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IMPACT ASSESSMENT

Accompanying the document

COMMISSION REGULATION (EU) .../...laying down ecodesign requirements for electronic displays pursuant to Directive 2009/125/EC of the European Parliament and of the Council,
amending Commission Regulation (EC) No 1275/2008,
and repealing Commission Regulation (EC) 642/2009

and

COMMISSION DELEGATED REGULATION (EU) …/... supplementing Regulation (EU) 2017/1369 of the European Parliament and of the Council with regard to energy labelling of electronic displays

and repealing Commission Delegated Regulation (EU) No 1062/2010

{C(2019) 1796 final} - {C(2019) 2122 final} - {SEC(2019) 339 final} -
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This report commits only the Commission's services involved in its preparation and does not prejudge the final form of any decision to be taken by the Commission.

1. INTRODUCTION: POLITICAL AND LEGAL CONTEXT

This impact assessment relates to the review of Commission Regulation (EC) No 642/2009[1] (Ecodesign) and Commission Delegated Regulation (EU) No 1062/2010 (Energy Label)[2] on televisions and television monitors.

1.1. Benefits of Ecodesign and Energy Labelling

Ecodesign and energy labelling are recognised globally as one of the most effective policy tools in the area of energy efficiency. It is central to making Europe more energy efficient, contributing in particular to the 'Energy Union Framework Strategy'[3], and to the priority of a 'Deeper and fairer internal market with a strengthened industrial base'[4]. Firstly, this legislative framework pushes industry to improve the energy efficiency of products and removes the worst-performing ones from the market. Secondly, it helps consumers and companies to reduce their energy bills. In the industrial and services sectors, this results in support to competitiveness and innovation. Thirdly, it ensures that manufacturers and importers responsible for placing products on the European Union (EU) market only have to comply with a single set of rules.

It is estimated that by 2020, ecodesign and energy labelling regulations will deliver around 175 Mtoe (i.e. about 2035 TWh) of energy savings per year in primary energy, roughly equivalent to Italy's energy consumption in 2010, close to half the EU 20 % energy efficiency target by 2020 and about 11 % of the expected EU primary energy consumption in 2020[5].

Moreover, the average household saves about € 500 annually on its energy bills by 2020, whilst for industry, service and wholesale and retail sectors it will result in € 55 billion per year of extra revenue.

This legislative framework benefits from a broad support from innovative European industries, consumers, environmental non-governmental organisations (NGOs) and Member States (MSs), because of its positive effects on innovation, increased information for consumers and lower costs, as well as environmental benefits.

Televisions have been subject to EU minimum energy efficiency requirements since 2009 and to energy labelling measures since 2010. Even before 2009, the energy consumption

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1 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. OJ L 191, 23.7.2009, p. 42–52

2 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. OJ L 314, 30.11.2010, p. 64–80

3 Communication from The Commission To The European Parliament, The Council, The European Economic And Social Committee, The Committee Of The Regions And The European Investment Bank - A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy. COM/2015/080 final. (Energy Union Framework Strategy)

4 Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - Upgrading the Single Market: more opportunities for people and business COM/2015/550 final. 28 October 2015. (Deeper and fairer internal market)

5 Ecodesign impact accounting – Overview report for the European Commission DG Energy, VHK December 2016

and carbon emissions per unit of viewing area reduced by more than 60 % compared to business as usual (BAU) due to technological developments, and likely also in anticipation of the Regulations.

However, at the same time the size of televisions screens increased, as did the number of sales with a peak in 2010. These trends were not fully foreseen in the preparatory study and impact assessment in 2007, because the available sales and stock data was poor and information from industry was not forthcoming at that time[6].

As a result, in 2017 the energy consumption of the installed television stock was around 10 TWh (around 13% of the total energy consumption of TVs) lower than what was expected in 2007, as can be seen in Figure 1. This was driven by both technological progress and regulatory pressure around the world.

The increase of the energy consumption estimated to start around 2024 is partly because the current regulations (which in the BAU scenario would not be revised) would lose their effect on the market. Moreover, efficiency improvement is expected to slow down because the technologies that thus far have caused the large efficiency improvements are nearing their limits and further improvements would require major investments (see also section 5.2.1). More details about the past and future market trends can be found in Annexes 4, 6 and 14.

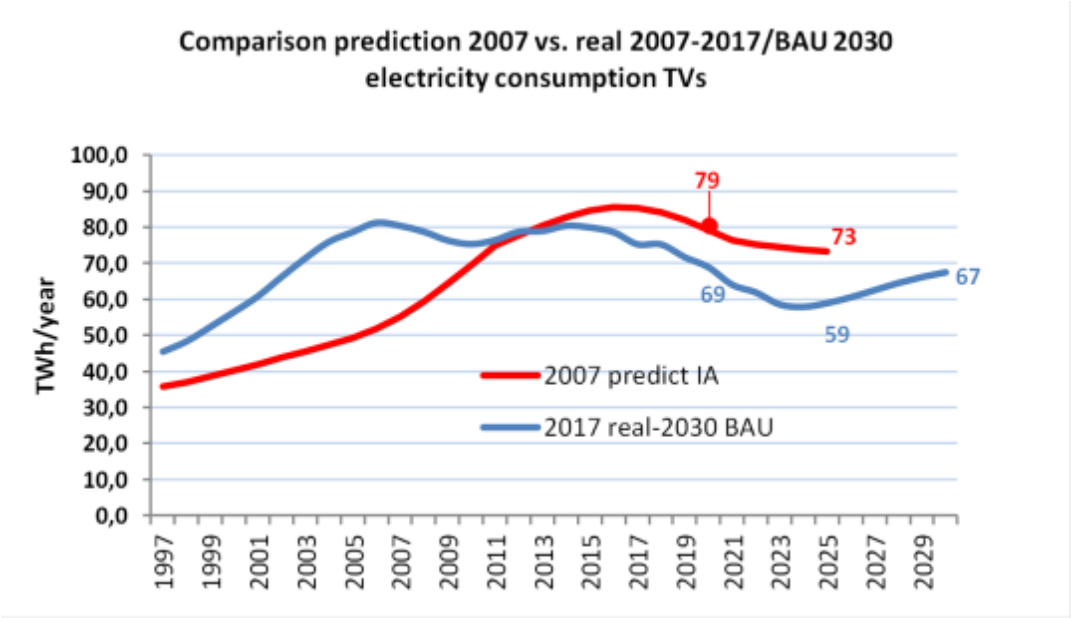

Figure 1: Electricity consumption of televisions 1990-2025, according to 2007 impact assessment (based on best data 2007) and real 2017 data as assessed in this study.

It has to be noted that it is very difficult to estimate to which extent the improvements are driven by autonomous technology progress, by competition or by regulatory pressure. However, we consistently see that product sectors regulated under ecodesign and energy labelling anticipate upcoming regulations. This was most obvious with televisions after the introduction of the first regulations in 2011: only after a few months of the rules starting to apply, many manufacturers came forward with models in the higher classes of the label. This is to be expected as companies need to plan their product development investment well in advance, in particular if new technologies are needed to meet requirements or move to

[6] More reliable sales and stock data is now available and industry has collaborated.

the higher energy classes[7]. If companies wait with such investment decisions until the requirements enter into force, they run the risk of being 'behind the curve' of sector-wide improvements and will lose market share[8].

The BAU assumes that without continued regulatory pressure further major efficiency gains will not materialise autonomously, and that with the increasing volume of displays and the introduction of new features that tend to be more energy consuming, total energy consumption will go up.

1.2. Legal framework

Lowering the demand for energy by **'putting energy efficiency first**' is one of the five main objectives of the Energy Union strategy. In 2015, Member States in the Council confirmed the imperative need to reach the 20% energy efficiency target for 2020. In November 2016, the Commission proposed to further strengthen this beyond 2020 with a 30% EU energy efficiency target for 2030[9]. In the EU, the **Ecodesign framework Directive**[10] sets a framework requiring manufacturers of energy-related products to improve the environmental performance of their products by meeting minimum energy efficiency requirements, as well as other environmental criteria such as water consumption, emission levels or minimum durability of certain components before they can place their products on the market.

The **Energy Labelling framework Regulation**[11] complements Ecodesign by enabling end-consumers to identify the better-performing energy-related products, via the well-known A-G/green-to-red scale. The Regulation sets out the general rules for rescaling the existing A+ to A+++ labels:

- Class A shall be empty at the moment of introduction of the label, and the estimated time within which a majority of the models falls into that class is at least 10 years;
- Where technology is expected to develop more rapidly, as in electronic equipment sectors such as displays, classes A and B shall be empty when introducing the label;
- Moreover, the A to G steps of the classification shall correspond to significant energy and cost savings and appropriate product differentiation from the customer's perspective.

In general, the boundaries of the label scale are defined by the performance of products on the market incorporating 'Best Available Technology' (BAT) and the minimum requirement under ecodesign for those products. Subsequently, the bandwidth of the classes is determined to keep the same effort to move from one class to the next one. For specific

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7 This is exemplified by the statement of CECED (industry trade association) in the Consultation Forum from 2012: "CECED disagreed with a view that the development of TVs has not been influenced by the existing EU Regulations. It explained that industry had been working on new energy efficient technologies already during the consultation phase preceding the adoption of the Regulations."

8 As an example, Japanese companies lost the TV market because they were too late with investing in LCD/LED technology. The more fast-moving a sector is, the higher the risk of being 'left behind'.

9 This target is currently under examination in the ordinary legislative procedure: there is no sign that final agreement will be on a level of ambition lower than that proposed by the Commission.

10 Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products. OJ L 285, 31.10.2009, p. 10 (Ecodesign Framework Directive)

11 Regulation (EU) 2017/1369 of the European Parliament and of the council of 4 July 2017 setting a framework for energy labelling and repealing Directive 2010/30/EU. OJ L 198, 28.7.2017, p. 1 (Energy Labelling Framework Regulation)

product groups this may however be different to take into account appropriate product differentiation.

The BAT is determined following the MEErP methodology, and is based on purely technical grounds, i.e. the product on the market with the lowest environmental impact, while ensuring that other functional requirements (e.g. performance, quality, durability) are equivalent to the base case.

The energy label is recognised and used by 85% of Europeans[12].

The legislative framework builds upon the **combined effect** of the two aforementioned pieces of legislation. See figure 2 for a visualisation of this effect.

The Ecodesign framework Directive and the Energy Labelling framework Regulation are implemented through implementing and delegated Regulations that cover specific energy-related products representing a significant volume of sales (more than 200 000 units a year), having a significant environmental impact within the EU and representing a significant energy improvement potential without increasing the cost excessively.

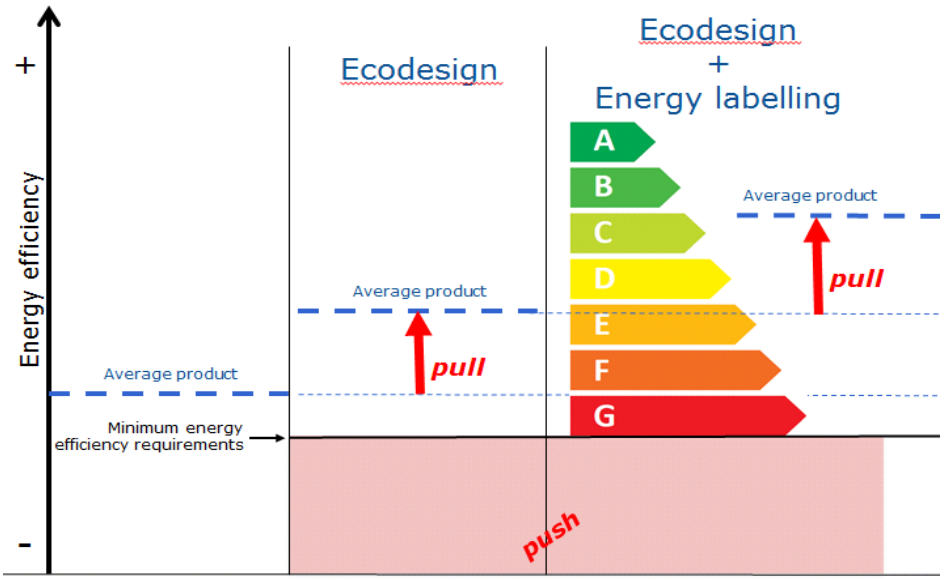

Figure 2: Effect of Ecodesign alone and when combined with Energy Labelling

As an alternative to the mandatory ecodesign requirements, voluntary agreements or other self-regulation measures can be presented by the industry, see also Article 17 of the Ecodesign Framework Directive. If certain criteria are met the Commission formally recognises these voluntary agreements[13]. The benefits are intended to be a quicker and more cost-effective implementation, which can be more flexible and easier to adapt to technological developments and market sensitivities.

[12] Study on the impact of the energy label – and potential changes to it – on consumer understanding and on purchase decisions - London Economics and IPSOS, October 2014

[13] Commission Recommendation (EU) 2016/2125 of 30 November 2016 on guidelines for self-regulation measures concluded by industry under Directive 2009/125/EC of the European Parliament and of the Council; OJ L 329, 3.12.2016, p.109

Under this framework, televisions and television monitors[14] are regulated by Commission Ecodesign Regulation (EC) No 642/2009 and Commission Delegated Energy Labelling Regulation (EU) No 1062/2010.

The EU Ecolabelling Regulation (Regulation (EC) 66/2010[15]) complements ecodesign and energy labelling. It is a voluntary scheme that awards products with the best environmental performance throughout their lifecycle. Products that fulfil the criteria can bear the EU ecolabel. Televisions and television monitors are covered by the EU Ecolabel under Commission Decision 2009/300/EC and follow-up acts[16]. The Ecolabel has some stricter energy efficiency requirements and addresses other environmental issues[17].

Displays, including computer monitors and signage displays, were included in Annex C of the EU-US Energy Star agreement, which expired on 20 February 2018[18]. The agreement did not allow the inclusion of products in its Annex C if such products would be covered by energy labelling. Hence, televisions were never included in the Agreement.

As regards waste management, article 4 of the Waste of Electric and Electronic Equipment (WEEE) framework Directive (which covers televisions and displays) explicitly states that Ecodesign requirements should be laid down to facilitate the re-use, dismantling and recovery of WEEE, its components and materials, by addressing such issues during the design phase.

Finally, under article 6 of the Energy Efficiency Directive, Member States shall ensure that central governments purchase only products, services and buildings with high energy-efficiency performance[19]. In this context, computer monitors and signage displays are also part of the Commission's Green Public Procurement (GPP) guidelines[20,21], which are developed to facilitate the inclusion of green requirements in public tender documents.

A more detailed overview of existing policies, legislation and standards covering televisions and computer monitors is given in Annex 8.

1.3. Legal context of the reviews

Article 6 of Commission Regulation (EC) No. 642/2009 requires the Regulation to be reviewed within 3 years after entry into force (i.e. by September 2012) in light of technological progress. Article 7 of Commission Delegated Regulation (EU) No. 1062/2010

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[14] Television monitors are, in short, televisions without a tuner for receiving/decoding broadcast signals. The definition in the current regulation is however far more specific and has become a source of legal uncertainty as it could also apply to computer monitors.

[15] Regulation (EC) No 66/2010 of the European Parliament and of the Council of 25 November 2009 on the EU Ecolabel. OJ L 27, 30.1.2010, p. 1 (EU Ecolabel Regulations)

[16] Commission Decision 2009/300/EC 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). OJ L 80, 28.3.2009, p. 3; [validity prolonged until 31.12.2019 by Commission Decision (EU) 2018/59 of 11 January 2018]

[17] About a hundred television models have been certified with an Ecolabel. Requirements include e.g. absence of the most toxic flame retardant (FR) additives, design facilitating repair and dismantling at end of life.

[18] Council Decision 2013/107/of 13 November 2012 on the signing and conclusion of the Agreement between the Government of the United States of America and the European Union on the coordination of energy-efficiency labelling programmes for office equipment. OJ L 63, 6.3.2013, p. 5–80

[19] Directive 2012/27/EU of the European Parliament and the Council on energy efficiency, OJ L315 of 14.11.2012, p.1

[20] GPP criteria can be found at http://ec.europa.eu/environment/gpp/eu_gpp_criteria_en.htm

[21] Technical background study GPP: JRC, Revision of the EU Green Public Procurement (GPP) Criteria for Computers and Monitors, JRC-IPTS and Öko-Institut e.V, November 2016.

requires a review within 5 years (i.e. by December 2015).

The **Ecodesign working plan 2016-2019**[22] also includes the review of both regulations, requiring in particular to examine how aspects relevant to the circular economy can be assessed and taken on board. This is in line with the Circular Economy Initiative[23] , which concluded that product design is a key in achieving the goals, as it can have significant impacts across the product life cycle (e.g. in making a product more durable, easier to repair, reuse or recycle).

Finally, in August 2017, the new Energy Labelling framework Regulation (EU) 2017/1369 entered into force, repealing Directive 2010/30/EU[24]. Under the repealed Directive, energy labels were allowed to include A+ to A+++ classes to address the overpopulation of the top classes. Over time, due to technological development, also the A+ to A+++ class became overpopulated, thereby reducing the effectiveness of the labels significantly. To resolve this, the new framework regulation requires a rescaling of existing energy labels, back to the original A to G scale. Article 11 of the Energy Labelling framework Regulation lists 5 priority product groups for which new delegated acts with rescaled energy labels must be adopted 15 months after the entry onto force of the Regulation. Televisions are one of the priority product groups.

1.4. Political Context

Several new policy initiatives indicate the need for a broader scope for the revision than required by Article 7 of the current Ecodesign and Energy Labelling Regulation. The main ones are:

- the Energy Union Framework Strategy which calls for a sustainable, low-carbon and climate-friendly economy;
- the Paris Agreement[25], which calls for a renewed effort in carbon emission abatement;
- the Circular Economy Initiative[26], which amongst others stresses the need to include reparability, durability and recyclability in ecodesign;
- the Emissions Trading Scheme (ETS)[27], which aims at cost-effective greenhouse gas (GHG) emissions reductions and indirectly affected by the energy consumption of the electricity-using products in the scope of ecodesign and energy labelling policies; and
- the Energy Security Strategy, which sets out a strategy to ensure a stable and abundant supply of energy.

1.5. Need to act

The need to act is driven by the following main considerations:

Cost effective energy savings:

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22 Communication from the Commission Ecodesign Working Plan 2016-2019. COM(2016) 773 final

23 Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Closing The Loop - An EU Action Plan For The Circular Economy (Circular Economy Initiative)

24 Directive 2010/30/EU of the European Parliament and of the Council of 19 May 2010 on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products. OJ L 153, 18.6.2010, p. 1.

25 http://ec.europa.eu/clima/policies/international/negotiations/future/index_en.htm (Paris Agreement)

26 Communication from The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions Closing The Loop - An EU Action Plan For The Circular Economy (Circular Economy Initiative)

27 https://ec.europa.eu/clima/policies/ets_en (ETS)

Manufacturers and consumers stand to benefit from the fact that there are still cost effective energy savings to be achieved in this product sector. By way of illustration, Figure 3 shows the past and expected future increase of total viewing surface area in 1990 (21 km^2), 2010 (125 km^2) and 2030 (496 km^2). It also shows what would have happened in 2010 and 2030 if television energy efficiency had stayed at the 1990 level, and the effect of the Business-as-Usual (BAU) scenario. The figure anticipates the potential savings in 2030 with updated measures (ECO-scenario) for televisions only (i.e. not including other displays that are currently not covered by the Regulations in force).

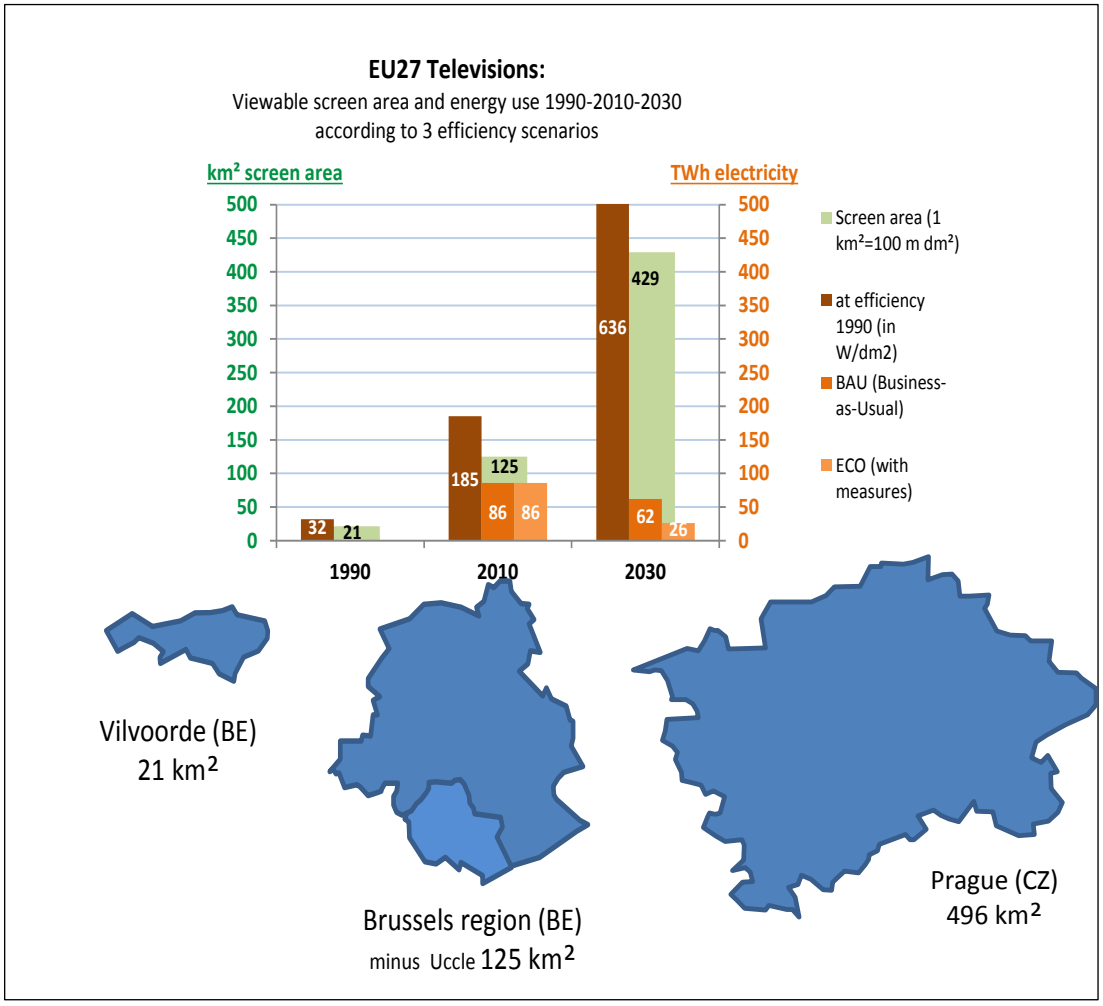

Figure 3: EU television screen area and energy use 1990-2010-2030 (source: VHK for the EC, 2017)

Other policies/political imperatives:

Several other policies and political priorities require the revisions to look beyond the technical revisions mentioned in the review article of the existing regulations, e.g.:

- renewed effort in carbon emission abatement through the Paris climate agreement;
- the Commission's Circular Economy policy;
- the Better Regulation policy aiming at more efficient and effective legislation;
- the need to address possible circumvention of testing standards;
- renewed energy efficiency targets.

Rescaling of energy labels

The new Energy Labelling framework Regulation requires the Commission to rescale the existing labels for five priority product groups, including televisions, 15 months after the entry into force of the Regulation, to remove the A+ to A+++ classes.

More generally, the filling up of the top classes means that the label is no longer effective. If there is still a significant difference in energy efficiency of products remaining on the market, a label will still bring added value in terms of guiding consumers to more efficient products.

In particular for televisions, over the past 5 years, the energy label has been successful in driving the market, by pulling consumer choice towards the highest classes and incentivising manufactures to compete by having a large offer of products in the top classes. As a result, in 2017 almost no televisions in classes below B were sold in the EU (Figure 4) and the top 3 energy efficiency classes are now overpopulated in terms of sales

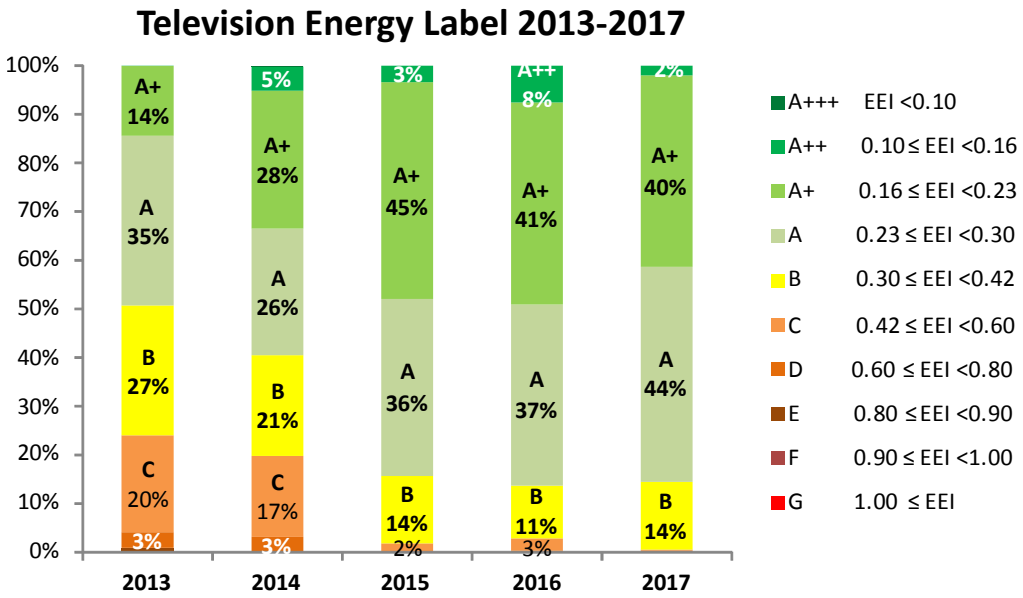

Figure 4: EU television unit sales by EU Energy Label classes 2013-2017 (source VHK based on data from GfK).

This means the use of the label to help consumers to differentiate between the products on the market is lost. Moreover, the "A+", "A++" and "A+++" classes introduced by the Energy Labelling Framework Directive (Directive 2010/30/EU) have been shown to be less effective in persuading consumers to buy more efficient products than the A to G scale[28]. The television energy label was therefore included in the list of product groups to be rescaled as a priority under the Energy Labelling framework Regulation.

1. PROBLEM DEFINITION

Televisions and other electronic displays constitute almost 3% of the European Union's electricity consumption: in 2016, the electricity consumption of televisions was almost 80 TWh/yr[29], up from 25 TWh/yr in 2005, close to the total electricity consumption of EU household refrigeration appliances (86 TWh/yr). This consumption is slowly decreasing

[28] Commission Staff Working Document Impact Assessment Accompanying the document Proposal for a Regulation of the European Parliament and of the Council setting a framework for energy efficiency labelling and repealing Directive 2010/30/EU. SWD/2015/0139 final - 2015/0149. (Impact Assessment Energy Labelling Regulation)

[29] Equivalent to more than the primary energy consumption of a country like Slovenia in 2012.

due to progress in energy-saving technology but still has the largest share amongst all electronic household products and, without policy action, is expected to reach 50 TWh/yr in 2030. However, revised Ecodesign and Energy Label measures could reduce this to around 30 TWh/yr by 2030 (i.e. back to pre-1990 levels) without significant negative impacts, both on life-cycle costs and product functionality.

In addition, although their energy efficiency has been improving, this is not fast enough to compensate for the increase in energy use due to a growing number of displays per household[30]. New image compression techniques and increasing Internet bandwidth availability are also driving the shift from traditional broadcasting to video streaming "on demand" that, in turn, encourages individual watching thereby increasing the number of hours each display is in use. See Annex 6 for market details and projections.

2.1. Problem 1: Outdated energy efficiency requirements

The problem: The current ecodesign requirements for televisions and television monitors no longer capture cost-effective energy savings. Moreover, the current energy label no longer allows consumers to differentiate effectively between the appliances on the market and no longer provides information reflecting real-use patterns as shown by the review. Although the 2012 Ecodesign limit (3 W) was ambitious at the time, nowadays for LED LCD televisions and monitors a level of 1 W/dm² is typical.

Without an update of the eco-design and energy label measures, they will lose their effectiveness and the incentives for industry to design more efficient products will be lower.

Drivers of the problem

Problem driver 1: technological progress, outdated testing methods and circumvention

As outlined in the review, a number of quickly-developing technology and market changes occurred since the entry into force of the existing regulations on televisions, such as ever-larger screens, new backlighting technology[31], increases in picture definition and contrast/colour gamut, in particular High Dynamic Range (HDR).

At the same time, the testing methodology used for setting minimum energy efficiency requirements under ecodesign and defining the efficiency classes on the energy label is based on the energy use of a television with "traditional" contrast/colour gamut control (known as Standard Dynamic Range or SDR)[32]. With the introduction of HDR, energy consumption can more than double. Premium televisions on the market from 2017 started offering this new feature[33] that is progressively offered on less expensive models.

Figure 5 shows, for two television models on the EU market since 2017, how the energy consumption can differ when operating in HDR mode: the left graph shows for a specific model an energy use in HDR of 456 W versus 199 W in SDR (which is the only indication reflected in the label). The right graph shows how for another model with a more energy-

[30] In 1990, only 23% of EU households had more than one TV; in 2010, 80% of households had two TVs, with video content usually watched also on other displays types, such as computer monitors.

[31] From Cold Cathode Fluorescent Lamp (CCFL) to Light Emitting Diodes (LED) to self-emissive panels

[32] To calculate the average on-mode power consumption for the current energy label (indicated in Watts), a testing methodology is in use (according to standard IEC/EN 62087-3:2015) that measures the average power consumption when playing a specific test video, with conventional broadcast images in Full HD, from material produced in SDR.

[33] Competing industry standards were consolidated only from 2016.

efficient implementation of HDR, the energy use has a negligible increase (129 W in HDR versus 128 W in SDR).

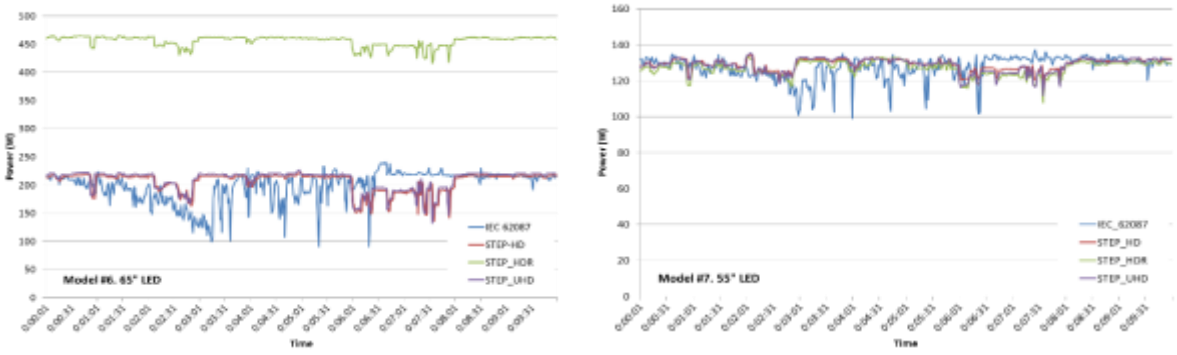

Figure 5: Second-by-second power use of two display models (source STEP project, personal communication).

The current testing method was not designed to deal with this feature and, as a result, the actual energy use of some televisions is possibly considerably higher than what is indicated on the energy label. Hence, in situations where HDR images are displayed on a HDR-capable display, the label does not always correctly represent the energy efficiency and energy use, also leading to an impaired comparability of different models (see annex 14 for more details).

Moreover, independent testing has shown that some displays from some manufacturers abnormally decrease their power consumption in certain situations, such as during the energy consumption test[34], raising suspicion of the use of so-called "defeat devices"[35]. Given the confidential nature of compliance control activities by market surveillance there is however no precise information on the size of the problem. Market surveillance authorities, and consumer and environmental NGOs have argued for improved test modalities and legislation provisions to better support enforcement and discourage circumvention.

The testing method also needs to be updated to include Auto Brightness Control, a new feature for adapting screen luminance to the ambient conditions, which can reduce power use up to 75% in specific circumstances whilst improving visual comfort.

Without an update of the measures, consumers' confidence in the energy label will decrease, as it will become less and less representative of the energy consumption and efficiency in real life conditions.

In addition, international standards are being developed for televisions, based on an update of the current testing loop[36]. Not including this new test in the ecodesign and energy labelling measures would result in double testing of televisions (i.e. according to the EU standard and other markets).

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[34] Articles appearing in the press in 2015, particularly in the USA, revealed the results of tests performed by NRDC that resulted in a few models inappropriately activating "low power modes", thus providing misleading power use information https://www.theguardian.com/environment/2015/oct/01/samsung-tvs-appear-more-energy-efficient-in-tests-than-in-real-life . The same test loop is used for compliance control in the EU.

[35] Action to combat the circumvention as possible "in principle" (e.g. by a smart display capable of recognising the typical pattern of the current test video) was discussed in the consultation Forum in 2014.

[36] EN 62087:2016 is being updated, specifically with provisions to avoid circumvention and take into account new features such as HDR (High Dynamic Range) and higher resolution (UHD, 8K).

Problem Driver 2: Increasing display size, outdated calculation method

Manufacturers' marketing pushes consumers towards bigger and bigger screens, with retailers encouraged to show only the biggest models, which have higher profit margins per unit sold. Figure 6 provides an overview of the market developments between 2015 and 2016 per display size, clearly showing the trend towards larger displays. Since 2005, the energy efficiency per unit of display surface area (i.e. Watts/dm²) started to go down, but by no means enough to compensate for the additional energy consumption due to the increased display size and higher number of displays.

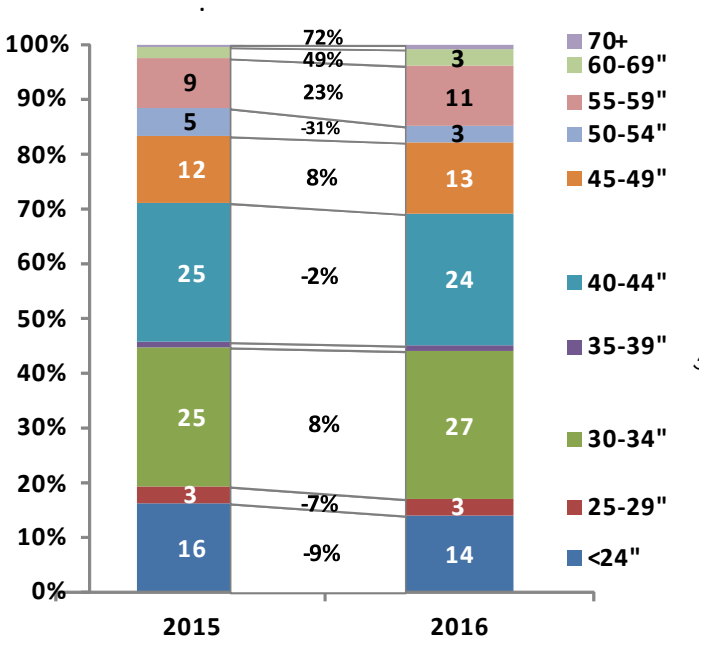


Figure 6: TV display unit sales Europe by diagonal size, in inch, 2015-2016 (source: VHK on GfK POS, April 2017).

At the time the current Regulations were established, the average display size was slightly above 30 inches of diagonal, and the contribution of the different electronic components (which is fixed) and that of the screen (which is relative to size) to the energy consumption of the display was more balanced. Because of the commercial trend to ever-increasing screen sizes, the relative contribution of the screen to energy consumption is increasing.

The current energy label for televisions provides a certain advantage to the biggest displays. Indeed, the calculation method (based on power consumption linearly increasing with screen area) does not correctly capture the influence of the display size with respect to other electronic components (the power consumption of which is independent from the screen area). This results in an indication of efficiency that can mislead consumers. More details can be found in Annex 6.

2.2. Problem 2: Outdated scope

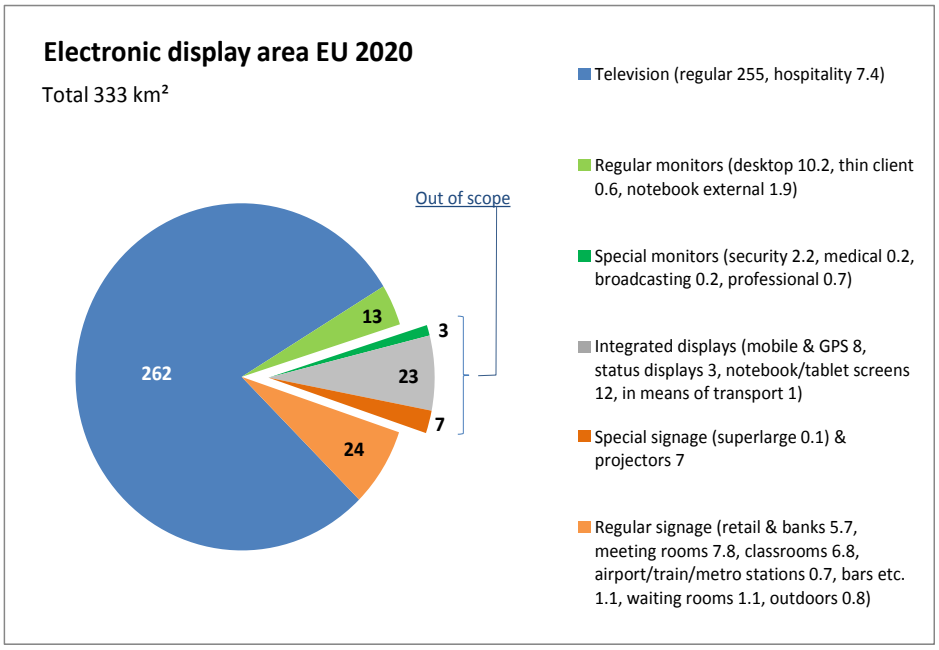
The problem: The outcome of the review shows that the current **scope** of both Ecodesign and Energy Labelling regulations **is unclear, technology-prescriptive and creates uncertainty** as to whether some products are in or out of the scope. This causes an unlevelled playing field for industry, and Market Surveillance Authorities (MSAs) have difficulties to evaluate the scope and perform proper market surveillance. In addition, the current scope of both regulations **does not cover an increasingly important share of devices on the market**.

The current Regulations cover:

- Televisions; defined as products designed primarily for the display and reception of audio-visual signals; and
- television monitors; defined as products designed to display on an integrated screen a video signal from a variety of sources, including television broadcast signals.

Technological progress and convergence of different products increasingly blurred the line between television monitors and other display products such as computer monitors or even signage displays[37]. A functional overlap is now evident, with, e.g. the classic television no longer the only way for watching video content[38] and, because of enhanced resolution levels now available, televisions are sometimes used as monitors for game consoles, although specific wide and curved monitors now exist for that. Already in 2012, most stakeholders agreed that the review of the television measures should be used to cover computer monitors and signage displays (see Annex 2 for details on the rationale of including these products in a revised television measure and Annex 5 for the position of stakeholders in the Consultation Forum of October 2012).

Moreover, new modular signage displays can be used to create video walls, and this market is moving from public spaces to premium domestic home theatre screens replacing projectors for domestic use (or even in public cinemas[39], replacing projectors). Most of the features and components of signage displays are the same as for domestic televisions and monitors and these products are replacing older signage boards because of their flexibility. Technology progress in one sector drives other related ones[40].



[37] Electronic signage displays (signage displays in the rest of the document) are displays, generally "resembling" a television but possibly far bigger and with a different size ratio (proportion of horizontal versus vertical size); common in train stations and airports to display timetables, they are nowadays uses far more widely. See also Annex 8.

[38] Laptops, tablets or even smartphones can be used to watch video content, although the displays integrated in these products would be better tackled within the review of the Regulation on computers.

[39] The Arena cinema in the Sihlcity shopping centre in Zurich is probably the first in Europe where the projection screen is replaced by a video wall of signage modules, using microLED technology. The manufacturer claims 10 times the peak brightness of projectors using 96 modules with UHD 4k HDR and 3D image capability.

[40] Tecnology progress not necessarily has energy efficiency as goal, as energy use is on the customer mostly with little transparency in the lack of appropriate labelling or information requirements.

Figure 7: Share of electronic display surface per product group (EU 2020, source VHK)

Figure 7 shows the estimated area of electronic displays per 'product group'. In combination with the energy consumption data (Figure 10) it becomes evident that the currently limited market of signage displays will become relatively more important in terms of energy use in the coming years.

If computer monitors and signage displays currently not covered by the ecodesign and energy labelling regulations remain unregulated, significant energy savings would not be realised. Consequently, consumers would not benefit from reduced energy consumption (and therefore reduced electricity bills) of those products. Since these two product categories fall within the scope of the WEEE Directive, recycling targets of 80 % as of 2018 would be more difficult to reach[41].

Moreover, signage displays are listed in the Commission's 2016-2019 Ecodesign Working Plan to be taken up in the revision of the existing regulations for televisions.

Drivers of the problem:

Driver 1: Outdated product definitions/unclear scope

Both regulations in force include in scope "televisions and television monitors". However, their definitions of "television monitor" based on the availability of certain input interfaces has become obsolete and inaccurate because of technology development, outdated terminology and because use patterns have changed significantly. This has resulted in legal uncertainty and there are recurring interpretation questions from market surveillance authorities and even court cases and litigation[42] (See Annex 11 for more information).

Driver 2: New product types

The outcome of the review has shown that the increasing availability of relatively cheap electronic displays is driving the replacement of traditional signage media (e.g. paper billboards, split-flap boards, etc.) and provides new opportunities for displaying video content, typically for advertisements (see Figure 8). From an energy perspective, many of these signage displays are on all the time, using up to 2.5 times more power than a normal TV of the same size[43]. Moreover, they tend to be much larger.

At the same time, 'professional' signage displays are migrating into the consumer market (driven amongst others by miniaturisation of LED technology, commonly known as Crystal LED or MicroLED), for example by bringing "video wall" technology used in commercial settings to homes, with new premium products such as 150-inch home theatres. This new "domestic" use of these products broadens their traditional customer base from commercial entities to include households. Annex 6 includes some examples of new signage display markets and of technologies now emerging.

[41] Correct management of these displays at their end of life as WEEE is desirable, as once disposed of, it is virtually impossible to distinguish a television from a monitor of from some types of signage displays. Lack of the same ecodesign requirements for such displays leads to improper and/or inefficient treatment.

[42] In February 2014 a German court judged that products marketed as computer monitors, if advertised showing video images, fall under EU Energy Labelling Regulation 1062/2010 (and, consequently, also under 642/2009).

[43] As a consequence of the higher luminance, e.g. between 500 to 700 cd/m² for indoor versions compared to 300-350 cd/m² of a domestic TV.



Figure 8: an electronic signage display in a hospital mimicking (sound included) a mechanical split-flap board.

2.3. Problem 3: Poor 'Circular Economy' performance

The problem: The existing ecodesign and energy labelling requirements for televisions focus on energy efficiency improvements as the most significant environmental impact during the life-cycle of electronic displays. However, since the introduction of these regulations, new policies on circular economy and other environmental aspects have been introduced and there is a need to address these issues increasingly through Ecodesign and, potentially, Energy Label measures. This was confirmed with the adoption of the current EU Circular Economy Action Plan in 2015, followed by the Ecodesign Working Plan 2016-2019 in November 2016.

The traditional Cathode Ray Tube (CRT) TVs and computer monitors had many environmental and health concerns, e.g. regarding phosphors, lead, large glass tubes, large high-voltage capacitors, heavy mass of casing materials, and in particular flame retardants in plastics. With the advent of the flat screen TV, although there were initially some issues with mercury in backlights and cadmium in nanomaterials, the total material input in producing displays has decreased by 80-90 %: new LED/LCD displays weigh only a fraction of the old CRT TV.

According to the latest Eurostat statistics for 2014, collected waste displays made up 83% of the weight of the consumer electronic products placed on the market and 79 % of that collected waste was recycled, with 2 % being recovered or re-used in another way.

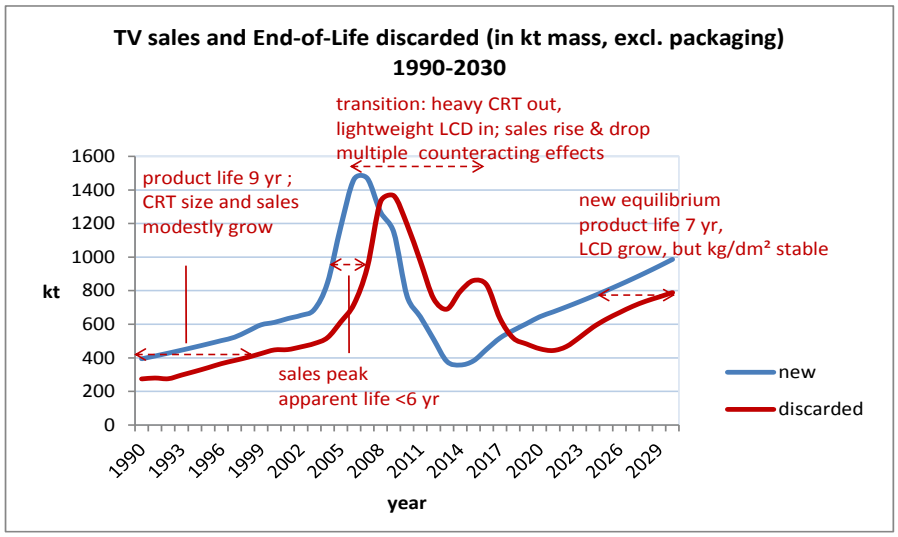


Figure 9: Estimated mass flow (in kt) of televisions sold and discarded (excluded packaging) over the 1990-2012 period with baseline projections for 2013-2030. (source: VHK. See Annex X)

As regards durability, a recent study for the German Environmental Protection Agency[44], found that planned technical obsolescence is not common for electronic displays. Most people discard the old TV, in perfect working order, to buy a better/bigger model.

One issue that has been raised by stakeholders, is the use of standardised external power supplies (EPSs), which convert 230 Volt AC current into low voltage DC current. This would address the following concerns in terms of reparability, durability and recyclability:

- Repairing a broken, internal power supply requires a technician and frequently is not cost-effective, e.g. because it is integrated on the main electronic board and the replacement cost is comparable to a new display. A broken standardised external EPS can be replaced by any user at moderate/low cost;
- An standard EPS can have a lifetime longer than the main load product (e.g. a television) and can thus be used after the main load product is at its end of life;
- Flame retardants hinder recycling of plastics and can be toxic and ecotoxic (in particular halogenated flame retardants). The power supply is the only component where AC current is supplied. By removing the power source from the interior of an electronic display the need for using flame retardants in plastics is reduced[45].

Finally, the WEEE Directive regulates the recycling of electronic displays. Article 8(2) of this Directive includes a list of materials that need to be collected separately during the recycling process, including LCD screens above 100 cm^2 and plastics with brominated flame retardants, and ecodesign requirements can facilitate this by requiring those components to be easily removable. Moreover, Article 4 of the WEEE directive refers to the role of ecodesign to address upstream issues related to re-use, dismantling and recovery. Recycling and material recovery are important for this product group because of the presence of critical or precious raw materials (such as Au, Ag, Pd, In)[46] and big plastic parts. Plastics recycling, mainly of the back-cover and the stand, is rendered more difficult because of the presence of halogenated flame retardants (HFRs) in some of the plastic parts.
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Although circular economy aspects were not specifically evaluated in quantitative terms, the need to examine options for better supporting circular economy objectives was articulated by stakeholders as early as 2012[47].

Drivers of the problem:

Driver 1: Glued and welded components

Typically, televisions and displays are not well designed for recycling. The WEEE Directive requires the removal, for separate treatment and before further processing such as shredding, of several electronic components usually contained in electronic displays[48]. Televisions and displays have many components, which cannot be easily detached because

[44] Siddharth Prakash et al., Einfluss der Nutzungsdauer von Produkten auf ihre Umweltwirkung: Schaffung einer Informationsgrundlage und Entwicklung von Strategien gegen „Obsoleszenz“, study for Umwelt Bundesamt (UBA) Texte/11/2016, Feb. 2016.

[45] Pilot projects have demonstrated the possibility of avoiding use of flame retardants by removing the power supply from inside the TV (e.g. https://corporate.bestbuy.com/fewer-chemicals-same-fire-safety-for-insignia-tvs/)

[46] The efficient use and recycling of critical raw materials is a priority of the EU circular economy action plan.

[47] Consultation Forum 8 October 2012, see Annex 5.3

[48] Obligations in the directive include LCD panels, plastics containing Brominated Flame Retardants (BFR), batteries, electrolyte capacitors, printed circuit boards greater than 10 cm^2, and other components containing substances hazardous for the operations, the workers' health or the environment.

they are welded or glued, and trying to remove them can be dangerous or ineffective. The European Electronic and Electric Recyclers Association (EERA) reports[49] almost every day a fire in recycling plants of one of its members, because e.g. lithium-ion batteries explode during extraction attempts or in shredding machinery.

Driver 2: Use of flame retardants

Electronic displays contain flame retardants (FR) as additives to plastic polymers, as well as synergists such as Antimony Tri-Oxide (ATO). FRs were introduced in old CRT displays, where high voltages were involved[50]. Safety standards required flame retardancy in the case a candle on top of those old TVs was reversed. It is estimated that currently around 20 kt of HFRs and ATOs is used in the production of electronic displays sold in the EU[51].

EFRA (2014) estimated that only 12% of the plastics in a display is recycled[52]. It should be noted that most of these plastics are currently either incinerated or landfilled, as it is not possible with most recycling technologies to separate out these plastics with sufficient quality. However, recent research has demonstrated that it is technically possible to sort these plastics after manual disassembly e.g. by means of spectroscopic analysis. It has also been demonstrated that these plastics can be recycled to produce products with the same properties[53].

Halogenated flame retardants (HFR), used in plastics of electronic displays, are a low-cost solution to obtain the high flame retardancy required by certain standards (i.e. UL94 class V1 or higher) but appear to hinder recycling[54]. The necessity to use HFRs is expected to diminish, because modern displays do not involve high voltages, with some using only low voltage DC current (when the power supply is external). As a result, the so-called 'candle test' (which entails an open flame being applied to the back cover of the television over a prolonged period without the back cover actually catching fire) is no longer required. It was prescribed in EN 60065:2002/A11:2008, a harmonised standard under the Low Voltage Directive (LVD). However, this standard was superseded by EN 60065:2014, which will in turn be superseded by the harmonised standard EN 62386-1:2014 that no longer requires this 'candle test'.[55]

Plastics with HFR additives, particularly bromine-based compounds (BFR), constitute a main bottleneck in reaching the required WEEE recycling rates as they pollute otherwise recyclable polymers that therefore have to be incinerated, thereby lowering recycling

[49] Private communication from the European recyclers association: https://www.eera-recyclers.com/

[50] Early TVs were using thermionic valves, that could heat up and even explode.

[51] Assuming 56 million TVs sold in the EU-2015 with a plastic back-cover weighing 2 kg (EERA 2013 mentions 1.6 kg for a 33" display), half of displays using back-cover with HFR/ATO with a HFR concentration of 25 wt.% (EFRA-2014 mentions 20-30%) with a 5 wt. % ATO (EFRA 2014 mentions 3-5%). Thus the HFR/ATO use is 56x2x0.5x0.3= 16.8 million kg= 16.8 kt. Including also PC-monitors the total is estimated at a rounded 20 kt annually.

[52] EFRA European Flame Retardants Association was, until 2017, a sector group of the European Chemical Industry association CEFIC. The new CEFIC sector group for flame retardants is PINFA (Phosphorous, Inorganic and Nitrogen Flame Retardants Association), representing 32 producers of non-halogenated flame retardants (https://www.pinfa.eu/about-pinfa/members/).

[53] See e.g. Peeters et al (2013), Wagner et al (2017) on recycling of PC/ABS from LCD TV back covers

[54] Some compounds of this group are restricted by RoHS legislation because of their demonstrated toxicity and hazardousness.

[55] Commission communication in the framework of the implementation of Directive 2014/35/EU of the European Parliament and of the Council on the harmonisation of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits (2017/C 298/02), OJ, C298, p. 14, d.d.8.9.2017

yields. In fact, the RoHS Directive[56] restricts the use of specific HFR[57], but a number of other HFR compounds are still allowed and more could be created.

For electronic and electric products, RoHS legislation has clearly defined limit values for the presence of any restricted substance such as BFRs and under the WEEE Directive plastics need to be treated in specialised plants, capable of separating e.g. BFR containing plastics[58], with consequent additional costs[59].

Mechanical separation of polymers containing HFRs from non-HFR polymers is feasible[60], however with state-of-the-art technologies it is currently not economically sustainable to separate plastics containing still allowed substances from those restricted by the RoHS Directive. Hence, recyclers opt for incineration of any plastic with HFRs[61]. Moreover, restricted HFR additives have serious toxicity and ecotoxicity[62] issues, constituting a major threat to the health of workers in recycling plants during end-of-life processing[63] (see Annex 15 for more details).

Banning of all flame retardants, particularly HFRs, is consistently requested by environmental NGOs[64] that have been also fighting the candle test for several years, claiming that the fire safety measures are disproportionate, based on outdated fire statistics and related to old TV technologies (CRT). The recycling industry is also in favour of completely banning[65] the use of at least halogenated flame retardants[66].

Alternative solutions exist[67], at least for the enclosure, that have been already in use for years by major manufacturers[68], such as:

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[56] Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment. OJ L 174, 1.7.2011, p. 88

[57] Polybrominated biphenyls (PBB) and Polybrominated diphenyl ethers (PBDE), tolerating maximum concentration values of 0,1 % by weight in homogeneous materials.

[58] Plastics are checked as described in the EN 50625-1 "General treatment and depollution standard" to verify that the plastics contain less than 2.000 ppm of Bromine restricted substances.

[59] According to EERA, about 10% of annual production of EEE plastics are delivered to specialized recycling facilities in Europe to be recycled as Post-Consumer Recycled (PCR) plastics. 3/4 of the WEEE plastics have been exported outside Europe and no data is available about the final amount recycled as PCR plastics.

[60] Polymers containing brominated flame retardants, for example, increase the specific weight, so separation techniques based on weight can be used.

[61] Presence of the now restricted PBB and PBDE is possible e.g. in electronic displays produced before their ban, but less than 0,1 % in weight is allowed in the recycled yield.

[62] Toxicity refers to the degree to which a toxic substance may harm a (human) cell or organism, while ecotoxicity refers to the potential for biological, chemical or physical stress, affecting the entire ecosystem.

[63] This issue had been already highlighted in the previous Impact Assessment (Sec(2009) 1011 final) but at that time alternative solutions appeared insufficient and possible action to limit them had been judged not yet feasible.

[64] See. e.g. http://ecostandard.org/category/flame-retardants/
http://greensciencepolicy.org/topics/flame-retardants/

[65] See positions expressed by EERA, EURIC and ECOS in particular in Annex 5.

[66] Non-halogenated FRs are e.g. aluminium hydroxide and phosphorus-based (PFR) and recent tests show that, for example, PFR PC/ABS compounds can be (closed loop) recycled.

[67] Two EU-funded projects are currently investigating these areas: CloseWEEE (http://closeweee.eu) and PolyCE (https://www.polyce-project.eu)

[68] Apple has completely eliminated BFRs since 2008, Sony from selected products since 2013, https://www.scientificamerican.com/article/do-we-need-flame-retardants-in-electronics/

- using polycarbonate PC/ABS[69] blends and HIPS/PPE blends that can be flame-retarded using phosphorus solutions[70];
- providing design solutions avoiding any FR such as shields between circuit boards and the enclosure, or increasing the separating space; or
- using non-flammable materials.

The Ecolabel for televisions[71] requires that plastic parts shall not contain a number of flame retardant substances.

As some safety standards still require a certain level of flame retardancy also for the enclosure, a complete elimination of all flame retardants, as recyclers crave, appears still difficult at this stage[72]. More details are given in Annex 15.

Driver 3: Spare parts availability

Currently no measures exist which regulate the availability of spare parts, or software and firmware updates, which has a direct impact on the durability of products.

The review showed that the replacement rate (a proxy for service life) of TVs reduced from 9-11 years in the 1990s to 5-6 years between 2003 and 2010, mostly due to the replacement of analogue, bulky CRT displays but is now again rising to 8-9 years (see Annex 6). Replacement is mostly driven by natural product obsolescence; i.e. people buy a new display because of functional requirements (i.e. size, resolution), but rarely because the display is broken. In the case of signage displays, which are often always on, replacement is driven by the degraded picture quality, often within 5 years.

Reparability of TVs is under investigation in a new study by JRC[73] and preliminary findings indicate that remote controls, external power supplies (EPS) and internal power boards are the components most likely to fail or break.

2.4. General market failures

In addition to the product specific problem drivers described in the previous sections, some general market failures have been identified:

Myopic behaviour - Without up to date energy efficiency requirements and energy labels, economic actors (both business and private) will not choose the product that is the most cost-effective over the product's life-time. This is because economic actors are limited by the information they have, their knowledge about products, and the finite amount of time they have to make a decision.

Split incentives – Without up to date energy efficiency requirements, the guarantee that the products will be cost-effective over their life-time is lost. This is especially important for a

69 PolyCarbonate Acrylonitrile Butadiene Styrene.

70 UL94 V0

71 Commission Decision 2009/300/EC of 12 March 2009 establishing the revised ecological criteria for the award of the Community Eco-label to televisions, OJ L 82, 28.3.2009, p. 3

72 Nevertheless, some manufacturers have already eliminated all HFRs, even from circuitry and use metal for the housing and stand.

73 The Joint Research Centre Directorate B, Circular Economy & Industrial Leadership unit, has compiled a multi-level approach for assessing the reparability and upgradability of products, which will be tested on televisions and is expected to be completed by the end of 2018.

certain groups of consumers, in particular those in a landlord-tenant situations, where the landlord buys the appliance and the tenant pays the energy bill, which for this product group is particularly relevant for signage displays.

Price reflection – The price of the products does not reflect the real environmental costs to society in terms of circular economy. Hence, without setting requirements that will improve circular economy aspects of the product, the different actors in the life cycle of the appliance will not be incentivised to improve the circular economy aspects of the appliance.

2.5. Who is affected?

All market actors, consumers and society in general are affected by the problems.

2.5.1. Manufacturers and retailers

For **manufacturers and retailers**, the energy label is one of the main market drivers and an important quality feature. The energy label allows industry to distinguish itself based on quality and innovation rather than solely on price.

Outdated energy efficiency requirements mean that new, innovative features are no longer properly reflected on the label, and manufacturers are thereby less able to distinguish their products based on quality and innovation rather than solely on price.

The overall energy use (and efficiency) of a display is mostly dependent on the panels (the "screen"). The electronic displays sold in the EU all use panels made in Asia. Jobs in this sector in the EU are mainly in assembly and distribution centres and in utilities supplying casings, non-video components and subassemblies[74].

It is estimated that a few thousand jobs (2000-4000) in the EU are involved. SMEs in this sector, i.e. companies with less than 250 employees, could not be found. Most companies involved in electronic display manufacturing/assembly/design are represented by DigitalEurope[75].

2.5.2. Repair-reuse sector

Statistics on repair shops are not detailed enough to give an exact estimate of the number of enterprises involved in TV and monitor repair. Based on their relative turnover it is estimated that there are between 5,000 and 10,000 repair jobs for TVs and monitors in the EU. More than 80-90 % of these jobs are in SME enterprises, most of them probably also in retail[76]. Lack of repair information hinders the development of the repair-reuse sector.

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[74] EU brands integrating display panels of Asian production into premium "home entertainment" products are Bang&Olufsen (DK), Loewe and Metz (DE). EU-based assemblers of mass-market televisions and monitors are wholly or partially owned by Chinese display manufacturers. Some have 'strategic partnerships' with South-Korean companies such as Barco (BE) or Solari (IT) that also use Asian panels.

[75] www.digitaleurope.org

[76] In Eurostat's SBS (Structural Business Statistics), NACE Rev. 1.1, there is a category 'Repair of electrical household goods' (G5272) that mentions for 2007 that there are over 50,000 businesses and an added value of 5.4bn Euro. The share of TVs and other displays will be at the most 20%, i.e. 10,000 repair shops with 1 bn euro turnover. It can be assumed that most of these enterprises combine repair with retail. So at the most we can assume one employee per enterprise dedicated to repairs, probably less. All in all, EU employment in TV repair is estimated at 5000 to 10,000 jobs. http://ec.europa.eu/eurostat/statisticsexplained/index.php/Computer_and_personal_and_household_goods_repair_statistics_-_NACE_Rev._2 gives data at a higher aggregation level (NACE Rev. 2, Division 95) and confirm the order of magnitude of the above estimate. Average personnel costs are between €23k and

2.5.3. Recyclers and waste disposal industry

For **recyclers**, design requirements that facilitate the separate collection of the materials listed in Article 8(2) of the WEEE Directive[77] would reduce the time needed to disassemble and process an electronic display. Workers in the recycling industry would also benefit from reduced presence of HFRs. The absence of requirements in this area would also delay investments by the recycling industry to improve WEEE treatment techniques and improve yields.

The recycling industry is represented by the European Recycling Industries' Confederation (EURIC) and by the European Electronic and Electric Recyclers Association (EERA). For more information on the end-of-life materials please see Annex 12.

2.5.4. Consumers

For **consumers**, the energy label offers a unique opportunity to make an informed choice as to which products offer the best environmental and energy performance allowing them to save money in the long run. Ecodesign requirements safeguard consumers from the worst performing products. Without up to date ecodesign and energy labelling requirements, consumers may miss out on savings of EUR 2.8 billion annually by 2030 (BAU compared to the ECO option, see Section 6).

Consumers are represented by the Bureau Européen des Unions de Consommateurs (BEUC) and the European Association for the Co-ordination of Consumer Representation in Standardisation (ANEC).

2.5.5. Society as a whole

For **society as a whole**, ambitious policies in the area of energy efficiency are important tools to mitigate climate change. Effective and efficient energy labelling and ecodesign regulations contribute to achieving goals set in the Paris Agreement; they help achieve the 2030 EU climate and energy objectives. In total, all these measures will generate 0.29 % of the total EU GHG-emissions savings target for 2030 and 0.66 % of the total EU final energy consumption savings target for 2030.

Environmental organisations are represented by the European Environmental Citizens Organisation for Standardisation (ECOS), the European Environment Bureau (EEB), TopTen, the Collaborative Labelling and Appliance Standards Program (CLASP).

2. WHY SHOULD THE EU ACT?

3.1. Legal basis

The legal basis for acting at EU level through the Ecodesign framework Directive and the Energy Labelling framework Regulation is Article 114 and Article 194 of the Treaty on European Union and the Treaty on the Functioning of the European Union (TFEU)[78] respectively. Article 114 relates to the "the establishment and functioning of the internal market", while Article 194 gives, amongst others, the EU the objective "in the context of

€33k per employee, which indicates a business revenue of at the most €50k per employee, i.e. overall EU repair revenue €0.25bn to €0.5bn per year (less than 2% of sales value).

[77] Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on Waste Electrical and Electronic Equipment. OJ L 197 of 27-07-2012, p 38 (WEEE Directive)

[78] Consolidated version of the Treaty on the Functioning of the European Union. OJ C 326, 26.10.2012, p. 47 (TFEU)

the establishment and functioning of the internal market and with regard for the need to preserve and improve the environment" to "ensure security of energy supply in the Union" and "promote energy efficiency and energy saving and the development of new and renewable forms of energy".

The Ecodesign Framework Directive and Energy Labelling Framework Regulation include a built-in proportionality and significance test. For the Ecodesign Framework Directive, Articles 15(1) and 15(2) state that a product should be covered by an ecodesign or a self-regulating measure if the following conditions are met:

- The product should represents a significant volume of sales;
- The product should have a significant environmental impact within the EU;
- The product should present a significant potential for improvement without entailing excessive costs, while taking into account:
    - an absence of other relevant Community legislation or failure of market forces to address the issue properly;
    - a wide disparity in environmental performance of products with equivalent functionality.

The procedure for preparing such measures is described in Article 15(3). In addition, the criteria of Article 15(5) should be met:

- No significant negative impacts on user functionality of the product;
- No significant negative impacts on Health, safety and environment;
- No significant negative impacts on affordability and life cycle costs;
- No significant negative impacts on industry's competitiveness (including SMEs see Section 6.6.3).

The Energy Labelling Framework Regulation includes similar criteria for products covered by an energy label:

- The product group should have significant potential for saving energy and where relevant, other resources;
- Models with equivalent functionality should differ significantly in the relevant performance levels within the product group;
- There should be no significant negative impact as regards the affordability and the life cycle cost of the product group;
- The introduction of energy labelling requirements for a product group should not have a significant negative impact on the functionality of the product during use.

Following the procedure as defined in Article 15(3) of the Ecodesign Directive, it was established that electronic displays fulfil the above eligibility criteria.

3.2. Subsidiarity: necessity of EU action

Action at EU level gives end-users the guarantee that they buy an energy efficient product and provides end-users with harmonised information no matter in which MS they purchase their product. This is becoming all the more relevant as the online trade increases. With ecodesign and energy labelling at EU level, energy efficient products are promoted in all MSs, creating a larger market and hence greater incentives for the industry to develop them.

It is essential to ensure a level playing field for manufactures and dealers in terms requirements to be met before placing an appliance on the market and in terms of the information supplied to customers for sale across the EU internal market. For this reason, EU-wide legally binding rules are necessary.

Market surveillance is carried out by the MSAs appointed by MSs. In order to be effective, the market surveillance effort must be uniform across the EU to support the internal market and incentivise businesses to invest resources in designing, making and selling energy efficient products.

Manufacturers of electronic displays are worldwide companies placing the same or equivalent product models in different regions of Europe. Consequently, the ecodesign and energy labelling requirements in Europe can only be effectively implemented at EU level.

Finally, Regulation (EU) 2017/1369 requires the Commission to update the current energy labelling regulation for televisions, in particular as regards rescaling the label to remove the A+ to A+++ classes. Under the repealed Directive, energy labels were allowed to include A+ to A+++ classes to address the overpopulation of the top classes. Over time, due to technological development, also the A+ to A+++ class became overpopulated, thereby reducing the effectiveness of the labels significantly.

3.3. Subsidiarity: Added value of EU action

There is clear added value in requiring minimum energy efficiency levels and energy label class limits at EU-level.

Without harmonised requirements at EU level, MSs would be incentivised to lay down national product-specific minimum energy efficiency requirements in the framework of their environmental and energy policies. This would undermine the free movement of products and increase design, manufacturing and distribution costs. Before the ecodesign and energy label measures were implemented, this was in fact the case for many products.

The added value of EU action in the area of the circular economy has already been enshrined in the Circular Economy Action plan and the Ecodesign Working Plan 2016-2019.

3. POLICY OBJECTIVES: WHAT IS TO BE ACHIEVED?

4.1. General objectives

Following the legal basis in the TFEU, the general objectives are to:

1. Facilitate **free circulation** of efficient electronic displays within the internal market;
2. Promote the **energy efficiency** of electronic displays as a contribution to the EU's objective to reduce energy consumption by at least 30 % and domestic greenhouse gas (GHG) emissions by 40 % by 2030; implement the energy efficiency first principle established in the Commission Communication on Energy Union Framework Strategy; and
3. Increase **energy security** in the EU and reduce energy dependency through a decrease in energy consumption of electronic displays.

There are several synergies between these objectives. Reducing electricity consumption (by increasing the energy efficiency) leads to lower carbon, acidifying and other emissions to air. Tackling the problem at EU internal market level enhances efficiency and effectiveness of the measure.

4.2. Specific Objectives

The specific objectives of the policy options considered in this impact assessment are to correct the problems identified in the problem definition:

1. **Update the energy efficiency requirements and the energy label** in line with international and technological developments, and the revised Energy Labelling framework Regulation, to achieve cost-efficient energy savings;
2. **Redefine the scope** to close loopholes, remove ambiguities, facilitate execution of the Regulation, align it with market developments and better capture the potential for energy savings;
3. **Contribute towards a circular economy** by facilitating dismantling and recyclability.

These objectives will drive investments and innovations in a sustainable manner, increase monetary savings for the consumer, contribute to the Energy Union Framework Strategy and the Paris Agreement, contribute to the Circular Economy Initiative and strengthen the competitiveness of EU industry.

4. WHAT ARE THE AVAILABLE POLICY OPTIONS?

The procedure for identifying policy options follows from the Better Regulation Toolbox[79]. Specific measures in the policy options are the result of a combination of initiatives including three discussions in the Ecodesign Consultation Forum, input from a public consultation and from WTO on a previous proposal on Ecodesign only and inspiration taken from the Ecodesign framework Directive, the Energy Labelling framework Regulation and the Circular Economy Initiative. They aim to address the issues identified in Section 3 and achieving the policy objectives defined in Section 4.

Some measures presented in this impact assessment were extensively discussed with stakeholders during three Consultation Forums (8 October 2012, 10 December 2014 and 6 July 2017) and represent the consensus achieved. They apply to all policy options and are further detailed under option 2 - ECO. The main elements that need to be further assessed are the inclusion of signage displays (see policy option 3), restricting the use of HFRs (see policy option 3) and more lenient requirements for newer display technologies (see policy option 4).

Subsequently, the policy options considered for this impact assessment are listed in Table 1 (detailed description in the next sections):

Table 1: Policy options

Option	Name	Short name	Description
Option 1	Baseline	BAU	No further action, the current regulations regarding televisions stay in place unchanged, no scope extension to other displays.
Option 2	ECO	ECO	Set the Ecodesign limits at a maximum Energy Efficiency Index (EEI) level of 0.9, reducing it to 0.75 after 3 years and 0.6 after 5 years. Rescaling the label, leaving the top two classes empty. Extending scope for on-mode energy use to computer monitors and improve definitions. Introduce circular economy requirements for a number of displays.

[79] https://ec.europa.eu/info/sites/info/files/file_import/better-regulation-toolbox-17_en_0.pdf (Better Regulation Toolbox)

Option 3	Ambitious	Ambi	As ECO but with inclusion of signage displays in the energy label nd.
Option 4	Lenient	Leni	As ECO but with a lower ambition level through a "50% allowance" for UHD/HDR displays (which allows them to satisfy ecodesign requirements more easily).

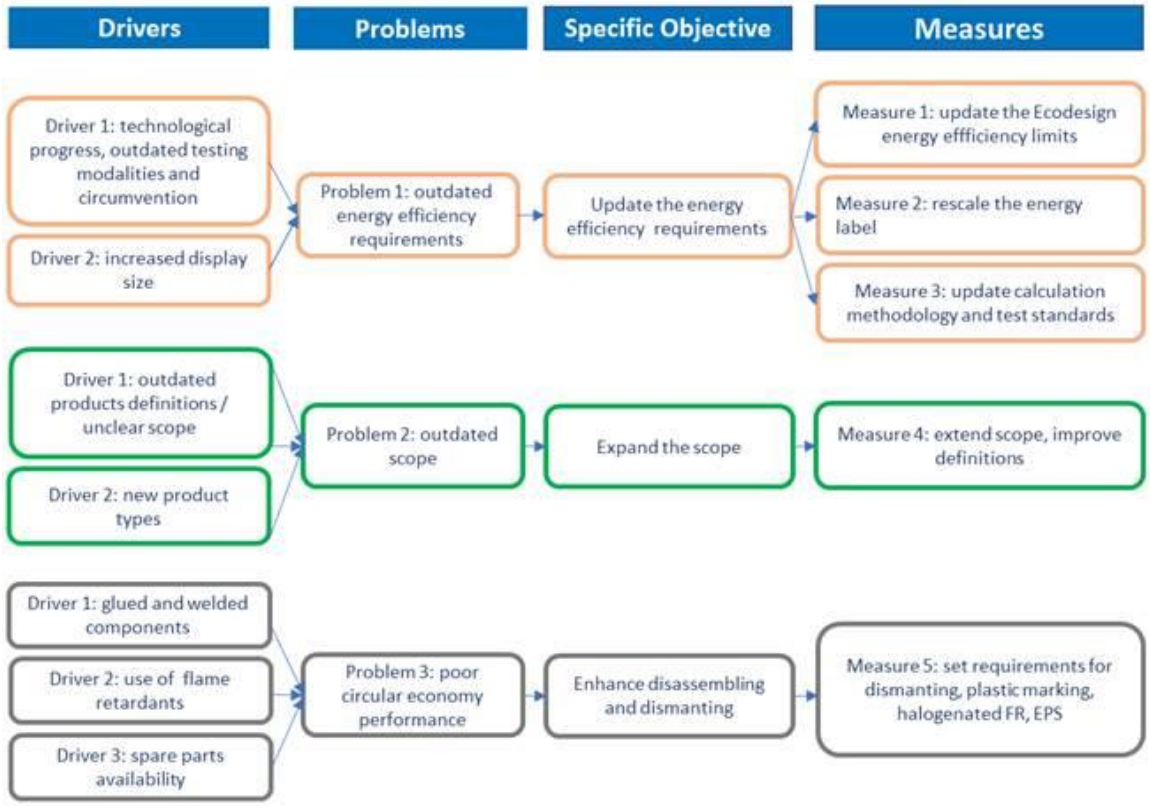
5.1. What is the baseline from which options are assessed?

In the baseline, the current Ecodesign and Energy Labelling Regulations and all other relevant EU-level policies and measures are assumed to continue.

The requirement in the ETS to reduce emissions (from amongst other electricity production) will impact electronic displays in a baseline scenario. Indeed, if the energy consumption of electronic displays is not reduced, the indirect emissions (i.e. from electricity consumption) of electronic displays relative to the allowed emissions will increase. This either leads to higher ETS prices (which could in turn increase electricity prices) or to the need for additional emission reductions in ETS sectors (higher renewable energy targets or more reductions in industry).

Sections 2.1, 2.2 and 2.3 have described how the situation will evolve in a baseline scenario in terms of energy savings, circular economy and scope.

Table 2: Intervention logic



5.2. Description of the policy options

5.2.1. Option 1 – Baseline

This option implies that the current regulations and all other relevant EU-level policies and measures will continue, without any changes.

Figure 10 gives an estimate of annual energy use in on-mode of the EU stock of televisions, monitors and signage displays until 2030. It has to be noted that only televisions (and television monitors) (blue area) are in the scope of the current Regulations.

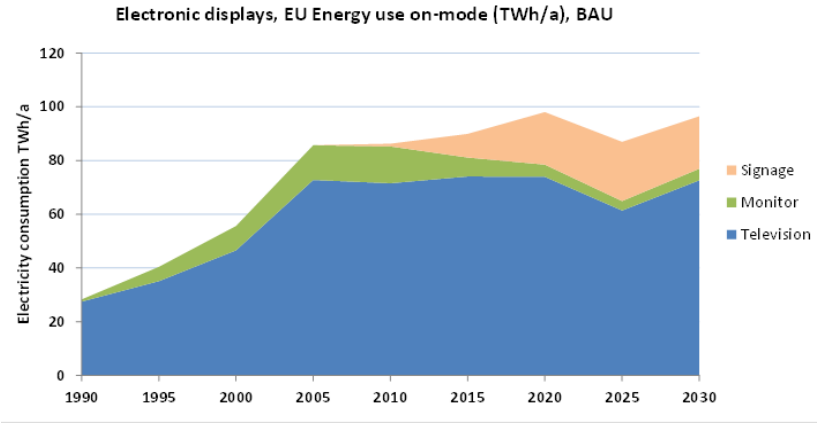


Figure 10: Yearly energy use in on-mode of the three most relevant types of electronic displays, in TWh, 1990-2030 (source VHK, 2018).

This shows that without further measures, the energy consumption of electronic displays will start to go up after around 2025 because of diminishing efficiency improvements and continued increase of the number of signage displays on the market.

This is largely because the sector is nearing some hard technological limits (see also Annex 4, section 6): getting beyond 5 nanometres in semiconductor manufacturing is not possible to date for electric signal processing and the development of light-chips or similar technology will take more time. Moreover, LEDs with an efficacy higher than the current market-best of 200 lm/W will be technically challenging and expensive. Although the development of so-called microLEDs (i.e. looking straight into millions of flawlessly operating LED-subpixels to create the picture without Liquid Crystals (polaroid and filters)) is advancing, and might bring the next step-change in energy efficiency, it has to be noted that the development and commercial mass production of microLEDs in conventional television sizes is considered as a major investment. This would probably mean at least a doubling of the 'normal' investment, which for a modern but still conventional display factory is over 10 billion Euros[80].

In this context, the question is whether the sector would make such investments if there is no commercial incentive through an up-to-date energy label and no regulatory pressure of ecodesign requirements phasing out the worst performing products from the market. While EU regulations are not the only driver in this sector, evidence shows that countries worldwide are regulating television efficiency and are looking at the EU to take the lead.

In conclusion, regulating electronic displays under Energy Labelling and Ecodesign is an important driver for energy efficiency and climate change abatement where the EU can tip the global balance in moving to the next stage of innovation. Without such regulatory pressure, the BAU assumes that further major efficiency gains will not materialise, and that with the increasing volume of displays, total energy consumption will go up.

To properly assess the impact of the different policy options, the BAU scenario includes signage displays. In this way, it has been possible to take into account the increasing market share of signage displays and their impact on the energy consumption of the products in the scope of the impact assessment.

[80] Cmparable to the cost of a nuclear power plant.

5.2.2. Option 2 – ECO

The ECO scenario includes the following measures for the Ecodesign and Energy Label scope, test standard and metrics, energy efficiency limits and circular economy.

Table 3: Proposed measures under Option 2-ECO

Identified problems	**Proposed measures**
Problem 1: Outdated energy efficiency requirements	1. Update Ecodesign energy efficiency limits 2. Rescale Energy Label 3. Update test standard and calculation method
Problem 2: Outdated scope	4. Extend scope and improve definitions
Problem 3: Poor 'circular economy' performance	5. Set requirements for dismantling, plastic marking, halogenated flame retardants, EPS

Measures related to Problem 1

Measure 1: Update Ecodesign energy efficiency limits

According to the Ecodesign framework Directive, minimum energy efficiency requirements should be set at the Least Life Cycle Cost (LLCC) level, provided there are no significant negative impacts. In principle, the LLCC can be calculated from purchase price (PP), lifetime of the unit (N in year), operating expense (OE), end-of-life costs (EoL), discount rate (d) and escalation rate (e). This assumes that the cost for improving the energy efficiency of a product is related to the price of that product: the price increases due to the cost for changing the product to improve the efficiency (this is the case for household appliances and lighting).

However, research[81] and market data (Annex 6) have shown that for consumer electronics and ICT products (including televisions), their price does not relate to the efficiency of the product. In fact, for displays, over the last 10-15 years, usually around one year after a new development, the average price of displays dropped, e.g. from EUR 800 in 2005 to EUR 450 in 2017, while at the same time the energy efficiency increased (up to 7-8 % per year).

Product price is largely driven by the size of the display, processor power, operating system characteristics, "smart" features (such as gaming, browsing or streaming), number of external interfaces, audio capabilities, screen curving, contrast ratio and luminance and capabilities newly introduced in the market. High prices are asked for new products with high performance features. Once on the market, the price of these products will decrease (exponentially) until they are superseded by new products with improved functionality or new features.

This means that a specific LLCC-point cannot be determined but rather an economically reasonable pace of improvement needs to be determined in the light of the iterative impact analysis on display databases compiled since 2012 to determine cut-off and trends over the years. The latest database with energy efficiency information used for the calculations was

[81] Hans-Paul Siderius. Setting MEPS for electronic products. Energy Policy 70: 1-13

created in January 2018[82] and covers over 600 models offered on-line until December 2017. Database analysis can be found in Annex 13.

Moreover, an analysis of requirements in other jurisdictions was undertaken to verify whether that was some level of alignment given the global nature of the display market. Figure 11 shows the minimum energy efficiency limits around the globe in comparison to the proposed EU values. More details on efficiency schemes, inside and outside the EU, are provided in Annex 8.

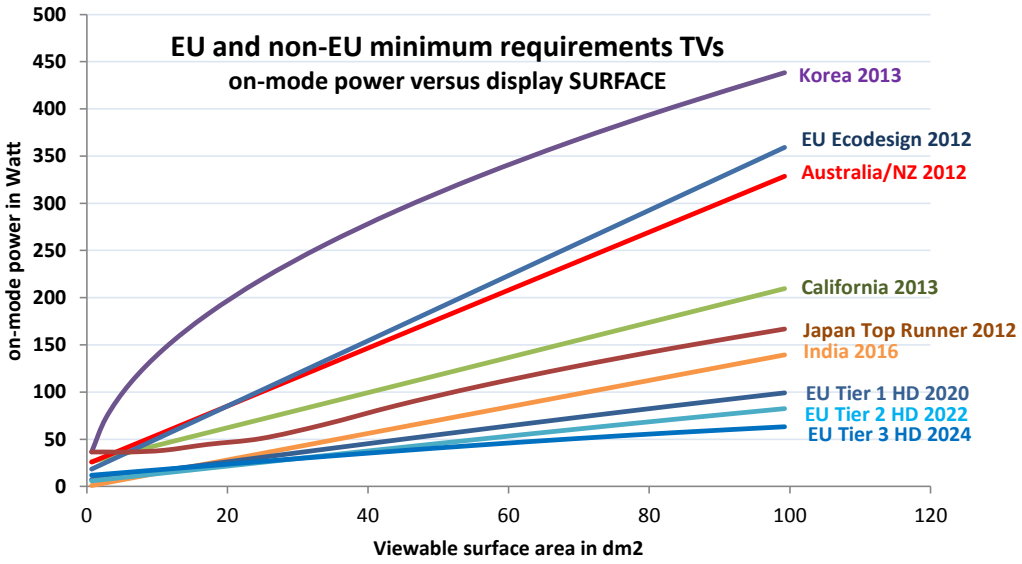


Figure 11: Proposed EU Ecodesign limits for 2020, 2022, 2024 in comparison to 2012 EU limit and non-EU limits for on-mode power in Watt per viewable surface area in dm².

The proposed EU Ecodesign limits follow maximum Energy Efficiency Index values of EEI_{max}=*0.9 EEI* (tier 1, one year after entry into force), EEI_{max}= *0.75 EEI* (tier 2, three years after entry into force) and EEI_{max}=*0.6 EEI* (tier 3, five years after entry into force).

Apart from this new on-mode requirement, stricter requirements for other modes are also proposed, i.e. 0,3 W on off-mode, 0,5 W in standby and 2 W/6 W in network standby. Allowances are proposed for the features of Auto Brightness Control (ABC) and for presence sensors (switching off the display would the room be empty or the user fallen asleep). For signage displays, no minimum efficiency requirements for on-mode are proposed, as available data is not sufficient to set meaningful limits.

Based on the analysis of the available energy consumption data, for UHD/HDR displays an allowance of 20 % on the EEI is proposed to take into account their intrinsically higher energy consumption (which is on average 20 % higher than HD displays).

[82] The data was taken from the product information sheets that the current Labelling regulation requires supplier to make available to dealers. Such a burden (of keeping data available by suppliers and of collecting the spread data for review purposes) will be eliminated once a product registration database as from Regulation 2017/1369, art. 12 will provide all data centrally.

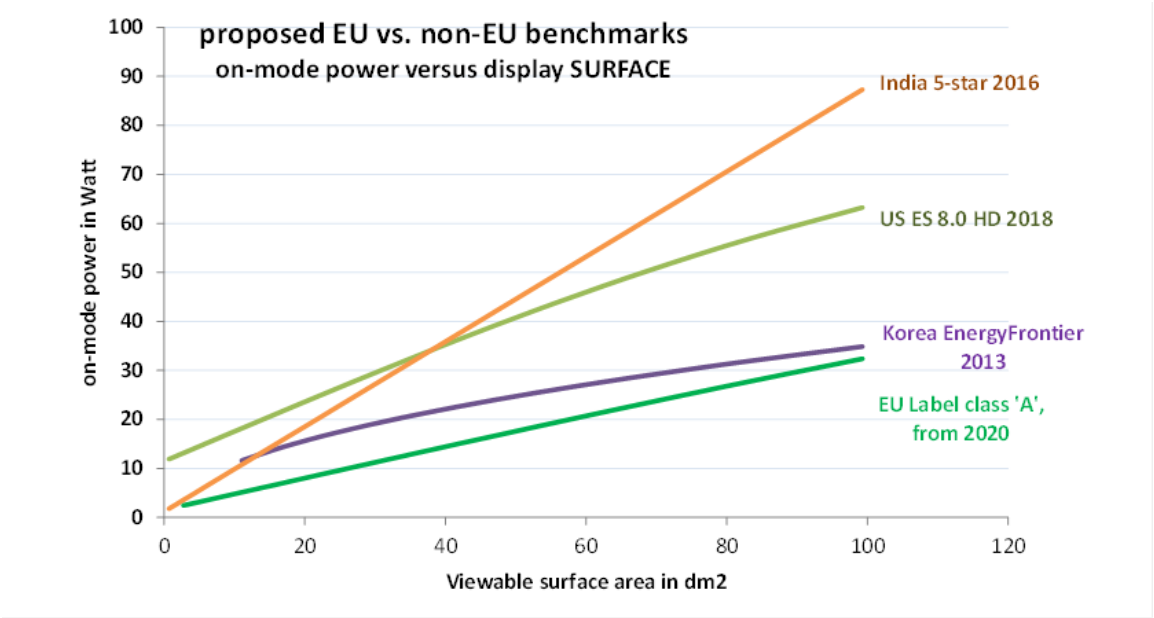


Figure 12: Proposed Labelling top class compared with non EU energy efficient top class displays

Stakeholder views: Some television manufacturers and some monitor suppliers consider the requirements too ambitious for some niche displays, although laboratory tests have not identified any reason for setting specific allowances (see Annex 13, Intertek tests). An exemption, limited in time, for OLED displays is proposed to take into account the relative youth of this technology and its low environmental impact at end of life. No major objection was raised by European manufacturer organisations on power limits in other modes than on-mode.

The Open Public Consultation (OPC) resulted in 64% of respondents considering the explicit indication on the label of power use in HDR influencing their purchase choice (with 16 % preferring to include this parameter in a single indicator) and 60.5 % asking to have the parameter clearly indicated.

Measure 2: Rescale the Energy Label

As per the new Energy Labelling framework Regulation, the updated energy label for displays would leave the 'A' and 'B' energy classes empty when the label is introduced, i.e. by April 2020. The estimate of Best Available Technology (BAT) and Best Not yet Available Technology (BNAT) are as follows:

- BAT: UHD/HDR is 0.76 W/dm^2 for a 55" TV display and 0.72 W/dm^2 for a 60" TV display. HD 0.53 W/dm^2 for a 49" TV. The computer monitor[83] that the US Energy Star rates as 'best in class' consumes 0.85 W/dm^2. All in all, BAT is close to the current A+++ class limit.
- BNAT: micro-LEDs promise a factor 2.5 to 3 improved energy efficiency over OLED with better picture quality. This would mean a value of 0.4 to 0.5 W/dm^2. Indium Gallium Zinc Oxide (IGZO) panels are a promising efficient technology for high-end portable computers/tablets, but identifying the specific power for a commercial IGZO screen that is optimised for efficiency was not possible so far.

The proposed energy classes provided in table 4 below are not directly comparable with the

[83] A portable USB-Type-C ready 15.6" LCD/LED model.

current classes[84]. However, Figure 13 illustrates how the new A-G class limits relate to the existing A+/A++/A+++ class limits.

Table 4: ECO energy efficiency classes

Energy efficiency class	New EEI
A	EEI ≤0.30
B	0.30 <EEI ≤0.40
C	0.40 <EEI ≤0.50
D	0.50 <EEI ≤0.60
E	0.60 <EEI ≤0.75
F	0.75 <EEI ≤0.90
G	0.90 <EEI ≤1.10

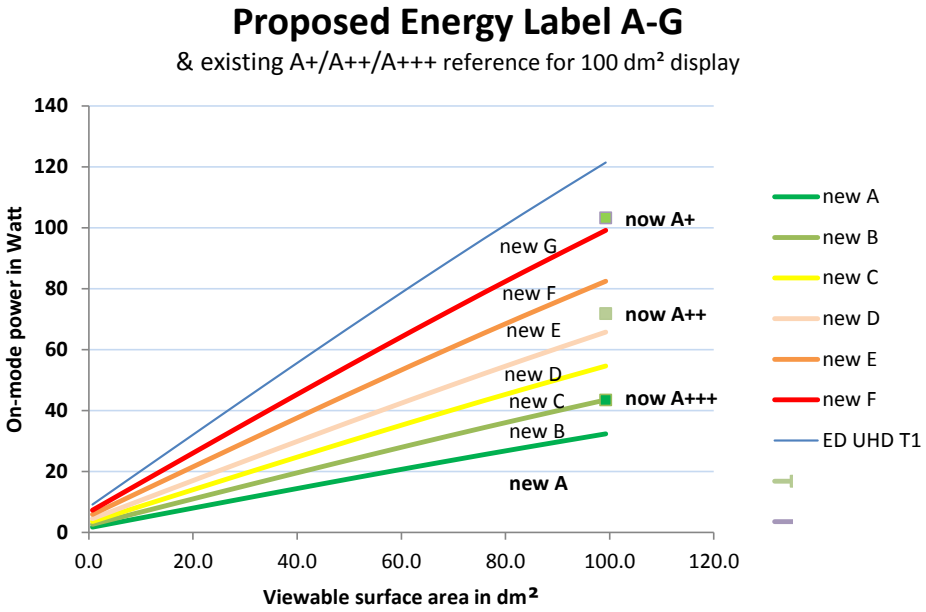


Figure 13: Approximate comparison between new and old energy labelling classes.

The proposed Ecodesign requirements will be synchronised with the Energy Label: Tier 1 in 2020 will eliminate high definition (HD) displays falling in the new 'G' class (but G-class will still apply to UHD products), which is similar to the current A+ and lower. Tier 2 in 2022 will eliminate HD displays in the new 'F' class and UHD ones in the 'G' class. Tier

[84] The EEI is calculated with a "linear" curve in the current regulations, whilst a tangent hyperbolic is proposed, that cannot be superposed.

3 in 2024 will eliminate HD displays[85] in the new 'E' class and UHD in the 'F' class.

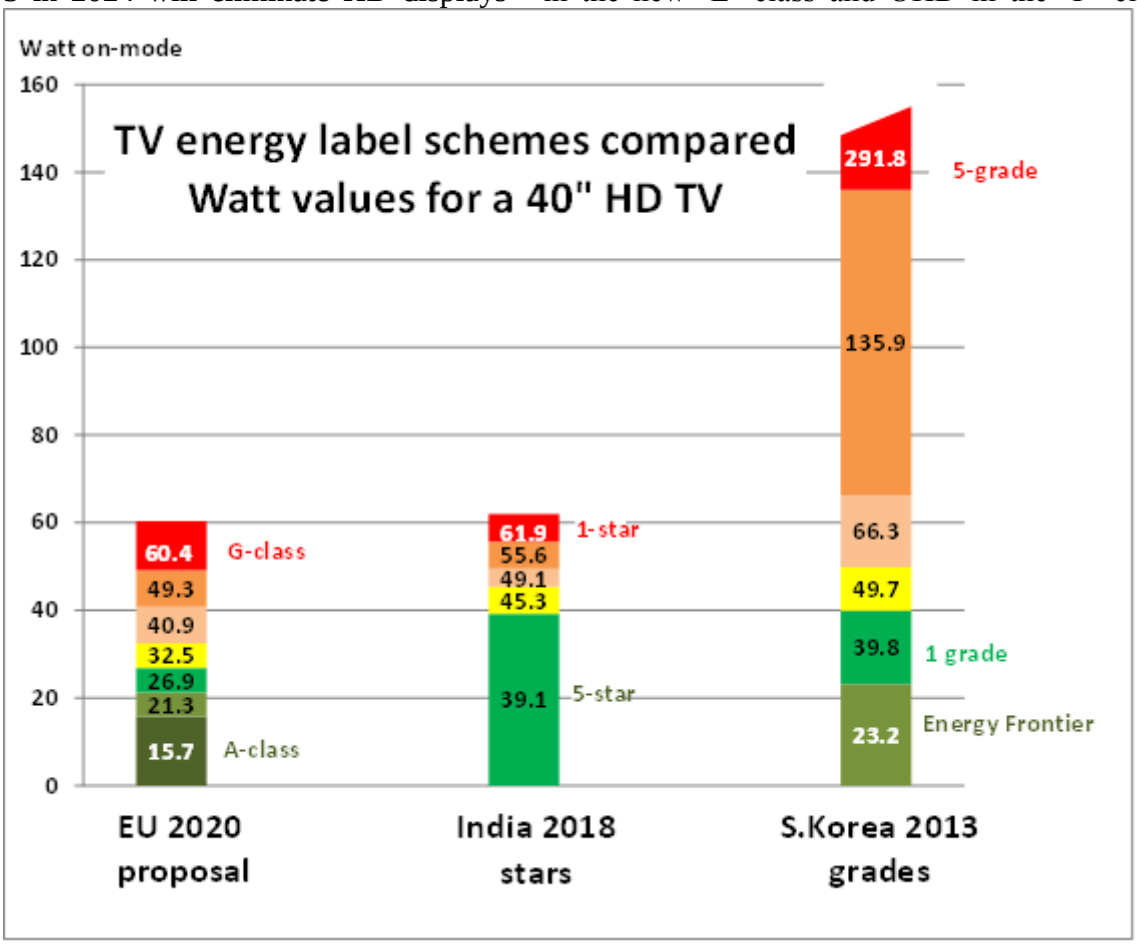


Figure 14 shows the proposed energy classes in comparison with two other non-EU labelling schemes with multiple energy classes (the numbers inside the coloured bars are Watts of energy use in on-mode, as the y-axis indicates[86]).

[85] It is likely that only very little HD displays may be produced by that time.

[86] For instance and for 40"HD, in the new EU proposal an A is <15.7W. For a B you add 5.6W (so <21.3W), etc. For India, the best is a 5-star and that is for energy on-mode<39.1W; a 4-star is 39.1+6.2 = <45.3W etc. In South Korea the labelling has a very large range, from the best class called "Energy Frontier" at <23.2W down to the 5th grade 291.8W.

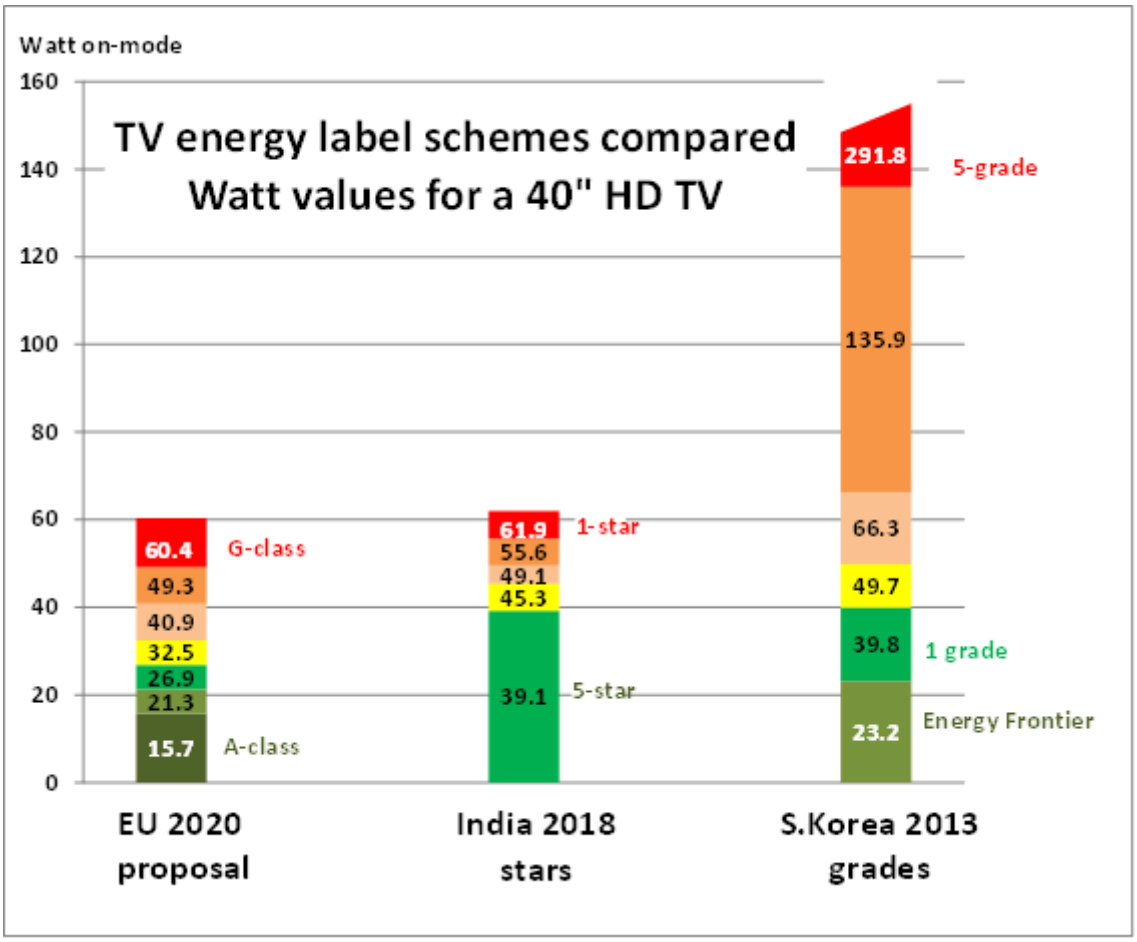


Figure 14: Proposed label classes compared with non-EU labelling schemes for a 40" (44dm2) HD display.

Stakeholder views: Industry stakeholders consider the proposed label classes after rescaling rather ambitious, while NGOs would prefer even more ambitious levels. Stakeholders also commented on a provisional draft of the label, generally suggesting not to overload it with indications considered not crucial for a fair comparison of different displays models. No consensus was identified on specific aspects such as printing the label on the display packaging, indicating on a separate scale the power use for SDR and HDR (manufacturers in favour, some MS hesitant) or indication of annual energy use (details in Annex 5). 75 % of respondents to the OPC considered it important to indicate the resolution level of displays, a parameter not present on the current label.

Measure 3: Update test standard and calculation method

The test standard will be adapted through a mandate to ESOs (European Standardisation Organisations)[87], in accordance with the global International Electrotechnical Committee (IEC) 62087 standard, adjusted to fit the EU's needs (but still largely comparable to the rest of the world, except for China see Figure 15 and Annex 8). This will inter alia include an

[87] Namely CEN, CENELEC and ETSI

update of the testing modalities to cope with higher resolutions (UHD-4K), larger colour gamut, and contrast ratios ('HDR'), and to mitigate the risk of defeat devices[88].

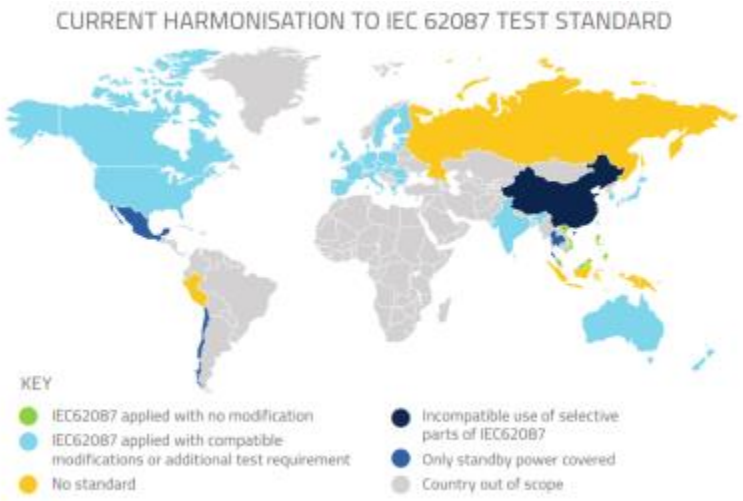


Figure 15: Use of the IEC 62087 standard worldwide (source: Catriona McCalister, Jeremy Tait for SEAD; www.superefficient.org)

At the same time, the calculation method will be adapted to address the relative advantage that bigger displays have in meeting the energy efficiency requirements for the different classes on the label.

Stakeholder views: All stakeholders supported the update of the test standard as it would better reflect real life conditions and help avoid circumvention. A testing method for ABC has been repeatedly discussed with manufacturers' representatives. Since the first Consultation Forum meeting (see Minutes in Annex 5.3), the majority of stakeholders were also in favour of a calculation method that was based on a logarithmic regression line[89], as this would be more stringent for the largest TVs.

Measures related to problem 2

Measure 4: Update scope, improve definitions

The scope of both Ecodesign and Energy Labelling would be extended from televisions to monitors and signage displays. For Ecodesign only, standby and non-energy requirements are extended to professional and commercial monitors as well. No requirements for on-mode energy efficiency are proposed as this professional market is very specialised.

These products are currently already covered by the horizontal standby Regulation[90]. However, standby requirements will be included in this revised Regulation to reduce administrative burden (all requirements for these products will be in one single regulation).

The energy savings that can be achieved from very small displays are not considered significant. Moreover, minimum efficiency requirements could interfere with the functional

[88] Personal Communication from. Robert Harrison, member of the IEC standardisation committee and https://www.nrdc.org/resources/secret-costs-manufacturers-exploiting-loopholes-governments-tv-energy-test

[89] Requirements laid down in the current Regulation 642/2009 are based on a "linear" regression line

[90] Commission Regulation (EC) No 1275/2008, with regard to ecodesign requirements for standby and off mode, and networked standby, electric power consumption of electrical and electronic household and office equipment.

specifications for certain special purpose displays. Therefore, full or partial[91] exemptions for small displays[92], special purpose displays (medical, broadcast, security displays, etc.), digital photo frames, projectors, displays in means of transport are proposed to ensure an appropriate balance between energy savings to be realised and estimated administrative burden.

Finally, this option does not include energy efficiency requirements for signage displays. While this is a growing market, little data is available on their energy efficiency (other than that it is typically higher than that for 'normal' displays) and they comprise a wide range of different products (see Annex 6.3 for further details). They are however covered by material efficiency and information requirements.

Stakeholder views: Since the first Consultation Forum a majority of Member States and NGOs agreed on extending the requirements to electronic displays other than televisions, including computer monitors and signage displays (see minutes in Annex 5). Industry representatives on the contrary considered that signage displays are a very specific market about which too little is known to justify setting minimum efficiency requirements and for which specific test standards would have to be developed. Moreover, manufacturers requested exceptions for specialised displays with distinct characteristics, and temporary extensions for new, emerging technologies, such as OLED. Manufacturers are also in favour of moving standby requirements for all displays into the "vertical" regulation on displays, as this would mitigate the administrative burden.

Measures related to problem 3

Measure 5: Set circular economy requirements

A number of requirements were discussed extensively with stakeholders throughout the revision process, and include:

- Requiring components subject to the WEEE Directive to be safely and easily removable[93];
- Marking of plastics components >50g;
- Requiring repair information relevant for replacement of defective components;
- Requiring detailed documentation on the presence and chemical composition of flame retardants in components[94];
- Requiring stickers/marking on the back cover and internally on the panel, indicating whether the product contains mercury ('Hg' icon) and/or cadmium ('Cd' icon), which are substances considered particularly toxic and needing specific manipulation by staff at recycling centres;
- Encouraging the use of standardised "universal" external power supplies (EPS),[95] by including a logo on the energy label indicating whether a standardised EPS is provided with the product.

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[91] For instance, no requirements on on-mode power are foreseen for the special purpose displays mentioned but they will be subject to requirements on maximum (networked) standby and off-mode power use as well as product information and circular-economy aspects.

[92] 100 cm^2, or about 6-7 inches of diagonal

[93] The WEEE Directive lists a number of components, some of which are present in electronic displays, to be removed before further treatment, such as shredding.

[94] Back covers and stands are generally the biggest and most cost-effective plastic parts to recycle and the presence of FR, particularly HFR, limits recycling opportunities.

[95] USB PD specification extends the power and voltage specifications up to 100 W and 3 voltages. "Universal" EPSs are coming to the market with multi-USB-ports being able to charge different devices, even at a time and at different voltage levels and using a unified reversible connector (USB Type-C): http://www.usb.org/developers/powerdelivery/

As regards reparability and durability, replacement of the entire display panel is technically feasible. However, the replacement costs are too high compared to the cost of a new display, to justify requirements on availability of spare panels.

While the requirement to provide information on the presence and chemical composition of flame retardants would in itself not reduce their presence in plastic parts, it would allow recyclers to identify them easier and avoid health risks during the recycling process.

Stakeholder views: Manufacturers and other industry sectors, particularly FEICA[96], as well as some third countries[97], strongly objected to a dismantling requirement that, in their view, would overly restrict the use of gluing techniques as was proposed in a draft discussed at the Consultation Forum in December 2014. An alternative requirement, proposed to the Consultation Forum in July 2017 satisfied manufacturers, but recycling and repair industry associations, and NGOs were critical (see Annex 2 and Annex 5.1).

Recyclers would also like to see a requirement for a minimum amount of recycled plastics in new products, although this would complicate compliance control by Member States. The Open Public Consultation (OPC) showed that 67% of respondents preferring a display with a standardised EPS and 63% considering it important to have it indicated on the energy label (as an indicator of durability/reparability).

The latest draft working document presented to the Ecodesign Consultation Forum in 2017 contained a proposal for marking and detailed information requirements regarding type and quantity of the flame retardants. This proposal met with criticism regarding the administrative burden for industry and market surveillance authorities. It was also questioned whether recyclers would really act on the availability of this type of information. On the other hand, recyclers and NGOs were in favour of a total ban of at least halogenated flame retardants, as any plastic containing any type of halogenated substance (mostly bromine compounds) is currently incinerated because separation of allowed additives from non-allowed ones is economically unsustainable.

5.2.3. Option 3 - Ambitious

Option 3 includes the same measures as option 2 but with an extension of the scope of Energy Labelling to include signage displays, and restricting the use of halogenated flame retardants in the enclosure and stand.

Inclusion of signage displays in the energy label

Most signage displays consume on average 2.5 times more energy than a television of the same size[98] and it is a rapidly growing market. While setting minimum efficiency requirements under ecodesign would be premature, their inclusion in the energy label would allow customers of these displays to be informed about their efficiency and be able to compare their performance. Labelling of signage displays, moreover, would be a useful, reliable and efficient tool in public procurement, in view of Directive 2012/27/EU, Annex III.(a) which requires Member State governments to procure only products in the highest efficiency classes of the energy label.

[96] Association of the European adhesive and sealant industry, http://www.feica.eu

[97] An earlier version of the ecodesign proposal was notified to the WTO with comments from South Korea, the USA and Japan.

[98] As a consequence of the high luminance such as 500 to 700 cd/m² for indoor versions, compared to 300-350 cd/m² of a domestic TV

The energy label for signage displays would be similar to the one for televisions and computer monitors. The EEI is adapted to take into account the higher luminance of signage displays, through a correction factor for peak luminance applied to the EEI formula.

Phasing out halogenated flame retardants

This option involves restricting the use of any HFRs in the display-casings and stands by April 2020, while maintaining the requirement to document the presence of any type of flame retardant as per the ECO option.

This has become feasible since, by June 2019 (i.e. almost one year before the proposed application date), a new safety standard EN 62386-1:2014 will supersede the old standards in the EU, thereby removing the 'candle' test. As a result, restricting the use of at least halogenated flame retardants in the casings and stands should be feasible for manufacturers. In fact, several display manufacturers are already making the switch to non-HFR such as phosphorous, inorganic and nitrogen-based flame retardants. Some display manufacturers claim that all brominated flame retardants were eliminated already a long time ago, not only from the enclosure and stand, but even from connectors, circuit boards and other internal components[99].

Stakeholder views: Throughout the consultation process, several Member States and NGOs advocated for the inclusion of signage displays in the scope of the Regulations (see Annex 5). Manufacturers never expressed "a priori" opposition but argued for specific tests and requirements, possibly adapted from televisions and monitors.

Many stakeholders in the Consultation Forum in 2012 (Annex 5.3) already solicited the Commission to introduce "non-energy" requirements and signalled in particular that the use of certain flame retardants was hindering recycling. However, some product manufactures and the representatives of producers of halogenated flame retardants (FRE) consider that RoHS or REACH legislation may be more appropriate for restricting the use of certain substances[100].

In the Consultation Forum of 2014 (Annex 5.2), the proposed resource efficiency requirements were supported by an overwhelming majority of stakeholders. However, some specific requirements, such as time limits as an indicator for compliance of dismantle-ability, were criticised by industry representatives as being overly prescriptive.

5.2.4. Option 4 - Lenient

Option 4 includes the same measures as option 2 but with a more lenient minimum energy efficiency requirement under ecodesign for UHD/HDR displays by allowing for a 50% higher on-mode consumption. In the Eco and in the Ambi options only 20% is foreseen[101] and no limit is set for HDR displays.

Stakeholder views: Several major manufacturers strongly requested a 50% allowance since the consultation forum meeting in 2014, to avoid stifling innovation and depriving

[99] E.g. https://www.apple.com/lae/environment/safer-materials/

[100] It should be noted that Directive 2011/65/EU (the RoHS directive) mentions that the Ecodesign Directive should enable "specific ecodesign requirements to be set for energy-related products which may also be covered by this Directive. Directive 2009/125/EC and the implementing measures adopted pursuant to it are without prejudice to Union waste management legislation" (recital 13).

[101] For many models the difference between equivalent UHD and HD is up to 20% (see VHK database)

consumers from the latest technology. On the contrary, NGOs and some Member States have supported an ambition level comparable or even higher than the ECO option.

Throughout the consultation process, most of the Asian manufacturers have requested generous energy allowances for every new feature that came on the market, such as a 50% bonus for 3D-TVs and a bonus of 50% for UHD-4K resolution compared to HD. Data analysis on the displays of 2016 and of end 2017, however, shows a clear trend to a power use for UHD resolution closer and closer to HD.

5.3. Option discarded at an early stage: Voluntary agreement by the industry

A voluntary agreement has to be given priority according to the Ecodesign Framework Directive, provided it meets the objectives in a quicker and more cost-effective manner. Today minimum mandatory requirements are already in force. Since no proposal has been put forward by industry, there is no voluntary agreement that meet the conditions of the Ecodesign Directive. As a consequence, this option is discarded from further analysis. When substituting mandatory requirements by a voluntary agreement there would be a risk of free riders[102], in case not all actors present on the market would sign such an agreement and comply with it.

Stakeholder views: None of the stakeholders is in favour of voluntary agreements for the reasons set out above.

5. WHAT ARE THE IMPACTS OF THE POLICY OPTIONS?

The options for further analysis include BAU, ECO, Ambitious (Ambi) and Lenient (Leni) scenarios as described above.

6.1. Methodology and key assumptions

The latest draft working document presented to the Ecodesign sources. Digital Europe delivered in 2012, 2014 and in 2016 datasets of televisions, computer monitors and some signage display models (600 or more models). Other databases, including 2017 models, established by CLASP, VHK and Intertek were used as well. For more information, please see Annex 13, which also contains the outcome of an Intertek measurement test for the Commission on computer displays.

Employment impacts are derived from revenue per employee, checked against reported revenue totals for the sector and information from annual reports of individual manufacturers.

In this Impact Assessment, in line with the MEErP[103], energy prices were assessed from Eurostat data and for future projections an escalation rate of 4% was used, together with a sensitivity analysis based on the most recent PRIMES rates (0.95% escalation rate from 2020). All prices and costs are expressed in Euro 2010, calculated with historical inflation. For investment-type considerations, a discount rate of 4% is used, in line with the Commission's recommended values (see guidelines in the Better Regulation Toolbox).

[102] A free-rider problem occurs when those who benefit from resources, goods, or services do not pay for them, which results in an under provision of those goods or services. (Baumol, William (1952). Welfare Economics and the Theory of the State. Cambridge, MA: Harvard University Press.)

[103] See annex 7 for detailed explanations on the model used.

For primary energy conversion rates for electricity generation and distribution, a Primary Energy Factor (PEF) of 2.5 is used, implying, by convention, a 40% efficiency over the full projection period. For GHG emissions, the emission rate (in kg CO_2 eq./kWh) varies over the projection period in line with overall EU projections as indicated in the MEErP. More details of the modelling can be found in Annex 4.

Figure 16 illustrates the expected trend in energy labelling under the ECO-scenario (only TVs and monitors in the scope). Under the Lenient scenario (with a credit of 1.5 instead of 1.2 for UHD/HDR) the lower classes will include more products (as more products are allowed on the market under Ecodesign). In the Ambitious scenario, where inefficient signage displays are in the scope, it is also expected that the lower energy label classes will be more populated.

This projection assumes a progression of 7.5% per annum improvement in energy efficiency – thus, each model in the 2018 database is improved by 7.5 % for 2019, and a further 7.5 % for 2020 and so-on. This rate of technology progression matches the levels observed in the market from 2011 through 2017 and also takes into account some new technology being introduced to televisions including quantum dots and logical pixels. Moreover, it assumes that half the models in the database adopt Automatic Brightness Control, which offers a power allowance of 15 %.

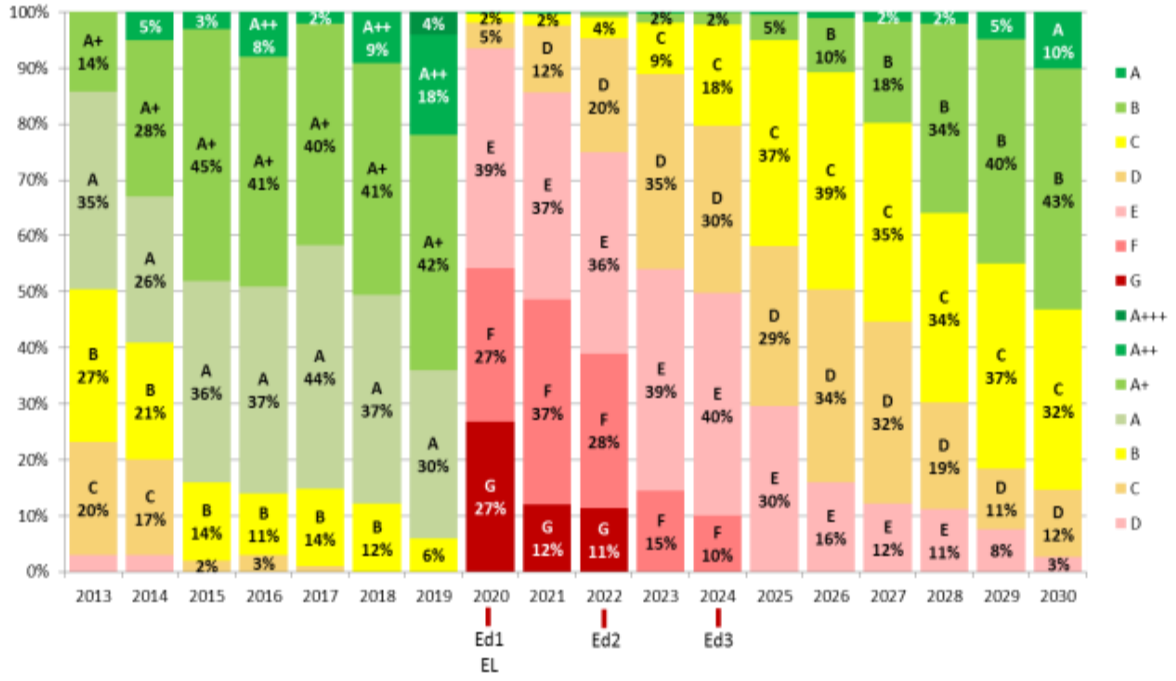

Figure 16: Energy label class distribution of standard electronic display models available in the EU over the period 2010-2030 (actual 2013-2016 and projections 2017-2030) with proposed Ecodesign and Energy Labelling measures.

It has to be noted that there are considerable uncertainties in future projections for this highly 'volatile' product group and consumption and savings estimates should be conceived as ranges within a certain bandwidth.

No direct relation appears to exist between retail prices and the level of energy efficiency. Topten analysed this specific aspect on television models, using sales data from GfK[104]: Figure 17 shows that, whilst there is a clear correlation between screen size and cost, there

[104] European TV market 2007 – 2012 Energy efficiency before and during the implementation of the Ecodesign and Energy Labelling regulation. TopTen, October 2013. The study can be found at: http://www.topten.eu/uploads/File/European_TV_market_2007%E2%80%932013_July14.pdf

is no clear relation between energy class and cost (e.g. the A++ class has an average cost lower than A+ and A and close to B). Moreover, as explained further, the formulas for calculating the energy class in the current regulation are advantageous for the biggest displays, thus the highest classes tend to be more populated with bigger displays.

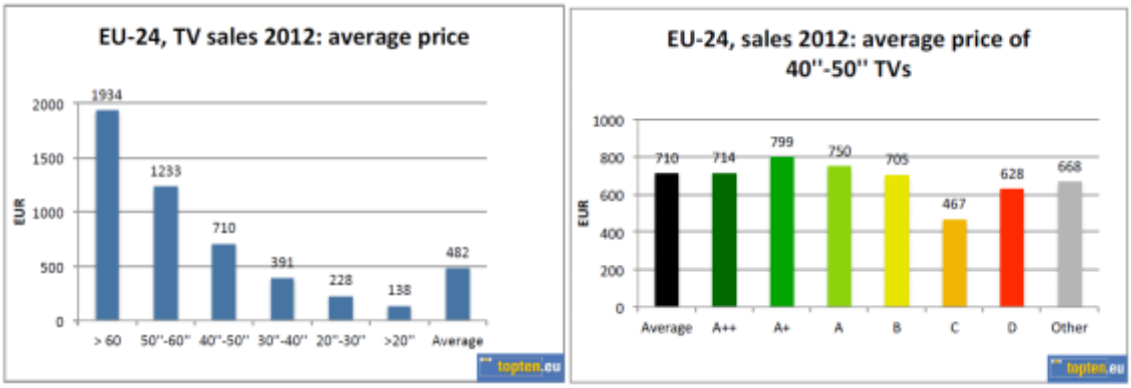

Figure 17: TV average retail price according to display size and to energy classe for 40-50 inch television displays (source: Topten on GfK data for 2012).

6.2. Environmental Impact

6.2.1. Electricity savings

Figure 18 shows the development of EU energy consumption of electronic displays under the different scenarios. The graph indicates that:

- In 2020, the BAU-scenario predicts 94 TWh/yr electricity consumption, equivalent to the 2016 final electricity consumption of Belgium.
- In 2030, the BAU scenario is estimated to result in 4 TWh/yr additional electricity consumption due to the lack of updated energy efficiency requirements, while the size and number of televisions keeps rising.
- The ECO scenario gives 24 TWh/yr additional savings in 2030 with respect to the BAU (equivalent to Irish final electricity consumption in 2013), while the Lenient scenario ('Leni', green line) saves 16 TWh/yr in 2030.
- The 'Ambi' scenario combines the ECO scenario with labelling for signage displays[105], which will save an additional 15 TWh/yr in 2030. In total, the saving of the 'Ambi' scenario is estimated to be 39 TWh/yr in 2030.

[105] No eco-design requirements for on-mode would be set, as minimum standards may possibly block new products coming to market over the coming years.

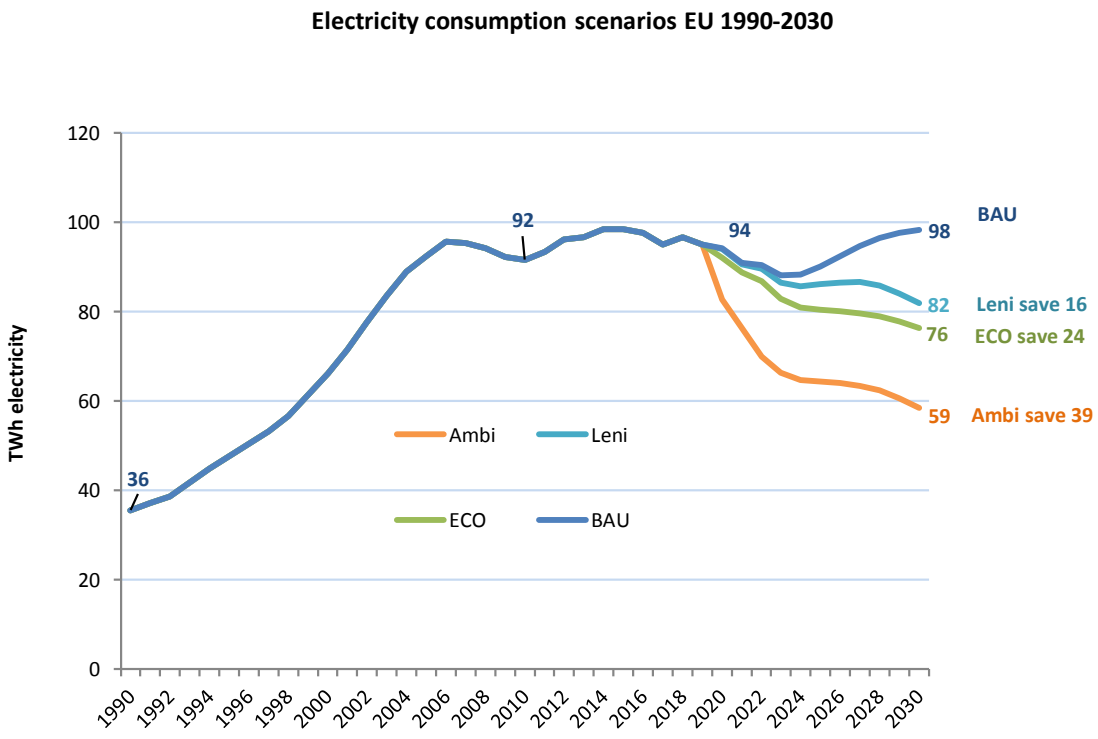

Figure 18: Energy consumption scenarios 1990-2030 electronic displays

The significant savings in all scenarios are driven by technology improvements, underpinned by the proposed measures, which counteract the increase in energy consumption in the BAU scenario. In the BAU scenario, the energy consumption of electronic displays will start to go up after around 2024 because of diminishing efficiency improvements and continued increase of the number of signage displays on the market.

Stakeholder views: Already since the second of the four Ecodesign Consultation forums (2012), there was a consensus among all stakeholders on the need of reviewing the Ecodesign Regulation, because the technology progress had been quicker than expected and some further adaptations would be cost effective, such as scope extension to computer monitors and signage displays.

In 2014, stakeholders requested to delay the review of the Labelling measure until after the revision of the framework Directive. The third Consultation forum in 2017 further confirmed the need to come forward quickly with revised Ecodesign and Labelling regulations, and confirmed the need to address signage displays.

Manufacturers always advocated for less strict requirements for UHD and for the exclusion of new technologies from Ecodesign, such as OLED and HDR. They also requested a different energy efficiency index and other specific requirements for signage displays, such as the removal of the "auto power down" requirement.

6.2.2. Greenhouse Gas Emissions

The trends in scenarios for greenhouse gas (GHG) emissions are similar to the energy consumption trends. The main difference is that the absolute savings over time are higher, as the energy scenarios use, by convention, a fixed power generation and distribution efficiency of 40 %, whereas for the projections of the GHG-emissions the changes in carbon-intensity of electric power generation are taken into account. As a result, figure 19 shows that by 2030 (compared to 2015):

- the BAU scenario gives a saving of 7 Mt CO_2 eq.;
- the ECO scenario saves an additional 7 Mt compared to BAU;
- the Ambitious scenario saves 13 Mt more than BAU; and
- the Lenient scenario gives an extra 5 Mt savings with respect to BAU.

Stakeholder views: Stakeholders never raised specific views on GHG emissions as they are closely linked to the energy requirements (see above). However, manufacturers have sometimes voiced the concern that, as improvements in the use-phase are increasing the relative importance of energy consumption and emissions during the manufacturing stage, where certain greenhouse gases are used[106].

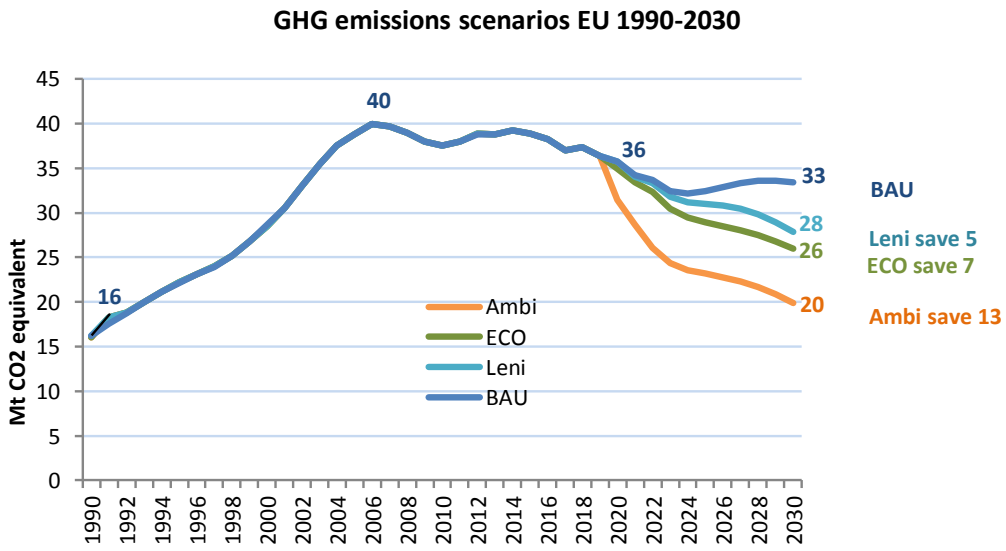

Figure 19: EU greenhouse gas over the period 2005-2030, in Mt CO2 equivalent, for various scenarios

6.2.3. Circular Economy perspective

The environmental life-cycle assessments in the technical review studies show that energy consumption and the related emissions, especially GHG emissions, are dominant environmental impacts for this product category.

Televisions and monitors are subject to the WEEE-directive. From August 2018, the recovery rate for these products must be 85 % with at least 80 % recycled. To facilitate recycling, the removability of key components as per Article 8(2) of the WEEE Directive is important.

Presence of (in particular halogenated) flame retardants in plastics is the main barrier to plastics recycling. Through the measures proposed in all scenarios it is estimated that an additional 76 kt plastics could be recycled instead of being incinerated. These measures would also prevent the introduction of 20 kt/year of halogenated flame retardants on the market.

[106] During manufacturing certain cleaning agents are used, such as Nitrogen Trifluoride and Sulfur Hexafluoride with a global warming potential (GWP) of over respectively 17200 and 24000 the GWP of CO_2. Mitigation of the use of compounds with high GWP or regulating the energy use in the production phase cannot be tackled for display panels as production is not in Europe and compliance control is not feasible.

Halogenated compounds degrade into dioxin derivatives, particularly when heated, such as during production, recycling or even exposure to sun. Electronic waste is often melted to recycle the metal components and such heating can generate toxic dioxins and furans. Poor-quality incineration, similarly, releases high quantities of toxic degradation products. Consequently, recycling can contaminate workers and communities near recycling plants. In humans, HFRs have been shown to cause reproductive abnormalities, diabetes, thyroid dysregulation, cognitive changes and undescended testicles in new-born boys (see also Annex 15).

There is no administrative burden for industry and distributors and a limited burden (laboratory spot-checks but no paper trails to check) for surveillance authorities.

Stakeholder views: Already since the Consultation Forum of 2012 (Annex 5.3), Member States and NGOs required the inclusion of circular economy requirements. The recycling industry argued that gluing and welding pose problems for the recycling process for the safety of workers, the environment and the increased contamination of the waste stream, particularly PMMA[107] boards (see e.g. EURIC position, Annex 5.1). At the same time, the chemical industry claimed that research is ongoing for more compatible glue compositions making depollution and de-bonding possible.

Recyclers and NGOs also systematically requested a ban of flame retardants, or at least of halogenated ones (Annex 5.1 and 5.2), while manufacturers claimed that this may involve the redesign of some products.

6.3. Business impacts

6.3.1. Business revenue

As mentioned before there is no demonstrated correlation between energy efficiency and the price of the displays[108]. In other words, there is no rational basis for establishing whether the prices and thereby business revenues and jobs will be different from Business-as-Usual (BAU) in the various policy scenarios. For the BAU we will assume the price (EUR 448/unit for a TV) and sales established in Annex 6.

'Business impacts' is a part of the Impact Assessment report that should give the impact of policy options on the European industry. As mentioned, there are no longer any European TV-panel manufacturers[109]. There is a 'business impact' of the measures from lower energy costs of operating signage displays for companies and institutions (shops, schools, public transport). This is taken into account in the consumer expenditure section hereafter.

As mentioned in section 2.5, another 'business impact' comes from recyclers who are a party most interested in the phasing out of halogenated flame retardants, better disassembly, etc. In addition, the 5000-10,000 persons estimated to be involved in display repair will benefit from better disassembly and repair information.

[107] PolyMethylMethAcrylate

[108] The production cost of displays is largely determined by a few components like screen panels, backlight units (BLUs) and electronics (e.g. video boards). Screen panels are produced by only a dozen manufacturing plants, mostly in mainland China. The screen cost increases with the area. Backlight units are also an area of strong global competition. Video boards are electronics and thus 'governed' by Moore's Law (every 2 years the number of 'transistors' is doubled, at the same price, same size and half the energy consumption). Furthermore, the production costs determine only a part of the market price as marketing strategies play the major role and determine large price differences for similar products between the US, China, India and Europe.

[109] Philips was the last one but gave up its share in a joint venture with the Taiwanese TPV

6.3.2. Innovation, Research and Development, Competitiveness and Trade

There is no EU industry for display panels nor, given the huge investment needed to set up a manufacturing plant and the current market situation[110], is it likely that it will develop in the near future. Hence, although an EU university or research institute might get an occasional assignment from an Asian industry to work in a related field, there is no relevant Research and Development in the field of display-technology in the EU. In short, most innovation in this sector will come from Asia. The EU is still an attractive market of 500 million relatively wealthy consumers. Setting ambitious mandatory minimum Ecodesign requirements, combined with a stimulating Energy Label scheme, will positively influence innovation.

Improving the potential yields of usable recycled material will encourage the development of technologies to treat properly waste from electronic displays, possibly in larger scale plants.

Trade data lack accuracy because the Asian display panels enter and leave the EU through various routes and in various forms (as an entire product, or just the display panel). All display panels and 80% of other components are imported.

6.3.3. Compliance costs

Ecodesign and energy label requirements for televisions and displays in the scope have had a strong influence on the market and have been in existence for almost 10 years.

Research and development as well as production investments are common practice in this innovative and dynamic sector. Redesign would happen with or without new measures. Any potential extra cost is expected to be absorbed by the industry. With or without the measures, manufacturers will be obliged to test their products according to the new test method, to compete on the global market. Therefore, costs from testing according to the new standard will be the same for all options.

6.3.4. Intellectual property rights

The technologies considered in all scenarios are commonly available to all major manufacturers and, as confirmed by stakeholders, the measures do not impose proprietary technologies.

6.3.5. Stranded investments

In the case of electronic displays, stranded investments may arise in Asia but not in the EU since there is no production. Stakeholders did not raise the issue.

6.4. Consumer expenditure

Consumer expenditure consists of acquisition costs, maintenance/repairs and running costs. In this case, where repair costs are modest (estimated in the order of EUR 0.5 bn/year), they are assumed to be included in the acquisition costs. The running costs consist thus only of energy costs.

[110] Building a display-panel manufacturing plant requires an investment of ca. €10bn. This is comparable to the investment in a nuclear power plant. Unless the EU wants to follow the US example and give a €3bn subsidy to one Taiwanese company to build a €10bn plant on its soil, it is unlike to have that manufacturing again in the EU. Further, the unit sales for electronic displays are declining, so there is also no commercial incentive for such an investment.

As explained before, it is not possible to differentiate between acquisition costs per unit in the various scenarios. The only acquisition cost differentiation is between a scenario including signage displays and a scenario excluding signage displays and in the difference in unit sales for these two scenarios. The average price of a signage display is set at twice the price of a normal television, because it is twice the average surface area and generally used in a more demanding environment (e.g. high ambient lighting, outdoors).

In 2020, the acquisition costs excluding signage displays in the EU are calculated at EUR 25.8 bn, of which standard TVs make up EUR 5.9 bn, smart TVs EUR 17.6 bn and monitors EUR 2.4 bn (all incl. VAT). Including signage displays, at acquisition costs of EUR 3.6 bn (excl. VAT[111]), the total acquisition costs are EUR 29.4 bn.

In the same year, the total energy costs are EUR 17.7bn excluding signage displays and EUR 23.5 bn including signage displays. For signage displays the nominal energy costs and acquisition costs add up to EUR 9.4 bn. For TVs and monitors, the sum of energy and acquisition costs is EUR 43.5 bn, of which the energy costs are around 35 %. Including also signage displays, the total becomes EUR 52.8 bn in 2020 as shown in

Table 5: Estimated costs of electronic displays in 2020

In EUR billion	Acquisition costs	Energy costs	Acquisition and Energy costs
TVs and monitors	25,8	17,7	43,5
Signage displays	3,6	5,8	9,4
Total	29,4	23,5	52,8

.

Table 5: Estimated costs of electronic displays in 2020

In EUR billion	Acquisition costs	Energy costs	Acquisition and Energy costs
TVs and monitors	25,8	17,7	43,5
Signage displays	3,6	5,8	9,4
Total	29,4	23,5	52,8

In accordance with the MEErP methodology, the escalation rate for the electricity price is 4 %. Inflation – to arrive at euros 2010 – follows historical tariffs as available and 2 %/yr thereafter. Figure 20 shows that the ECO scenario will save the consumer EUR 8 bn/yr in 2030 compared to BAU. The Lenient scenario will save EUR 6 bn/yr. When including signage displays, it is assumed that the 'Ambi' scenario would add another EUR 10 bn/yr savings to the ECO scenario and thus result in a total saving of EUR 18 bn.

[111] Signage displays are a B2B market, meaning the consumers can recuperate VAT; VAT is thus not included.

Figure 20: Consumer expenditure scenarios 1990-2030 (in fixed euros 2010).

6.4.1. Sensitivity analysis

The consumer expenditure above has been calculated according to the MEErP with an escalation rate, i.e. a price increase above inflation, of 4 %. This means for instance for 2030 a household electricity tariff of EUR 0.36/kWh (in Euro 2010). Recent PRIMES scenarios use a considerably lower tariff, which on average results in an escalation rate of 1.5 %. This means a tariff of EUR 0.24/kWh (in Euro 2010) for 2030.

The sensitivity analysis presented in the table below gives the consumer expenditure and energy costs at this lower tariff, in order to validate whether this would make the scenarios uneconomical for consumers. The costs are given per year (2015-2040) and accumulative over the periods 2021-2030 and 2021-2040.

Table 6. Scenario results with electricity tariff escalation rate 1.5%(from 2015) instead of 4%

Consumer expenditure (in bn Euros 2010)	per year					accumulative	
	2015	**2020**	**2025**	**2030**	**2040**	**'21-30**	**'21-40**
BAU	43	50	53	61	65	542	1176
ECO	43	50	52	57	58	527	1097
Lenient	43	49	51	55	58	515	1078
Ambi	43	47	47	51	52	478	988
Energy costs (in bn Euros 2010)							
	2015	**2020**	**2025**	**2030**	**2040**	**'21-30**	**'21-40**
BAU	19	20	20	24	28	212	475
ECO	19	20	19	20	21	197	397
Lenient	19	19	18	19	21	185	377
Ambi	19	17	15	14	15	148	288

The most important outcome is, although monetary savings are of course lower than at an escalation rate of 4 %, the energy costs are still a substantial part of life cycle costs and savings are worthwhile in all scenarios.

6.5. Administrative burden

In the impact assessment prepared in view of the revision of the Energy Labelling framework Regulation[112] the administrative burden of the new measures under that regulation was calculated. Table 7 summarizes those costs for the product group of electronic displays.

For Ecodesign measures, the above-mentioned impact assessment study considers that there is no additional administrative burden for industry, because there is a vested commercial interest[113]. More details can be found in Annex 12.

Table 7: Administrative burden in '000 euros

Administrative burden	**one-off**	**annual**	**BAU**
For the first 6 months provide a second label and supply extra labels on request to dealers	3300		-
Dealers re-labelling around 2.5% of products on stock/display or on the internet.	600		-
Database, supplier costs		90	-
Database, EU budget	90	9	-
Joint support actions, EU budget (e.g. EEPLIANT)		33	x
Support joint surveillance actions (Horizon2020)		60	x
External laboratory costs (SMEs)		66	x
Market surveillance, Member State costs		330	x
Total business-as-usual (BAU)	**-**	**489**	
Total new costs of measures	**3990**	**99**	
of which			
- Supplier budget	*3300*	*90*	
- Dealer budget	*600*	*-*	
- EU budget	*90*	*9*	

Stakeholder views: No issue was raised regarding affordability.

6.6. Social Impact

6.6.1. Affordability

As mentioned before, there is no direct relation between the energy efficiency level of electronic displays and their retail price. Moreover, the new technologies generally bring – after the first introduction period – both an energy efficiency increase and a price decrease. In that sense, no negative impact on affordability is expected.

Stakeholder views: No issue was raised regarding affordability.

6.6.2. Health, Safety and Functionality Aspects

There are no known negative impacts from using more efficient appliances as prescribed by the policy options. Reduced/no use of flame retardants, some of which are toxic, would be beneficial for workers in WEEE plants (for further details see section 6.2.3).

[112] SWD(2015)/319 final, European Commission, 15.7.2015, Brussels.

[113] Industry associations recently issued a Joint Position Paper on implementation aspects of the database http://www.ceced.eu/dam/site-ceced/PUBLIC-WEBSITE-ASSETS/MEDIA-RESOURCES/Position-Papers/2017/2017---11---Joint-Industry-Position-Paper-on-EPREL/2017%20-%2011%20-%20Joint%20Industry%20Position%20Paper%20on%20EPREL.pdf

6.6.3. Employment

No significant impact of the proposed measures on EU employment is expected. No product price increase is expected due to higher efficiency. The measures to improve resources efficiency have mostly neutral or positive business impacts.

Stakeholder views: No issue was raised regarding employment.

6.6.4. SMEs

As mentioned in section 2.5, no independent SMEs working in the production chain of electronic displays could be identified[114]. SME retailers do exist, but it is not expected that the specific measures proposed here will have a significant impact on them. The 5,000 to 10,000 SME repair shops will benefit from better repair information and easier disassembly. Likewise, SME recyclers will benefit, in the long term, from the elimination of HFR for non-electric components and from measures for easier disassembly.

6. HOW DO THE OPTIONS COMPARE?

7.1. Summary of the impacts

Tables 8 and 9 summarise the impacts described in Section 6. **Option 1** – baseline – does not contribute to any of the objectives. **Option 2** – ECO – contributes to all objectives but does not achieve as many cost effective energy savings as option 3. **Option 4** – lenient – only contributes to two out of three specific objectives (does not achieve cost effective energy savings) and it is therefore not seen as an appropriate policy option. **Option 3** – Ambitious – contributes to all three objectives and achieves most cost-effective energy savings. Therefore, **Option 3** is the preferred option.

Table 8. Overview main annual impacts of the policy options

Impact (unit)	2020	2030				2040			
	absolute	absolute	increment			absolute	increment		
	BAU	BAU	Leni	ECO	Ambi	BAU	Leni	ECO	Ambi
On-mode specific power stock (W/dm²)	**1,82**	**1,20**	-0,31	-0,50	-0,58	**0,83**	-0,28	-0,40	-0,45
Electricity consumption (in TWh/yr)	**94**	**98**	-16	-22	-40	**98**	-22	-25	-45
GHG emissions (in Mt CO2 eq./a)	**33**	**28**	-6	-7	-14	**29**	-7	-7	-13
Material resources inputs (in kt) [1]	**770**	**1185**	0	0	0	**1438**	0	0	0
Waste collected (in kt, 10yr post-input) [2]	**700**	**700**	0	0	0	**1066**	0	0	0
Waste recycled/reuse/recovered [3]	**595**	**595**	76	76	84	**906**	126	126	140
Acquisition costs (in €bn)	**29**	**36**	0	0	0	**37**	0	0	0
Energy costs (in €bn)	**23**	**36**	-6	-8	-15	**53**	-12	-13	-24
Consumer expenditure (in €bn)	**50**	**73**	-6	-8	-15	**90**	-12	-13	-24
EU Industry revenue (in €bn)	**1**	**1**	0	0	0	**1**	0	0	0
Importers revenue (in €bn)	**14**	**17**	0	0	0	**18**	0	0	0
Retail revenue (in €bn)	**10**	**12**	0	0	0	**12**	0	0	0
Total business revenue (in €bn)	**25**	**31**	0	0	0	**31**	0	0	0
Employment (in '000' jobs, mainly retail)	**224**	**272**	0	0	0	**275**	0	0	0

[1] Sales x weight. TV sales in 2020/'30/'40 was 52/69/70 m units at weight of 12/15/18kg per unit. Monitor weight in those years was 5/6/7 kg, always at 10 m unit sales. Signage display sales was 4/3/3 m units at product weight 24/30/36 kg.

[2] 90% of materials input 10 years before (trend in WEEE statistics)

[114] Metz GmbH, Bang&Olufsen and Loewe, EU display manufacturers, do not qualify as SMEs.

[3] In BAU, recovery rate is 85% of collected waste (80% recycled) ; in policy scenarios without halogenated flame retardants and optimal disassembly some 76 kt plastics could be recycled extra (theoretical maximum at 100% and c.p.).

Table 9. Overview main accumulative impacts of the policy options

Impact (unit)	2021-2030				2021-2040			
	absolute	increment			absolute	increment		
	BAU	Leni	ECO	Ambi	BAU	Leni	ECO	Ambi
EU electricity consumption (in TWh/yr)	**927**	-64	-115	-277	**1922**	-303	-385	-744
EU GHG emissions (in Mt CO2 eq./a)	**332**	-22	-40	-98	**648**	-98	-126	-247
Consumer expenditure (in €bn)	**619**	-22	-38	-89	**1448**	-132	-162	-304
Energy costs (in €bn)	**289**	-22	-38	-89	**615**	-132	-162	-304
Acquisition costs (in €bn, incl. VAT)	**325**	0	0	0	**691**	0	0	0
Industry revenue (in €bn)	**10**	0	0	0	**20**	0	0	0
Wholesale revenue (in €bn)	**158**	0	0	0	**166**	0	0	0
Retail revenue (in €bn)	**112**	0	0	0	**124**	0	0	0
Total revenue (in €bn)	**280**	0	0	0	**310**	0	0	0

7.2. Market Surveillance

All proposed policy options would be subject to Article 15(8) of the Ecodesign Framework Directive, as well as Article 8(1) and (3) of Energy Labelling Framework Regulation, which requires that market surveillance authorities can verify the conformity of a product with all regulatory requirements.

The ComplianTV project[115] has shown that current compliance level for this product group is good and would be further improved under the Ambi scenario.

The cost for market surveillance is lowest for the baseline because in this case there would not be a new energy label. The cost for surveillance of the other options would be the same, i.e. as indicated in section 6.4. The extension of the Energy Label scope in the Ambi scenario will add to surveillance costs, but the new Energy Label database will contribute in lowering surveillance costs.

Stakeholder views: DigitalEurope have emphasised the importance of securing a sufficient level of market surveillance to ensure that only compliant products are placed on the market. In this respect, they call for increased enforcement by MSAs.

7.3. Assessment in view of Article 15(5)

According to Article 15 of the Ecodesign Directive, each policy option should not have a significant negative impact. Qualitative aspects discussed across Section 6 are summarised in Table 10 below.

Table 9: Evaluation of policy option impacts compared to the baseline

Significant impacts as stipulated in Article 15 of the Ecodesign Directive	**BAU**	**ECO**	**Ambi**	**Leni**

[115] A joint market surveillance project funded by the European Commission that checked compliance of televisions on the EU market. For more information see: www.compliantv.eu

No significant negative impacts on the functionality of the product from the perspective of the user (section 6.4.1)	✓	✓	✓	✓
Health, safety and the environment shall not be adversely affected (section 6.6.2)	✓	✓	✓	✓
No significant negative impact on consumers in particular as regards affordability and life-cycle costs (section 6.6.1)	✓	✓	✓	✓
No significant negative impacts on industry's competitiveness (section 6.3)	✓	✓	✓	✓
Setting of an ecodesign requirement shall not have the consequence of imposing proprietary technology on manufacturers (section 6.3.4)	✓	✓	✓	✓
Impose no excessive administrative burden on manufacturers (section 6.5)	✓	✓	✓	✓

All options fulfil the criteria of Article 15(5).

Pursuant to Article 16(2) of the Energy labelling Framework Regulation, future implementing measures should fulfil a number of criteria (see Section 3.1). The criteria are fulfilled, namely:

- The product group has significant potential for saving energy;
- The proposed bands of the energy label will differentiate among displays (see section 6.1), which are today all concentrated in the top classes;
- There is no negative impact on affordability, as shown in Section 6.6.1 and Table 9;

All options with the new energy label fulfil the criteria of Article 16(2).

7.4. Assessment in view of the objectives

The qualitative evaluation according to the objectives presented in Section 4, on the basis of Tables 8 and 9, is shown in Table 10.

Table 10: Score of impacts against objectives (see section 4).

General Objectives	**BAU**	**ECO**	**Ambi**	**Leni**
1. Ensure free circulation of efficient products within the internal market;	0	+	+	+
2. Promote competitiveness of the electronic display industry through the creation or expansion of the EU internal market for sustainable products;	0	0	0	0
3. Promote the energy efficiency of electronic displays as contribution to the EU's objective to reduce energy consumption by 30 % and domestic GHG emissions by 40 % by 2030;	0	+	++	0/+
4. Increase the security of energy supply in the Union through a reduction in energy consumption of electronic displays	0	+	++	0/+
Specific Objectives				
1. Update the energy efficiency requirements and the energy label in line with international and technical developments;	0	+	++	0/+
2. Redefine the scope to close loopholes, remove ambiguities	0	++	++	++
3. Contribute towards a circular economy	0	+	++	+

No Change (0), slight improvement (0/+), limited improvement (+), significant improvement (++).

Option 1 – BAU does not contribute to any of the specific objectives.

Option 2 – ECO is a balanced option for televisions and computer monitors that also takes into account circular economy aspects. However, it does not take into account the rapidly

growing market of signage displays and there is thus a risk that the energy savings from televisions and computer monitors will be overshadowed by an uncontrolled increase of energy consumption of signage displays.

Option 3 – Ambi builds on the ECO scenario, but the scope is extended to include signage displays, which are estimated to become a major energy consumer in the near future and could constitute a major loophole for television and computer monitors if not regulated. In addition, it contributes most to circular economy objectives through the restriction on the use of halogenated flame retardants in relevant parts of displays.

Option 4 - Leni has the least savings and thus contributes the least to the energy efficiency-related objectives.

7. PREFERRED OPTION

8.1. Preferred option – Why?

Option 3 - Ambitious fulfils the criteria in Article 15(5) of the Ecodesign Regulation and Article 16(2) of the Energy Labelling Regulation (see Section 3.1) and will achieve the objectives as set out in Section 3 in the best way.

Building on option 2, option 3 brings the most savings and, in terms of avoiding loopholes, is the most robust. Therefore, it is considered the preferred option and results in the following overall net savings and impacts versus the BAU option in 2030:

- Electricity savings of 39 TWh/yr and GHG emission abatement of 13 $MtCO_2eq/yr$, i.e. 2.66 % of the Commission's 2030 target for final energy consumption savings (30%) and 1.22 % of the Commission's 2030 target for GHG-emissions savings (40%);
- Savings on annual end-user expenditure of EUR 15 bn;
- Additional 84 kt of plastics could be recycled instead of being incinerated. 20 kt/year of halogenated flame retardants would not enter the EU market.
- Scope and ambition level aligned with technological progress and global minimum energy efficiency requirements in other economies.

With respect to signage displays, the fact that this option does not include minimum on-mode efficiency requirements means that there will only be limited impact on compliance cost (i.e. only for product testing but not for redesign or production).

8.2. REFIT (simplification and improved efficiency)

This section describes how the preferred option is expected to improve the efficiency of the existing measures.

Given that there is no relation between increased efficiency and product price (see section 5.2.2), it is assumed that industry, wholesale and retail revenue will not be effected by the measure. While there will be cost for industry to comply with the revised ecodesign and energy labelling requirements, the absence of a link between price and increased energy efficiency implies that those costs are absorbed as part of the normal competition pressure in this market. This also means that acquisition cost for consumers are assumed to remain the same, and that the energy cost is the only cost driving consumer expenditure as compared to the baseline. Table 11 gives an overview of the increment in cost and as compared to the baseline.

Table 11: Increment in costs, revenue and administrative burden

	Implementation date	2030	2040	Comment
Acquisition costs (EUR million)		0	0	No correlation between acquisition cost and efficiency could be identified. Energy costs decrease.
Energy costs (EUR million)		6 000	10 000	
Consumer expenditure (EUR million)		6 000	10 000	
Industry revenue (EUR million)		0	0	There is no increase in revenue for industry, wholesale and retail related to the proposed measure
Wholesale revenue (EUR million))		0	0	
Retail revenue (EUR million)		0	0	
Administrative burden dealers (EUR million)	0.6			The increase in administrative cost is due to the introduction of the rescaled energy label and the database requirements
Administrative burden suppliers (EUR million)	3.9	0.09	0.09	
Administrative burden EU (EUR million)	0.09	0.009	0.009	

The administrative burden for dealers and suppliers is related to the introduction of the rescaled energy label imposed by the new Energy Labelling framework Regulation.

8. HOW WILL ACTUAL IMPACTS BE MONITORED AND EVALUATED?

The main monitoring element will be the tests carried out to verify compliance with the ecodesign and energy labelling requirements. This monitoring should be done by MS market surveillance authorities to ensure that requirements are met.

The main indicator for evaluating the impact of potential ecodesign and energy labelling regulations is the achievement of a market improvement towards electronic displays with a smaller environmental impact.

For products subject to energy labelling, the main tool to monitor this indicator is the product registration database[116] that will show the progress of products placed on the market towards the highest classes.

An analysis of the products on the market (sales figures, performance, etc.) will determine if the shift towards more resource efficient products has happened as estimated, in particular based on the following sub-indicators, which reflect the general and specific objectives:

- Percentage of sales for products in the top energy efficiency classes on the label;
- Speed with which products move towards the higher efficiency classes on the label;
- Reduction of the electricity consumption and related GHG emissions of electronic displays;
- Increasing the economic savings for European consumers;
- Improving the regulatory effectiveness and efficiency of the regulation;
- Compliance with the energy efficiency requirements, i.e. maximum EEI for the different product categories;
- Compliance with the circular economy requirements, in particular:

[116] According to the Energy Labelling framework Regulation, products have to be registered in a product registration database from 1 January 2019 onwards, for all products belonging to models placed on the market after 1 January 2019; and by 30 June 2019 for products belonging to models placed on the market between 1 August 2017 and 1 January 2019

- Restricting the use of halogenated flame retardant in the plastic parts most relevant (in size/weight/volume);
- dismantling of components relevant for the WEEE Directive;
- information requirements to facilitate reparability.

The evaluation should assess these indicators in line with the originally anticipated impacts of the policy option.

A review will be necessary in such a quickly evolving market sector within three years after entry into force. Such a review should focus in particular on the following aspects:

1. the need to update the scope and the definitions of the Regulation;
2. the need to adapt requirements as result of new available technologies, such as HDR, 3D mode, and resolution levels above UHD-8K (33,177,600 pixels), or new standards.
3. the appropriateness of setting specific on-mode energy efficiency requirements for signage displays or other displays not covered in this respect;
4. different or additional requirements to enhance durability and to facilitate repair and reuse;
5. different or additional requirements to improve dismantling at end of life and recyclability including on material efficiency aspects, such as targeting other possibly problematic flame retardants that may hinder the recyclability of plastics;
6. resource efficiency requirements for displays integrated into products covered by other Ecodesign regulations implementing Directive 2009/125/EC and in any other products in scope of Directive 2012/19/EU.

As per the Energy Labelling framework Regulation, the energy labelling delegated regulation shall be reviewed if the Commission estimates that 30% of the units of models placed on the Union market fall into class A, or if 50% of those units fall in classes A and B. The availability of data from the registration database should inform such an assessment, where necessary augmented with additional market data.