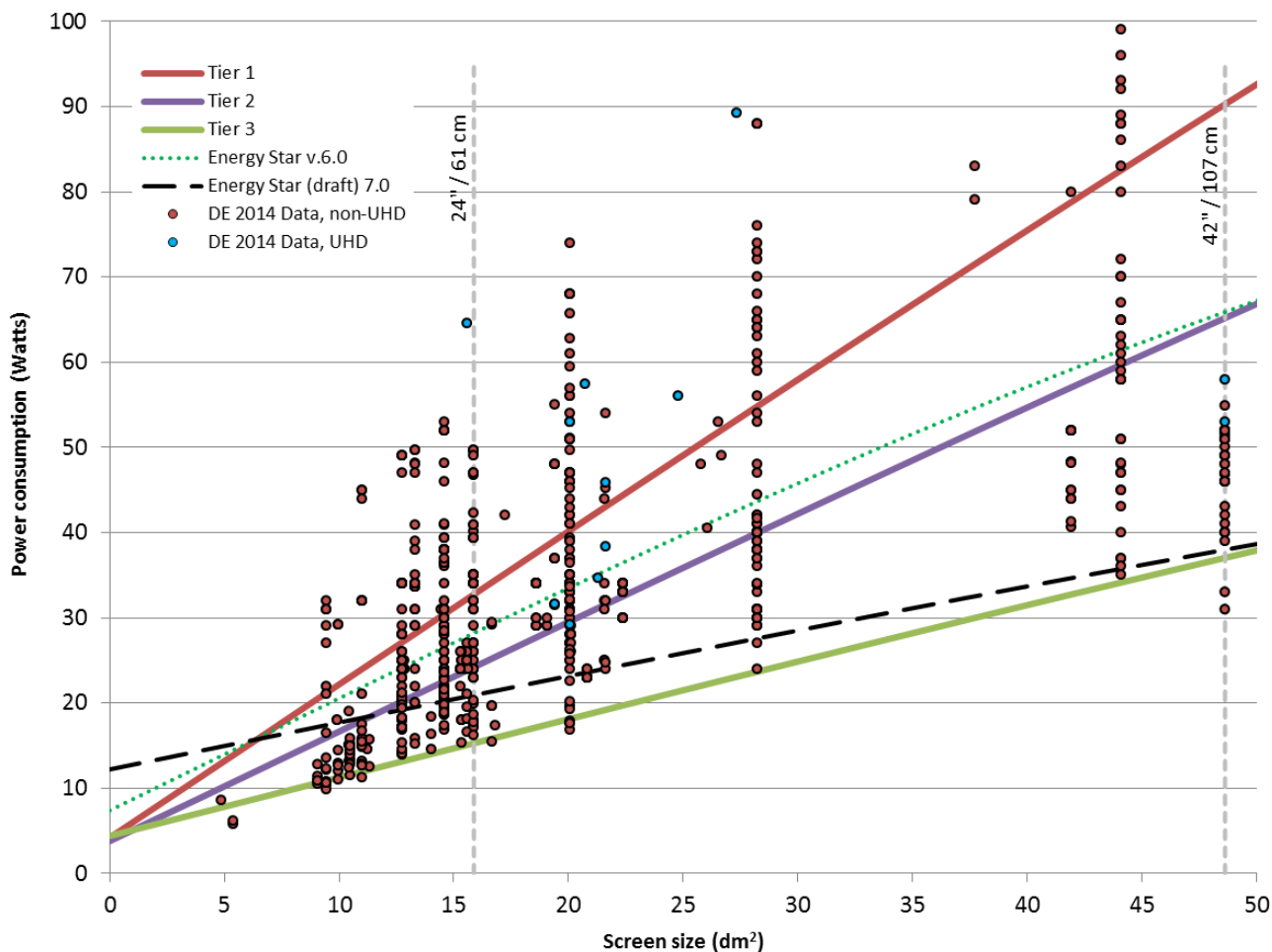


Figure 4-6. Proposed MEPS Curves and 2014 Data, with ENERGY STAR Curves; Small Screen Size

The three proposed curves were compared to three curves that were proposed by DigitalEurope in an email to Bob Harrison / CLASP in mid-August. The table below provides the EEI values and the equations from the DigitalEurope proposal, which have three different sections based on screen size in square decimetres. Please see Annex A for the original comment and email provided by DigitalEurope.

Table 4-4. Digital Europe’s Proposal for EEI values and functions

EEI values	Tier 1 = 0.6, Tier 2 = 0.54, Tier 3 = 0.48
EEI values for 4K	Tier 1 = 0.9, Tier 2 = 0.81, Tier 3 = 0.73
EEI functions	$EEI = \frac{P_m}{(1,10 \cdot A + 9,11) \cdot 2,10} \quad A \leq 15,9 \text{ dm}^2$ $EEI = \frac{P_m}{(42,66 \cdot \ln(A) - 90,68) \cdot 2,10} \quad 15,9 \text{ dm}^2 < A \leq 45,9 \text{ dm}^2$ $EEI = \frac{P_m}{(57,00 + 2,10 \cdot A)} \quad 45,9 \text{ dm}^2 < A$

The level of ambition associated with the DigitalEurope proposal is lower than the level proposed in this (CLASP) report. The figure below presents a comparison of the DigitalEurope and CLASP curves.

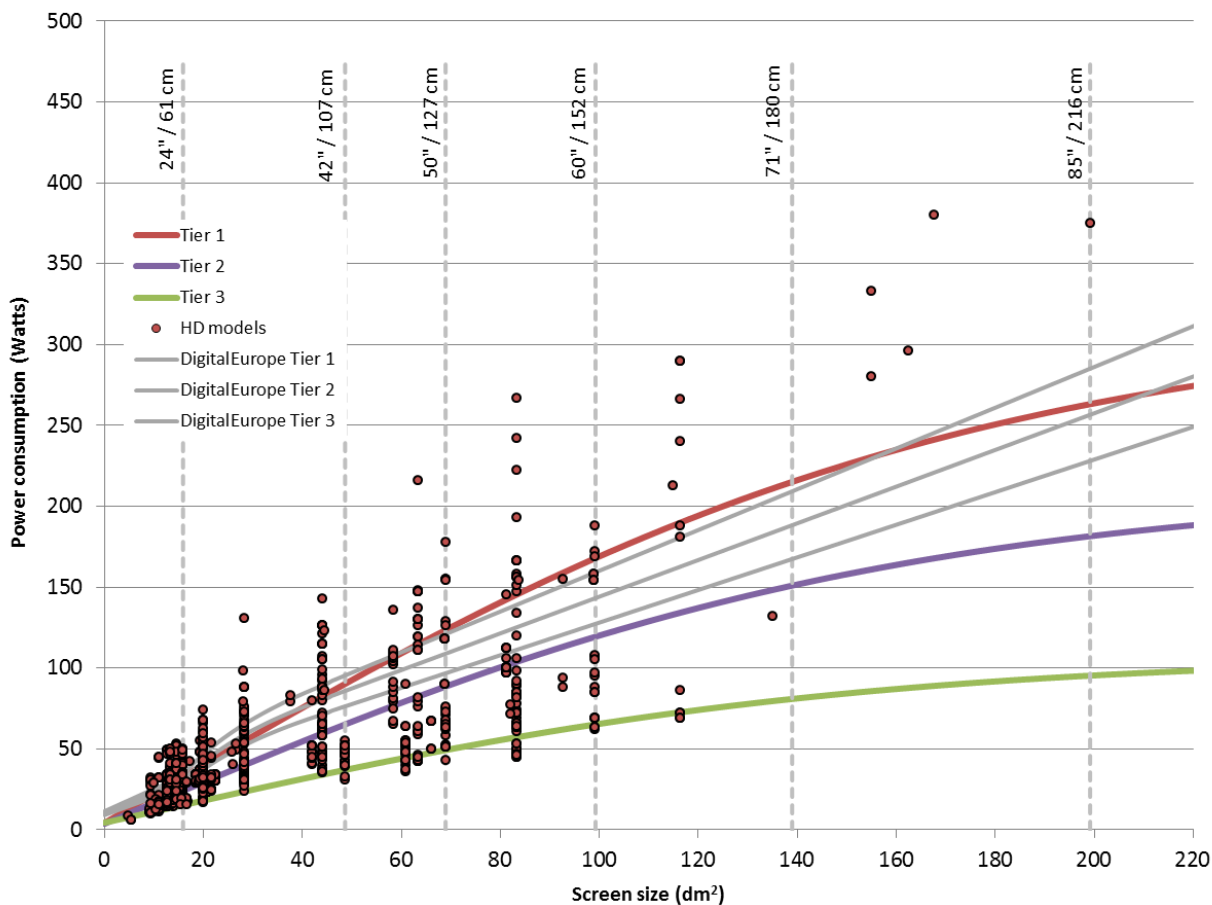


Figure 4-7. Proposed MEPS Curves and 2014 HD Only Data with DigitalEurope Proposed MEPS

The three MEPS levels proposed by DigitalEurope span the maximum power range between Tier 1 and Tier 2 proposed in this report, however the DigitalEurope curves tend to have slightly less ambition relative to the CLASP curves above a 71" screen size. The three DigitalEurope tiers were applied to the European 2014 model database, to determine the number of units that would pass/fail. The table below presents the rate of compliance for the 2014 models with standard high definition resolution (n=965).

Table 4-5. Models from the 2014 Database that Pass the Digital Europe Proposed Three Tier Levels

DigitalEurope Proposal	Possible Effective Date	Number of 2014 Models that Comply	Percent Compliant Models in 2014 Database
Tier 1	2016	753	78%
Tier 2	2018	688	71%
Tier 3	2020	629	65%

DigitalEurope proposes a separate, less ambitious, set of EEI values for UHD displays with higher EEI values (that translate into higher levels of power consumption). The figure below shows how the DigitalEurope proposal compares with the UHD models in the 2014 database (n=45).

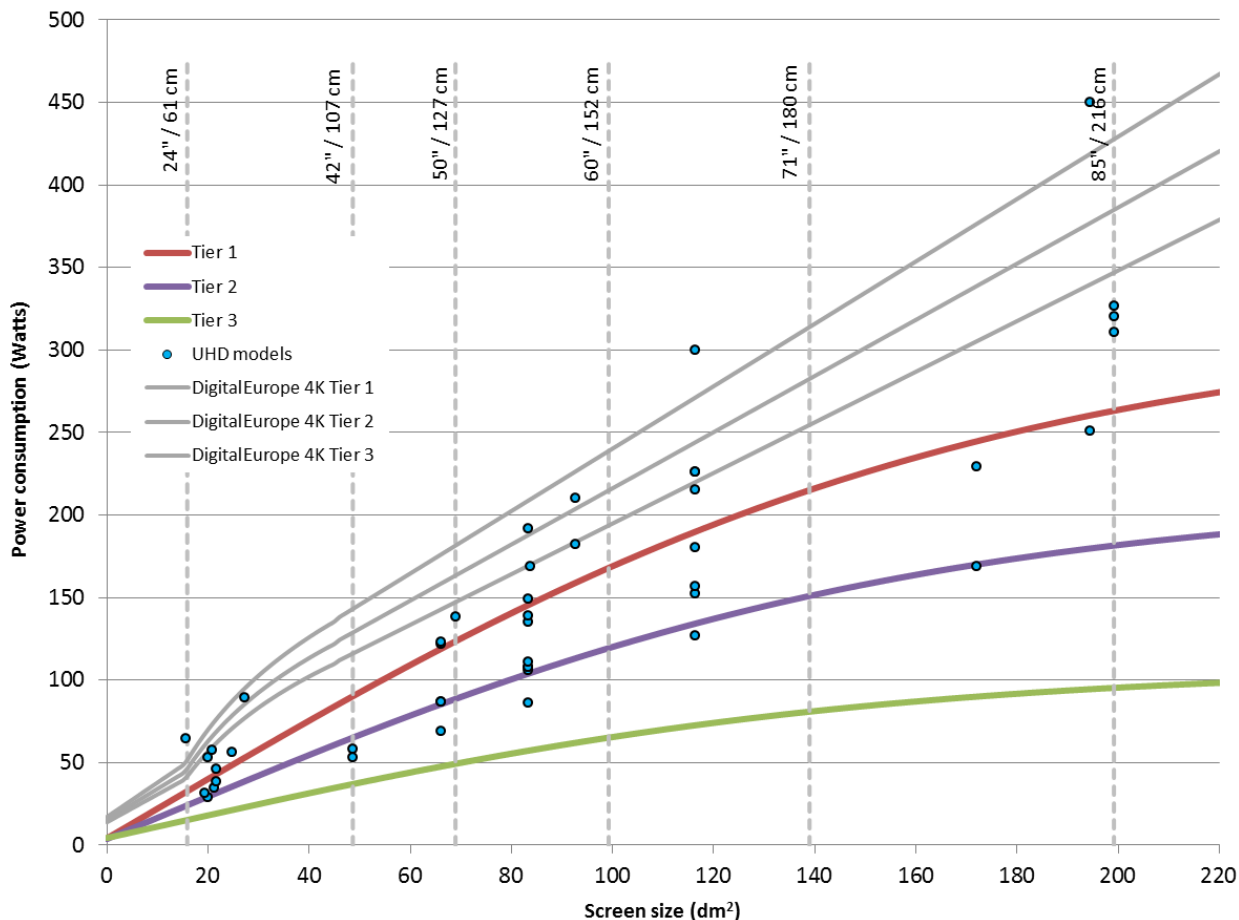


Figure 4-8. Proposed MEPS Curves and 2014 HD Only Data with DigitalEurope 4K Proposed MEPS

It was found that three UHD models were excluded at Tier 1, six models at Tier 2 and eight models at Tier 3. This means that the compliance rate of the 2014 database is 93% pass the Tier 1 level, 87% pass Tier 2 level and 82% pass Tier 3. This high pass-rate on 2014 UHD models does not appear to take into account the fact that displays will improve in efficiency in the coming years.

The three curves proposed in this report were also compared to the draft proposal of the Commission presented in October 2012, based on two different equations for large and small screens and EEI threshold values of 0.60, 0.40 and 0.20. These three curves are shown in Figure 4-9 and Figure 4-10 as pale grey lines.

It should be noted that the new proposed curves are slightly less ambitious in the larger screen sizes, but they are more ambitious at the smaller screen sizes for Tiers 1 and 2, and offer a better fit overall with the database, as shown earlier in this report in Table 4-3. There is also an improvement in the requirements placed on smaller screen sizes, visible in the figure showing the smaller screen sizes resulting from eliminating the split between small and large screens.

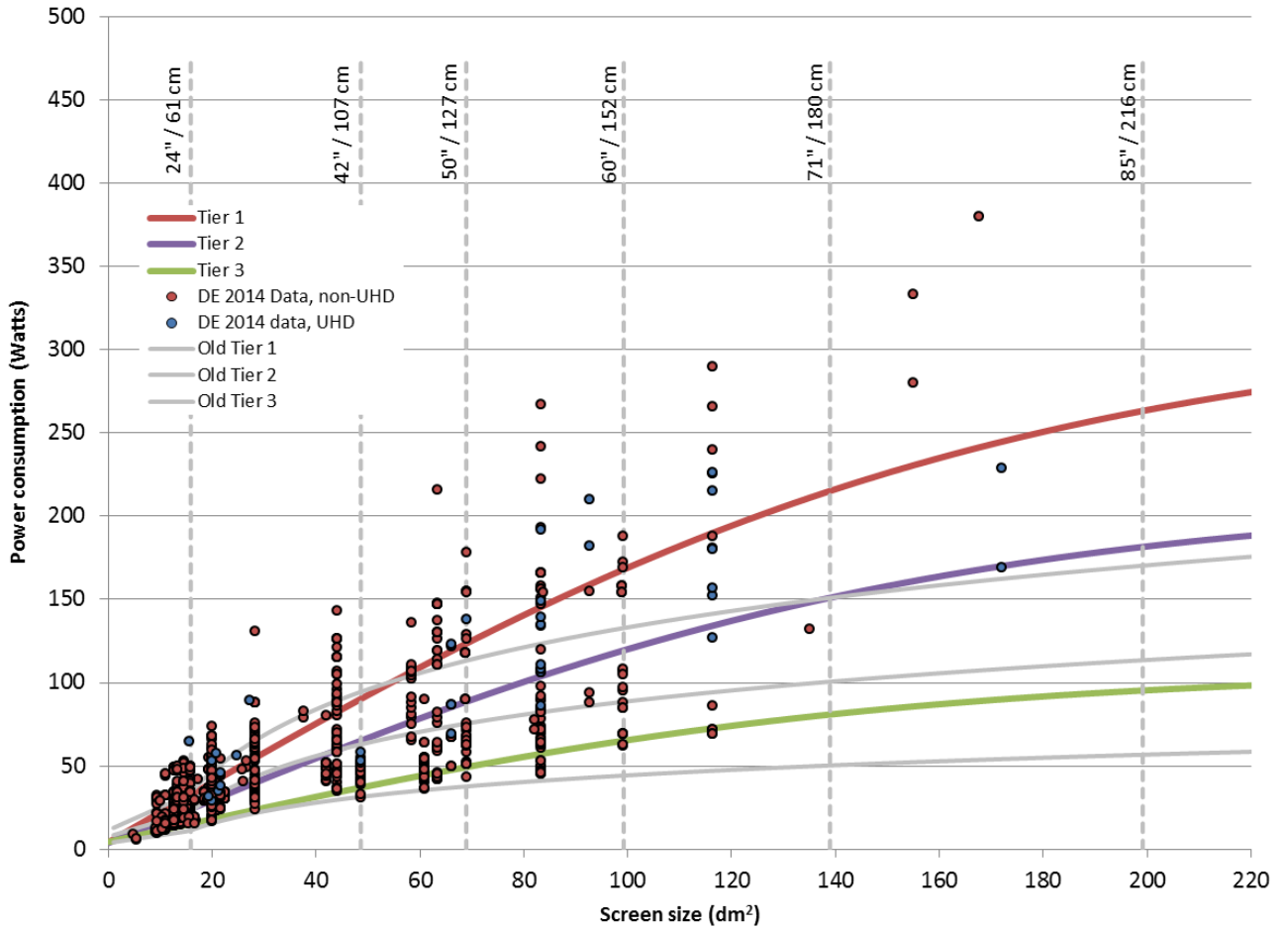


Figure 4-9. Comparison of the proposed 2014 MEPS levels with the draft 2012 MEPS curves

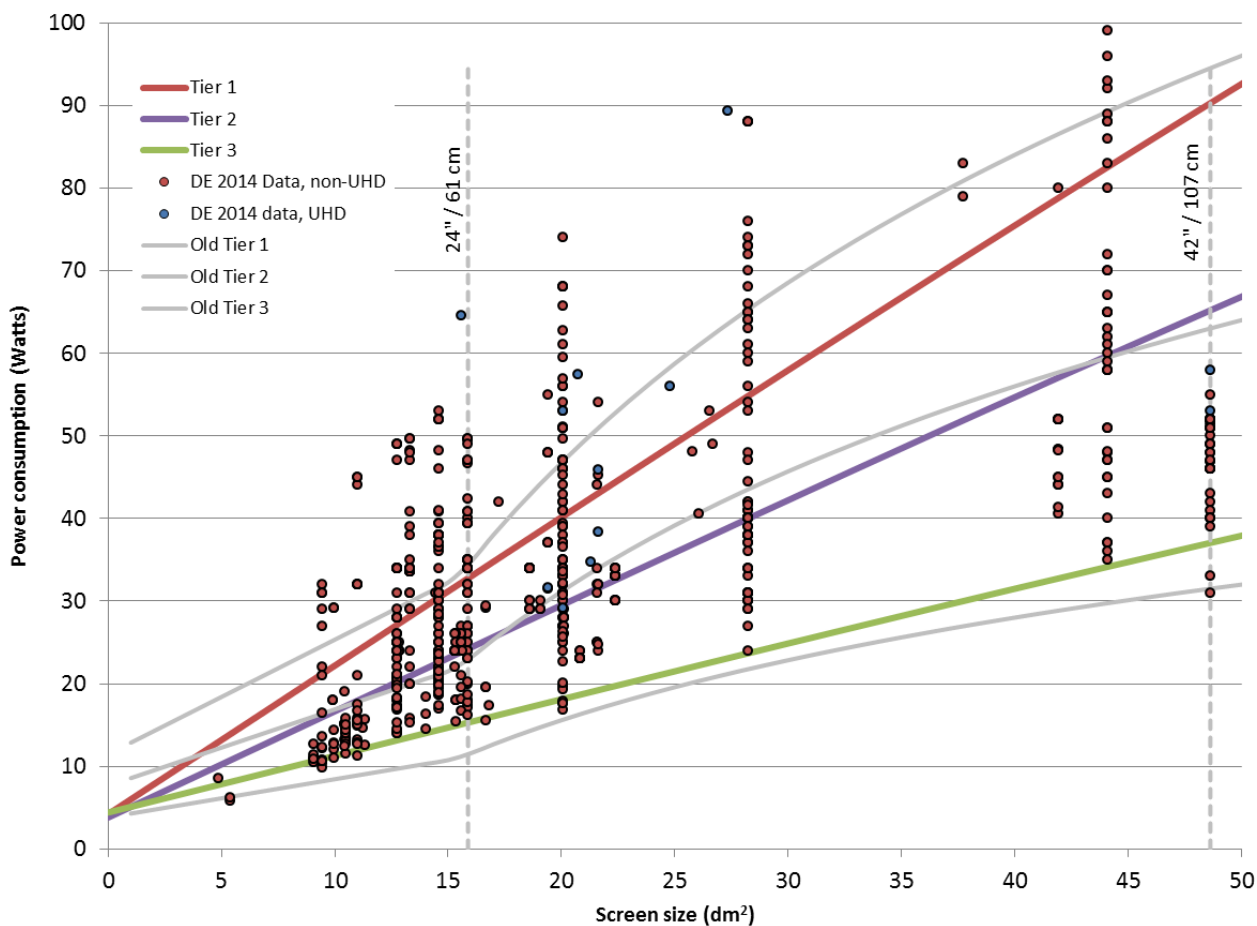


Figure 4-10. Comparison of the proposed 2014 MEPS levels and 2012 levels, smaller screen sizes

In order to make a very rough assessment of whether the level of ambition in the three proposed Tiers is reasonable, a comparison was made between the 2012 and 2014 model datasets. The average power consumption per unit viewable area for all of the models in each database was calculated and compared. The percentage improvement between the models in 2012 and the models in 2014 was calculated, and that same percentage improvement was applied to the 2014 dataset in order to estimate the performance of electronic displays in 2016, 2018 and 2020 assuming that the rates of innovation in the next six years are equal to those of the last two years. In other words, a technology improvement projection to 2020 was developed based on the improvement observed in the data from the last two years.²⁶

The average maximum on-mode power consumption per unit viewable area in the 2012 dataset was 1.91 W/dm². This same value in the 2014 dataset was 1.63 W/dm², representing an improvement in power consumption per viewable area of 15% over 2 years. Applying that same rate of improvement to the 2014 dataset, new maximum on-mode power consumption levels were calculated for 2016, 2018 and 2020. These new, hypothetical future power consumption levels for electronic displays were then

²⁶ Please see section 4.2 of this report for information on future technology innovations that promise to further improve the energy-efficiency of electronic displays.

compared to the proposed Tiers levels to estimate how many of the future models would pass. The following table presents the percentages of models that are expected to pass the future Tier levels if energy-efficiency innovation continues at the same pace of the last two years. For example, although it stated earlier that 72% of the models in the European 2014 database would pass Tier 1 (see Table 4-3) in this table, it is projected that in fact 86% of models will pass Tier 1 when it takes effect in 2016 due to anticipated improvements in efficiency that will occur in the next two years.

Table 4-6. Hypothetical Pass-Rate Projecting Performance Improvement for Displays to 2020

	Approximate Year	Tier 1	Tier 2	Tier 3
Tier 1	2016	83%		
Tier 2	2018		73%	
Tier 3	2020			46%

Thus, in 2016 the ambition of Tier 1 would allow 83% of the models on the market in that year to remain. This means that approximately 17% of the models that would have been offered in that year would be removed by the regulation. If the performance trends are maintained, then it is expected that Tier 2 would eliminate approximately 27% of the models that would have been in the market in 2018 in Europe (allowing 73% to remain). Finally, at Tier 3, approximately half of the models that would be in the market in 2020 will remain and half will be removed.

This crude energy-efficiency innovation projection was conducted to help ensure that if the current (natural) performance improvements are maintained for televisions, consumers will still have a wide variety of models to choose from, and yet the Tier levels adopted will (unlike the previous regulation on televisions, EC No 642/2009²⁷) have some impact in driving the market toward higher efficiency models.

The original draft of the Working Document scheduled Tiers 1, 2 and 3 to take effect a fixed period of time following publication of the regulation the Official Journal of the European Union (OJEU). The dataset being used for the current analysis is current (i.e., 2014) proposes the same schedule of one, three and five years from date of publication in the OJEU. It would again reference the publication date in the OJEU, taking effect in approximately 2016, 2018 and 2020. It is suggested that a review be scheduled for four years after publication in the OJEU, or 2019.

4.2.1. Auxiliary Functions

Regarding any auxiliary function, (e.g., internal media recorder/player), this should be taken into account by the measurement method. The current Energy Labelling Regulation for Televisions has allowances for hard disc(s) and multiple tuners that are not necessary because these components should be switched off when not needed by power management or are already at power requirement levels well below the tolerance limits of on-mode power measurement.

²⁷ As discussed in section 3.4 of this report, the tier levels in the previous ecodesign regulation (EC No 642/2009) did not have any measurable impact on the market.

If manufacturers do not include a capability for the product to manage the power of auxiliary functions like these to a low / no power state when they are not needed, then the overall power consumption during the test measurement will be higher than necessary. The additional power consumption of these auxiliary functions may result in the product being classified in a less efficient energy label class. Therefore, it is suggested that no allowances are granted for auxiliary functions in the regulatory measures.

4.2.2. Power management and other modes

The current Ecodesign Regulation for televisions includes a requirement for Auto Power Down (APD), i.e. after no more than four hours in on-mode following the last user interaction and/or a channel change, the television shall automatically switch into a standby or off-mode and the user must be alerted prior to this switch. The APD shall be set as default, which implicitly means that the APD can be disabled by the user.

It is suggested that for those display products that offer computer monitor or other interface connectors with power management protocols, the TV APD requirement is automatically overridden when these connector signals are selected and that power management then reverts to the protocols associated with the interconnection involved or the host device power management protocols (e.g., support for VESA display power management signalling – DPMS, HDMI CEC, etc.).

Products should offer appropriate power management features, enabled by default, in addition to the APD requirement, to allow connected host devices to over-ride the APD requirement as appropriate to the product usage (i.e., the power management protocols appropriate to the input source the user has selected).

To encourage power management in low power modes it is recommended that a scenario of “functional adders” is avoided. Extra functionality in a display product should be user controlled or power managed. Power allowances for such additional functions do not catalyse manufacturer's effort to minimise the energy requirement of additional functions.

4.2.3. Peak luminance ratio

The Television Ecodesign Regulation 642/2009 has a requirement for peak luminance ratio that stipulates the following starting on 20 August 2010:

- Televisions without forced menu: the peak luminance of the on-mode condition of the television as delivered by the manufacturer shall not be less than 65 % of the peak luminance of the brightest on-mode condition provided by the television.
- Televisions with forced menu: the 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.

New wording of this on peak luminance provision is proposed below in order to provide clear guidance for manufacturers and surveillance authorities:

- Televisions and all displays without forced menu: the peak luminance of the on-mode condition of the television/display as delivered by the manufacturer shall not be less than 65% of the peak luminance of the brightest on-mode condition provided by the television/display. The brightest on-mode condition is defined as that mode, pre-set by the manufacturer, which provides the brightest acceptable picture. This is usually the mode provided to demonstrate the television/display in high luminance (retail) conditions (shop mode).

Televisions and all displays with forced menu: the peak luminance of the home-mode/delivered for intended use condition shall not be less than 65 % of the peak luminance of the brightest on-mode condition, in a manufacturer pre-set mode, provided by the television/display.

4.2.4. Other (non-energy) requirements

The 2007 ecodesign preparatory study stated that the environmental impact of televisions was mainly determined by the power consumption in the use phase. Applied materials and related manufacturing processes (production phase) were found to contribute to approximately one seventh of the overall “life cycle” impact (EuP Lot 3, 2007). But display products have, in the last seven years, reduced their energy in use and material consumption through technically driven changes in display form factor, related reduction in product weight and packaging material. These improvements are product specific, and will vary with the technologies applied and the particular product designs. There is an intrinsic incentive for the manufacturer to reduce production costs by optimising manufacturing processes and improving production yield.

Non-energy requirements, however, are outside of the scope of this technical report.

4.3. Energy labelling

There has been a problem created by the current definition of a television monitor, where the market has had uneven application of the labelling scheme to computer monitors, i.e. those with HDMI interfaces have been classified as televisions and those without have not. To avoid this anomaly, and the unreliable qualification of an input signal interface, it is suggested that a common approach to all electronic display labelling be considered. It is suggested that the scope of the Energy Labelling Regulation be extended to all electronic display products.

In addition, as discussed in sections 2.5 and 4.1 of this report, the television market has evolved much faster than was expected with 41 models that could be classified as A++ already offered in the 2014 market when A++ isn’t scheduled to be introduced until 2017. It is therefore suggested that the EEI threshold values be adjusted for A++ and A+++ classes, to help extend the useful life of the label for the next five years. This suggested adjustment is as follows:

- A++ threshold value changed from EEI of 0.16 to an EEI of 0.13
- A+++ threshold value changed from EEI of 0.10 to an EEI of 0.05

DigitalEurope submitted a comment suggesting the adjustment in the EEI for A+++ to 0.05 in their written comments following the 2012 draft Consultation Forum documents issued by the Commission. In addition to this adjustment, CLASP is proposing that the Commission consider adjusting the A++ threshold value will help to ensure that category doesn't become saturated too quickly, and to better distribute the categorisation of products in these high energy classes.

Please note that the equation used to calculate $EEI_{\text{EnergyLabel}}$ is different from the equations given in section 4.2 for the ecodesign maximum power calculation. This equation is not ideal because it is linear, and fails to track the natural performance improvement and inherent physical properties of electronic displays, however it would be potentially disruptive to the market to re-classify the energy classes at this time, just before the Commission conducts an overall update of the energy label. Therefore it is suggested to continue to use the same equation until after the overall label update.

$$EEI_{ELdsp} = \frac{P_m}{(4.3244 \times A + 20)}$$

Where A is the viewable area, given in decimetres squared.

The table below shows the distribution of products for the existing and proposed revised EEI ranges in red text for the European 2014 model database. The two suggested changes are shown: A++ adopts a threshold EEI of 0.13 and A+++ shifts to an EEI of 0.05. Under this proposal, A+ remains the largest class in the database, but A++ has been reduced from 41 models to 8 models. Furthermore, the best performing model in the database has an EEI of 0.118, so it is extremely close to the A+++ threshold value of 0.10.

Table 4-7. Existing and Suggested New Energy Label Classes and Distribution of 2014 Model Database

Label Class	Existing Energy Classes			Proposed Energy Classes		
	Label Range	Comply	%age	Label Range	Comply	%age
A+++	EEI < 0.10	0	0.0%	EEI < 0.05	0	0.0%
A++	0.10 ≤ EEI < 0.16	41	4%	0.05 ≤ EEI < 0.13	8	0.8%
A+	0.16 ≤ EEI < 0.23	286	28%	0.13 ≤ EEI < 0.23	319	32%
A	0.23 ≤ EEI < 0.30	256	25%	0.23 ≤ EEI < 0.30	256	25%
B	0.30 ≤ EEI < 0.42	224	22%	0.30 ≤ EEI < 0.42	224	22%
C	0.42 ≤ EEI < 0.60	171	17%	0.42 ≤ EEI < 0.60	171	17%
D	0.60 ≤ EEI < 0.80	31	3%	0.60 ≤ EEI < 0.80	31	3%
E	0.80 ≤ EEI < 0.90	0	0.0%	0.80 ≤ EEI < 0.90	0	0.0%
F	0.90 ≤ EEI < 1.00	1	0.1%	0.90 ≤ EEI < 1.00	1	0.1%
G	1.00 ≤ EEI	0	0.0%	1.00 ≤ EEI	0	0.0%
Total:		1010	100%		1010	100%

Two graphs were also prepared to illustrate the above proposed revision to the Energy Classes. The first graph shows the existing energy classes and the second graph shows the proposed revised energy classes. Both graphs also include the proposed three tier levels and the scatter plot of 2014 model data.

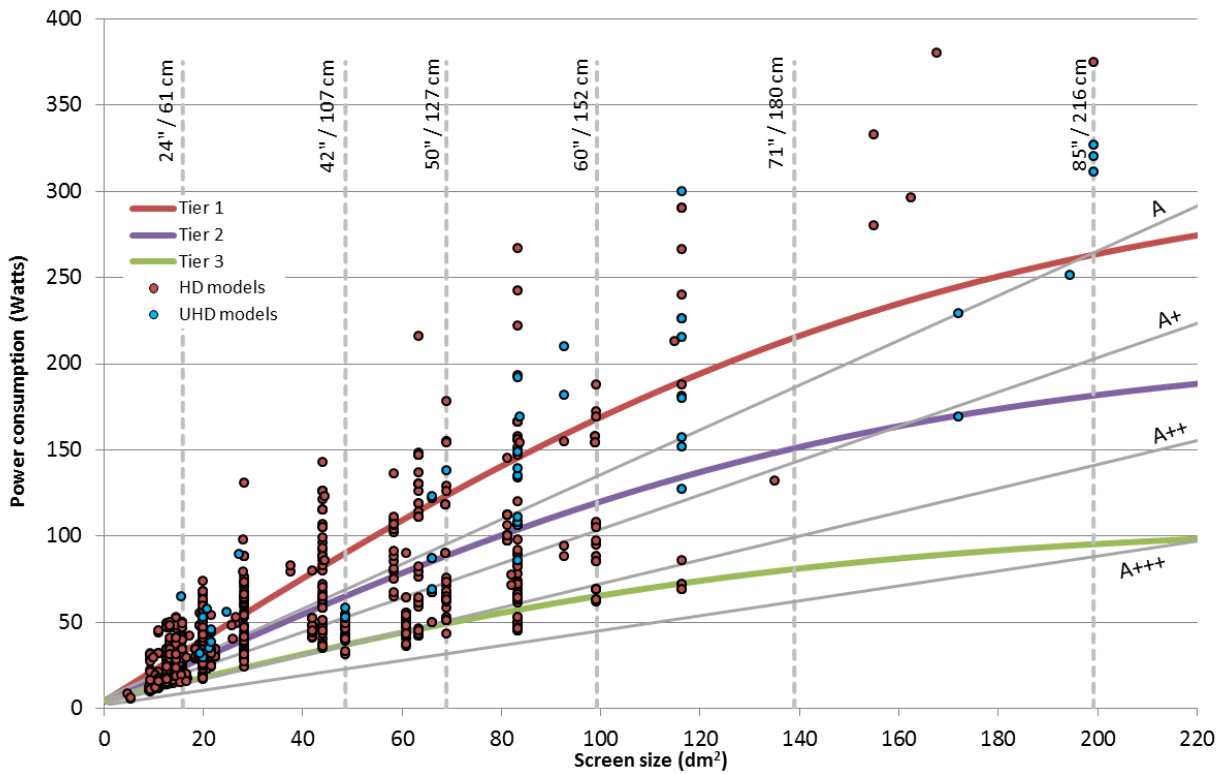


Figure 4-11. Existing Energy Label Classes with proposed MEPS and 2014 Database

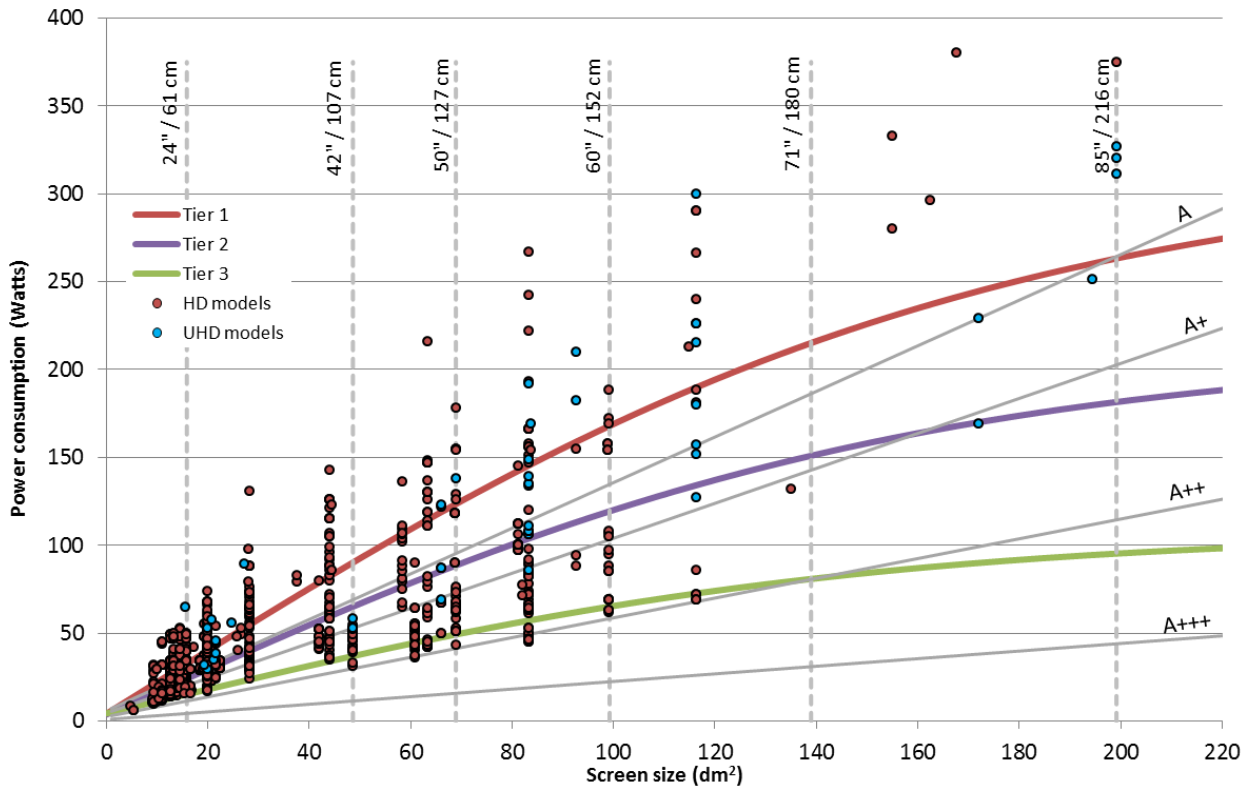


Figure 4-12. Proposed New Energy Label Classes with proposed MEPS and 2014 Database

4.4. CENELEC harmonised European measurement standard

The Commission has issued a mandate (EC M/477) to CENELEC to produce a “harmonised” measurement standard in support of the television Ecodesign Regulation EC 642/2009. This standard will mirror the updated version of the international measurement method IEC 62087, which will include a separate television testing part and computer monitor testing part. It should, however, be noted that the Commission's mandate given to CENELEC only specifies televisions and television monitors for the development of a measurement method and does not yet cover other display products that may be covered by the future displays Regulation.

Annex A. DIGITALEUROPE comments on the Display regulation revision

On 11 August 2014, DigitalEurope provided a copy of their comments on the Display Regulation revision to CLASP. In addition, DigitalEurope prepared a letter to experts informing the Commission in which they provided their recommendation for possible MEPS curves for Tiers 1 through 3. Both of these comments have been included in this Annex, in their entirety, for the benefit of all members of the Consultation Forum. CLASP secured permission from DigitalEurope to include these comments in this report.



DIGITALEUROPE comments on the Display regulation revision

Scope, definition, requirements and labelling implications

Brussels, 711August 2014

DIGITALEUROPE, as the voice of the Consumer and Information Technology Industry in Europe, would like to outline with this paper the continuing concerns and problems that DIGITALEUROPE has identified with the direction that the revision of the regulations seems to be heading and suggests potential solutions for the main items.

1. SCOPE

Industry acknowledges the European Commission's decision supported by the majority of the Member States to merge televisions (TV) and computer monitors into a single regulation only for these particular product groups, under the condition that some specific displays intended for specialized professional application will be exempted.

DIGITALEUROPE would also like to request that products already under the scope of other product specific Implementing Measures, such as notebooks and integrated desktop computers are clearly excluded from the scope of this regulation.

We also recognize the need to have a regulation with solid and future-proof definitions and would therefore like to put forward some suggestions for these definitions, namely for the following product categories:

1.1. High Performance Displays

DIGITALEUROPE welcomes that High Performance Display products shall be exempt from the scope of the regulation since they require more energy to provide a higher level of performance, including an increased colour range/colour accuracy, wider viewing angles and higher resolution. With this set of features, high performance displays are often used in specialised applications such as engineering (particularly computer aided design), architecture, and photography/video and graphic design. High performance displays are sold in relatively low volumes due in large part to their high cost.

DIGITALEUROPE therefore proposes the following changes to the proposed definition:

A High Performance Display is a monitor that has all of the following features and functionalities:

- a. A contrast ratio of at least 1000:1 measured perpendicular to the plane of the screen and maintained to a minimum contrast ratio of 60:1 at the limits of a horizontal viewing angle of at least 85°, with or without a screen cover glass;
- b. A native resolution greater than or equal to 2.3 megapixels (MP);
- c. A colour gamut of 72%;
- d. A pixel response time commensurate with the frame rate of the image, including 3D imaging;



- e. A brightness uniformity of >75% across the image (based on a 9 point grid measurement);
- f. A viewing angle greater than or equal to 178° (at contrast ratio of min. 1:10);
- g. A diagonal size greater than or equal to 61 cm (24 inches).

1.2. Digital Signage Displays (Public Displays)

DIGITALEUROPE also welcomes the exemption of Digital Signage Displays from the scope of this regulation. In our understanding a “digital signage display” is not only a public/signage display, but rather a whole display application, typically controlled by personal computers, media players or servers. A typical application is an airport flight information display system.

It also covers collaboration displays that is designed to be used exclusively in commercial/business applications to display commercial or business information (e.g., meeting documents, or slide shows, in primarily, such as, but not restricted to corporate meeting rooms or classrooms).

Regarding the technical differentiators used in this definition, we realize that some have been suggested as possible technical features of such products in our position paper from October 2012. However, this was never intended to represent an exhaustive list of features, to be present in all signage products in the market.

Therefore DIGITALEUROPE suggest that the following differentiators, as used in the Australian MEPS, are used as specifications present in all Digital Signage Displays:

- a. Product has a screen size of 81 cm (32 inches) or above.
- b. The product is marketed as a product that is intended to be viewed by more than one user at a time.
- c. The product is not intended for desktop use.
- d. The product is not supplied with a means of allowing it to be freestanding.
- e. The product requires installation on a fixed basis.

Additionally, the specific ID to address the selected display screen (for example in display groups up to 25 units), could also be used as a differentiator present in all Digital Signage Displays.

Regarding the remaining differentiators proposed they should be added to the 2nd list of features that may also be present (but are not mandatory differentiators).

1.3. Broadcast Monitors

DIGITALEUROPE also welcomes the exemption of Broadcast Monitors from the scope of this regulation. Industry suggests that the definition for Broadcast Monitors should cover professional use by Broadcasters or Video Production Houses.

Current definition:

‘Broadcast monitor’ means an electronic display that is designed and marketed for professional use in television or broadcast production rooms, and whose specification shall include all of the following functions and features:



Suggested change:

‘Broadcast monitor’ means an electronic display that is designed and marketed for professional use by Broadcasters or Video Production Houses for video content creation, and whose specification shall include all of the following functions and features:

DIGITALEUROPE would also like to see a clear differentiation between products defined as Broadcast monitors and High Performance Displays.

1.4. Medical Monitors

DIGITALEUROPE would like to point out to the fact that the referenced directives and regulations will change soon. Therefore an addition is suggested:

‘Medical monitors and other medical devices’ means electronic displays and other products covered by the scope of *below Directives and their amendments:*”

1.6 Future 8K TV products

Targeting the 2020 Olympics, the Japanese public broadcaster NHK (Nippon Hoso Kyokai) announced a plan for the 8K broadcasting implementation. As there is currently no data available on this technology, we recommend either an exemption or discussing the 8K issue around Tier 2 timing in the view of Tier 3, or after the product introduction.

2. STANDBY AND OFF MODE REQUIREMENTS

DIGITALEUROPE would like ensure that all products in scope of the future regulation (including Computer displays) should be removed from scope of EC 1275/2008, just like televisions.

3. NETWORK STANDBY REQUIREMENTS

DIGITALEUROPE would like to reiterate the interpretation issues we are facing with the wording in the new requirements for network standby and power management, set as an amendment to regulation 642/2009 by regulation 801/2013. This refers specifically to the following wording,

The power management function, or a similar function, shall be activated, unless all wireless network ports are deactivated. In that case the power management function, or a similar function, shall be activated if any one of the network ports is activated.

(c) A networked television that has one or more standby modes shall comply with the requirements for these standby mode(s) when all wireless network ports are deactivated.

DIGITALEUROPE would like to ask for a clarification and/or an amendment in revision of the regulation.

4. POWER MANAGEMENT REQUIREMENTS

DIGITALEUROPE would like to request that application of the current Automatic power down (APD) requirement under the 642/2009 regulation (power down within 4 hours without user interaction) is limited to products with a tuner. In this way it would avoid that this requirement applies to products to which it would be inappropriate for their intended use. Such is the case for Computer Monitors where they are designed to obey a power-down command from the host computer (as supported by the DVI, HDMI, and DP protocols) and don't rely on user interaction as defined in the current regulation.

5. NON-ENERGY REQUIREMENTS

DIGITALEUROPE would once more like to reiterate the arguments of our past position papers (March 2013, February 2013 and December 2012) regarding our concerns with the proposed non-energy requirements to be included in the Ecodesign regulation for displays.

Our industry has invested significantly in the past 10 years in technical changes that have already resulted in an impressive 83% reduction in material use; with transformation from a CRT dominated market in 2002 to today's LED dominated market.. Display manufacturers are seeking practical solutions for setting non-energy requirements, and we are already proposing the phase-out of CCFL for LCD television, and voluntary introduction of a mercury-free logo to support consumer choice and better management of hazardous materials in recycling processes.

However DIGITALEUROPE cannot support the introduction of the following requirements:

Manual disassembly of key components

In general we have serious concerns with the proposal on disassembly times, not only with regard to the time length itself but also with the verifiability, the impact on innovation, the administrative burden, and above all, the demonstrable environmental benefit.

Marking of plastics

Although most display makers currently mark their plastic parts >100 gram following the ISO 1043-1 (polymer type) and ISO 1043-4 (FR code) standards on a voluntarily basis, Manufacturers will face serious legal difficulties from Suppliers to obtain all the information required by the current draft proposal. Also the added value of this requirement in the future might be questionable, considering developments in recycling technologies towards automated detection and segregation of the plastic material types.

Recyclability rate for plastics

The requirement on use of plastics with minimum recyclability rate, base on a closed list of polymers with nominal recyclability rate scores could hamper innovation in product design and resource efficiency. The fact that all polymers not included in this list are considered to have a 0% recyclability rate would restrict their use and limit the design options in new product development. New technologies currently under development, such as flexible and transparent displays could therefore not be allowed in the EU market due to this limitation in polymer selection available to designers.

Indium declaration



DIGITALEUROPE is uncertain of the added value of this requirement. At this moment there is no viable recycling process to recover indium from displays, and considering the low economic value of indium, there are doubts that this will ever be economically feasible. Additionally, Industry expects the use of indium to be reduced in upcoming display technologies (OLED uses half of the indium used for LCD). Nevertheless, DIGITALEUROPE is willing to consider declaring Indium in order to promote future developments in recovery processes.

6. ENERGY LABELLING IMPLICATIONS

DIGITALEUROPE would like to highlight the conclusions of the Consultation Forum regarding the need to avoid any downgrading of Energy Class of products currently on the market with the current review of the Ecodesign and Energy Label regulation. Although we accept the conclusion to extend the scope to the Energy Label regulation in order to include computer monitors, we believe this is not the time for a full rescale of the Energy Label, either by complete change in EEI threshold for Energy Classes or by changing the current formulas for calculation.

Although we acknowledge that the use of different equations for Ecodesign and Energy Label might not be ideal, we believe this is necessary in order to avoid the confusion in the market caused by rescaling exercises. This is even more relevant considering the expected changes to be introduced by the revision of the Energy Label Directive. We believe that any rescaling should only happen under this New Directive, which would avoid two rescaling exercises in such close period.

However DIGITALEUROPE recognizes the need to increase the longevity of the current Energy Label, and would support the rescaling of the top Energy Class threshold as currently proposed. This would ensure that the top class is only populated by a small share of the highest energy efficient displays.

For more information please contact:

Sylvie Feindt, DIGITALEUROPE's Environmental Policy Director
+32 2 609 53 19 or Sylvie.feindt@digitaleurope.org



ABOUT DIGITALEUROPE

DIGITALEUROPE represents the digital technology industry in Europe. Our members include some of the world's largest IT, telecoms and consumer electronics companies and national associations from every part of Europe. DIGITALEUROPE wants European businesses and citizens to benefit fully from digital technologies and for Europe to grow, attract and sustain the world's best digital technology companies.

DIGITALEUROPE ensures industry participation in the development and implementation of EU policies. DIGITALEUROPE's members include 59 corporate members and 36 national trade associations from across Europe. Our website provides further information on our recent news and activities: <http://www.digitaleurope.org>

DIGITALEUROPE MEMBERSHIP

Corporate Members

Acer, Alcatel-Lucent, AMD, Apple, BlackBerry, Bose, Brother, CA Technologies, Canon, Cassidian, Cisco, Dell, Epson, Ericsson, Fujitsu, Hitachi, Hewlett Packard, Huawei, IBM, Ingram Micro, Intel, iQor, JVC Kenwood Group, Konica Minolta, Kyocera, Lenovo, Lexmark, LG Electronics, Loewe, Microsoft, Mitsubishi Electric Europe, Motorola Mobility, Motorola Solutions, NEC, Nokia, Nokia Siemens Networks, Nvidia Ltd., Océ, Oki, Oracle, Panasonic Europe, Philips, Pioneer, Qualcomm, Ricoh Europe PLC, Samsung, SAP, Schneider Electric IT Corporation, Sharp Electronics, Siemens, Sony, Swatch Group, Technicolor, Texas Instruments, Toshiba, TP Vision, Western Digital, Xerox, ZTE Corporation.

National Trade Associations

Belarus: INFOPARK	Greece: SEPE	Slovakia: ITAS
Belgium: AGORIA	Hungary: IVSZ	Slovenia: GZS
Bulgaria: BAIT	Ireland: ICT IRELAND	Spain: AMETIC
Cyprus: CITEA	Italy: ANITEC	Sweden: Foreningen Teknikföretagen, IT&Telekomföretagen
Denmark: DI ITEK, IT-BRANCHEN	Lithuania: INFOBALT	Switzerland: SWICO
Estonia: ITL	Netherlands: Nederland ICT, FIAR	Turkey: ECID, TESID, TÜBISAD
Finland: FTTI	Norway: IKT NORGE	Ukraine: IT UKRAINE
France: Force Numérique, SIMAVELEC	Poland: KIGEIT, PIIT	United Kingdom: techUK
Germany: BITKOM, ZVEI	Portugal: AGEFE	
	Romania: ANIS, APDETIC	

Dear Bob,

Following our data set, we have worked on proposal for an EEI formula. As a result of our discussion we would like to propose the following two EEI formula options for the ErP Lot5 revision:

Option 1: a logarithm function

- According to Fig1, the power consumption of TV (on-mode) apparently is proportional to screen size [dm²].

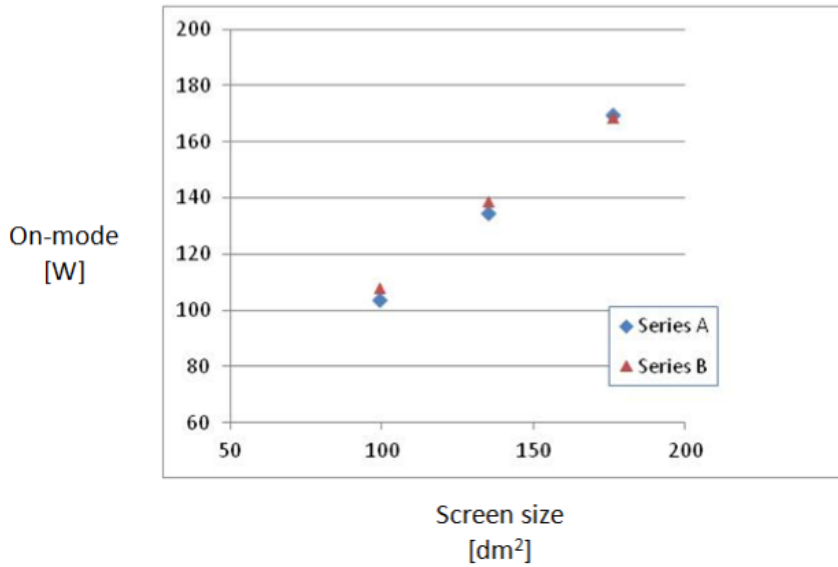
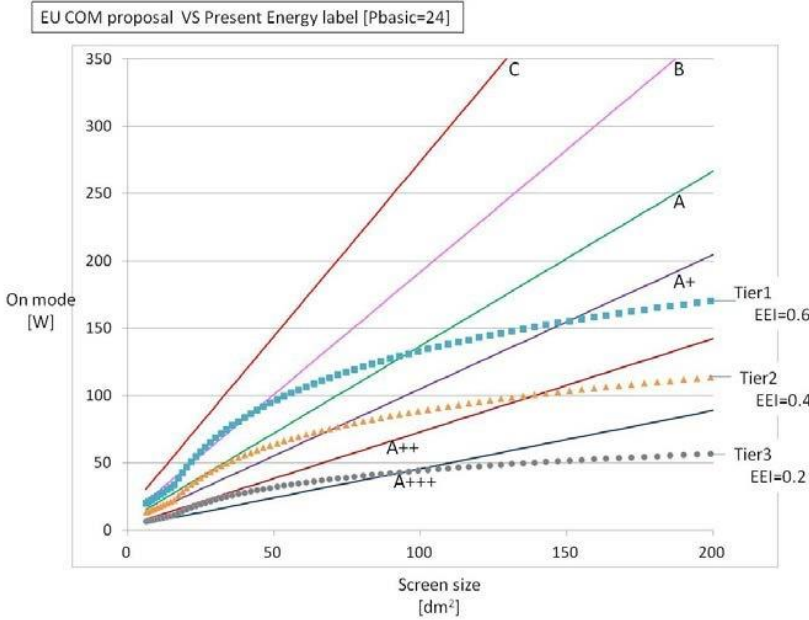


Fig.1

-While, EEI function (>15.9dm²) proposed by EUCOM is logarithm function. Therefore, the standards specified by the EEI function are too strict for big size TV. [Fig.2]

- We would like to review EEI function, in the light of the relation between power consumption and screen size.

Fig.2



- We suppose the following concept for EEI function.
-

	• EU COM proposal	• (e.g.) Alternative proposal • [Refer to Fig. 3]
• EEI	Tier1=0.6, Tier2=0.4, Tier3=0.2	Tier1=0.6, Tier2=0.54, Tier3=0.48
• EEI function	$EEI = \frac{P_m}{(1,10 \cdot A + 9,11) \cdot 2,10} \quad A \leq 15,9 dm^2$ $EEI = \frac{P_m}{(42,66 \cdot \ln(A) - 90,68) \cdot 2,10} \quad A > 15,9 dm^2$	$EEI = \frac{P_m}{(1,10 \cdot A + 9,11) \cdot 2,10} \quad A \leq 15,9 dm^2$ $EEI = \frac{P_m}{(42,66 \cdot \ln(A) - 90,68) \cdot 2,10} \quad 15,9 dm^2 < A \leq 45,9 dm^2$ $EEI = \frac{P_m}{(57,00 + 2,10 \cdot A)} \quad 45,9 dm^2 < A$

Regarding 4K we propose the following EEI: Tier 1 = 0.9, Tier 2 = 0.81, Tier 3 = 0.73.

Fig.3 proposal for other than 4k-TV: Tier1=0.60, Tier2=0.54, Tier3=0.48

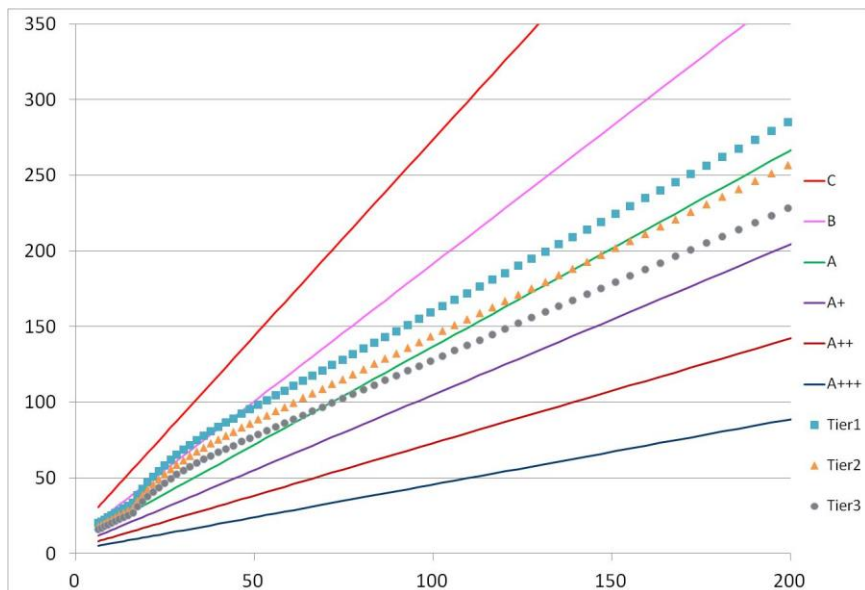
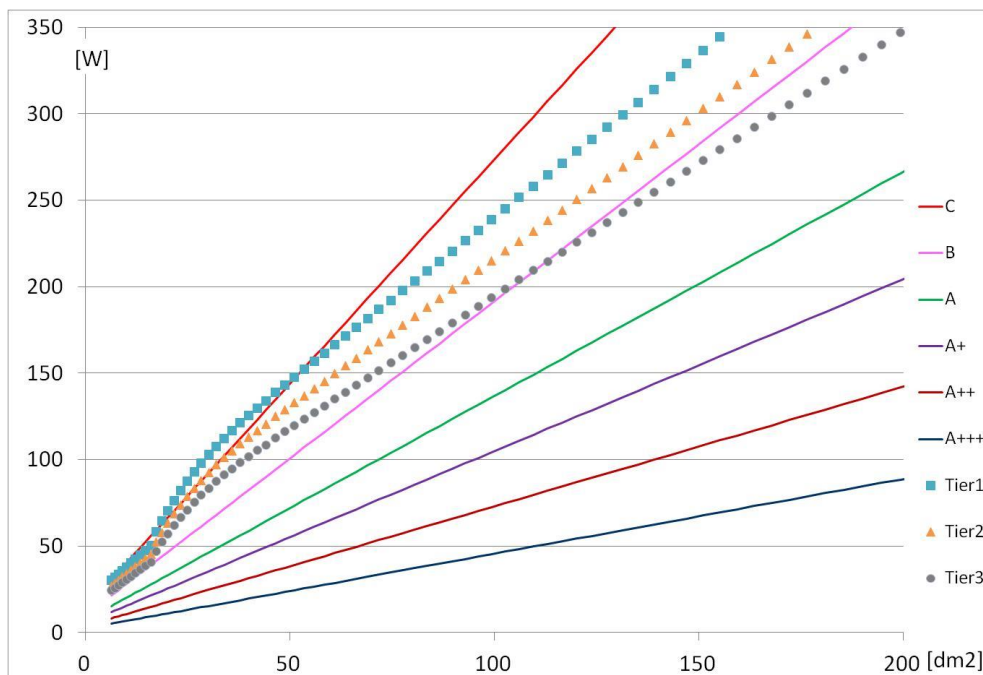
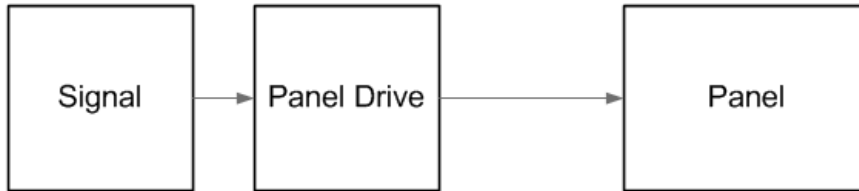


Fig.4 proposal for 4K-TV: Tier1=0.90, Tier2=0.81, Tier3=0.73



Option 2: A formula with a linear power consumption limit

LCD:



HDMI
Tuner(s) &
Decoder(s)
Amplifier & Speakers
Integrated HDD

Frame Rate Converter
Timing Controller
Local Dimming

Backlight
Resolution
Color Gamut

xx Watts

+

yy Watts/dm²

Comments to some of the features blocks:

Decoder: New and better decoders are introduced continuously. MPEG2, H264, H265.

Frame Rate Conversion: Increasing frame rate from 25Hz or 50Hz to e.g. 100Hz.

Color Gamut: Panel with wider color range could have lower efficacy.

Luminance (cd/m²) is received by multiplying panel efficacy (cd/W) and power per screen area (W/m²).

Different basic circuit power consumption limits could be defined between TVs which have tuner(s) integrated and Monitors which don't have tuner(s). Monitors could have audio amplifiers and speakers and TVs could have HDD included.

Additional features are often implemented for higher resolution displays.

Maybe scaling of power consumption limit could be done using the display resolution in Megapixels?

	H	V	r in Megapixels
HD	1366	768	1
	1440	900	1,5
	1280	1024	1,5
	1600	900	1,5
FHD	1680	1050	2
	1920	1080	2
	1920	1200	2,5
	2560	1080	3
UHD/4K	2560	1440	3,5
	2560	1600	4
	3440	1440	5
	3840	2160	8
8K			0
			0
			0
			0
8K	7680	4320	33

ROUND(Dx*Ex/1000000*2;0)/2

ROUND(Dx*Ex/1000000;0)

The linear power consumption limit for LCD could be scaled in both, basic circuit power and in backlight power:

$$xx \text{ Watts} + r \cdot aa \text{ Watts} + (yy \text{ Watts/dm}^2 + r \cdot bb \text{ Watts/dm}^2) \cdot \text{Area in dm}^2$$

Example for tier1: $(27 + r \cdot 3)W + (1,04 + r \cdot 0,11)W/\text{dm}^2 \cdot A \text{ in dm}^2$

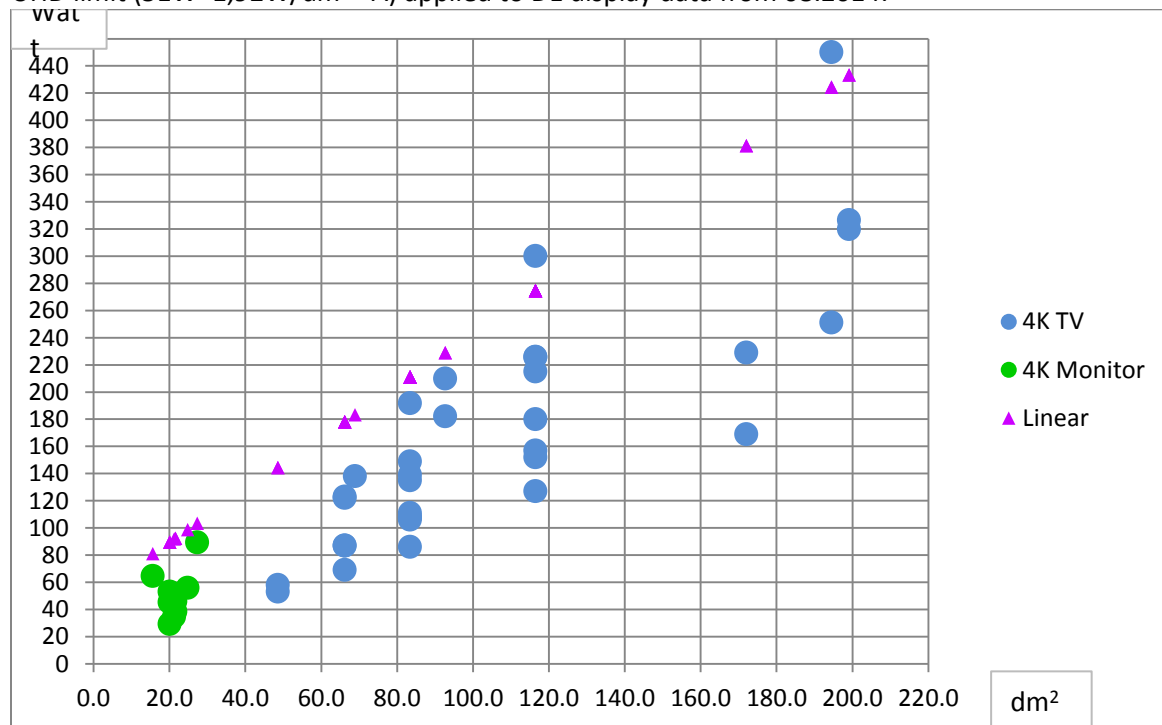
HD: $30W + 1,15W/\text{dm}^2 \cdot A$

FHD: $33W + 1,26W/\text{dm}^2 \cdot A$

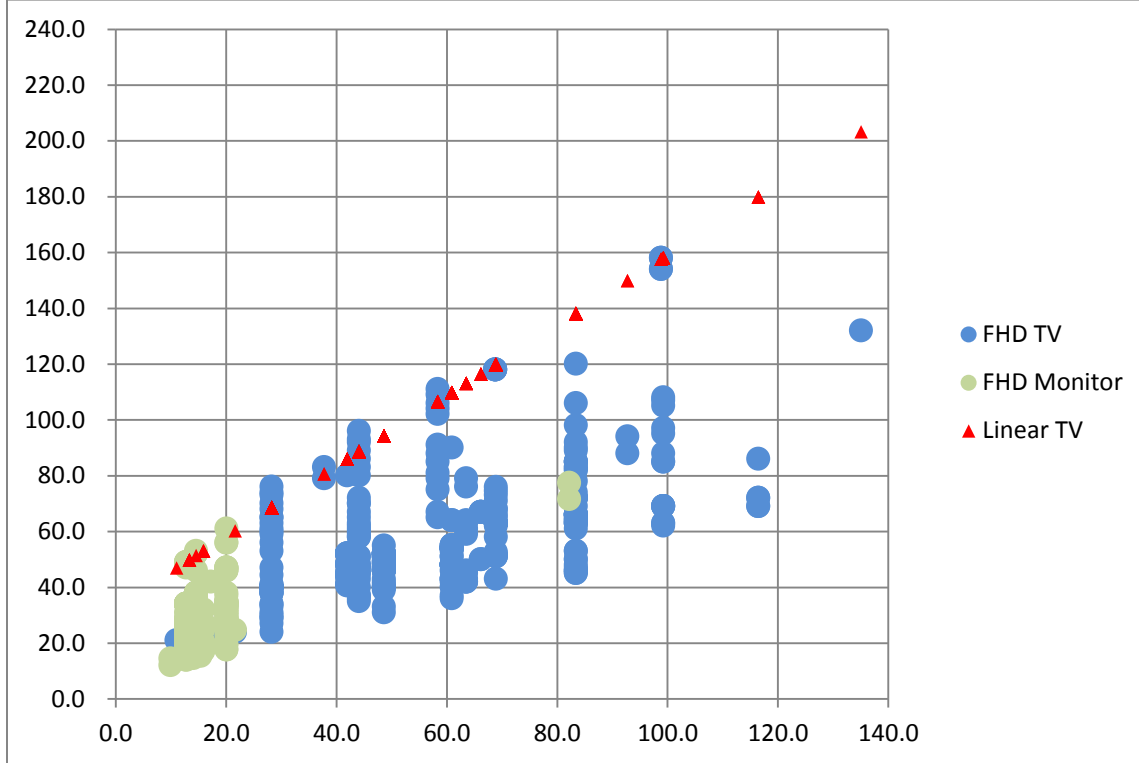
UHD: $51W + 1,92W/\text{dm}^2 \cdot A$

As in the first option we suggest a tier to tier reduction of 10%.

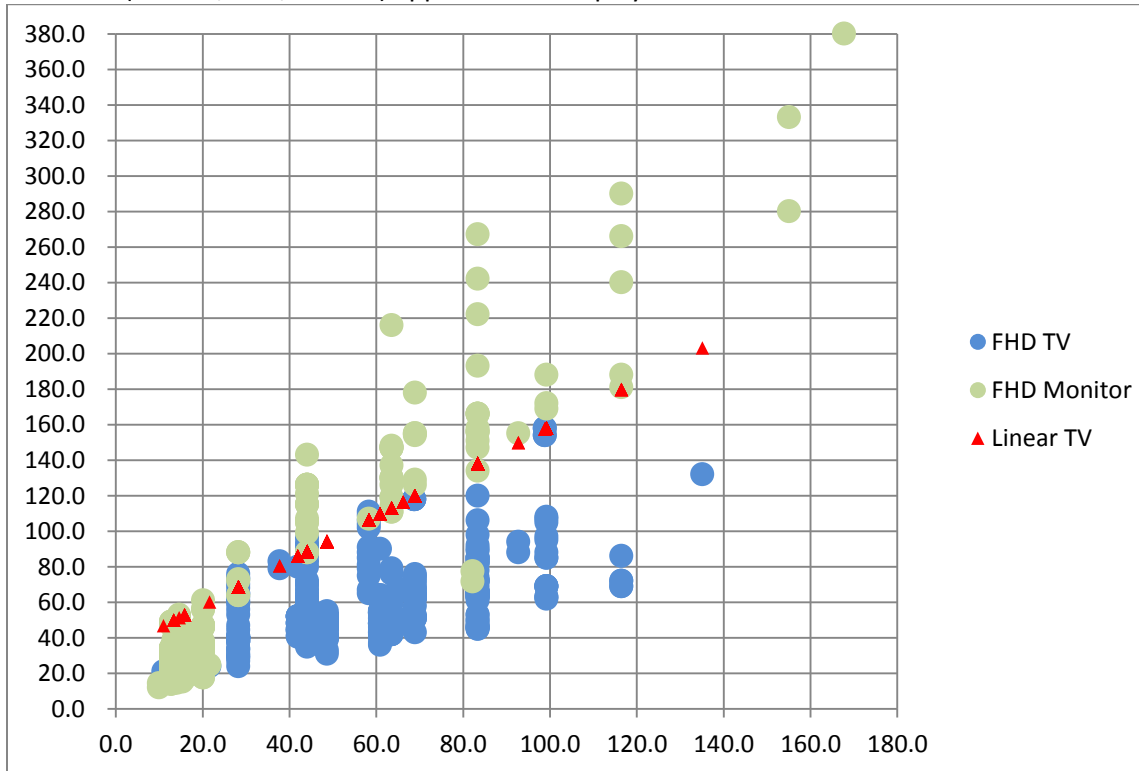
UHD limit ($51W + 1,92W/\text{dm}^2 \cdot A$) applied to DE display data from 08.2014:



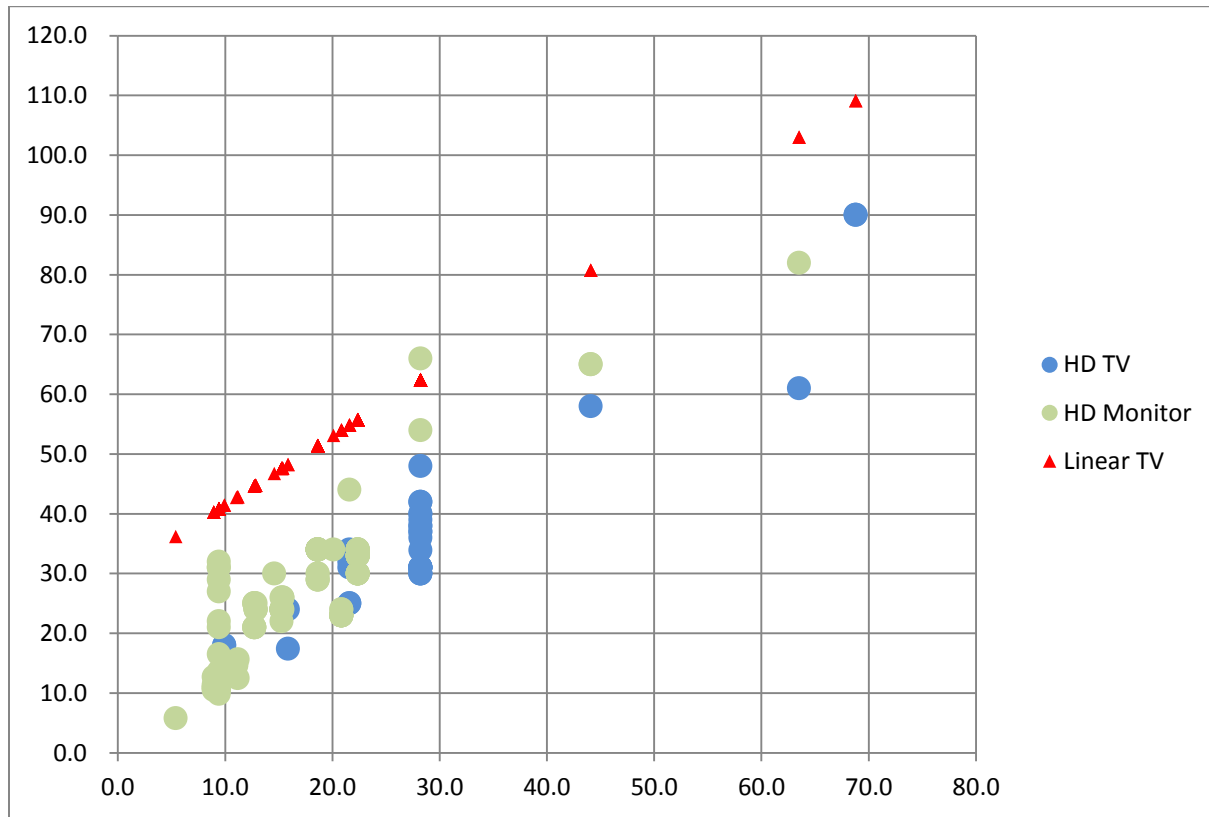
FHD limit ($33W+1,26W/dm^2 * A$) applied to DE display data from 08.2014 (small size FHD monitors only)



FHD limit ($33W+1,26W/dm^2 * A$) applied to DE display data from 08.2014



HD limit ($30W+1,15W/dm^2 * A$) applied to DE display data from 08.2014



I hope you find our proposition helpful. Please don't hesitate to contact me if you have any further questions. We are looking forward to a fruitful discussion.

Kind regards,

Sylvie

References

3M, 2011. Demonstration of “DBEF Energy Saving Solution”. International Meeting on Information Display (IMID) 2011. Korea. October.

Chen et al, 2014. “High Efficiency LCDs using Quantum Dots.” Jian Chen, Nanosys NCCAUS Thin Film Users Group (TFUG), July 15 2014. Link: http://www.avusergroups.org/tfug_pdfs/2014_7chen_NANOSYS.pdf

COMMISSION DECISION of 12 March 2009 establishing the revised ecological criteria for the award of the Community Eco-label to televisions (notified under document number C(2009) 1830) (Text with EEA relevance) (2009/300/EC)

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 (Text with EEA relevance)

COMMISSION DECISION of 26 October 2009 determining the Community position for a decision of the management entities under the Agreement between the Government of the United States of America and the European Community on the coordination of energy-efficiency labelling programmes for office equipment on the revision of the computer monitor specifications in Annex C, part II, to the Agreement (Text with EEA relevance) (2009/789/EC)

COMMISSION DELEGATED REGULATION (EU) No 1062/2010 of 28 September 2010 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of televisions (Text with EEA relevance)

COMMISSION DECISION of 9 June 2011 on establishing the ecological criteria for the award of the EU Ecolabel for personal computers (notified under document C(2011) 3737) (Text with EEA relevance) (2011/337/EU)

Coolproducts, 2010. Energy Savings in Practice: Potential and Delivery of EU Ecodesign Measures, December 2010. Weblink: <http://www.coolproducts.eu/resources/documents/EnergySaving-in-Practice.pdf>

CSES, 2012. “Framework Service Contract for the Procurement of Studies and other Supporting Services on Commission Impact Assessments and Evaluations Interim, final and ex-post evaluations of policies, programmes and other activities; Evaluation of the Ecodesign Directive (2009/125/EC)” Final Report, March 2012 prepared by the Centre for Strategy and Evaluation Services and Oxford Research, Kent, UK. Website: www.cses.co.uk

Daily Tech, 2014. “Samsung Prepping 14-nm for Apple A9 Production, Handling 30 Percent of A8 Orders”, October 2, 2014. Link: <http://www.dailytech.com/Samsung+Prepping+14nm+for+Apple+A9+Production+Handling+30+Percent+of+A8+Orders/article36657.htm>

DigitalEurope, 2014. Personal communication and supply of 2014 European model database for this analysis. August and October 2014.

DisplaySearch, 2011. “Quarterly Advanced Global TV Shipment and Forecast Report, Fourth Quarter, 2010”, January 2011.

ECCJ, 2009. “2008 Standby Power Consumption Report”, Energy Conservation Centre, Japan (ECCJ), March 2009. Weblink: http://www.eccj.or.jp/standby/08/standby_power_product_report_2008.pdf
EuP Preparatory Study, “Personal Computers (desktops and laptops) and Computer Monitors” (Lot 3), Final Report, August 2007.

EuP Preparatory Study “Televisions” (Lot 5), Final Report, Fraunhofer IZM, Aug 2007. Weblink: http://www.ecotelevision.org/finalised_documents.php

GfK, 2011. World Market of Consumer Technics, Jürgen Boyny, GfK Retail and Technology; IFA Global Press Conference 2011. Link to presentation:
http://www.gfu.de/srv/easyedit/ts_1303132009000/page:home/news/presentationen/sl_1303132008995/args.link01/de_IFA_Press_Conference_2011_GfK_Boyny.pdf

JRC, 2012. Lifecycle Thinking and Assessment, the Joint Research Centre, 2012. Weblink: <http://lct.jrc.ec.europa.eu/assessment/projects#d>

LBL, 2011. “TV Energy Consumption Trends and Energy-Efficiency Improvement Options”, by Won Young Park, Amol Phadke, Nihar Shah, Virginie Letschert; Environmental Energy Technologies Division; International Energy Studies Group; Lawrence Berkeley National Laboratory, July 1, 2011. Web link: <http://www.superefficient.org/~media/Files/SEAD%20Televisions%20Technical%20Analysis.pdf>

LBL, 2012. “Efficiency Improvement Opportunities in TVs: Implications for Market Transformation Programs” by Won Young Park, Amol Phadke, Nihar Shah, Virginie Letschert; Lawrence Berkeley National Laboratory, One Cyclotron Road, Berkeley, CA 94720 USA. February 2012.

Topten, 2012. Topten Focus Newsletter, dated 5 June 2012. Link to newsletter: <http://www.topten.eu/uploads/File/Newsletters/Topten%20Focus%20TVs%20June%2012.pdf>

Topten, 2014. European TV market 2007 – 2013 Energy efficiency before and during the implementation of the Ecodesign and Energy Labelling regulations Second report, complemented with 2013 sales data. By Anette Michel, Sophie Attali, Eric Bush, Topten International Services, Zurich, Switzerland, 17 July 2014. http://www.topten.eu/uploads/File/European_TV_market_2007-2013_July14.pdf

UCSB, 2010. Fast-Tracking Widespread Adoption of LED Lighting, May 2010. Weblink: <http://iee.ucsb.edu/files/pdf/UCSB%20LED%20Workshop%20White%20Paper%20FINAL.pdf>

USDOE, 2012. Solid-State Lighting Research and Development: Multi-Year Program Plan. Prepared for the US Department of Energy, April 2012. Weblink: http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/ssl_mypp2012_web.pdf

USEPA, 2010. US EPA Energy Star for Televisions, Version 5.3 Weblink: http://www.energystar.gov/index.cfm?c=archives.tv_v5_3

USEPA, 2012. Draft Energy Star for Televisions, version 6.0. Weblink: http://www.energystar.gov/index.cfm?c=revisions.television_spec

USEPA, 2012b. ENERGY STAR® Program Requirements: Product Specification for Displays, Test Method – Draft 3.0, Rev. June-2012. Weblink:

http://www.energystar.gov/sites/default/files/specs//ENERGY_STAR_Final_Draft_Test_Method_for_Displays_June_2012.pdf