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COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT

Accompanying the document

COMMISSION REGULATION (EU) .../... laying down ecodesign requirements for light sources and separate control gears pursuant to Directive 2009/125/EC of the European Parliament and of the Council

and repealing Commission Regulations (EC) No 244/2009, (EC) No 245/2009 and (EU) No 1194/2012

and

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

and repealing Commission Delegated Regulation (EU) No 874/2012

{C(2019) 1805 final} - {C(2019) 2121 final} - {SEC(2019) 340 final} - {SWD(2019) 358 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

The present impact assessment relates to the review of:

→ Commission Regulation (EC) No 244/2009 on **ecodesign requirements**[1] **for lighting products** applicable to non-directional household lamps,

→ Commission Regulation (EC) No 245/2009 on **ecodesign requirements for lighting products** applicable to fluorescent lamps without integrated ballast, high intensity discharge lamps and ballasts and luminaires able to operate such lamps,

→ Commission Regulation (EU) No 1194/2012 on **ecodesign requirements for lighting products** applicable to directional lamps, Light Emitting Diode (LED) lamps and related equipment[2], and

→ Commission Delegated Regulation (EU) No 874/2012[3] on **energy labelling for lighting products** applicable to electric lamps and luminaires.

In concreto, the four current Regulations apply to:

- *'light sources' (including lamps, bulbs, LED modules):* electrically operated products that emit light using incandescence (GLS and halogens), fluorescence, high-intensity discharge, light emitting diodes (LEDs) technology – see Figure 1;
- *'control gears' (including ballasts, electronic components, drivers):* the devices needed to connect light sources to the electrical mains[4] - see Figure 1;
- *'luminaires'*: equipment which distributes, filters or transforms the light transmitted from one or more light sources and which includes all the parts necessary for supporting, fixing and protecting the light sources and, where necessary, circuit auxiliaries together with means for connecting them to the

[1] Ecodesign requirements are energy efficiency, functional and information requirements.

[2] Commission Regulation (EC) No 244/2009 of 18 March 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for non-directional household lamps, OJ L76/3, 24.3.2009 and amendments Commission Regulations (EC) No 859/2009 and (EU) 2015/1428; Commission Regulation (EC) No 245/2009 of 18 March 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for fluorescent lamps without integrated ballast, for high intensity discharge lamps, and for ballasts and luminaires able to operate such lamps, OJ L76/17, 24.3.2009 and amendments Commission Regulations (EC) No 347/2010 and (EU) 2015/1428; Commission Regulation (EU) No 1194/2012 of 12 December 2012 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for directional lamps, light emitting diode lamps and related equipment, OJ L342/1, 14.12.2012 and amendment Commission Regulation (EU) 2015/1428 (ecodesign regulations)

[3] Commission Delegated Regulation (EU) No 874/2012 of 12 July 2012 implementing Directive 2010/30/EUC of the European Parliament and of the Council with regard to energy labelling of electrical lamps and luminaires, OJ L258/1, 26.09.2012 and amendment Commission Delegated Regulation (EU) No 518/2014 (energy labelling regulation)

[4] A control gear may include transforming the supply and starting voltage, limiting operational and preheating current, preventing cold starting, correcting the power factor and/or reducing radio interference.

electric supply. Luminaires include wall-mounted, ceiling, table or standing luminaires.

For the purposes of this impact assessment, "lighting products" are thus *light sources*, *control gears* and *luminaires*. When the control gear is integrated in the light source, the combined product is a light source.

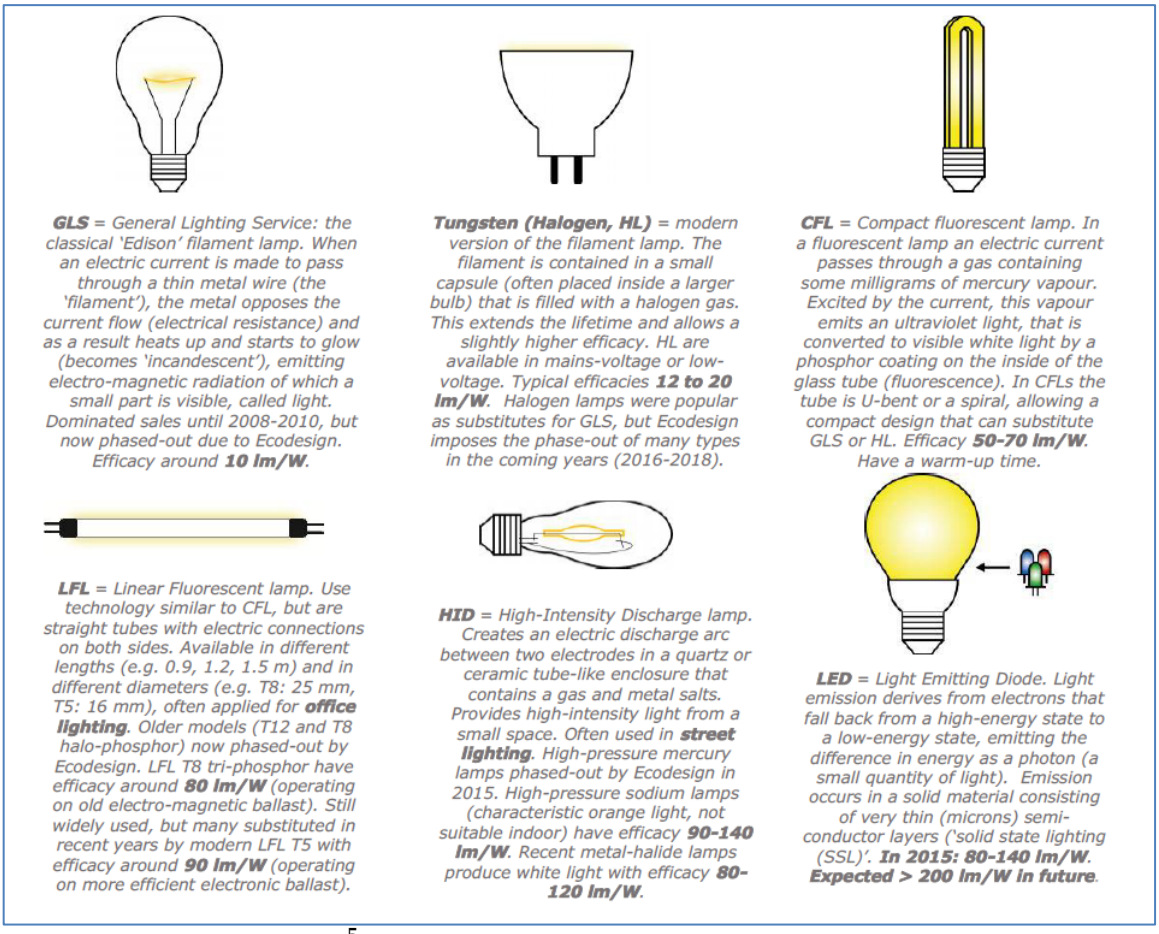

Figure 1: Lighting technologies[5] (above) and example of a control gear for linear fluorescent lamps (below)

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

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[6]. They are central to making Europe more energy efficient, contributing in particular to the 'Energy Union Framework Strategy'[7], and to the priority of a 'Deeper and fairer internal market with a strengthened industrial base'[8]. 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 EU-wide 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 in comparison to if there were no measures in place. This is 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[9].

The average household will invest in more expensive and efficient products, but in return saves about EUR 500 annually on its energy bills by 2020. Although the cost for industry, service and wholesale and retail sectors will increase, it will result in EUR 55 billion per year of extra revenue by 2020.

This legislative framework benefits from **broad support** from 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.

In the EU, lighting products have been subject to Ecodesign requirements since 2009 and Energy labelling since 2012. Electricity consumption in the EU in 2015 would have been 41 TWh higher without the existing legislation[10]. Light sources in particular are one of the largest electricity consumers worldwide and are subject to minimum energy efficiency and labelling requirements around the globe[11].

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6 All the parts in italic in the text are common to the other impact assessments presented for the 2018 package.

7 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)

8 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)

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

10 Impact Assessment report for the revision of lighting products. VHK November 2017

11 Over 50 countries have legislation in place (see CLASP database https://clasp.ngo/ and the UNEP activity www.united4efficiency.org).

1.2. Legal framework

In the EU, the **Ecodesign Framework Directive**[12] 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**[13] complements the Ecodesign Framework Directive by enabling end-consumers to identify the better-performing energy-related products, via an 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, 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 so as to keep the same effort to move from one class to the next one. For specific 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[14].

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

[12] 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 OJ L 285, 31.10.2009, p. 10 (Ecodesign Framework Directive)

[13] 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)

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

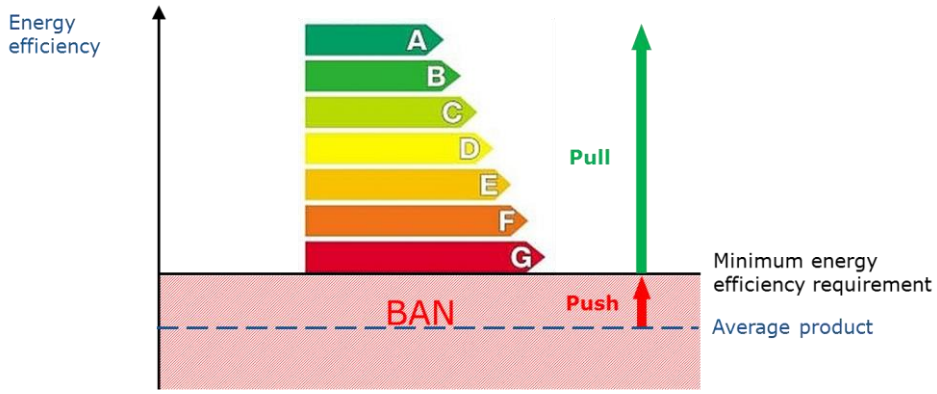

Figure 2: Synergetic effect Ecodesign and energy labelling

For those consumers that do not use the energy label to select a product and for consumers in a tenant-landlord situation (where the landlord set the lighting equipment and the tenant pays the bill), ecodesign requirements are important, as it safeguards consumers from the worst performing products.

The Ecodesign framework Directive and the Energy Labelling framework Regulation are implemented through product-specific implementing and delegated regulations. To be covered, the energy-related products must (i) represent a significant volume of sales (more than 200000 units a year), (ii) have a significant environmental impact within the EU and (iii) represent a significant energy improvement potential without increasing the cost excessively, see also Article 15.2 of the Ecodesign Framework Directive.

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[15]. The benefits are a quicker and more cost-effective implementation, which can be more flexible and easier to adapt to technological developments and market sensitivities

For more details about the legal framework, including a full list of ecodesign and energy labelling measures, see Annex 7.

Under this framework, as listed in Section 1, **lighting products are regulated by Commission Ecodesign Regulations (EC) No 244/2009, (EC) No 245/2009 and (EU) No 1194/2012** and **Commission Delegated Energy Labelling Regulation (EU) No 874/2012**.

An overview of existing policies, legislation and standards affecting lighting products in the EU and outside is given in Annex 8.

1.3. Legal context of the reviews

The **Ecodesign** and **Energy Labelling Regulations for lighting products** require all the regulations to be reviewed in the light of technological progress no later than five years

[15] 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

(three years for the 2012 acts) after their entry into force. The review of the energy labelling act should in particular assess the verification tolerances[16].

The **Ecodesign working plan 2016-2019**[17] mentions the review of the four lighting regulations as one of the major energy savings opportunities, with anticipated primary energy savings of 125 TWh per year in 2030. The working plan also requires examining how aspects relevant to the circular economy can be assessed and taken on board, in line with the Circular Economy Initiative[18].

Finally, in August 2017, the new Energy Labelling framework Regulation (EU) 2017/1369 entered into force, repealing Directive 2010/30/EU[19]. 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 at the latest on 2 November 2018. Lighting products are one of the priority product groups.

1.4. Political Context

Several new policy initiatives indicate that ecodesign and energy labelling policies are relevant in a broader political context. The main ones are the **Energy Union Framework Strategy,** which calls for a sustainable, low-carbon and climate-friendly economy, the **Paris Agreement**[20], which calls for a renewed effort in carbon emission abatement, the **Gothenburg Protocol**[21], which aims at controlling air pollution, the **Circular Economy Initiative**[22], which amongst others stresses the need to include reparability, recyclability and durability in ecodesign, the **Emissions Trading Scheme** (ETS)[23], aiming 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**[24], 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:

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[16] Verification tolerances are used by the national authorities when they test products to verify their compliance with the legislation, If the resulting value from the verification exceeds by X% the value declared by the manufacturer, the product is not compliant.

[17] Communication from the Commission Ecodesign Working Plan. COM(2016) 773 final, Brussels, 30 November 2016. (Ecodesign Working Plan 2016-2019)

[18] 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)

[19] 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.

[20] Global agreement in response to climate change of 2015 (Paris Agreement)

[21] Protocol to abate acidification, eutrophication and ground-level ozone of 1999 (Gothenburg Protocol)

[22] See footnote 14

[23] https://ec.europa.eu/clima/policies/ets_en (ETS)

[24] Communication of the commission to the European Parliament and the Council European Security Strategy. COM/2014/0330 final.

Cost effective energy savings:

Manufacturers and consumers stand to benefit from the fact that there are still cost effective energy savings to be achieved in the lighting sector. By way of illustration, electricity savings due to the existing requirements on lighting products were expected to be 110 TWh in 2020, but according to the last estimation will be limited to 70 TWh[25].

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 lighting, by 2 November 2018 at the latest, to remove the A+ to A+++ classes.

Label effectiveness

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.

2. PROBLEM DEFINITION

The review of the ecodesign and energy labelling for lighting products started in 2015 and several studies were conducted for this purpose, as described in Annex 1. These studies evaluated the impact of the current legislation, as reported in Annex 9; they also looked at the technological and economic evolution of the sector and at stakeholders' views. Results from the studies have been used directly as input to the problem definition analysis model (see Annex 4).

The review process for lighting products ran for longer than usual for a product group in scope of ecodesign and energy labelling and had two Ecodesign Consultation Forums (in December 2015 and in December 2017, see Annex 2 and Annex 5), while usually only one is needed. This happened to take properly into account all relevant aspects and shape the problem definition.

The main finding from the evaluation of the impact of the current legislation is that electricity savings due to the existing requirements were expected to be 110 TWh in 2020, but according to the latest estimation they will be limited to 70 TWh. The evaluation showed that the gap in energy savings is the result of:

[25] In 2015, an amendment to the current ecodesign regulations (Commission Regulation (EU) 2015/1428) postponed the phase-out of non-directional halogen lamps from 2016 to 2018, but this is not at all enough to justify such a difference in energy savings.

- Insufficient market surveillance by Member States;
- Too many parameters to verify by market surveillance, and too expensive/long verification testing required (e.g. 6000h test for lumen maintenance);
- Unclear definitions for exempted lamp types ("special purpose lamps", as defined in the current legislation), using a description of intended use rather than measurable parameters;
- Tolerances intended for use by market surveillance during verification that have been used also by manufacturers in the declaration of lamp characteristics, with the result to bring on the market products with an efficacy that is lower than the minimum required one;
- Recent appearance on the market of 'fully-integrated luminaires' from which the light source cannot be removed for compliance verification.

Moreover, incandescent lamps, which the ecodesign legislation phased-out from 2009, were expected to be mainly replaced by compact fluorescent lamps. However, many consumers preferred the less energy-efficient halogen lamps. Fluorescent lamps have not been adopted as expected because of (real or perceived) sub-standard performance (e.g. colour rendering and temperature, ignition time, mercury hazards).

The options presented in Section 5 were built on the outcome of the review to address the above listed concerns.

2.1. Problem 1: Outdated energy efficiency requirements

The problem:

The current ecodesign requirements for lighting products **no longer capture cost-effective energy savings** and the current energy label **no longer allows consumers to differentiate** sufficiently between the products on the market.

In 2008, prior to the entry into force of the current Ecodesign and Energy Labelling Regulations in 2009 and 2012 respectively, there were 9.2 billion light sources operating in EU28, consuming 330 TWh/a of electricity. **Without the current Regulations, in 2015 the electricity consumption of light sources in scope would have been 41 TWh higher** (377 TWh instead of 336 TWh – see 'BAU2008' in Figure 3)[26], **equivalent to the total final electricity consumption of Denmark and Lithuania together**. Savings happened despite the fact that the number of light sources had increased to 11.4 billion (+23.7% compared to 2008; +3.1% per year). Ecodesign and energy labelling measures have also reversed the growth trend of electricity consumption for light sources faster than under business-as-usual conditions.

[26] Data from the Model for European Light Sources Analysis by VHK (MELISA; 2017 update). In the model, BAU2008 is the scenario "business-as-usual from the year 2008", meaning how the situation would have evolved up to 2030 if no measure had been taken from 2008.

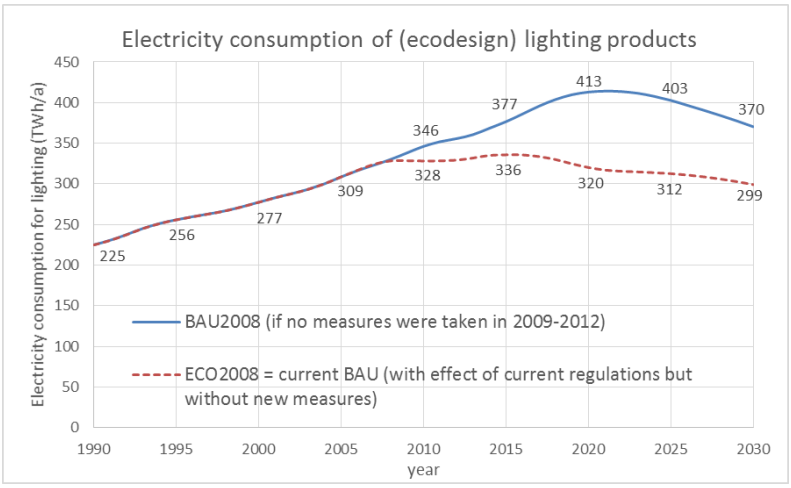

Figure 3: Energy consumption of lighting products in scope of ecodesign – MELISA modelling, 2017 data

Nevertheless, lighting remains the second[27] largest electricity consumer in the EU ecodesign programme (around 12% of all gross electricity production in the EU28[28]).

Moreover, the **energy label for luminaires** does not necessarily drive the consumer towards the most energy-efficient option: this label is different from a normal energy label, because it informs customers on the compatible light sources and on the possibility to remove the light source but not on the energy consumption of the luminaire.

The drivers of the problem:

Driver 1: Technological progress. Technology for light sources keeps evolving, thereby improving energy efficiency. LED technology, which is for almost all applications the most energy efficient lighting technology that exists, has had a rapid uptake on the EU market: **from 0% of sold lamps in 2008 to 22% in 2015** with models on the market often being replaced by updated versions every six months to one year. In addition the average energy efficiency of LEDs quadrupled[29] between 2009 and 2015, and prices dropped significantly: compared to 2010, in 2017 a typical LED lamp for household use was 75% cheaper and a typical LED lamp for offices 60% cheaper.

As a result of this technological progress the top three energy efficiency classes of the energy label are overpopulated: they cover 66% of the models and all LEDs are in these three classes. By 2020 over 50% of LEDs will be A++[30]. This makes it more difficult to distinguish between models. Moreover, the "A+", "A++" and "A+++" classes introduced by the Energy Labelling Framework Directive (Directive 2010/30/EU)[31] have been shown to be less effective in persuading consumers to buy more efficient products than the A to G scale, with consumers wrongly believing that there is not much difference between A and A+++ [32].

27 After electric motors.
28 Eurostat Energy Balance Sheets, 2017 edition, 2015 data
29 From 20 lumen per Watt to 70-90 lumen per Watt (lm/W).
30 VHK light source database 2015-2017 (4000 models)
31 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. (Energy Labelling Framework Directive)
32 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

Driver 2: Additional use functions. New features to make lights more "human centred" and "smart"[33] have been added to lighting products since the adoption of the Ecodesign and Energy Labelling Regulations. The new functionalities have an impact on the energy efficiency of the lighting products but are not reflected in the existing energy efficiency calculations.

Driver 3: Current focus on household lighting. 2/3 of the energy savings achieved by the current legislation come from the residential sector, because of the existing ecodesign requirements for incandescent and halogen lamps, which are typically used for household lighting. However, 80% of lighting electricity is now consumed in the non-residential sector, 60% of this by linear fluorescent lamps (including the typical T8 fluorescent tube lights in offices[34])[35]. Without an update of the requirements, the energy savings potential of non-residential lighting will not be realised at the required pace to contribute to the EU 2030 energy and greenhouse gas emissions reductions goals.

How the problem will evolve:

Ecodesign is a key driver for innovation in product energy efficiency and supports the EU's technological and environmental leadership. The EU lighting regulations are generally in line with worldwide regulation and in some cases cover a wider scope of light sources or set more stringent requirements[36].

Without requirements adapted to technological progress, light sources used in the EU are expected to be less energy efficient than they could be, and EU consumers will lose out from buying slightly cheaper but more energy consuming products, because the lifecycle costs which include energy consumption will be higher. Without improved legislation, the potential to save energy would not be reached in time to contribute to achieving the EU's energy and greenhouse gas emissions reductions goals for 2030.

Finally, light sources used in the EU could become less energy efficient than in other economies such as US and Australia[37] [38]. As a result, **the EU could become a dumping ground for less efficient products** that can no longer be sold in other parts of the world.

2.2. Problem 2: Burdensome implementation and surveillance

The problem:

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labelling and repealing Directive 2010/30/EU**.** SWD/2015/0139 final - 2015/0149. (Impact Assessment Energy Labelling Regulation)

[33] Lights can act as repeaters (e.g. WiFi) or access points for communication signals (e.g. in building automation); can detect presence, daylight or sound; can monitor air quality and visually 'notify' certain 'events' (mail, door ringing); and so on.

[34] 'T8' means a tubular fluorescent light source with diameter of approximately 26 mm, as defined in harmonised standards. The tube can be straight (linear) or bent (e.g. U-shaped, circular).

[35] For more details: Ecodesign impact accounting – Overview report for the European Commission DG Energy, VHK December 2016 and Annex 9

[36] Over 50 countries have legislation in place (see CLASP database https://clasp.ngo/ and the UNEP activity www.united4efficiency.org).

[37] In the last years EU traditional lighting companies did not keep a competitive edge through energy-efficient innovation at the expected levels: previously announced innovations promising efficacy levels of 200-300 lm/W do not materialise in the market and new announcements are scarce.

[38] The COAG Energy Council agreed on 20/4/2018 to introduce minimum standards for LEDs in Australia and New Zealand by 2020/2021 (http://www.coagenergycouncil.gov.au/sites/prod.energycouncil/files/publications/documents/16th%20COAG%20Energy%20Council%20Communique%20Final.pdf). In the US the standard body NEMA developed norms for LED quality which are not yet in the EU, e.g. for flicker and the stroboscopic effect.

Practice shows that compliance with current Ecodesign legislation for lighting products can be difficult. Stakeholders have complained that (i) the norms are scattered between legislative texts, (ii) the scope and exemptions are not always clear and (iii) conformity assessment is demanding. Industry reported having problems in implementing this legislation and Market Surveillance Authorities (MSAs) encounter difficulties evaluating if products are in scope and in performing proper surveillance.

In addition, industry (mostly SMEs) find the **Energy Label for luminaires** a burden with limited added value. Many MSAs also find the verification of this label not worth the effort and consider that their enforcement efforts should rather focus on other aspects which would achieve more energy savings.

The drivers of the problem:

Driver 1: Complex legislation. Ecodesign requirements for lighting products are laid down in three different regulations: Commission Ecodesign Regulations (EC) No 244/2009, (EC) No 245/2009 and (EU) No 1194/2012. This creates uncertainty as to the applicable regulation to specific products[39]. Furthermore, each regulation has its own formulae to calculate energy efficiency.

Driver 2: Unclear scope. The way that some exemptions are formulated makes the inclusion of certain products in the scope uncertain. In particular, **"special purpose lamps"** are exempted only on the basis of their "intended" use, which is a subjective test. It is not unusual to have special purpose lamps marketed for general lighting applications, thereby circumventing the minimum requirements that should apply to them. One example are the 'special purpose lamps' intended for ovens, which are incandescent lightbulbs because they have to withstand high temperatures. Nevertheless, they are also sold for general lighting purposes because they are compatible with some normal luminaires, thereby circumventing the ban on incandescent lightbulbs for general lighting[40]. Another example comes from the special purpose lamps for stage/studio/theatre lighting, especially the tungsten halogen lamps. The estimate for the energy consumption of special purpose lighting for movie/TV or photo studio/theatre/event applications is a small part of the total energy consumption for lighting products (0.075 TWh/y for special purpose lamps in theatres, compared to the total 336 TWh/y for all lamps as shown in Figure 3). Nevertheless, certain exemptions in the current Regulation, including the one on stage/studio/theatre lighting, have been used as loopholes. It is not uncommon to find installations of stage/studio/theatre lighting in residential apartments. Stakeholders, including the lighting industry, are keen for the revised legislation to close such loopholes.

Driver 3: Long and expensive testing. The number of parameters for compliance testing and the length of the test procedures make conformity assessment expensive and time-consuming. This is particularly true for the 6000 hours testing for the lamp survival factor and lumen maintenance. By way of illustration, LED lamp models have often sold out by the time the testing by MSAs is completed.

How the problem will evolve:

[39] The regulations are built on classification of lamps for household and tertiary uses that no longer fully reflect today's reality. For example: LEDs are in scope of Regulation (EU) 1194/2012 which is intended for household-type lamps and not of Regulation (EC) 245/2009 on office and street lighting).

[40] Commission Regulation (EU) 2015/1428 was a first step to better regulate the exemptions for special purpose lamps which are often energy inefficient, but ambiguities remain (e.g. for decorative lamps or for the appealing message that they send, being sold as 'shock-proof', 'low-electromagnetic interference', 'low UV emission', etc.).

Electricity savings due to the existing regulations were expected to be 110 TWh in 2020[41], but according to the last estimation they will be limited to 70 TWh. Ambiguities in the legislation on special purpose lamps and hampered capacity of MSAs to check compliance are relevant causes, especially because many lamps exempted for special purposes are energy inefficient incandescents[42] and as exempted products they are therefore not subject to minimum energy efficiency requirements.

2.3. Problem 3: Limited energy savings and circular economy potential from non-dismountable products

The problem:

Sales of luminaires with separate, replaceable light sources are shifting towards **non-dismountable LED luminaires** (also known as fully integrated luminaires). With these devices, when the contained light source fails, the entire luminaire has to be replaced.

This trend is taking place because an integrated design offers advantages for energy efficiency and safety, and because LED light sources have longer lifetimes than classical technology light sources. Because these lifetimes are closer to the useful lifetime of the luminaire, it is often superfluous to make the light source replaceable. But integrated LED luminaires may still fail or be damaged. Representatives of lighting designers reported on various occasions during the review process[43] that practical problems have arisen where large quantities of integrated luminaires were bought for an office or a shop: some luminaires failed prematurely (for various reasons), but the same luminaire model was not available anymore, requiring the user to replace it by another type or even to replace all luminaires when the lighting effect could not be the same.

The Energy label for luminaires provides information to consumers about the possibility of removing the contained light source, but this is not enough to avoid unwanted waste because non-dismountable products hamper replacement and recycling[44].

The problem is even bigger when considering all the non-dismountable furniture products containing a light source (e.g. shelves, mirrors, etc.).

The current regulations impose ecodesign requirements on light sources wherever they are contained. But in practice MSAs may not be able to test them because they cannot access them. In practice, those light sources cannot always be monitored, and this creates an unfair level playing field compared to the same light source type which is accessible (e.g. because it is sold separately).

Addressing the issue of non-dismountable luminaires, and other products containing light sources, would help the development of products that are dismountable, and thus

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41 Ecodesign and energy labelling together. VHK, Ecodesign Impact Accounting, study for the European Commission, March 2016.

42 From Impact Assessment Study 2018, VHK. For completeness, another main cause is consumers' preference for halogen lamps rather than for compact fluorescent lamps as replacements for the phased out incandescent lamps. Fluorescent lamps are much more energy efficient than halogens but were not well perceived by many consumers due to e.g. unpleasant light and warm up time.

43 See Annex 5.

44 Lighting products are in scope of Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 On Waste Electrical and Electronic Equipment (WEEE Directive). The recycling requirements in Article 8(2) of the WEEE Directive are not directly applicable to product manufacturers, they are applicable to recyclers. Hence manufacturers are not always incentivised to design their products in view of this requirement. See Section 6.2.3.

reparable, better recyclable and with the option to replace the contained light source. This will contribute to a Circular Economy.

***The drivers of the problem*:**

Driver 1: Increase on the market of fully integrated luminaires. According to a survey by EU consumer association ANEC/BEUC on LED luminaires, in 2016 removability of light sources was not possible in 40% of the cases, compared to 30% in 2015.

Driver 2: Thermal characteristics of LEDs. Many luminaires are manufactured so that LED light sources are tightly mechanically integrated to optimise thermal management and for protection purposes. The side effect of this technology solution is that the unsealing and resealing of LED lights in the luminaire may hamper their energy efficiency.

How the problem will evolve:

With the growing trend of fully integrated luminaires on the market, the situation will become worse if no action is taken.

2.4. General market failures

In addition to the product specific problem drivers described in Sections 2.1, 2.2 and 2.3, 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 certain group of consumers, in particular those in a landlord-tenant situations, where the landlord buys the appliance and the tenant pays the energy bill.

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 by the problems?

2.5.1. Manufacturers

Manufacturers of lighting products include **manufacturers of light sources**, **manufacturers of lighting-related electronics** and **manufacturers of luminaires**[45]. More information on employment and the size of the lighting products market can be found in Annex 6.

[45] The European lighting industry is mainly represented by LightingEurope.

As for **manufacturers of light sources,** the EU28 employment in the light sources industry is 60 000 jobs (1/3 direct manufacturing, 1/3 OEM[46] and 1/3 services: worldwide the total is 194 000). The major suppliers of light sources in EU28 are Philips Lighting[47], Ledvance/Osram, General Electric (GE) Lighting[48] and Feilo-Sylvania. Together, they make EUR 3 billion of estimated revenue from the sale of light sources for general lighting, directly employ 15 000 people in direct manufacturing and generate employment for further 30 000 people (in OEM and services)[49].

The largest part of the production chain for LEDs is in Asia, while European companies tend to specialise in high quality LEDs with new features (e.g. "smart lights"). Some European companies have sold their general lighting business in the last years, especially to Asian companies.

Asian manufacturers are rapidly expanding their global market share, using price as their main selling point. The energy label and ecodesign requirements play a crucial role for EU industry, to distinguish itself based on quality and innovation.

With the ongoing rapid shift to LED lighting, **manufacturers of lighting-related electronics** are required to adjust from electronic control gears for classical lighting technologies to drivers for LEDs. Less efficient electro-magnetic control gears are being phased out from the market since 2017 and have been replaced by more efficient, high-frequency electronic ones. These manufactures have a dynamic business also due to the increasing trend to have 'smart lights" with new features.

Manufacturers of luminaires are mostly SMEs. The EU luminaire market is very fragmented: the ten largest European manufacturers cover 45% of the total market[50]. Manufacturers of luminaires say they find it burdensome to implement the current energy labelling regulation.

2.5.2. Consumers

For **consumers**[51], the energy label offers a unique opportunity to make an informed choice as to which products offer the best energy performance allowing them to save money in the long run. Ecodesign requirements safeguard consumers from the worst performing products.

The new features that are increasingly included in LED lamps (e.g. dimming, change of colour or white-tone by remote control, etc.) allow consumers to create their desired functionality and 'atmosphere'; but as the energy consumption or quality characteristics of such features are not considered in the current legislation, consumers do not get the full picture from the existing information and energy scale.

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[46] An Original Equipment Manufacturer (OEM) is a company that produces parts and equipment that may be marketed by another manufacturer.

[47] The company is now separate from former mother-company Philips and is quoted on the stock exchange. Its name will soon change to 'Signify', to reflect the separation from Philips.

[48] Non-American parts of GE have been bought by a Hungarian company in 2018. GE is also selling the rest of its lighting business.

[49] Revenues and employment figures relate to light sources. They do not include the production, sales and installation of luminaires, nor the design and installation of lighting systems in the non-residential sector. In the current regulation, the luminaire manufacturers are in scope of energy labelling only.

[50] Zumtobel Group, Annual Financial Report 2014/15

[51] 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).

The increasing number of fully integrated luminaires from which the light source is not removable, could mean more costs for consumers.

In 2015, the average European **household** spent EUR 113 for lighting (acquisition and energy costs).

2.5.3. Market Surveillance Authorities

The complex legislation and the increasing popularity of non-dismountable LED luminaires hampers compliance checks by national market surveillance authorities.

2.5.4. 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 and they help achieve the 2030 EU climate and energy goals[52].

3. 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)[53] 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 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 represent 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;

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[52] 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).

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

- 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).

The Energy Labelling Framework Regulation includes similar criteria for products covered by an energy label, in Article 16(2):

- 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.

During the review process (Review study 2015), it was established that lighting products 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 of 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.

Regulation (EU) 2017/1369 requires the Commission to update the current energy labelling regulation for lighting products, in particular as regards rescaling the label to remove the A+ and A++ classes.

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, Member States 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. Before the existing ecodesign and energy label measures were implemented, this was in fact the case for many products.

4. 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 lighting products within the internal market;
2. Promote **competitiveness** of the EU lighting products industry through the creation or expansion of the EU internal market for sustainable products;
3. Promote the **energy efficiency** of lighting products as a contribution to the Commission'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
4. Increase **energy security** in the EU and reduce energy dependency through a decrease in energy consumption of lighting products.

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 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 (Section 2):

- **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 further cost-efficient energy savings;
- **Redefine the scope and the exemptions to reduce the administrative burden and close loopholes,** to better protect consumers and to make the obligations clear to manufacturers and MSAs;
- **Contribute towards a circular economy** in the EU by including requirements for non-dismountable products containing light sources.

5. WHAT ARE THE AVAILABLE POLICY OPTIONS?

The procedure for identifying policy options follows from the Better Regulation Toolbox[54]. Specific measures in the policy options are the result of a combination of initiatives mentioned in the Review study 2015, the evaluation in Annex 9, the Inception Impact Assessment[55], and inspiration taken from the Ecodesign Framework Directive and the Energy Labelling framework Regulation. They aim to address the issues identified in Section 2 and achieving the objectives defined in Section 4.

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

[55] Inception impact assessment - Regulatory measures on the review of ecodesign requirements for lighting products and Inception impact assessment - Regulatory measures on the review of energy labelling for lighting products

Figure 4 shows the link between the problems, the drivers, the specific objectives and the possible measures to tackle the problems. For every option, Section 5.2 describe the proposed measures.

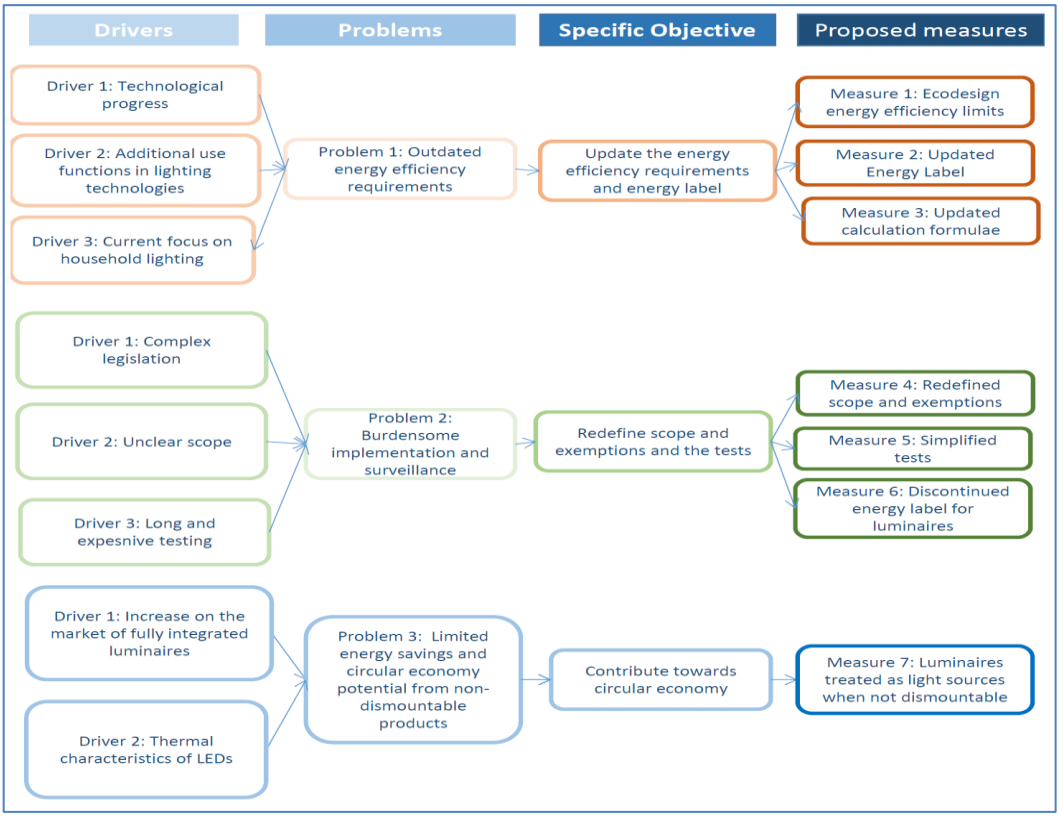


Figure 4: Link between the problems, drivers, objectives and measures

Some measures presented in this impact assessment were extensively discussed with stakeholders during two Consultation Forums (7 December 2015 and 7 December 2017) and represent the consensus achieved. They apply to all policy options and are further detailed under option 2 – ELOnly and Option 3 – ECOEL2021[56]. The main element that needs to be further assessed is the timing for the phase out of linear fluorescent T8 lamps (see Options 3 and 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 (Business as usual)	**BAU**	No further action, the regulations currently in place remain unchanged
Option 2	Energy Label only	**ELOnly**	Only the Energy labelling regulation is reviewed with application from 09/2021; the ecodesign requirements remain unchanged
Option 3	Ecodesign & Energy Label 2021	**ECOEL2021**	Both Ecodesign and energy labelling are reviewed, with application from 09/2021. Option 2 is encompassed in Option 3.

[56] See also Annex 2.

Option 4	Ecodesign & Energy Label 2021-23	**ECOEL2tiers**	Similar to Option 3, except for the timing for phasing out the fluorescent T8 lamps which would occur in 09/2023[57]

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 without revision.

In the baseline a shift towards LED lighting products will anyway happen, at a pace that is derived from current trends in sales, efficiency increase and price decrease. These trends are different for residential and non-residential applications.

The new Framework Regulation also prescribes the creation of a database (called EPREL) with information on all products in scope of delegated acts on energy labelling. The proposed act on lighting products specifies the information to be entered in this database.

The requirement in the ETS to reduce emissions (from amongst other electricity production) will impact lighting products in a baseline scenario. Indeed, inefficient lighting products lead to more energy consumption. More electricity consumption increases the demand for ETS allowances. 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).

5.2. Description of the policy options

5.2.1. Option 1 – Baseline (BAU)

Option 1 is the baseline for the impact assessment as described in Section 5.1. None of the measures in Figure 4 is implemented.

5.2.2. Option 2 – Energy label at 2021 ("ELonly")

Under Option 2, only the energy labelling legislation will be updated, while the ecodesign requirements would stay unchanged. Table 2 below depicts the link between the different problems identified in Section 2 and the proposed measures under Option 2.

Table 2: Proposed measures under Option 2

Identified problems	Corrective measures
Problem 1: Outdated energy efficiency requirements	2. Updated Energy Label
	3. Updated formula (for energy label)
Problem 2: Burdensome implementation and surveillance	6. Discontinued energy label for luminaires
Problem 3: Limited energy savings and circular economy potential from non-dismountable products	7. Luminaires treated as "light sources" when not dismountable (for energy label)

Measures related to problem 1

Measure 2: Updated energy Label – Framework Regulation (EU) No 2017/1369 requires a rescaling of energy efficiency classes for light sources, from an A++ to G scale to an A-G scale by 2 November 2018. Class limits are to be set such that at the introduction of the rescaled label (2021) the A and B classes are empty, while the estimated time within which a majority of models falls into class A is at least 10 years later. The limits for the energy efficiency classes have been defined directly in terms of

[57] Main point of contention amongst stakeholders (see Annex 5).

light source efficiency, as a result of the total light output of a light source (in lumen, *lm*) divided by the mains (230V) power input (in Watt, *W*) and expressed as *lm/W*.

All light source models with efficacy below 85 lm/W will be class G. To obtain an A classification, a light source shall have an efficacy of at least 210 lm/W. Class widths are constant at 25 lm/W. As of October 2017 there are no light sources on the market that can meet the efficiency limits of classes A and B (but there are at laboratory level), so these classes would initially be empty as required by Regulation (EU) 2017/1369. The best LED light sources typically used by households today on the market would have new label class E; the best LED light sources for professional use today on the market would be class D and by 2021 some would be expected to be class C. In 2021, when the new classes will start to apply, class A is still expected to be empty while there might already be some class B light sources on the market.

Table 3: LLCC - Energy efficiency classes

Energy efficiency class	**Total mains efficacy ηTM (lm /W)**
A	$210 \leq \eta_{TM}$
B	$185 \leq \eta_{TM} < 210$
C	$160 \leq \eta_{TM} < 185$
D	$135 \leq \eta_{TM} < 160$
E	$110 \leq \eta_{TM} < 135$
F	$85 \leq \eta_{TM} < 110$
G	$\eta_{TM} < 85$

Table 4 gives an overview of the action that needs to be undertaken.

Table 4: LLCC, Energy efficiency requirements and Energy label - Who, what and by when

	Action	**Who**	**By When**
Energy Label	Provide the updated energy labels with the product	Supplier	1 May 2021[58]
	Display the updated energy labels with the product	Dealer	1 September 2021
	Remove products from the shelves if they do not have the new label	Dealer	1 June 2022

Following the outcome of the 2015 Review study, the measure aims in particular to increase the visibility of the label (e.g. arrow on front of package).

The energy label for lighting products is typically printed on the package of the product. Suppliers and dealers have shown concerns about how in practice to re-scale lighting products with the new energy label. The proposal to apply stickers on the products that at the date of application of the new label will be on shelves got much criticism at the Consultation Forum of December 2017 (see Annex 5) from almost all stakeholders. According to the new Framework Regulation (EU) 2017/1369 (art. 11(13)), specific rules can be provided for energy labels printed on the packaging, like in the case of lighting products. The proposed derogation for this measure is to put a deadline of nine months to

[58] For products placed on the market before the date of application of the new label and that will be on the shelves of dealers with the old label after 1 June 2022, suppliers would need to provide dealers with a sticker with the new label on the request of dealers until 1 June 2022.

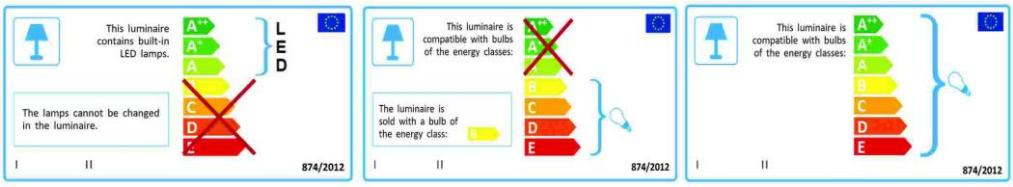
dealers, after which the products can no longer be sold unless a rescaled label is attached on their package[59].

Measure 3: Updated formula[60] for energy label - A new formula for energy labelling is proposed that better reflects energy efficiency and is more intuitive in the calculation than the Energy Efficiency Index set out in the current energy labelling regulation. In the new metrics the limits for the energy efficiency classes have been defined directly in terms of light source efficiency, as a result of the total light output of a light source (in lumen, lm) divided by the mains (230V) power input (in Watt, W) and expressed as lm/W. This change implies that light sources with high light output do not need a higher efficiency to obtain a given energy efficiency class than light sources with low light output. This is reasonable considering that when the new energy labelling requirements start to apply, the label classes' main purpose will be to differentiate between LEDs according to their respective efficiencies[61].
The introduction of the new metrics is not an additional burden on the manufacturers, importers and suppliers as they already have to compute them under the current regulations. In conclusion, the new metrics reflect technological progress and improve the transparency. A comparison of the proposed and old formulae is given in Annex 10.

Measure related to problem 2

Measure 6: Discontinued energy label specifically dedicated to luminaires.

These are three ways of showing the energy label for luminaires today:



As explained in Section 2.2, the energy label for luminaires is often considered a burden for SMEs and MSAs, and does not necessarily drive the consumer towards the most energy-efficient solution. Indeed, contrary to the lamp label, the luminaire label does not show the energy consumption of the luminaire, but rather inform consumers on the energy class of the compatible and/or contained light sources. In addition, the current label also informs consumers when the light source cannot be removed. However, other relevant information is missing on the luminaire label: the compatible/contained light source type and technology[62].
In the interest of consumers, even if the label for luminaires is discontinued, relevant information from the current label, as well as additional information, should still be provided on the package, namely: (i) in case the luminaire is sold with a light source inside, the energy class of the contained light source; (iii) the compatible/contained light source type and technology; and (iii) if the light source can be removed.

Measure related to problem 3

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[59] This will simplify life to dealers and suppliers and significantly reduce their costs for re-labelling. See an estimation of the costs in Section 6.4. Nine months is set following similar derogations in the new framework regulation for energy labelling for e.g. products in stock of dealers ceasing their activity.

[60] Method to evaluate the performance of the appliance, including determination of the need and value of the correction factors.

[61] For LEDs the efficiency does not strongly depend on the amount of light output.

[62] With the sole exception for LED technology, but without specifying which LED type.

Measure 7: Fully integrated luminaires to be treated as light sources – Fully integrated luminaires will be considered a light source for the purposes of the energy labelling legislation and will be required to have an energy label. This measure will: (i) resolve the problem that MSAs have to test light sources when these are not accessible; (ii) resolve the issue of an unfair level playing field for industry when the same light source type is accessible; and (iii) support consumers in their conscious choice when buying integrated luminaires; In the longer run this measure will also stimulate innovation in LEDs, in particular towards thermal interfaces for LED modules that maintain their thermal dissipation characteristics when unmounted and remounted and, consequently, will reduce waste from old or damaged luminaires that cannot be refurbished or repaired.

As for all other products containing a light source (e.g. shelves, mirrors, etc. as well as the dismountable luminaires), this measure introduces the concept of the "containing product". Manufacturers of the containing products will be obliged to add to the information material of the containing product which light source type is inside, what is its energy class and if it is removable or not.

***Stakeholders view on Option 2 - ELOnly*:** All stakeholders think that it is likely that an Energy Label alone will not reach important parts of the market, that there will be missed savings and loss of competitiveness through dumping. Regarding the discontinuity of the energy label for luminaires, industry, notably SMEs, and MSAs welcome this measure. This measure was part of the online public consultation on the revision of the lighting legislation, whose respondents were mostly private citizens and NGOs. Respondents did not show a clear preference for an option (30% would like to keep the label as it is, while 28% would favour its replacement by a label that concerns only the light source which is contained inside; 37% had no opinion), but only 5% favoured to discontinue the label for luminaires without an alternative. The solution that meets all needs is to keep the most relevant information that the energy label for luminaires gives and improve it (as explained in Measure 6) but to remove the requirement to supply the label for luminaires.

5.2.3. Option 3 – Ecodesign and Energy label at 2021 (ECOEL2021)

As regards energy labelling, Option 3 - ECOEL2021 puts forward similar measures as Option 2. In addition, and in response to the stakeholders view expressed on the energy-labelling only scenario in 5.2.2, Option 3 integrates revised ecodesign requirements with application from September 2021.

Table 5 below shows the link between the different problems identified in Section 2 and the proposed measures under Option 3.

Table 5: Proposed measures under Option 3 – (measures in bold are specific to ecodesign. The other measures are encompassed from Option 2)

Identified problems	**Corrective measures**
Problem 1: Outdated energy efficiency requirements	**1. Ecodesign energy efficiency limits**
	2. Updated Energy Label
	3. Updated formula (for ecodesign)
Problem 2: Burdensome implementation and surveillance	**4. Redefined scope and exemptions**
	5. Simplified tests
	6. Discontinued energy label for luminaires
Problem 3: Limited energy savings and circular economy potential from non-dismountable products	**7. Luminaires treated as "light sources" when not dismountable (for ecodesign)**

Option 3 would propose gathering all ecodesign requirements for light sources, for control gears and the correction factors in one single annex over three different tables. This will amount to a significant reduction of the dozens of pages contained in the relevant annexes in the current three Ecodesign regulations, making conformity assessment by industry and market surveillance by Member States easier.

Measures related to Problem 1:

Measure 1: Updated Ecodesign energy efficiency limits – As a general principle, it is proposed to have on the market only light sources that meet a certain minimum efficacy. The minimum efficacy is defined by means of a maximum power formula that uses η=120 lm/W and L=1.5[63] as constants and that, reflecting the state of technological progress, will take into account in the calculation:

- light source characteristics such as the emitted luminous flux;
- the directionality of the light;
- the ability to operate directly on mains power supply (230V);
- the ability to render colours; and
- the presence of special features (anti-glare shield, tuneable colour, network connections).

For details, see Measure 3: Updated formula.

The energy efficiency requirements proposed in Measure 1 will no longer allow on the market linear fluorescent lamps T8 with a length of 2-, 4- or 5-feet[64], compact fluorescent lamps with integrated control gear (the old 'energy saving lamps' with slow start time), almost all remaining halogen light sources, and LED light sources with low efficiency. As of 2017, around 30% of the existing LED light sources would not meet the new proposed requirements. but with the rapid trend of new LEDs on the market this share is expected to decrease by September 2021. See Table 6.

Table 6: Proposed phased-out light sources at September 2021

LFL T8 2-, 4- and 5-foot length
HL low voltage directional (MR11-GU4, MR16-GU5.3, AR111-G53)
HL low voltage capsules (G4, GY6.35)
HL mains voltage capsules (G9)
HL linear R7s>2700 lm
CFLi
All other light sources which are not listed in Table 7 (including LEDs) and which do not meet the general minimum efficacy requirement based on the maximum power formula

As exceptions to the general minimum efficacy requirement, T5 fluorescent light sources (mainly office use), high-intensity discharge light sources (mainly street lighting and industrial use), compact fluorescent lamps without integrated control gear (mainly tertiary sector) and linear halogen light sources (R7s cap) with less than 2700 lm light output (mainly household use) would continue to be allowed on the market. These light

[63] L=2.0 for network connected light sources.

[64] 'T8',means a tubular fluorescent light source with diameter of approximately 26 mm, as defined in harmonised standards. The tube can be straight (linear) or bent (e.g. U-shaped, circular). Linear fluorescent (LFL) T8 2-foot', 'LFL T8 4-foot' or 'LFL T8 5-foot' means a linear T8 fluorescent light source with a length of approximately 600 mm (2 feet), 1200 mm (4 feet) or 1500 mm (5 feet) respectively, as defined in harmonised standards.

sources are not phased out because adequate higher efficiency LED light sources are not yet commonly available or not yet economically advantageous for the average user. Keeping lamps like T5 on the market avoids that users are requested too soon to switch again to another technology, following the application of the most recent ecodesign requirements.

Table 7: Light sources that would stay on the market as an exception to the general principle, their constants η and L used in the maximum power formula, and comparison with the current legislation

REMAIN ON THE MARKET

	η [lm/W]	L [W]	
LFL T5-HE	98,8	1,9	SAME LEVEL
LFL T5-HO, 4000≤Φ≤5000 lm	83	1,9	
LFL T5-HO, other lm output	79	1,9	
FL T5 circular	79	1,9	
FL T8 other than LFL 2-, 4- and 5-foot (incl. FL T8 U-shaped)	89,7	4,5	
FL using magnetic induction, any length/flux	70,2	2,3	
CFLni	70,2	2,3	
FL T9 circular	71,5	6,2	
HPS single-ended	88	50	
HPS double-ended	78	47,7	
MH ≤ 405 W single-ended	84,5	7,7	
MH > 405 W single-ended	79,3	12,3	NEW
MH ceramic double-ended	84,5	7,7	
MH quartz double-ended	79,3	12,3	
Organic light-emitting diode (OLED)	65	1,5	
HL R7s ≤ 2700 lm	26	13	

Table 7 shows which light sources would stay on the market as an exception to the general minimum efficacy requirement and the values of constants η and L per type. For these light sources the minimum required efficacy is defined using the same maximum power formula, but with different values for the constants η and L. As a result, the required minimum efficacies are lower than the general requirement. As Table 7 shows, the constants η and L are in most cases tuned to closely match the existing requirements (where it reads "same level"). In practice nothing changes for these lamps compared to today. Where instead it reads "new", those lamps will still be allowed on the market, but with a higher minimum energy efficacy than today.

For control gears, the minimum efficiency requirements for halogen-, fluorescent- and HID-gear remain the same. The efficiency requirements for LED-gear are new.

Light sources that are no longer allowed on the market because they cannot meet minimum efficiency requirements of existing regulations will remain banned under the new regulation, i.e. there is no backsliding of requirements.

Measure 3: Updated formula for ecodesign – The proposed solution for ecodesign requirements on light sources that are today spread over three regulations entails a single formula defining the maximum allowed input power as a function of the emitted luminous flux[65]. The formula uses two constants (η and L) whose values differ per light source type (see Table 7). In addition, there are three correction factors: F for use of flux in a cone instead of total flux (directional vs. non-directional light sources), R to reflect the influence of colour rendering characteristics (bonus for light sources with good colour rendering; penalty for bad colour rendering), and C as a correction factor (bonus) for special characteristics (see Annex 10).

[65] See details in Annex 10.

Measures related to Problem 2:

Measure 4: Redefined scope and exemptions – Under this measure it is proposed to drop the criterion of "intended use" to define "special purpose lamp" and to replace it with clearer specifications to define what is exempted and what is in scope of the legislation. Exemptions, including for 'special purpose lamps', would depend on measurable parameters (spectrum, light-emitting surface area, luminous flux <60 or >100 000 lm, etc.), exclusive use for certain applications or certification. As a specific example, in the case of stage/studio/theatre lighting the exemption for tungsten lamps would be based on the socket type: this would avoid installations of specific lights for stage/studio/theatre in residential apartments, as explained in Section 2.2[66].

Measure 5: Simplified tests – The tests to ensure the conformity of the products with the requirements are considerably modified, with the aim to reduce the burden on industry and help MSAs in their surveillance. The modifications to the tests are not lowering the ambition of the legislation. The main change is for the endurance testing: the proposed test will last half the time of the current one (3000 h vs. 6000 h) and will combine two tests which were developed in recent years (switching test and accelerated endurance test). The new endurance test will be for LEDs only. Other tests include the displacement power factor (limiting the disturbance of the electricity grid by LEDs), colour rendering index (ensuring good colour rendering for indoor light sources), colour consistency (limiting colour differences between LEDs of the same type), and flicker (ensuring absence of visible flicker for LED light sources). The proposal removes tests that have progressively lost their relevance (notably the start time test typical for fluorescents)[67].

The procedure to be used by market surveillance authorities for compliance verification has been aligned with the common procedure for other Ecodesign products as introduced by Commission Regulation (EU) 2016/2282[68].

Verification tolerances are made more specific, i.e. no longer a general 10% tolerance but a differentiation in the range of 2.5% to 10%, depending on the type of light source, parameter and possibly the power range. The number of test samples is reduced to 10, instead of 20. For expensive light sources the number of samples can be reduced to 3.

***Measures related to Problem 3*:**

Measure 7: Fully integrated luminaires to be treated as light sources – Luminaires (more generically 'containing products') are not in scope of the current ecodesign legislation, but the light sources and separate control gears used inside them have to comply with the current ecodesign legislation. To enable verification of these contained parts, and for reasons of material resource efficiency (circular economy), this measure would provide for fully integrated luminaires to be considered as light sources for the purposes of the ecodesign regulation when the luminaire cannot be dismounted without mechanical damage. Fully integrated luminaires would be considered as light sources also for the purposes of energy labelling.

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66 This is a good compromise between the different interests: the Commission would keep its line of precise exemptions and the theatre sector would not suffer from a whole ban. .

67 Removed parameters include starting time, warm-up time, switching cycles, UV-radiation, power factor (except displacement factor for LEDs), equivalence with incandescent lamps, premature failure rate, lifetime (except for LEDs), efficiency during dimming, lower output limit for dimming.

68 OJ L 346, 20.12.2016, p. 51.

Energy labelling has in scope light sources. For fully integrated luminaires, the same as for ecodesign applies. Not all the products that are exempted in ecodesign would be exempted in energy labelling: this is to allow consumers to know the energy consumption of as many light sources as possible that are on the market.

Stakeholders view on Option 3 – ECOEL2021: Stakeholders support the revision of both ecodesign and energy labelling regulations. At the online public consultation on the revision of lighting legislation that ran until 7/5/2018, a high majority of respondents (75%) supported to update ecodesign measures for lighting to take into account technological development (only 11% answered no, see Annex 2). For non-LED light source types, stakeholders generally support to keep on the market HID, LFL T5, CFLni and to phase out CFLi and almost all remaining halogens. Stakeholders also support the take up of good quality LEDs. The timing for the phase out of T8 fluorescents is the most sensitive point, as some stakeholders question the availability of LED replacements for all applications using T8, but the date of September 2021 and targeted exemptions tackle most concerns of stakeholders (see the discarded option that proposed measures at September 2020 in Section 5.3.3).

5.2.4. Option 4 – Ecodesign and Energy label at 2021 and 2023 (ECOEL2tiers)

Option 4 is identical to Option 3, apart from the fact that it implements the requirements for T8 fluorescents two years later, i.e. in 2023 instead of 2021. The phase out of T8 lamps is the most relevant of the ecodesign measures: it would deliver 90% of the energy savings from lighting products in 2030. Postponing the phase out of T8 lamps would give the industry some extra time to prepare for the phase-out of T8 fluorescents, but it will come at a cost in terms of lower energy and emission savings, as explained in Section 6: it would mean missing 2-3 TWh of savings per year of postponement (for comparison: the electricity consumption of Malta in 2015). Many lighting companies are already commercialising LED replacements to T8. Lighting designers confirm that the vast majority of new installations use LEDs.

Stakeholders view on Option 4 – ECOEL2tiers: Part of the industry and a minority of Member States expressed preference for postponing the phase-out of T8 lamps to 2023, in particular to allow a smoother transition in some sectors. The majority of Member States supports an earlier phase-out together with targeted exemptions for problematic sectors. NGOs and consumers 'associations oppose a late phase out of T8 lamps.

5.3. Options discarded at an early stage

5.3.1. 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 Framework 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[69], in case not all actors present on the market would sign such an agreement and comply with it.

[69] 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.)*

Stakeholders view: None of the stakeholders are in favour of voluntary agreements for the reasons set out above.

5.3.2. LLCC

The Ecodesign Framework Directive states that minimum efficiency requirements shall be set at the level of Least Life Cycle Costs (LLCC), relating to the economically most advantageous proposition for end-users. The 2015 Review study[70] shows that for most household applications, LEDs already have the lowest life cycle costs. For professional applications, e.g. office lighting and street lighting, it depends on the application, but in many cases the classical technologies (fluorescent and high-intensity discharge lamps) still offer the lowest life cycle cost. This is expected to change by 2020, when payback times for an investment in LED for these applications will come down to two-three years. Hence, according to the LLCC-criterion, the minimum required efficiency for ecodesign could be set at a level that only LEDs would meet.

However, there are several reasons why an only-LED choice at this point would not be feasible. First, despite LED-lamps enjoying considerable commercial success, there is the legacy of an existing park of light sources, control gears and luminaires. More importantly, there are still applications for which LEDs are not yet suitable. Second, for large investments in lighting, professionals may also encounter problems in obtaining loans, as lenders thoroughly scrutinise any investment that is higher than the bare minimum on payback and return-on-investment. Finally, many businesses were incentivised by government programmes to invest in efficient fluorescent lamps (especially the "T5") only a few years ago and need time to recuperate their investments. The same goes for municipalities that invested in new city street lighting after the phase out of high pressure mercury lamps from April 2015[71].

Stakeholders view: Almost all stakeholders, including some environmental NGOs, agreed that the timing to phase out from the market all non-LED lights was too demanding. Some among the most environment-friendly stakeholders proposed to add to the new legislation an only-LED set of requirements at a later stage (2023 or 2024).

5.3.3. Ecodesign and energy labelling at 2020

At first instance, the European Commission suggested at the Consultation Forum of December 2017 to apply Option 3 described in Section 5.2.3 as of September 2020, i.e. a year earlier than what is presented in this Impact Assessment. The main reason for discarding this option is to allow one more year for more good quality LEDs to come to the market that would replace the proposed-to-be phased out technologies, especially fluorescents. The phase-out of fluorescents would be as important as the ban of incandescents that happened from 2009. Fluorescent lamps well served the purpose to help with the phase-out of energy-inefficient incandescent lamps, but fluorescents have not been adopted as expected because of (real or perceived) sub-standard performance (e.g. colour rendering and temperature, ignition time, mercury hazards). Consumers bought less energy-efficient halogen lamps instead. As LEDs would play the role to replace fluorescents, like fluorescents played the role to replace incandescents, it is important not to ban fluorescents too early.

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[70] ENER Lot 8/9/19 preparatory study, Task 6 report, http://ecodesign-lightsources.eu/documents

[71] High-pressure mercury lamps have been effectively phased out by the minimum energy efficiency requirements in Commission Regulation (EC) No. 245/2009 starting from April 1st 2015.

Stakeholders view: Relevant stakeholders, including industry and some Member States normally known to support ambitious environmental policies, commented that September 2020 would be too early to implement the proposed requirements. See Annex 5 for the minutes of the Consultation Forum.

5.3.4. Ecodesign only

The Ecodesign only option would introduce new measures for ecodesign only and leave unchanged the current legislation for energy labelling of lighting products. This option was discarded for the following reasons:

1. Over 11 TWh of electricity savings at 2030 would be missed if the energy labelling measures were not updated (see Section 6.2.1 for details);

2. Without an update label, consumers will not be able anymore to make an informed choice based on energy-efficiency performance. As shown in Section 2.1, today the top three energy efficiency classes of the energy label are overpopulated: they cover 66% of the models and all LEDs are in these three classes. By 2020 over 50% of LEDs will be A++[72]. In conclusion, there is still significant difference in energy efficiency between the products remaining on the market to justify an energy label. Without an updated energy label, consumers will base their choice solely on price and the pull mechanism created by energy labelling will disappear.

3. Last but not least, the EU legislator already decided on framework legislation governing this initiative. Lighting was identified as a priority group for the rescaling of the energy label by 2 November 2018 (Regulation (EU) 2017/1369). An "Ecodesign only" option would have to be discarded anyway to comply with framework Regulation.

6. WHAT ARE THE IMPACTS OF THE POLICY OPTIONS?

6.1. Methodological considerations and key assumptions

With the adoption of the Ecodesign Working Plan 2016-2019 in November 2016, the Commission committed for the first time explicitly to systematically exploring resource efficiency requirements in ecodesign. As a result, the methodological basis for the inclusion of such requirements is not yet fully developed; there are no well-established and accepted methodologies in place to identify requirements in the context of mandatory legislation (contrary to green public procurement, ecolabels, etc.).

Therefore, the 'circular economy' requirements that are proposed are based in particular on stakeholder input, existing studies and evidence of product failure (e.g. on spare parts), and focus on measures that can be relatively easily implemented. As such, they can be considered a starting point that can subsequently be complemented or refined when the methodological tools are available.

There is also a lack of methodologies to 'quantify' the costs and benefits of such criteria in the context of the 'least life cycle cost' (LLCC) calculations applied for energy efficiency in ecodesign, in particular as regards the assessment of trade-offs.

Although a fully quantified impact assessment of such requirements has not been possible at this stage, a qualitative impact assessment was made, based on inputs taken from technical, scientific and policy-making literature, and nascent evidence from other similar product groups. This forms the basis of an assessment, which can be refined over

[72] VHK light source database 2015-2017 (4000 models)

time in due course, to be supplemented with actual quantitative data collected via the monitoring and the evaluations. These data will also serve at the time of the next revisions of the product regulations.

To address the gaps in the methodological framework, the Commission mandated CEN/CENELEC to develop standards for material efficiency under ecodesign and a first set of horizontal standards is expected next year, in 2019. These will be integrated in the MEErP methodology as appropriate. A broader update of the MEErP is foreseen in 2019, in particular to see how circular economy aspects could be better integrated in preparatory and review studies, and the LLCC calculations.

The scenario analysis for this impact assessment has been performed using the 'Model for European Light Sources Analysis' (MELISA). The input data for the model (e.g. annual sales volumes, average luminous flux, power and efficacy, light source prices, etc.) have been extensively checked against other data sources[73] and discussed with stakeholders. In July 2016 this resulted in an updated MELISA version, incorporating new input data supplied by industry association LightingEurope[74], and implementing an enhanced method to compute the installed stock of light sources from the annual sales and (variable) lifetimes. A further update took place in October 2017 as regards the projections for the development of average LED efficacy and price. The projection curves were adapted to match the average LED efficacy derived from 2015-2017 catalogue data and taking into account recent projections from UNEP and US DoE [75]. A separate projection curve was created for directional lamps. In addition, electricity rates were updated from Eurostat data.

MELISA derives the installed stock of light sources in the EU28 from data on the annual sales and on the average useful lifetimes. These stock data are combined with average unit power values (W) and average annual operating hours per unit (h/a) to compute the total electricity consumption per base case (TWh/a). The contributions of the various base cases are summed up to arrive at the EU28 totals for all sectors. The shift in (light source) sales from the classical technology base cases to the LED base cases of the same group is one of the essential elements in the scenario projections in MELISA.

Greenhouse gas (GHG) emissions are directly related to electricity consumption by means of the Global Warming Potential (GWP) for electricity.

As regards the main limitations, risks and uncertainties of MELISA, the methodology itself (largely based on the MEErP) is sound, but as with any model, the results depend on the quality of the input data. The data was extensively checked during the review study and largely agreed with stakeholders to mitigate the risk from the quality of input data.

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[73] See the Task 2 and Task 3 reports of the Lot 8/9/19 preparatory study on Light Sources.

[74] These changes mainly regard the lifetime (longer), average luminous flux, power and efficacy of LFL and HID-lamps. The lifetime for LEDs substituting LFL and HID was also increased. To enable lifetime to be variable with the years, a lifetime distribution was introduced for LFL T8t, LFL T5, HPS, MH and LEDs substituting these lamps. The main effect of these changes, with respect to results reported in Task 7 of the Light Sources study, was that energy savings in 2020 and 2025 slightly decreased while savings in 2030 increased.

[75] 'Accelerating the Global Adoption of Energy-Efficient Lighting', UN Environment – Global Environment Facility, United for Efficiency (U4E), U4E policy guide series, UNEP 2017, in particular figure 4 (based on US DoE 2016 data).

A second factor is the uncertainty about the future development of electricity prices. MELISA uses the price projections from the MEErP (with a 4% annual escalation rate), while the PRIMES[76] projection for electricity prices have a much lower escalation rate. However, a sensitivity analysis was performed using the PRIMES process for all options and the results are reassuring: the overall trend is confirmed and the classification of the options according to their monetary savings does not change when using PRIMES electricity rates instead of MEErP electricity rates (see Annex 4.9).

Third, as regards lighting in non-residential buildings, there is uncertainty about the average annual operating hours for lighting. The MELISA model could not be used because MELISA follows a conservative approach with relatively low operating hours, meaning that non-residential electricity consumption and savings might be underestimated. To overcome this problem, a separate estimate of the electricity consumption was made by using a completely different methodology. This used the building areas per type of space/activity derived from the Building Heat Demand report, lighting level requirements per type of space/activity from standards, and parameters and procedures from standard EN 15193. Following this method, using higher non-residential operating hours would not change the choice of the preferred option, but rather reinforce it.

More generally, the MELISA model has been used not only in the study on lighting products, but also in the Ecodesign study on lighting systems and in the study on the impact of RoHS-measures on light sources. The industry organisation LightingEurope examined the model in detail and largely supports it. This shows that there is confidence in the robustness of the model data.

The analytical methods used to determine the impacts are described in detail in Annex 4.

6.2. Environmental impact

6.2.1. Final energy savings

Figure 5 shows the EU final energy (i.e. electricity) consumption of light sources for the different policy options. This includes energy consumption by control gears. The projected savings for the different scenarios vs. the baseline are given in Table 8.

The baseline already shows decreasing energy use. This reflects the continuing effect of existing regulations and the general trend in the market, which anyway includes a gradual shift to higher efficient LED products. Relative to 2015 the reductions are 16 TWh/a (-4.8 %) in 2020, 24 TWh/a (-7.1 %) in 2025, and 37 TWh/a (-11 %) in 2030.

In the other options, compared to the baseline, additional energy savings are obtained, due to the increase in average LED efficacy (labelling), and due to the accelerated shift to LED products (ecodesign). The annual savings increase with the years, as the installed stock of light sources is gradually being replaced by more efficient models.

In the ELOnly option (labelling only) savings vs. the baseline in 2030 are 11.5 TWh/a (-3.8%). 11.5 TWh/y is almost equivalent to the total final electricity consumption of Slovenia in 2015. Adding the ecodesign measures, the savings increase to 41.9 TWh/a (-14.0%) for ECOEL2021 and to 40.1 TWh/a (-13.4%) for ECOEL2tiers. The difference between the two Ecodesign options is the effect of the two year postponement of the phase-out of T8 linear fluorescent lamps. The labelling measures represent 21% of the

[76] PRIMES is the main modelling for energy that the European Commission, DG Energy, uses.

total energy savings in 2030 from energy label and ecodesign combined together (40-42 TWh/y depending on the Ecodesign option).

Cumulative over the period up to 2030, the highest energy savings are obtained in the ECOEL2021 option: 267 TWh or 7.1% less than in the baseline.

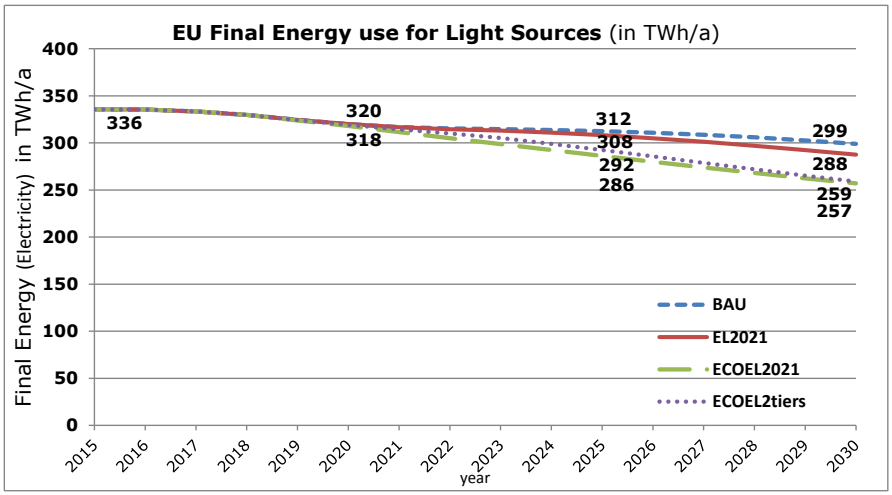

Figure 5: EU final energy consumption by light sources over the period 2005-2030, in TWh/a electricity, for various scenarios (Impact assessment study 2018)

Table 8: Total EU Final Energy (Electricity) for lighting in TWh annual or cumulative. Absolute value for the baseline (BAU) and savings vs. BAU for the other scenarios. (Impact Assessment Study 2018)

Final Energy (Electricity) (TWh)		**2015**	**2020**	**2025**	**2030**	**Cumulative 2019-2030**
Baseline (BAU)	Electricity	336	320	312	299	3745
EL2021	saving		0.0	-4.2 *(-1.3%)*	-11.5 *(-3.8%)*	-54 *(-1.4%)*
ECOEL2021	Saving		-2.0	-26.3 *(-8.4%)*	-41.9 *(-14.0%)*	-267 *(-7.1%)*
ECOEL2tiers	Saving		-0.8	-20.1 *(-6.4%)*	-40.1 *(-13.4%)*	-220 *(-5.9%)*

(includes control gear energy; excludes electricity consumption by controls, special purpose lamps and standby)

6.2.2. GHG-emissions

Figure 6 shows the EU GHG-emissions due to lighting for the different policy options. As these emissions are those occurring during electricity generation, the trends are similar to those for energy consumption presented above. The main difference is that for the energy scenarios, by convention, a primary energy factor[77] of 2.5 (according the Annex V of the Energy Efficiency Directive (Directive 2012/27/EU[78]) is used, whereas for the projections of the GHG-emissions changes in carbon-intensity of electric power generation are taken into account.

The emission reduction in the baseline relative to 2015 thus reflects the energy savings in the same scenario: 11 $MtCO_2$eq./a (8 %) in 2020, 21 $MtCO_2$eq./a (16 %) in 2025, and 31

[77] For the conversion from electricity to primary energy, it reflects the primary energy efficiency of electricity generation and distribution.

[78] Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC**.** OJ L 315, 14.11.2012, p. 1

$MtCO_2eq./a$ (23 %) in 2030. The GHG emission savings projected for the different scenarios are given in Table 15.

Similar to the energy savings, the largest reduction of emissions is obtained in the ECOEL2021 scenario: 14.3 $MtCO_2eq./a$ less than in the baseline in 2030 (-14%). Cumulative over the period up to 2030 the savings amount to 94 $MtCO_2eq.$ (-6.9%).

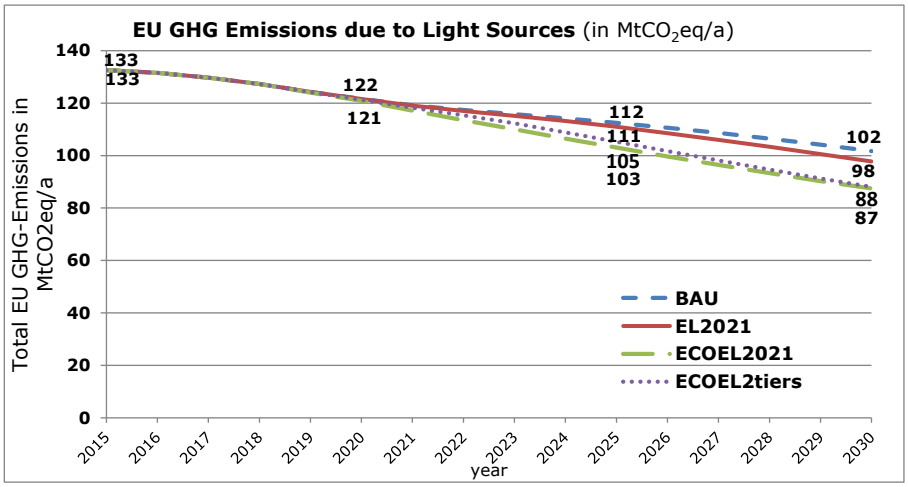

Figure 6: EU Greenhouse gas emissions due to use of light sources and control gears, over the period 2015-2030, in Mt CO_2 equivalent per year, for various scenarios

Table 9: Overview of GHG emissions due to electricity consumption by light sources and control gears. Absolute value for the baseline (BAU) and savings vs. BAU for the other scenarios. (Impact Assessment Study 2018)

GHG emissions ($MtCO_2$ equivalent)		**2015**	**2020**	**2025**	**2030**	**Cumulative 2019-2030**
Baseline (BAU)	Electricity	133	122	112	102	1356
EL2021	saving		0.0	-1.5	-3.9	-19
ECOEL2021	Saving		-0.7	-9.5	-14.3	-94
ECOEL2tiers	Saving		-0.3	-7.2	-13.6	-77

6.2.3. Circular Economy perspective

The environmental life-cycle assessments in the Review Study 2015 show that the energy consumption and the related emissions are by far the dominant environmental impacts for this product category.

For material resources efficiency, all options, except the baseline option, introduce clear requirements to address the phenomenon of fully integrated luminaires as explained in Section 2.3 and Section 5.2.2. As for energy labelling, luminaires with non-dismountable light sources will be considered as light sources for the purposes of the energy labelling legislation and will be required to have an energy label. As for ecodesign, in the two options that have ecodesign measures (Options 3 ECOEL21 and 4 ECOEL2tiers), luminaires with non-dismountable light sources will be considered a light source for the purposes of the ecodesign legislation and will need to satisfy the ecodesign requirements.

The aim of the proposed requirements is to stimulate manufacturers to find innovative solutions and design for dismountable luminaires using LEDs. Better design can make products more durable or easier to repair, upgrade or remanufacture. It can help recyclers to disassemble products in order to recover valuable materials and components. Overall,

it saves resources. The current market signals appear insufficient to make this happen, in particular because the interests of producers, users and recyclers are not aligned. In addition, reparability can be important to consumers. It is therefore essential to provide incentives for improved product design, while preserving the single market and competition, and enabling innovation through ecodesign.

The proposed requirements address the problem of non-dismountable luminaires in an indirect way. In 2017 the Commission checked the possibility to have mandatory removability of light sources from luminaires, but there are technological drawbacks. Many luminaires are manufactured so that LED light sources are tightly mechanically integrated to optimise thermal management and for protection purposes. The side effect of this technology solution is that the unsealing and resealing of LED lights in the luminaire may hamper their energy efficiency. A way forward would be to include a review clause in the legislative proposal to investigate mandatory removability of light sources from luminaires, which will impact recyclability as well.

Even though the Circular Economy dimension is not directly addressed, the proposed requirements for non-dismountable luminaires are in the spirit to promote circular economy because they will: (i) resolve the problem that market surveillance authorities have to test light sources when these are not accessible; (ii) resolve the issue of an unfair level playing field for industry when the same light source type is accessible; and (iii) support consumers in their conscious choice when buying integrated luminaires.

As for recyclability, this impact assessment does not explore measures for the recyclability of lighting products because lighting products are already in scope of Directive 2012/19/EU on waste of electric and electronic equipment[79] (WEEE).The WEEE Directive introduced in August 2018 new recovery and recycling targets, including for lighting products. Until 14 August 2018 the lighting equipment in scope of the WEEE Directive includes all lamps, with the exception of filament bulbs, and all luminaires, with the exception of luminaires in households (Annex II of the WEEE Directive, Category 5). From 15 August 2018 the scope is enlarged to all luminaires, with specific requirements for large and small luminaires (Annex III of the WEEE Directive, Categories 4 and 5).Because of the close date of application of the new WEEE target for lighting products, it is deemed more relevant to look into requirements that would complement the WEEE directive in the next review of the ecodesign legislation.

The producers of the lighting equipment in scope of the WEEE Directive are in charge of meeting recycling and recovery targets that increase over time:

- Until 14 August 2018:
  - 75 % shall be recovered, and 55 % shall be prepared for reuse and recycled (for gas discharge lamps, 80 % shall be recycled);
- From 15 August 2018:
  - for lamps (category 3): 80 % shall be recycled;
  - for large luminaires (category 4): 85 % shall be recovered, and 80% shall be prepared for reuse and recycled;

[79] Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on Waste Electrical and Electronic Equipment (WEEE Directive).

- for small luminaires (category 5): 75 % shall be recovered, and 55% shall be prepared for reuse and recycled.

Currently the lighting equipment in scope of the WEEE Directive represents 5% of the total electrical and electronic equipment placed on the EU28 market annually and 2% of the total WEEE collected and recycled annually.

6.3. Business impacts

6.3.1. Business revenue

Business[80] revenues mainly depend on the quantity of products being sold and on their average price. For light sources there is a complex interaction between factors that increase and decrease the revenues:

- There is a tendency for the number of installed light sources to increase with the years (more households, more light sources per household, increasing GDP). This potentially indicates an increase in sales quantities.
- However, at the same time the average lifetime of light sources is increasing. This implies a lower need to buy replacement lamps and thus a decrease in sales. At least for the next 10 years, this decrease is stronger than the increase deriving from the general growth of the previous point. Hence on the short-medium term, sales quantities of light sources are going down.
- Energy savings and GHG emission reductions for light sources are obtained by a shift from traditional lighting technologies to LEDs with higher energy efficiency. For the same light output, these LEDs have higher acquisition costs (but lower electricity costs) than the traditional lamps. So the shift to LEDs potentially implies a higher average sales price per lamp.
- Due to the learning effect and the exponential increase in the quantities of LEDs being sold, their price is rapidly coming down and this trend is expected to continue in the BAU scenario (Option 1).
- However, the proposed regulation aims at increasing the average efficacy of LEDs being sold, and these high-efficient LEDs have a higher sales price.

The assumptions made in the analysis model regarding the development of the sales quantities and of the average unit prices are reported in detail in Annex 4. They lead to the business revenues shown in Table 10. Figure 7 shows the projected industry revenue for the different policy options.

In the baseline option, business revenues show a decreasing trend due to the decrease in sales quantities. In ten years, from 2015 to 2025, total business revenues from light sources decrease from EUR 21.6 to 17.0 billion per year (-21%). In the same period, industry revenues decrease from EUR 9.7 to 6.3 billion per year (-35%). Towards 2030, revenues slightly increase again due to the general growth in the number of light sources (first point above).

The effect of Option 2 – ELOnly is an increase in the average efficacy of LED products being sold (pull-effect of labelling). Starting from 2021, compared with the baseline, this increases the average price per light source and thus increases total business revenues by 9-11% in 2025 and 2030 relative to the baseline scenario.

[80] Meaning industry, wholesale and retail, installation and maintenance.

The same effect of improved labelling is also present in Option 3 – ECOEL2021 and Option 4 – ECOEL2tiers, but additionally the introduced Ecodesign measures increase the number of LED light sources being sold, by phasing-out from the market some traditional lamp types. This situation further increases business revenues due to an increase in sales quantities, with anticipatory effects from 2019[81]. Different from the labelling effect, this increased-sales effect is temporary: instead of a gradual shift to LEDs in the base line, the Ecodesign measures accelerate the LED sales in earlier years, but then lead to lower sales of LEDs in later years.

In Option 3 – ECOEL2021 this leads to higher total business revenues especially in early years, with, respect to Option 2 – ELOnly, a 5% increase in 2020, 9% increase in 2025, and a 2% decrease in 2030. Considering only industry revenues, the increase is 10% in 2020, 18% in 2025, and zero in 2030.

In Option 4 – ECOEL2tiers, the phase-out of T8 linear fluorescent tubes is postponed from 2021 to 2023, and consequently also the associated increased sales of LEDs and the corresponding increase in business revenues shift forward by two years. Increases in business revenues in Option 4 are therefore much smaller than those in Option 3 in 2020, but higher in 2025 and 2030.

Cumulatively over the period up to 2030, increases in revenues have the highest value for Option 3 – ECOEL2021: EUR 29 billion (+13%). The same explanation also applies to associated jobs, which are directly related to revenues (see Section 6.5.3).

Table 10: Overview business revenue per sector[82] and per scenario, in billion EUR [2010] in the EU (Impact Assessment Study 2018).

bn EUR		INDUSTRY				WHOLESALE&RETAIL				INSTALLATION			
		2015	**2020**	**2025**	**2030**	**2015**	**2020**	**2025**	**2030**	**2015**	**2020**	**2025**	**2030**
Baseline	**revenue**	9.7	9.3	6.3	6.4	4.0	2.9	1.8	1.7	3.0	3.1	2.6	2.5
EL2021	variation		0	+1.3	+1.2		0	+0.3	+0.3		0	0	0
ECOEL2021	variation		+0.9	+2.7	+1.2		+0.2	+0.5	+0.2		0	-0.1	-0.2
ECOEL2tiers	variation		+0.2	+2.8	+1.5		0	+0.5	+0.3		0	-0.1	-0.1
		MAINTENANCE				TOTAL							
		2015	**2020**	**2025**	**2030**	**2015**	**2020**	**2025**	**2030**	**Cumulative 2019-2030**			
Baseline	**revenue**	5.0	5.6	6.3	7.2	21.6	20.9	17.0	17.8	221			
EL2021	variation		0	0	0		0	+1.6	+1.4	+14			
ECOEL2021	variation		0	0	0		+1.1	+3.2	+1.1	+29			
ECOEL2tiers	variation		0	0	0		+0.1	+3.4	+1.7	+26			

[81] Experience from the past learns that both manufacturers and users tend to anticipate Ecodesign measures. In addition, existing products in stock can still be sold after the phase-out date. The phase-out of a product is therefore never abrupt at the regulatory date, but more gradual. The analysis model reflects this, see details in Annex 4.6.

[82] Installation and Maintenance costs for the residential sector are assumed to be zero. In a non-residential context, light sources are typically installed by dedicated personnel. The unit time goes from 3 to 15 minutes, depending on the lamp type. Luminaires installation, their rewiring and change of control gear are not included. Due to the increasing lifetime of light sources, less replacements take place and thus installation revenues decrease with time. Maintenance costs are a share of annual luminaire cleaning costs assigned to light sources. The unit time depends on the ease of accessibility of the luminaires. As the quantity of light sources in use increases with time, maintenance revenues increase. Cleaning a LED luminaire is assumed to take the same time as cleaning a conventional luminaire. For both Installation and Maintenance, a labour cost of EUR 37/hour is assumed.

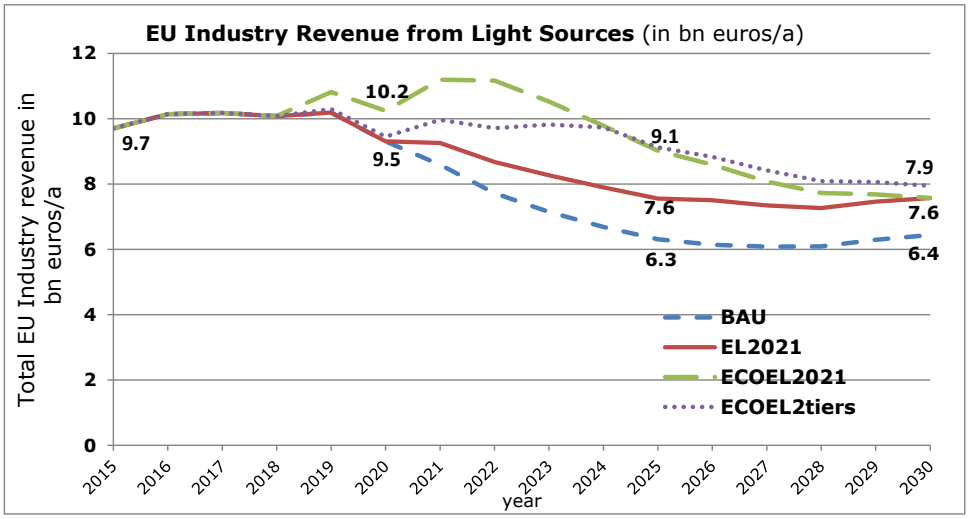

Figure 7: Projected EU industry revenue over the period 2015-2030, in bn EUR/y, for various scenarios (Impact assessment study 2018)

6.3.2. Innovation, Research and Development, Competitiveness

The revision of the lighting energy labelling regulation is expected to support innovation and drive market transformation, as was observed in the past. It is in line with ongoing market trends towards higher energy efficiency, where a high energy label rating is a strong commercial driver (Review Study 2016).

All LED technologies are today in the three top energy labelling classes. A new labelling scale based on the re-scaling required in the new energy labelling framework regulation will stimulate innovation to develop LEDs that will reach the new top classes.

The development of innovative energy-efficient technologies at competitive prices[83] will enhance the competitiveness of European manufacturers. This is important because Asian manufacturers are rapidly expanding their global market share. For these manufacturers, product price, rather than quality, is one of the main selling points.

6.3.3. Intellectual Property Rights

The technologies considered in all scenarios are commonly available to all major manufacturers.

6.4. Consumer expenditure

Consumer expenditure consists of acquisition costs (purchase and installation), maintenance costs and electricity costs. Maintenance costs are assumed not to change between the options. The options different from the baseline promote a shift to LEDs and this causes additional acquisition costs in early years. This initial investment made by users is gradually paid back in later years through lower electricity costs. The acquisition cost, energy cost and overall consumer expenditure for the different scenarios are shown in Table 11 and Figure 8[84]. Table 11 shows that the overall effect in 2030 for consumers when considering acquisition costs and electricity costs is positive for all options. See Annex 4 for further details.

[83] The development of innovative energy-efficient technologies at competitive prices has been observed with the introduction the current ecodesign and energy labelling regulation (See also Annex 9). It is assumed that this will be the case for a revised measure as well.

[84] Data are for the 'MEErP' electricity prices (with 4% escalation). A sensitivity analysis was performed for PRIMES prices (Annex 4) which does not change conclusions.

Option 3 – ECOEL2021 requires the highest investment in LED products, concentrated in earlier years, cumulative EUR +30 billion (+20%) vs. Option 1 – BAU over the period up to 2030. However, the same option also leads to the highest energy cost savings, increasing in later years, cumulative EUR -52 billion (-7.8%) vs. Option 1 – BAU, and therefore has the highest user expense savings, cumulative EUR -21 billion (-2.4%).

Table 11: Total EU Acquisition costs, Electricity Costs, Maintenance Costs and Total User Expense for light sources, in billion EUR/y or billion EUR cumulative over the period 2019-2030. Totals for the BAU-scenario and savings vs. BAU for the other scenarios. Costs in fixed 2010 EUR, incl. VAT for residential. Negative numbers are saving; positive numbers additional expense. (Impact Assessment Study 2018)

Acquisition (bn EUR)		**2015**	**2020**	**2025**	**2030**	Cumulative 2019-2030
BAU	Absolute	17.9	16.1	10.9	10.8	150
EL2021	saving		0.0	+1.7	+1.5	+15
ECOEL2021	saving		+1.1	+3.3	+1.2	+30
ECOEL2tiers	saving		+0.1	+3.4	+1.7	+27
Electricity (bn EUR)		**2015**	**2020**	**2025**	**2030**	Cumulative
BAU	Absolute	47.5	48.3	56.0	65.0	666
EL2021	saving		0.0	-0.8	-2.6	-11
ECOEL2021	saving		-0.3	-4.8	-8.9	-52
ECOEL2tiers	saving		-0.1	-3.8	-8.5	-44
Maintenance (bn EUR)		**2015**	**2020**	**2025**	**2030**	Cumulative
ALL scenarios	Absolute	5.0	5.6	6.3	7.2	76
Expense (bn EUR)		**2015**	**2020**	**2025**	**2030**	Cumulative
BAU	Absolute	70.4	70.0	73.3	83.0	891
EL2021	saving		0.0	+0.9	-1.1	+4
ECOEL2021	saving		+0.8	-1.5	-7.7	-21
ECOEL2tiers	saving		0.0	-0.3	-6.8	-17

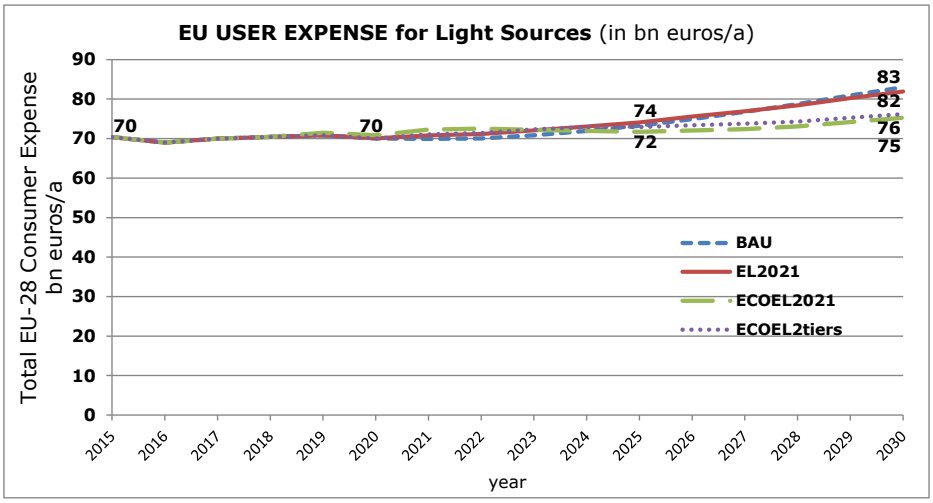

Figure 8: Projected consumer expenditure over the period 2015-2030, in billion EUR [2010] per year (Impact Assessment Study 2018)

6.5. Administrative burden

The administrative burden for industry and MSAs is an area that could be improved in the current legislation, as explained in Section 2.2. With the new regulations proposed in Options 2 – EL2021, 3 – ECOEL2021 and 4 – ECOEL2tiers, the total administrative burden will decrease, especially for European SMEs.

Indeed, Options 2 – EL2021, 3 – ECOEL2021 and 4 – ECOEL2tiers propose the abolition of the energy label applicable to luminaires. This measure will save costs and reduce burden for luminaires' suppliers – 90% of which are SMEs. The burden will be reduced because of the fact that SMEs will not need to prepare the label and ensure its conformity, also in view of possible surveillance by market authorities.

The reduced burden will come not only from the abolition of the label but also from the abolition of the obligation to insert data in the products database EPREL introduced by the Energy Labelling Framework Regulation (EU) 2017/1369. Between 1 million and 3 million model luminaires are estimated to need a label today[85]. Based on Eurostat data for year 2016, around 250 million luminaires are sold each year in EU28. With the revised energy labelling, only the fully integrated luminaires would be assimilated to light sources and thus added to the list of light sources that need to have an energy label. It is estimated that savings for SMEs will be at least EUR 35 million[86]. Moreover, increased turnover should also be considered[87].

In addition, the simplification of tests in Options 3 and 4 will reduce the number of tests and eliminate tests that lost relevance by time. The impact on the industry from the new tests for LEDs is estimated to be negligible because the existing testing appliances are set or can be easily set to run the new tests. The same is valid for MSAs (see in Section 7.2).

Conversely, the rescaling of the label of products on the market as required by the Energy Labelling Framework Regulation (EU) 2017/1369 would bring new costs in Options 2 – EL2021, 3 – ECOEL2021 and 4 – ECOEL2tiers. It is estimated that suppliers and dealers will encounter extra costs of respectively EUR 30 million and EUR 4 million. Suppliers will need to provide a second label for the products to rescale for each light source that will stay on the shelves of dealers after nine months (an estimated 10% of products), while dealers will need to relabel with stickers and 2.5 % of their products on display[88].

[85] The estimation comes from LightingEurope with reference to the obligations to insert data on all products with an energy label in the database EPREL, following the new Framework Regulation for energy labelling.

[86] Calculations assume 2500 lighting suppliers in the EU, 2 million luminaire models (halfway between 1 million and 3 million) and that 40% of these luminaires will need an energy label for light sources for being fully-integrated luminaires. 1 hour work of an employee for every luminaire is assumed. The costs for registration in EPREL assume an employee tariff of EUR 27 per hour (the 2017 Eurostat average in the whole economy excluding agriculture and public administration). A cost of EUR 1000 for ICT support for every lighting manufacturing company is also assumed. Calculations are cautious: EUR 27 is the tariff for an unskilled employee, but as the validation in EPREL would be relevant to certify compliance of the lighting products with EU legislation, it is highly possible that the validation of the data in EPREL will be done by employees with a certain degree of responsibility.

[87] For instance, if an SME produces a yearly turnover of EUR 5 million with 10 employees, EUR 0.5 million per year would be saved (source: LightingEurope).

[88] Calculations assume that suppliers will need to provide a new label for 10% of the annual 1250 million lamps sold with a label, because 10% will stay on shelves longer than nine months (see Section 5.2.2). The cost to print a label is assumed at EUR 0.03. The costs for dealers assume an employee tariff of EUR 14.30 per hour representative for shop sale workers. Data are from the Impact Assessment of the new Framework Regulation for energy labelling.

6.6. Social Impact

6.6.1. Affordability

To obtain the energy savings and reduction of GHG emissions, users have to invest in more, and more efficient, LED lighting products. Compared to the baseline, this leads to additional acquisition costs (see Section 6.3). For the EU as a whole, for the ELOnly option these are maximum 1.8 billion EUR/y in 2026 (EUR 3.6 per citizen; +17% vs baseline in that year). For the ECOEL2021 option the maximum is EUR 4.2 billion per year in 2022 (EUR 8.4/citizen; +31%), and for the ECOEL2tiers option EUR 3.7 billion per year in 2024 (EUR 7.4/citizen; +32%). See also the graphs at the end of Annex 4.

This investment is payed back in later years in terms of lower electricity costs, leading to the total user expense savings reported in Section 6.3. On average, payback times are around 1 year or less for low-output residential lamps, and around 3-4 years for higher-output LED tubes replacing T8 linear fluorescent lamps[89].

On the other hand, both options that would introduce new requirements for ecodesign (Option 3 – ECOEL2021 and Option 4 – ECOEL2tiers) do not change the requirements for LFL T5, HPS and MH that exist today: consequently, nothing changes for the users of these lamps. The reason for this choice is that many non-residential lighting users recently invested in luminaires for higher efficiency T5 linear fluorescent lamps (LFL T5), or for sodium or metal-halide lamps (HPS, MH), to replace lamp types that were phased-out by existing regulations. It would not be acceptable to force these users to change again before they have amortised their previous investments. In addition, LED replacement lamps (also known as "LED retrofit lamps") for these classical lamp types are scarce so that users would often be forced to substitute entire luminaires.

Stakeholders view – In relation to the phase-out of T8 linear fluorescent lamps, some stakeholders argued that for organisations managing large quantities of such lamps, the investment to make in LEDs would be too high to bear in such a short time. This is a misunderstanding of the intention of the regulation, i.e. there is no obligation to replace all installed LFL T8 by LED before the date set in the regulation: lamps can gradually be replaced when they fail, over a much longer period, thus spreading out the costs.

6.6.2. Health, Safety and Functionality Aspects

LEDs are sometimes criticised to have flicker or stroboscopic problems[90], colour inconsistency or bad colour rendering. Especially the problem of flicker has been confirmed for many lamps during screening testing carried by the EU-funded project EEPLIANT which was finalised in 2017[91]. Following comments at the Consultation Forum[92] and from the online public consultation that ran until 7/5/2018[93], Option 3 –

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89 Source: 2015 Review study, Task 4 and Task 7 reports.

90 The flicker and stroboscopic phenomena are undesired effects in visual perception. The term 'flicker' refers to unacceptable light variation that is directly perceived by an average observer. 'Stroboscopic effect' is an effect which may become visible for an average observer when a moving or rotating object is illuminated. Lighting products with flicker or stroboscopic effect are considered not good quality lighting.

91 http://eepliant.eu/images/Documents/WP1/EEPLIANT2014-Final-Report-12-12-2017.pdf

92 See Annex 5,

93 74% of respondents agreed on the idea that lamps should be tested against the flicker effect and 60% find it a relevant piece of information when they buy lamps (11% and 8% were against, the others had no opinion). See Annex 2.

ECOEL2021 and Option 4 – ECOEL2tiers include functional requirements for flicker and stroboscopic effects for LEDs[94] to improve the quality of LEDs on the market.

Some stakeholders have raised functionality concerns as regards e.g. colour tuneable lamps and some special purpose applications, including lighting in railways and studio, theatre and stage lighting. These comments have been taken into account for the formulation of exemptions in the ecodesign measures in Options 3 and 4.

It is also considered to introduce mandatory information on the date of production of light sources and control gears, wherever they are contained. Manufacturers are required to indicate the expected lifetime of the product, also following a high favour from respondents to the online public consultation (72% - see Annex 2).

Finally, it is considered to introduce an exemption for the purchase of incandescent lamps with medical prescription for people that are photosensitive to LEDs, to meet their health concerns (despite studies found no significant or safety hazard from using LEDs[95]).

Stakeholders view – Many stakeholders, especially Member States, consumers and their associations, welcomed the idea of a requirement to tackle the flicker effect[96] and asked to think of a requirement for stroboscopic effect. Some consumers are concerned that LEDs emit more UV-radiation or have other potential health risks from blue light.. Stakeholders from the theatre/stage/studio sector would like to keep a full exemption for lighting used in their sector: however many comments assumed that at the date of application of the new legislation, theatres and similar would need to replace all lamps and luminaires (which is not true, because ecodesign and energy labelling only apply to the placing on the market of new products and not to products in use or in stock).

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[94] In 2013 the European Commission issued a mandate to the standardisation bodies CEN/CENELEC to develop standards on flicker and stroboscopic effects. In April 2017 CEN/CENELEC completed the task by making reference to the work done by other international standardisation bodies: in IEC Technical Report TR 61547-1:2015 'Equipment for general lighting purposes - EMC immunity requirements - Part 1: An objective voltage fluctuation immunity test method' and in CIE Technical Note TN 006:2016 'Visual Aspects of Time-Modulated Lighting Systems – Definitions and Measurement Models'. The criteria and the metrics *P*stLM for flicker and SVM for stroboscopic are reported in the Technical Note.

[95] IEA 4E Solid-State Lighting Annex, Potential Health Issues of Solid State Lighting, Final Report, 24 September 2014, http://ssl.iea-4e.org/task-1-quality-assurance/health-aspects-report
http://ec.europa.eu/health/archive/ph_risk/committees/04_scenihr/docs/scenihr_o_019.pdf
http://ec.europa.eu/health/scientific_committees/emerging/docs/scenihr_o_035.pdf
http://ec.europa.eu/health/scientific_committees/environmental_risks/docs/scher_o_124.pdf
http://ec.europa.eu/health/scientific_committees/environmental_risks/docs/scher_o_159.pdf
In 2016 the Commission requested the Scientific Committee on Health. Environmental and Emerging Risks (SCHEER) to provide a scientific opinion focusing on potential risks to human health of LEDs. The final Opinion was published on 12 July 2018 (https://ec.europa.eu/health/sites/health/files/scientific_committees/scheer/docs/scheer_o_011.pdf). The SCHEER concluded that there is no evidence of direct adverse health effects from LEDs in normal use (lamps and displays) on the general healthy population. Although there are cellular and animal studies showing adverse effects raising concerns, particularly in susceptible populations, their conclusions derive from results either obtained using exposure conditions that are difficult to relate to human exposures or using exposure levels greater than those likely to be achieved with LED lighting systems in practice.

[96] See footnote 78.

6.6.3. Employment

In the baseline scenario, the global jobs related to the EU light source business are projected to decrease from 314 000 in 2015 to 243 000 (-23%) in 2030. This follows the decreasing trend in sales and in business revenues discussed in Section 6.2. The decrease in jobs is mainly in EU28 industry, due to lower production of incandescent-, halogen- and fluorescent-lamps. Jobs in retail and installation decrease due to lower sales volumes, while jobs in maintenance increase due to the increase in number of light source in use.

The other scenarios accelerate the shift to high-efficacy LED products, leading to an increase in jobs worldwide. This partly avoids the loss of jobs that occurs in the baseline. The positive effect on wholesale and retail is inside EU28. A large part of the increase in industry jobs is outside EU28: the production of basic LED components is mainly done in Asia. The additional jobs in EU industry regard e.g. machinery for the production of LED components, the integration of LED components (dies, packages, modules) into higher level products (lamps, light engines, luminaires), development of new applications (smart lighting, network connected lamps, colour-tuneable devices, human-centric lighting), research and development for increase of efficacy and quality, involving also new optical and thermal solutions.

In Option 3 – EL2021 the increase in jobs is gradual and due only to an increase in LED efficacy that brings an increase in the production of LEDs of higher quality than in the baseline scenario. In addition to the label effects, the LED sales increase in early years, leading to more jobs especially in 2020-2025. This effect vanishes by 2030.

In Option 4 – ECOEL2tiers the phase-out of T8 linear fluorescent lamps is postponed by two years, and consequently also the increase in LED sales and the associated increase in jobs shift forward in time. This leads to additional jobs especially in 2025-2030.

Table 12 gives an overview of the employment impact worldwide due to EU light source business. Jobs related to the sale and installation of luminaires are not included.

The analysis takes into account only jobs in the supply chain: induced employment from spending of e.g. employees' earnings or tax revenues, is not included. A large share (estimated 60-70%) of the industry jobs, especially those related to LED light sources, is outside the EU28. Jobs for wholesale, retail, installation and maintenance are assumed to be all inside the EU28.

Table 12: Overview of direct employment per sector and per scenario, in '000 jobs (Impact Assessment Study 2018)

sector	INDUSTRY				WHOLESALE				RETAIL				INSTALLATION			
scenario	**2015**	**2020**	**2025**	**2030**	**2015**	**2020**	**2025**	**2030**	**2015**	**2020**	**2025**	**2030**	**2015**	**2020**	**2025**	**2030**
Baseline	194	186	126	129	8	6	4	3	31	23	14	14	30	31	26	25
ELOnly		186	151	151		6	4	4		23	17	16		31	26	25
ECOEL2021		205	180	151		6	5	4		24	19	16		31	25	23
ECOEL2tiers		189	182	159		6	5	4		23	19	16		31	25	24

sector	MAINTENANCE				TOTAL				Increase
scenario	**2015**	**2020**	**2025**	**2030**	**2015**	**2020**	**2025**	**2030**	**2030**
Baseline	50	56	63	72	314	302	234	243	Ref
EL2021		56	63	72		302	262	269	+26
ECOEL2021		56	63	72		322	293	266	+23
ECOEL2tiers		56	63	72		304	295	275	+32

The worldwide impact on employment is estimated from the variations in EU light source business revenue, using a sector-dependent turnover per employee[97]. Consequently, projections for jobs closely follow the projections in business revenues that were explained in Section 6.2.1. Similarly, these revenues are closely related to the acquisition costs for users, see Figure 9. For further details on employment see Annex 6.

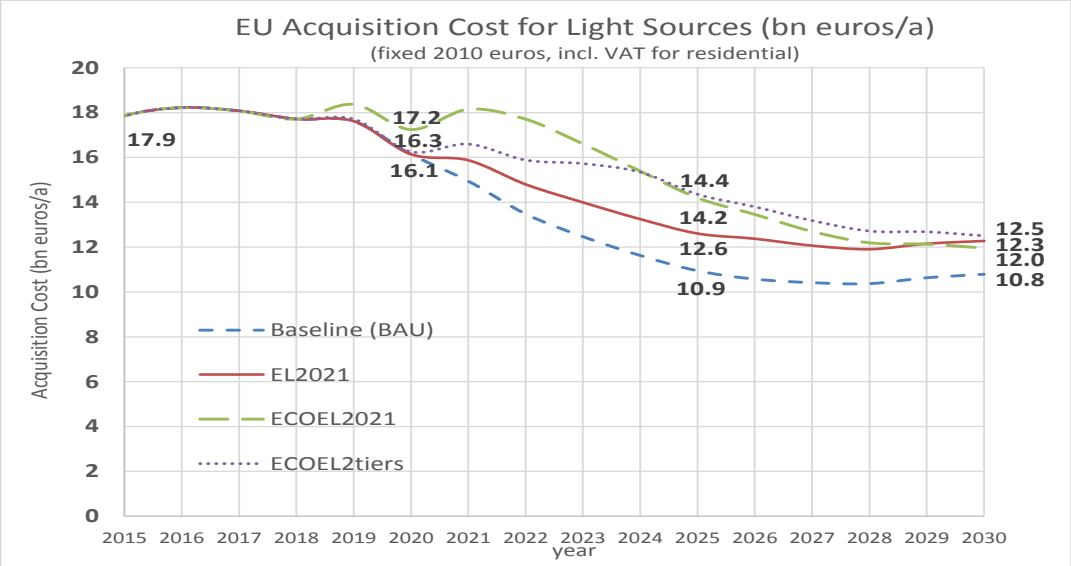

Figure 9: EU Acquisition costs for light sources over the period 2015-2030, in billion EUR [2010] per year. Business revenues for industry, wholesale and trade closely follow these projections. (Impact Assessment Study 2018)

7. HOW DO THE OPTIONS COMPARE?

7.1. Summary of the impacts

Table 13 summarizes the impacts described in Section 6.

Option 2 – ELOnly option has the lowest additional acquisition costs and maintains installer revenues at the same level as the baseline, but energy savings, emission reductions and user expenditure savings are much smaller than in the other two options.

Option 3 – ECOEL2021 option offers the highest electricity savings and the highest reduction of GHG-emissions. It requires higher acquisition costs especially in earlier years (user investment in high efficiency LED products), but this is more than compensated by lower energy costs in later years, so that this option leads to the highest savings on total user expenditure. In general this option also entails the highest business revenues and the best preservation of jobs, concentrated in earlier years.

Option 4 – ECOEL2tiers option is similar to Option 3 – ECOEL2021 but with the phase out of the fluorescent T8 lamps delayed in time. Due to this delay, it leads to lower

[97] See details in Annex 6. The methodology is in line with other publications on the issue, e.g.: 'Cambridge Econometrics, Assessing the Employment and Social Impact of Energy Efficiency, Cambridge Econometrics in collaboration with E3M-Lab, Warwick Institute for Employment Research and ICF International, main report and annex, November 2015', and 'Europe Economics, The Economic Impact of the Domestic Appliances Industry in Europe, Report for the European Committee of Domestic Equipment Manufacturers (CECED), London, April 2015'.

energy savings, lower reduction in emissions, and lower user expense savings. The option seems preferable for business revenues and jobs in 2025 and 2030, but this is due to the shift in time: cumulatively over the period up to 2030 Option 3 is more favourable.

Table 13: Overview of the main annual impacts of the options compared to the baseline. Absolute values for the baseline and variations for the optional scenarios (negative values are savings or reductions; positive values are additional costs, revenues or jobs). Annual values for 2015, 2020, 2025 and 2030; cumulative values over the 2015-2030 period. Best values indicated in Bold. (Impact Assessment Study 2018)

		2015	**2020 Annual**				**2025 Annual**			
	Unit	BAU absolute	BAU absolute	EL 2021	ECOEL 2021	ECOEL 2tiers	BAU absolute	EL 2021	ECOEL 2021	ECOEL 2tiers
Electricity use	TWh	336	320	0.0	**-2.0**	-0.8	312	-4.2	**-26.3**	-20.1
GHG emissions	$MtCO_2eq$	133	122	0.0	**-0.7**	-0.3	112	-1.5	**-9.5**	-7.2
Acquisition costs	bn. EUR	18	16	**0.0**	+1.1	+0.1	11	**+1.7**	+3.3	+3.4
Energy costs	bn. EUR	48	48	0.0	**-0.3**	-0.1	56	-0.8	**-4.8**	-3.8
Expenditure[1]	bn. EUR	70	70	**0.0**	+0.8	0.0	73	+0.9	**-1.5**	-0.3
Industry revenue	bn. EUR	10	9	0.0	**+0.9**	+0.1	6	+1.2	+2.7	**+2.8**
Trade revenue	bn. EUR	4	3	0.0	**+0.2**	0.0	2	+0.3	+0.5	**+0.6**
Installer revenue	bn. EUR	3	3	0.0	0.0	0.0	3	**0.0**	-0.1	-0.1
Employment	000 jobs	314	302	0.0	**+20.3**	+2.5	234	+28.2	+58.9	**+61.6**

			2030 Annual				**2015-2030 Cumulative** [2]			
	Unit		BAU absolute	EL 2021	ECOEL 2021	ECOEL 2tiers	BAU absolute	EL 2021	ECOEL 2021	ECOEL 2tiers
Electricity use	TWh		299	-11.5	**-41.9**	-40.1	5079	-54	**-267**	-220
GHG emissions	MtCO2eq		102	-3.9	**-14.3**	-13.6	1878	-19	**-94**	-77
Acquisition costs	bn. EUR		11	+1.5	**+1.2**	+1.7	222	**+15**	+30	+27
Energy costs	bn. EUR		65	-2.6	**-8.9**	-8.5	853	-11	**-51**	-43
Expenditure	bn. EUR		83	-1.1	**-7.7**	-6.8	1171	+4	**-21**	-17
Industry revenue	bn. EUR		6	+1.1	+1.1	**+1.5**	127	+11	**+25**	+22
Trade revenue	bn. EUR		2	+0.3	+0.2	**+0.3**	40	+3	**+5**	+4
Installer revenue	bn. EUR		3	**0.0**	-0.3	-0.2	45	**0**	-1	-1
Employment	000 jobs		243	+25.6	+22.6	**+31.8**				

1 Expenditure = Acquisition Cost + Energy Cost + Maintenance Cost, latter not shown in table

2 The variations due to measures in general occur from 2021, but for the Ecodesign measures there are anticipatory effects starting from 2019

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 require that MSAs can verify the conformity of a product with all regulatory requirements.

The burden for MSAs to assess compliance is significantly reduced by the new proposals, as explained in the previous chapters. However, this would not mean a monetary saving from reduced administrative burden for MSAs: MSAs would spend the freed-up time on other market surveillance activities instead, thereby contributing to higher compliance rates for the overall ecodesign and energy labelling policy[98].

[98] MSAs (Spain, Poland, Slovenia, Estonia, Denmark, Italy, Czech Republic, Malta, Luxembourg, Slovakia, Bulgaria and Cyprus) also reported a lack of (financial and human) resources in a survey done in 2016. http://ec.europa.eu/DocsRoom/documents/15241/attachments/1/translations

As for the new verification tests that the proposals introduce, MSAs either have their own facilities for testing or rely on expert laboratories. In both cases, the new tests do not put extra burden on MSAs as the existing testing appliances are set or can be easily set to run the new tests. Stakeholders 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) of the Ecodesign Framework Directive and Article 16 (2) of the Energy Labelling Regulation

Pursuant to Article 15(5) of the Ecodesign Framework Directive, future implementing measures should fulfil a number of criteria, see Section 3.1. An assessment of the options in view of these criteria is shown in Table 14.

Table 14: Evaluation of policy options in terms of their impacts compared to the baseline (Impact Assessment Study 2018)

Significant impacts as stipulated in Article 15 of the Ecodesign Directive	BAU	EL 2021	ECO EL 2021	ECO EL 2tiers
No negative impacts on the functionality (Section 6.6)	✓	✓	✓	✓
No negative impacts on health, safety and environment (Section 6.6)	✓	✓	✓	✓
No negative impact on consumers (Section 6.4 and 6.6)	✓	✓	✓	✓
No negative impacts on industry's competitiveness (Sections 6.3)	✓	✓	✓	✓
Not imposing proprietary technology (Section 6.3)	✓	✓	✓	✓
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 (See Figure 5: at 2030 the savings are equivalent to the electricity consumption of Slovenia in 2015);
- The proposed bands of the energy label will differentiate among LEDs, which are today all concentrated in the top classes;
- No negative impact on affordability, as shown in Section 6.5.1 and Table 11;
- Additional functionality requirements, to improve the quality of products.

All options with the new energy label (Option 2 EL2021, Option 3 ECOEL2021 and Option 4 ECOEL2tiers) fulfil the criteria of Article 16(2).

7.4. Assessment in view of the objectives

An assessment of the options, in view the objectives in Section 4, is shown in Table 15, on the basis of

Table 13 and Table 14.

Table 15: Score of impacts against objectives. No Change (0), limited improvement (+), significant improvement (++). (Impact Assessment Study 2018)

General Objectives	Option baseline	Option ELOnly	Option ECOEL2021	Option ECOEL2tiers

1. Ensure free circulation of efficient products within the internal market;	0	+	+	+
2. Promote competitiveness of the lighting industry through the creation or expansion of the EU internal market for sustainable products;*	0	+	+	+
3. Promote the energy efficiency of lighting products as contribution to the Commission's objective to reduce energy consumption by 30 % and domestic GHG emissions by 40 % by 2030;	0	+	++	+
4. Increase the security of energy supply in the Union through a reduction in energy consumption of lighting products.	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 and the exemptions to reduce the administrative burden and close loopholes	0	+	+	+
3. Contribute towards a circular economy in the EU by including requirements for non-dismountable products containing light sources	0	+	+	+

*Innovation will enhance competitiveness of the EU manufacturers; the effect on innovation is therefore included in this objective.

Option 1 – BAU does not contribute to any of the objectives. The other options contribute to the general objectives. **Option 2** – **ECOELOnly** only contributes fully to two out of three specific objectives: it is therefore not seen as the preferred policy option. **Option 3 – ECOEL2021 and Option 4 – ECOEL2tiers positively contribute** to all objectives in the same way, except for the contribution to the EU 2030 goals and the specific objective 'Update the energy efficiency requirements and the energy label in line with international and technical developments'. Here Option 3 performs best thanks to the earlier time of application of the new measures. As a consequence **Option 3 – ECOEL2021** is the preferred option. More information on the benefits of Option 3 is included in the next section.

8. PREFERRED OPTION

8.1. Preferred option – Why?

Option 3 – Ecodesign and Energy label at 2021 ("ECOEL2021") 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 4 in the best way, see Section 5.2.3.

By 2030, compared to Option 1 – BAU, Option 3 will result in the following:

- Extra energy savings of 41.9 TWh/yr and GHG emission savings of 14.3 $MtCO_2eq./a$, i.e. 2.88% of the Commission's 2030 target for final energy consumption savings and 1.34 % of the Commission's 2030 target for GHG-emissions savings;
- Extra savings on annual end-user expenditure of EUR 7.7 billion and extra business revenue of EUR 1.1 billion per year, which translates into around 23 000 jobs;
- An alignment with technological progress and global minimum energy efficiency requirements in other economies;

- Ensuring EU industry's competitiveness and leading role as high-quality manufacturers;
- Safeguarding of European SMEs.

This option promotes innovation and medium-term cost reduction for more efficient lighting products.

8.2. REFIT (simplification and improved efficiency)

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

Option 3 – ECOEL2021 will reduce the total administrative costs for industry, especially for SMEs manufacturing luminaires following the abolition of the energy label for luminaires. Lighting industry will in general benefit from a simplification of the tests. These measures overcome the one-off cost linked to the application of the new Energy Labelling Framework Regulation which is estimated in EUR 0.34 billion and will not have an impact anymore in 2030 (see Section 6.4).

The burden for MSAs to assess compliance is significantly reduced by the new proposals. It is, however, assumed that MSAs spend the freed-up time on other market surveillance activities, contributing to higher compliance rates: thereby there is no monetary saving from reduced administrative burden for MSAs.

The ECOEL2021 option will also reduce the total consumer expenditure as compared to the baseline. This consumer expenditure includes the acquisition cost and the energy cost. The acquisition cost will be higher, but the energy cost will decrease significantly as compared to the baseline. In addition, this option will improve industry's revenues significantly.

Table 16 gives an overview of the increment in costs, revenue and administrative burden at 2030 as compared to the baseline.

Table 16: Increment in costs, revenue and administrative burden

	2030	**Comment**
Acquisition costs (EUR billion) Energy costs (EUR billion) Consumer expenditure (EUR billion)	1.2 -8.9 -7.7	The acquisition cost increases, but the total consumer expenditure decreases
Industry revenue (EUR billion) Wholesale and retail revenue (EUR billion)) Installation revenue (EUR billion)	1.2 0.2 -0.2	There is an increase in total business revenue
Administrative savings (EUR billion)	0.001	Minimum estimated value. The decrease in total administrative burden also stems from freed resources for other activities (for both market surveillance authorities and SMEs) which cannot be easily monetised. See Sections 6.5 and 7.2.

9. 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 Member States' 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 lighting products with a smaller environmental impact. 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:

- Reduction of the electricity consumption and related greenhouse gas emissions from lighting;
- Increasing the economic savings for European consumers;
- Safeguarding the competitiveness of the European lighting industry and the full value chain;
- Improving the regulatory effectiveness and efficiency of the regulation;
- Compliance with energy efficiency requirements[99];
- Compliance with functional requirements;
- Compliance with information requirements;
- Compliance of those products that were potentially excluded due to (i) loopholes or (ii) difficulty in verification.

The evaluation should therefore assess these sub-indicators.

[99] Ecodesign requirements are energy efficiency, functional and information requirements.