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1. Introduction; scope

Regarding TVs energy consumption in the on-mode is as important as energy consumption in the standby mode. Since power consumption in standby is decreasing, power consumption in other modes, i.e. the on-mode is determining the energy consumption of a TV to a large extent. Therefore the criteria for the GEEA label will be based on – amongst others – the on-mode power consumption.

As shown in the report of the SAVE study 'Analysis of Energy Consumption and Efficiency Potential for TVs in the on-mode', the concept of the energy efficiency index can be used to evaluate the (total) energy consumption of TVs. For further reference on the background of the concept, please see section 3.5 and appendix V of this report.

This document shows the methodology of using an energy efficiency index for use within the GEEA framework, including a proposal for reference values to calculate the energy efficiency index. The values in this proposal are based upon measurement data of 102 (analogue) TVs and on discussions at the European Commission regarding the Code of Conduct on Energy Efficiency of Digital TV Service Systems.

The scope is the same as indicated in the GEEA Product Sheet for Television Sets (CE01-011000): mains operated television receivers (TV) with a visible screen diagonal of more than 20 centimeters. According to EN50301 a television receiver is defined as an 'Appliance for the reception of television broadcast and similar services for terrestrial, cable and satellite transmission of analogue or digital signals'.

2. Energy efficiency index

Energy consumption of TVs varies with characteristics (features) of the TV. The energy efficiency of TVs with different features can be compared by introducing an energy efficiency index E_i . This energy efficiency index E_i can be defined as:

$$E_i = \frac{E}{E_R} \quad [2.1]$$

where

- E is the energy consumption of the TV for which the energy efficiency index is calculated [kWh], based on a standard measurement method
- E_R is the reference energy consumption [kWh]
- E_i is the energy efficiency index

The reference energy consumption E_R is the energy consumption of an average TV with the same (energy relevant) features as the TV for which the index is calculated. Thus, a TV with the same energy consumption as the reference TV has energy efficiency index equal to 1.00, a TV that is more efficient than the reference TV has an energy efficiency index < 1.00, and a TV that is less efficient has an index > 1.00.

The energy consumption will be calculated taking into account the various modes of the TV: on, standby, off. Thus a duty cycle of e.g. 24 hours (1 day) can be used in which each mode has a representative share of the total time.

The energy efficiency index is calculated as follows.

Firstly the reference value for the TV to be categorized is calculated for a duty cycle of 24 hours which takes into account the various modes (standby, on, off) of the TV.

$$E_{24hrs,R} = \sum_{i=1}^n P_{i,R} \times t_{i,R} \quad [2.2]$$

and

$$\sum t_{i,R} = 24 \text{ hours} \quad [2.3]$$

The period that the TV is in a certain mode ($t_{i,R}$) will be derived from EU averages. These values will be used for calculating both the E and the E_R because the energy efficiency index should be independent from (specific) consumer behaviour.

Secondly, the actual power consumption for the various modes P_i of the TV is measured (according to standard measurement conditions) and the energy consumption for the duty cycle E_{24hrs} is calculated:

$$E_{24hrs} = \sum_{i=1}^n P_i \times t_{i,R} \quad [2.4]$$

Thirdly, the energy efficiency index is calculated:

$$E_i = \frac{E}{E_R} \quad [2.1]$$

3. Criteria

For the criteria for the GEEA label two aspects are important:

1. the values for the variables to calculate the reference power consumption values and reference times for the modes
2. the criterium for the energy efficiency index (calculated with the reference values and the measured values)

3.1 Values to calculate reference power consumption and reference times

For the calculation of the energy efficiency index the following modes are considered to be relevant:

- on-mode: P_{on} and $t_{on,R}$
- standby modes: standby passive (P_{sbp} and $t_{sbp,R}$) and standby active/low (P_{sba} and $t_{sba,R}$)
- off mode: P_{off} and $t_{off,R}$

The standby active/high mode is not considered yet, but can be added when needed.

Reference values standby and off power consumption

The following values are proposed for the reference power consumption $P_{i,R}$ (table 3.1).

Table 3.1 Reference power consumption

Mode	TV without APO (W)		TV with APO (W)	
	TV without digital decoder	TV with digital decoder	TV without digital decoder	TV with digital decoder
standby passive	4*	4	6	6
standby active/low	0	12	0	12
off	0	0	0	0

* based upon figures of the EACEM – EU Voluntary Agreement (1998 and estimate of 1999)

Reference value power consumption on mode

Equation [3.1] will be used to calculate reference power consumption values. No subcategories are needed, because all features can be dealt with in a single formula.

$$P_{on,R} = \frac{P_{basis} + P_{digital} + P_{sb, audio} + P_{decoder} + \alpha_{screen} \times [0.80; 0.87]_{ws0;1} \times scrnsize + \alpha_{tube} \times scrnarea + \Delta_{scanrate}}{\eta_{powersupply} \times \eta_{SMPS}} \quad [3.1]$$

Features needed for calculating the reference value $P_{on,R}$ are:

- screen size (in cm)
- screen format: 4:3 or 16:9
- screen area (in dm^2): to be calculated from screen size and screen format
- scan rate: 50 Hz or 100 Hz
- digital signal processing: no or yes
- integrated digital decoder for digital broadcast signals: no or yes

For the parameters in equation [3.1] the reference values according to table 3.2 will be used.

Table 3.2 Reference values parameters

Variable	Description	Reference value
$\eta_{power supply}$	overall efficiency of the power supply	0.75
η_{SMPS}	efficiency of the (main) switched mode power supply	0.825
P_{basis}	power consumption of analogue small signal processing	6 W
$P_{digital}$	power consumption of digital signal processing	9 W*
$P_{sb, audio}$	power consumption of large signal audio	6 W
$P_{decoder}$	power consumption of integrated digital decoder	12 W**
α_{tube}	tube coefficient	0.38 W/dm ²
α_{screen}	coefficient of screenwidth	0.75 W/cm
$\Delta_{scanrate}$	impact of scanrate of 100 Hz	23 W***

* if digital signal processing is yes, otherwise 0

** if integrated digital decoder is yes, otherwise 0

*** if scan rate is 100 Hz, otherwise 0

Reference values times $t_{i,R}$

The following values are used for the reference times $t_{i,R}$ (table 3.3).

Table 3.3 Reference times for TVs

Mode	TV without APO (hrs/day)		TV with APO (hrs/day)	
	TV without digital decoder	TV with digital decoder	TV without digital decoder	TV with digital decoder
on	4	4	4	4
standby active\low	0	10	0	2
standby passive	20	10	4	2
off	0	0	16	16

3.2 Criterium for the energy efficiency index

The criterium for the energy efficiency index for a TV to be eligible for the GEEA label is proposed to be: $E_{i,GEEA} \leq 0.75$.

This means that a TV with a GEEA label should (at least) be 25 % more efficient than an average TV (with the same energy relevant features).

4. Market check

In order to check whether the proposed values in section 3 are realistic, i.e. allow for various types of TVs to comply with the GEEA energy efficiency index criterium, data from measurements of 102 (analogue) TVs was used. These TVs represent in the UK a market

share of more than 70 %. Checks for TVs with integrated digital decoder have to be made when they are on the market.

All measurements were carried out according to the same standard by Consumers' Associations Research & Testing Centre in the UK. Since GEEA will adopt the prEN50301 when it comes into force, data for the on mode power consumption at a luminance of 80 cd/m² was used for the calculations.

Details of the measured TV and the data can be found in the Excel spreadsheet 'TV duty cycle and GEEA label database'

With the proposed values of section 3, the following results were obtained (see table 4.1).

Table 4.1 Evaluation of TV duty cycle criteria for GEEA-Label (analogue TVs)

Category	complying with GEEA $EEI \leq 0.75$	base (n=)
all TVs	20%	102
conventional TVs	29%	48
widescreen TVs	11%	54
analogue TVs with digital signal processing	19%	26
small (screensize < 50 cm) TVs	23%	26
medium (50 cm ≤ screensize ≤ 63 cm) TVs	n=2	7
large (screen size > 63 cm) TVs	17%	69

Table 4.1 shows that the proposed values and the energy efficiency index criterium of 0.75 is indeed reasonable. In each category at least 10 % of the models can comply, up to almost 30 % of the conventional (no widescreen, not digital) TVs. Please note that these percentages refer to TVs already on the market. Furthermore, applying the current GEEA standby criterium (1 W) to the dataset reveals that of all TVs 16 % is complying with the GEEA criterium.