

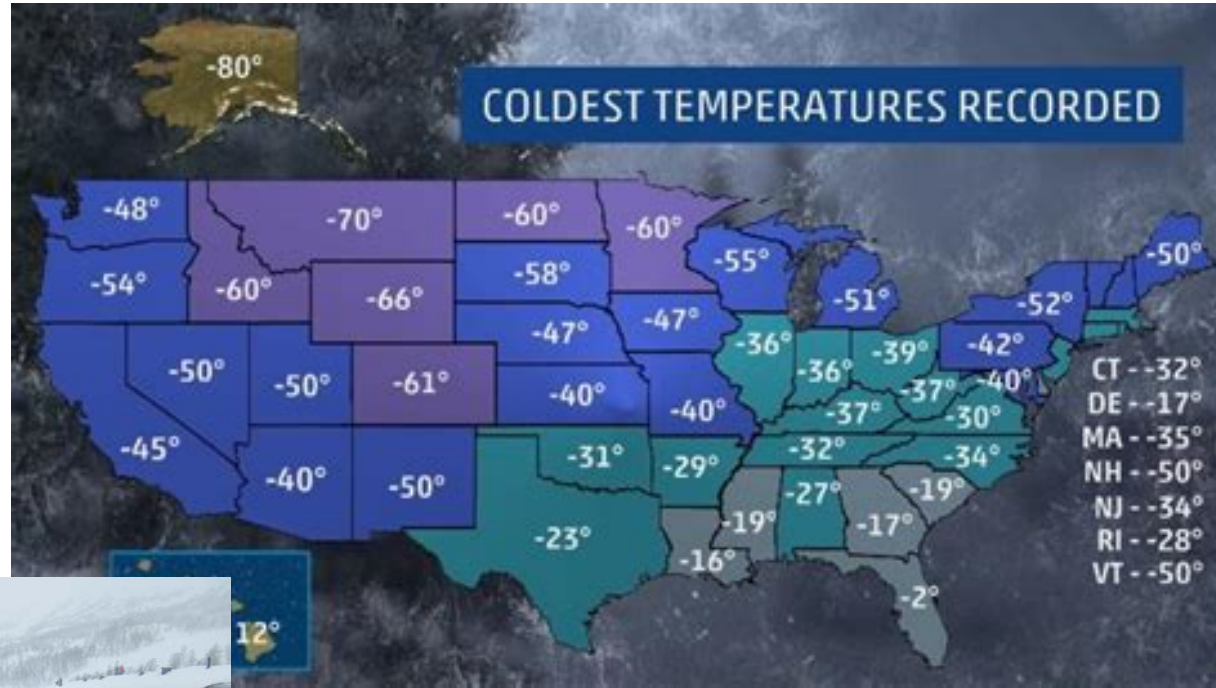
New EU ecodesign regulation for lighting – requirements and timing

Peter Bennich, Ph.D.

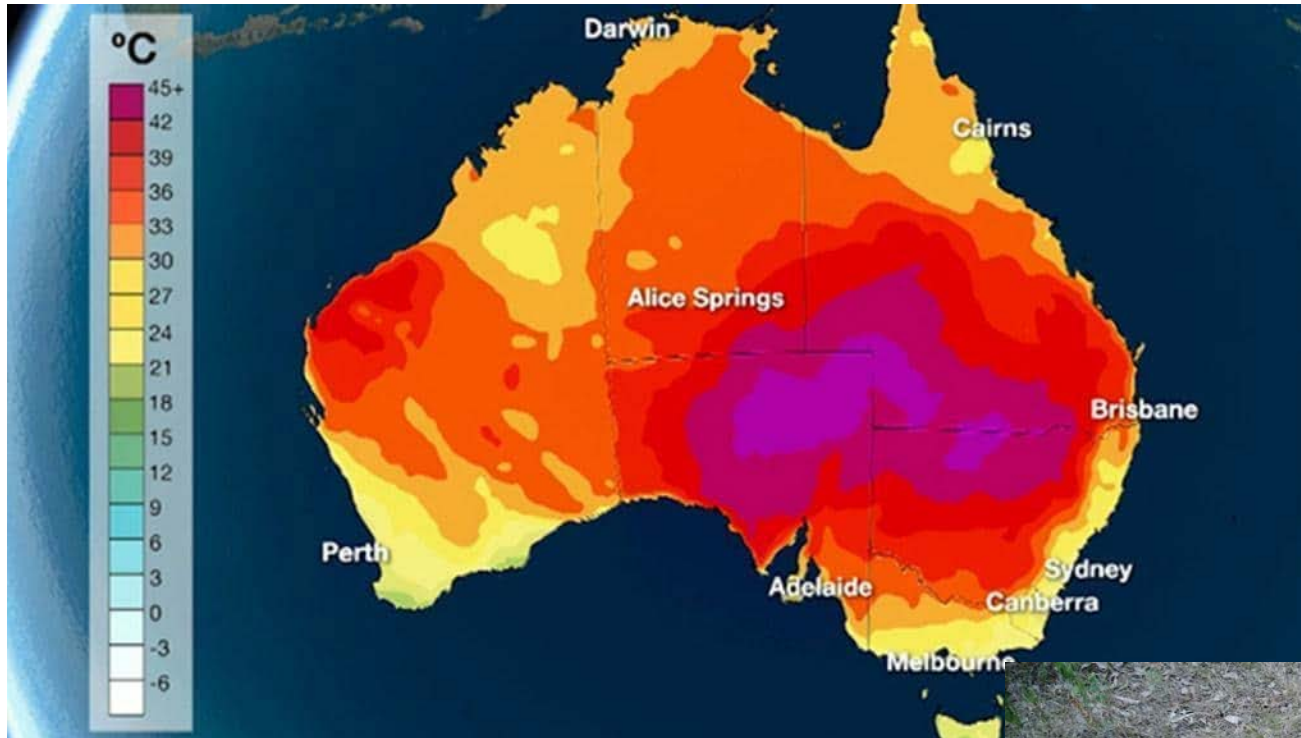
Principal Adviser, Energy Efficiency, Swedish Energy Agency

7 October 2019, DTU Risø Campus, Roskilde, Denmark

Intro: USA January 2019



Australia January 2019



Global Energy Supply 1973 and 2014

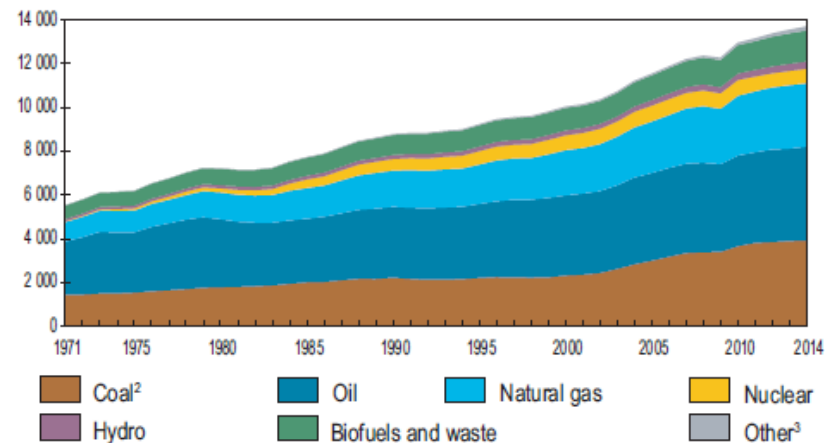
1 Mtoe = 11.63 TWh

Så 2014 använde vi globalt

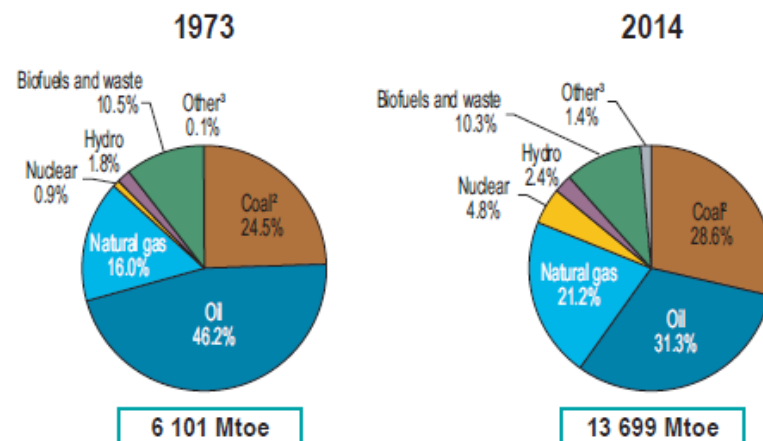
ca 13 700 Mtoe = **159 000 TWh** = 286 Sverige!

Varav ca **80 %** kom från fossila bränslen som samtidigt stod för utsläpp på ca **33 000 Mt CO₂**...

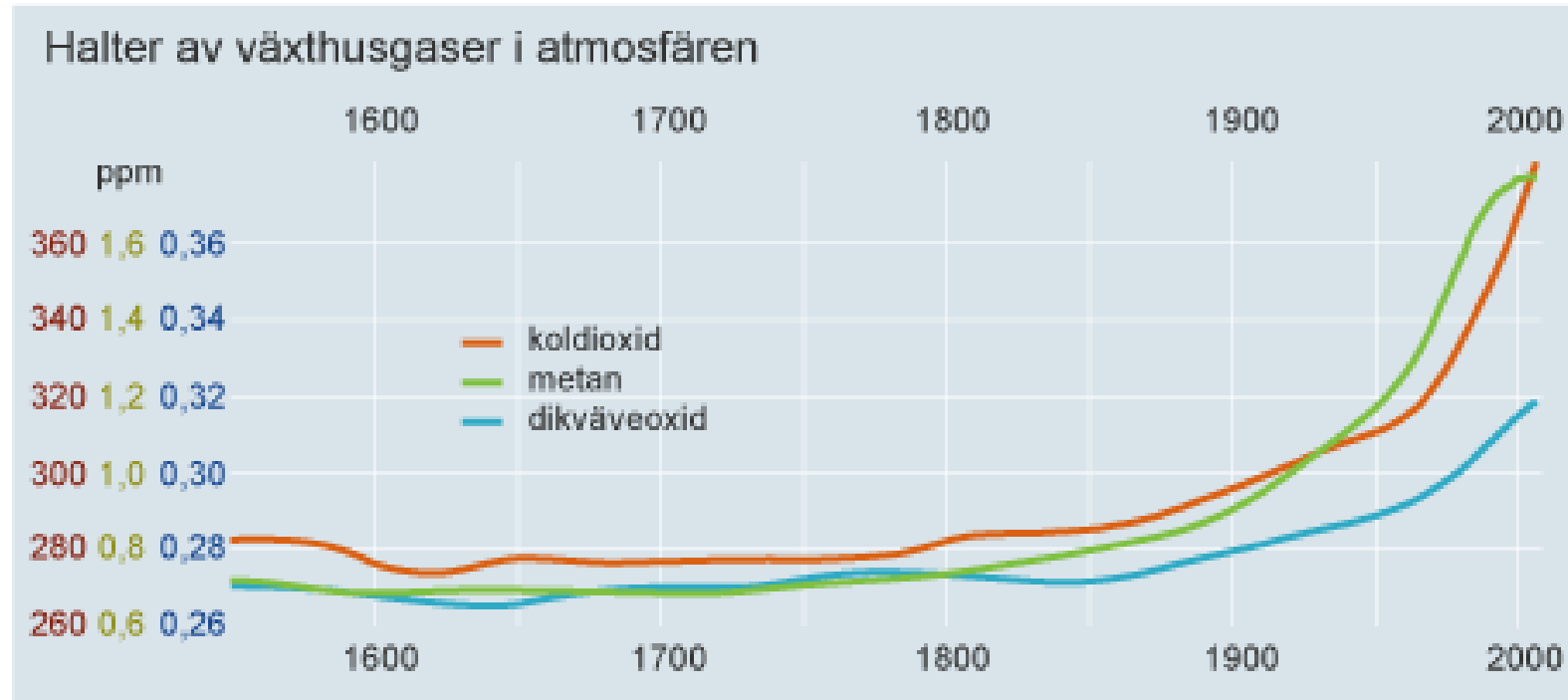
World¹ total primary energy supply (TPES) from 1971 to 2014 by fuel (Mtoe)



1973 and 2014 fuel shares of TPES



CO₂-levels in the atmosphere

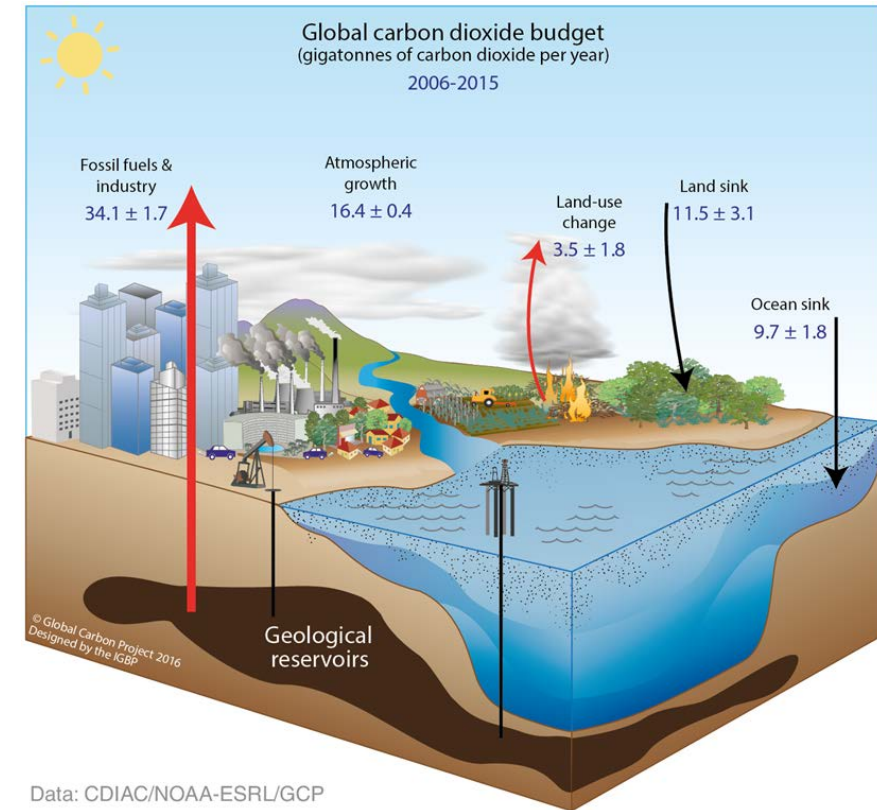
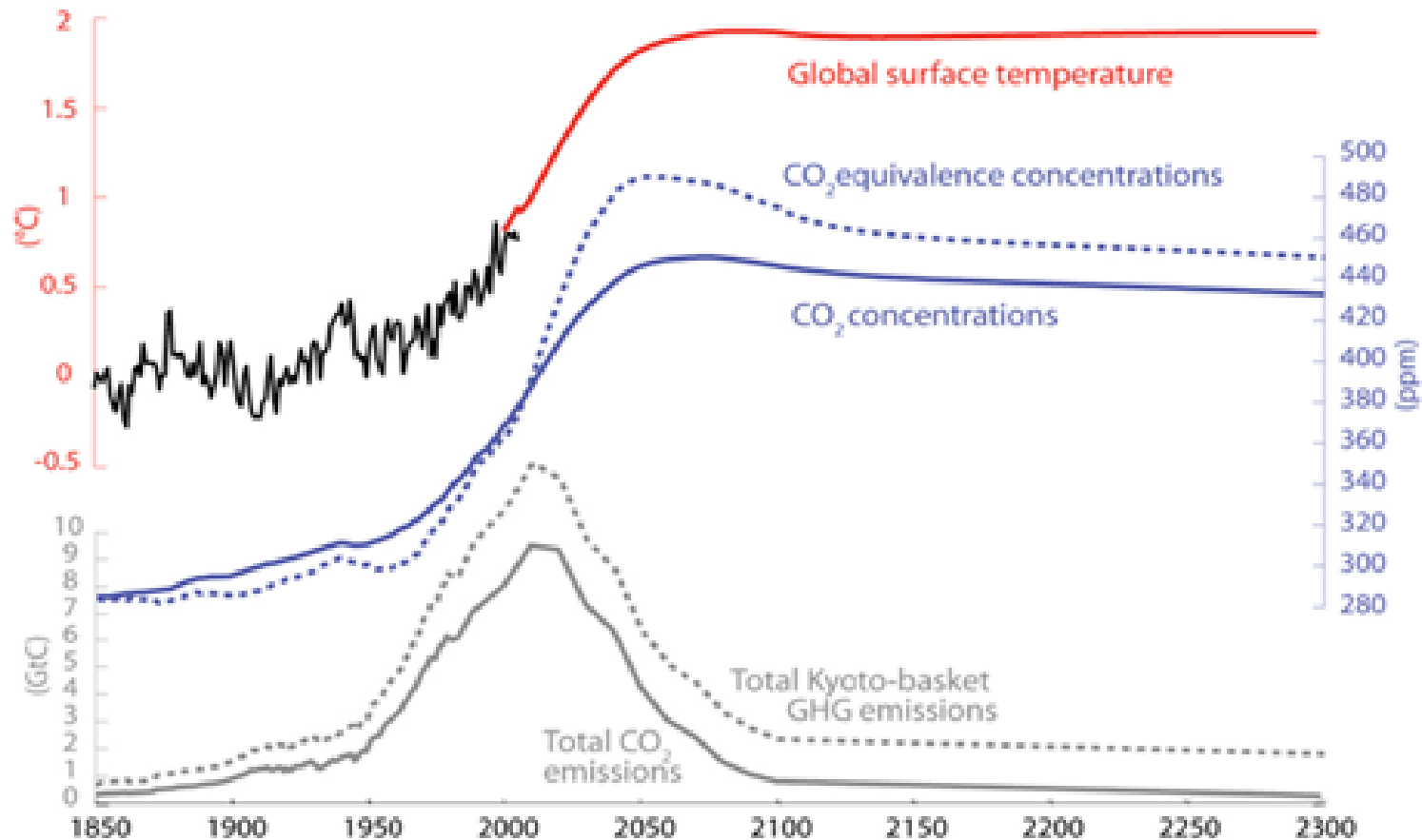


CO₂-level at pre-industrial time: ca 280 ppm.

May 2013: 400 ppm!

May 2018: 410 ppm...

1.5 degree target and corresponding remaining CO₂-budget

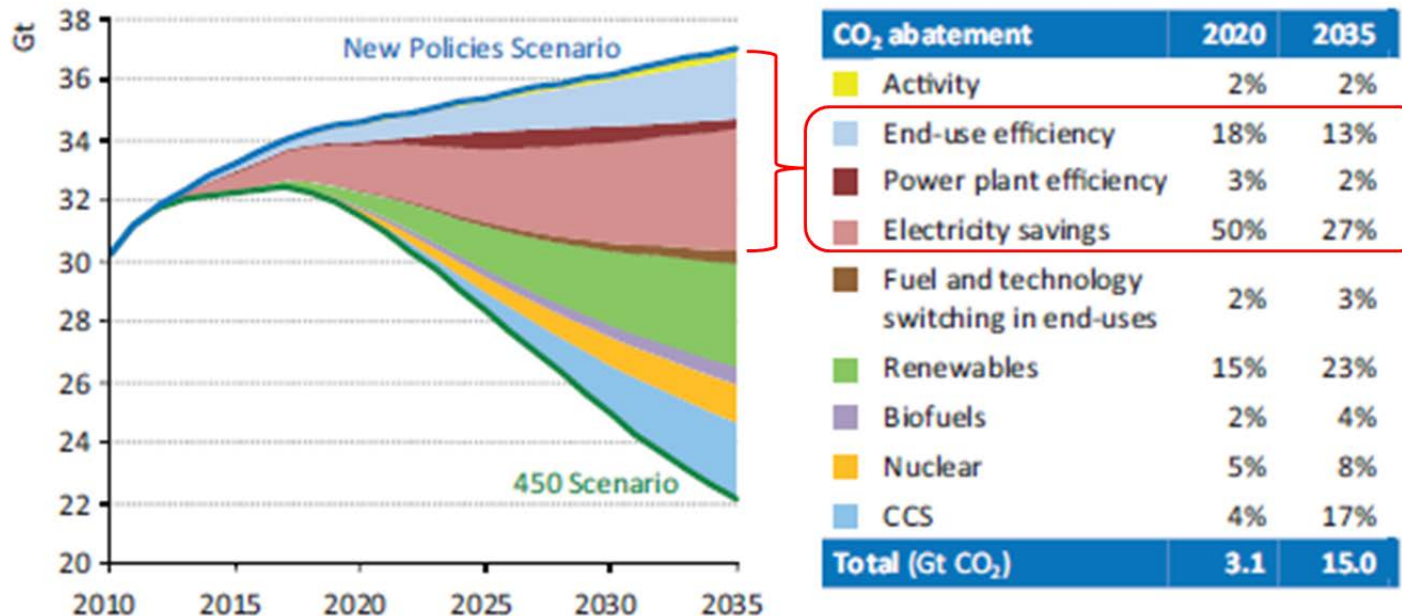


2018: Remaining CO₂-budget for a 1.5 degree target: 420-570 Gt

<https://www.ipcc.ch/> and <http://www.climatechangenews.com/2018/10/08/37-things-need-know-1-5c-global-warming/>

Need to address both Renewable Energy and Energy Efficiency *at the same time*

Figure 8.7 ▷ Global energy-related CO₂ emissions abatement in the 450 Scenario relative to the New Policies Scenario

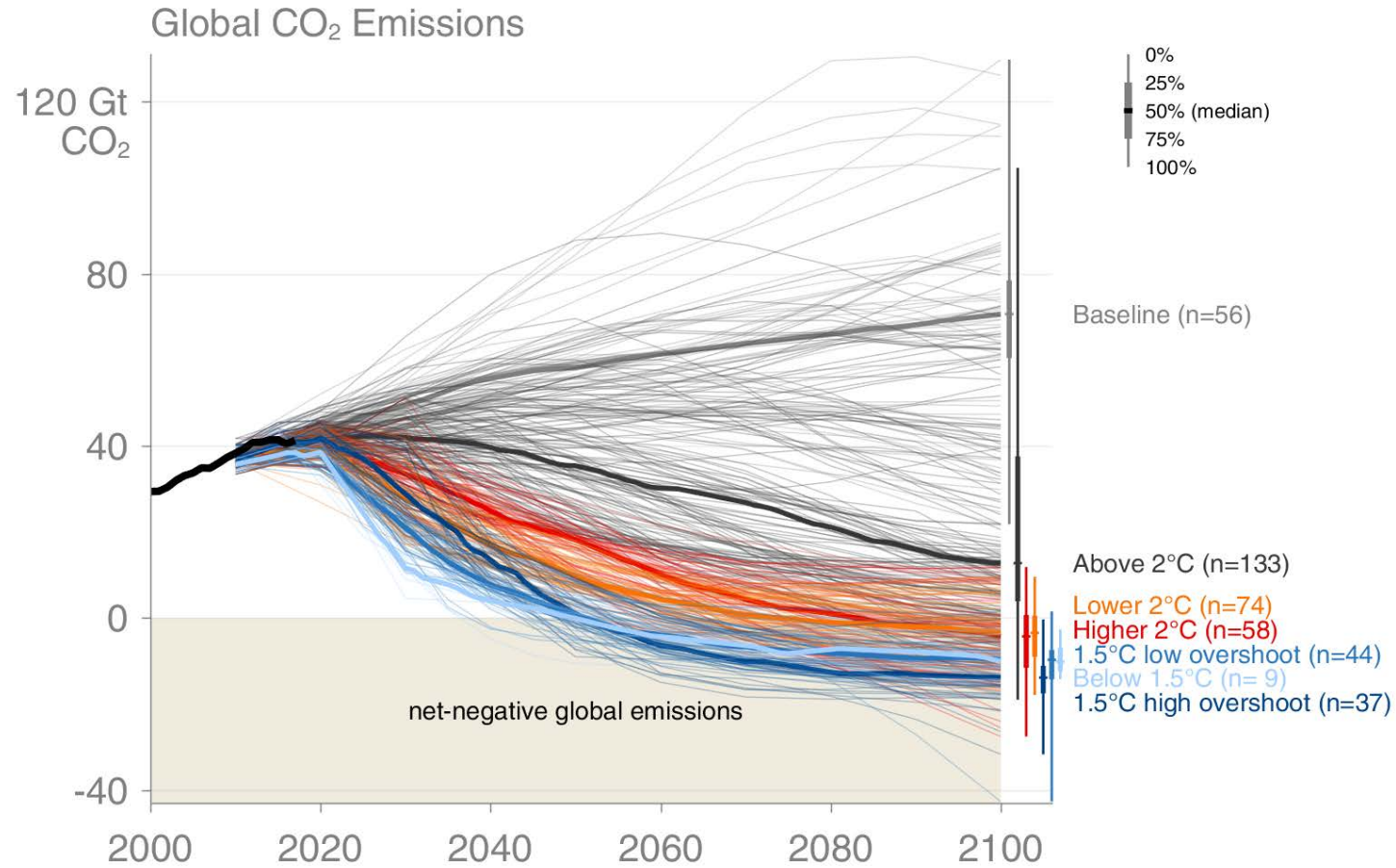


Notes: Activity describes changes in the demand for energy services, such as lighting or transport services, due to price responses. Power plant efficiency includes emissions savings from coal-to-gas switching. For more detail on the decomposition technique used, see Box 9.4 in Chapter 9.

Check <https://www.iea.org/tcep/> for updates and interactive graphics!

The IPCC Special Report on “Global Warming of 1.5°C”

The IPCC Special Report on “Global Warming of 1.5°C” presented new scenarios:
1.5°C scenarios require halving emissions by ~2030, net-zero by ~2050, and negative thereafter



© Global Carbon Project • Data: IAMC 1.5°C Scenario Explorer (hosted by IIASA)

Net emissions include those from land-use change and bioenergy with CCS.

Source: [Huppmann et al 2018](#); [IAMC 1.5C Scenario Database](#); [IPCC SR15](#); [Global Carbon Budget 2018](#)

Table of Contents

1

Introduction to European Regulations

2

Current EU Lighting Regulations

245/2009 – Tertiary Sector (Professional) Lamps

244/2009 – Household Non-Directional Lamps

1194/2012 – Directional Lamps and LEDs

874/2012 – Energy Label for Lamps and Luminaires

3

Future EU Lighting Regulations

European-wide Requirements for Energy and Labelling

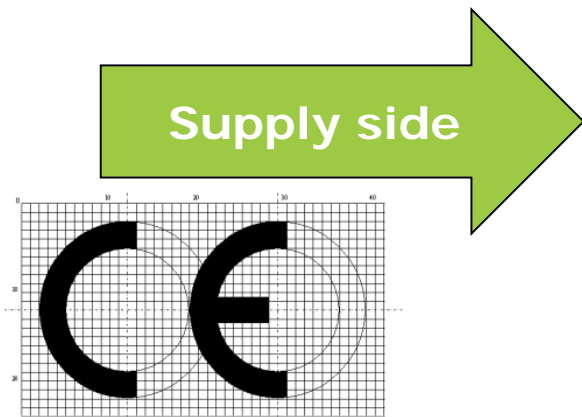
- One Regulation for all 28 Member States and 3 European Economic Area countries
 - Second largest market in the world¹
 - 515 million people in EU + EEA (2017)
 - US\$20 trillion GDP (Nominal, 2018)
 - Impact **outside** EU + EEA – Middle East, North Africa, Eastern Europe, etc.
- All Member States take part in the decision
- New regulation comes into force at same time in every country
- Everyone must follow the same rules – no exceptions
- One Market



¹ GDP ranking: USA: 21 Trillion (2019); Europe + EEA: 20 Trillion (2018); China: 9.2 Trillion (2019)

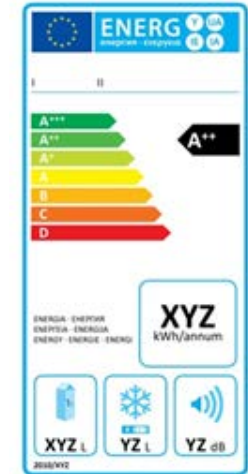
Ecodesign and Energy Labelling Influence the Market for Products

Ecodesign Directive 2009/125/EC



Efficient
products

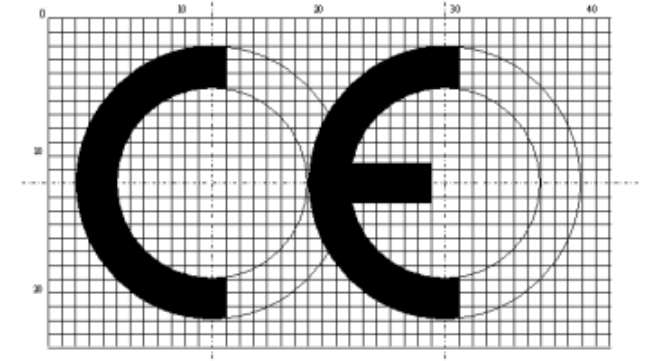
Energy Labelling Directive 2010/30/EU



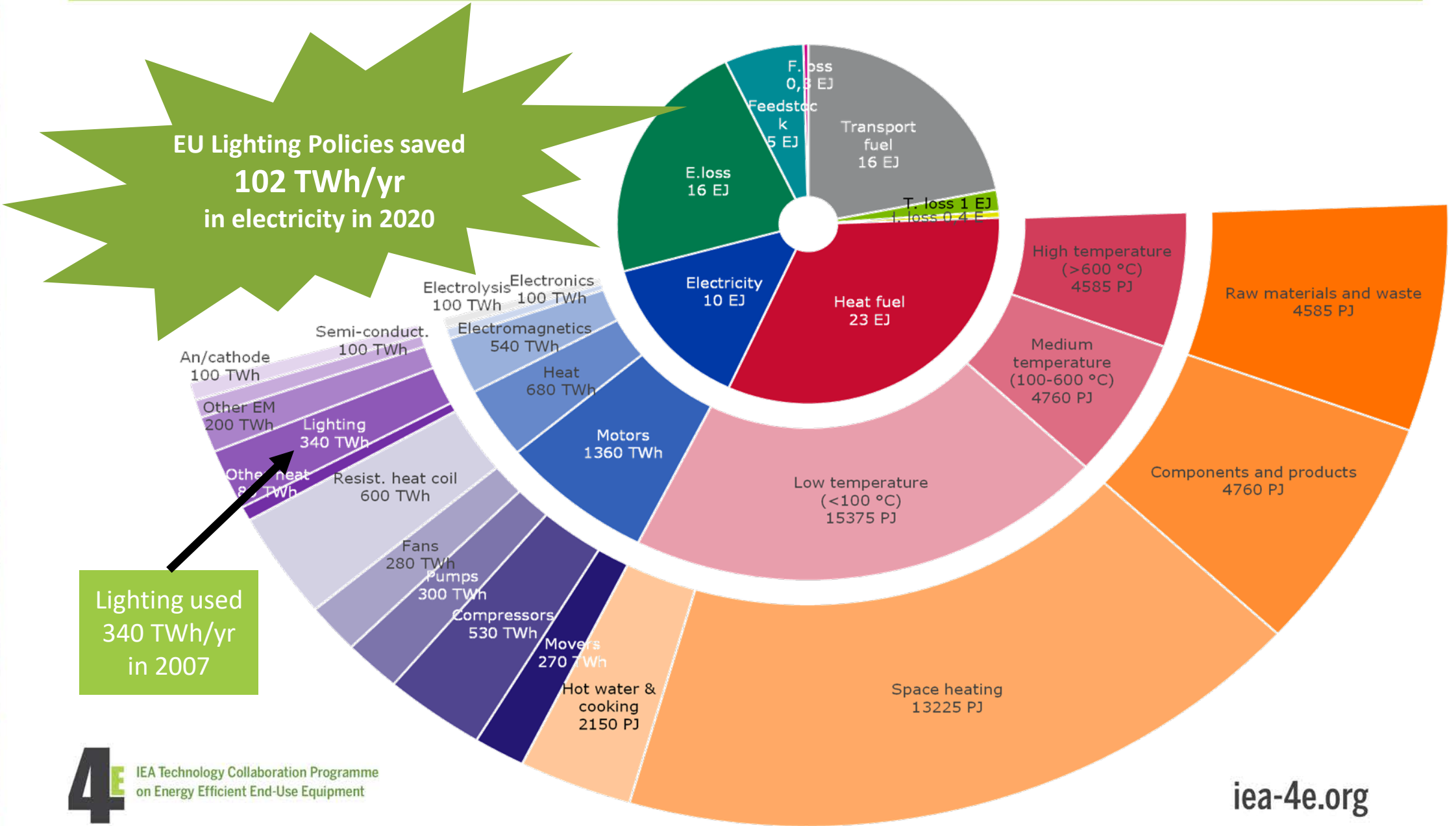
- Both are framework directives, defining the rules for establishing product-specific mandatory requirements:
 - Ecodesign: product performance and quality
 - Energy Labelling: energy label
- The combined effect – **push and pull** - ensures a sustained market transformation

Ecodesign Directive - 2009/125/EC - Overview

- Mandatory (Framework Directive 2009/125/EC)
- Reduces environmental impact of products
- Looks at production, distribution, use and end-of-life management of energy-related products
 - Energy related impacts (most important)
 - Consumption of materials/resources
 - Waste generation and use of hazardous substances
- Product design phase is crucial
 - Over 80% of product-related environmental impacts are determined in the design phase
 - Life-Cycle Assessment is important
- Ecodesign sets limits on energy-using (*e.g.*, lighting, motors, air conditioners) and energy-related products (*e.g.*, windows, showerheads)

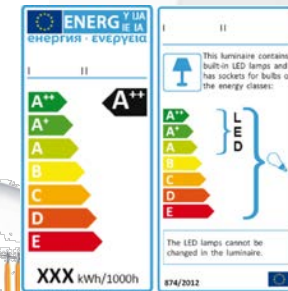


EU Energy Consumption by End-Use (2007)

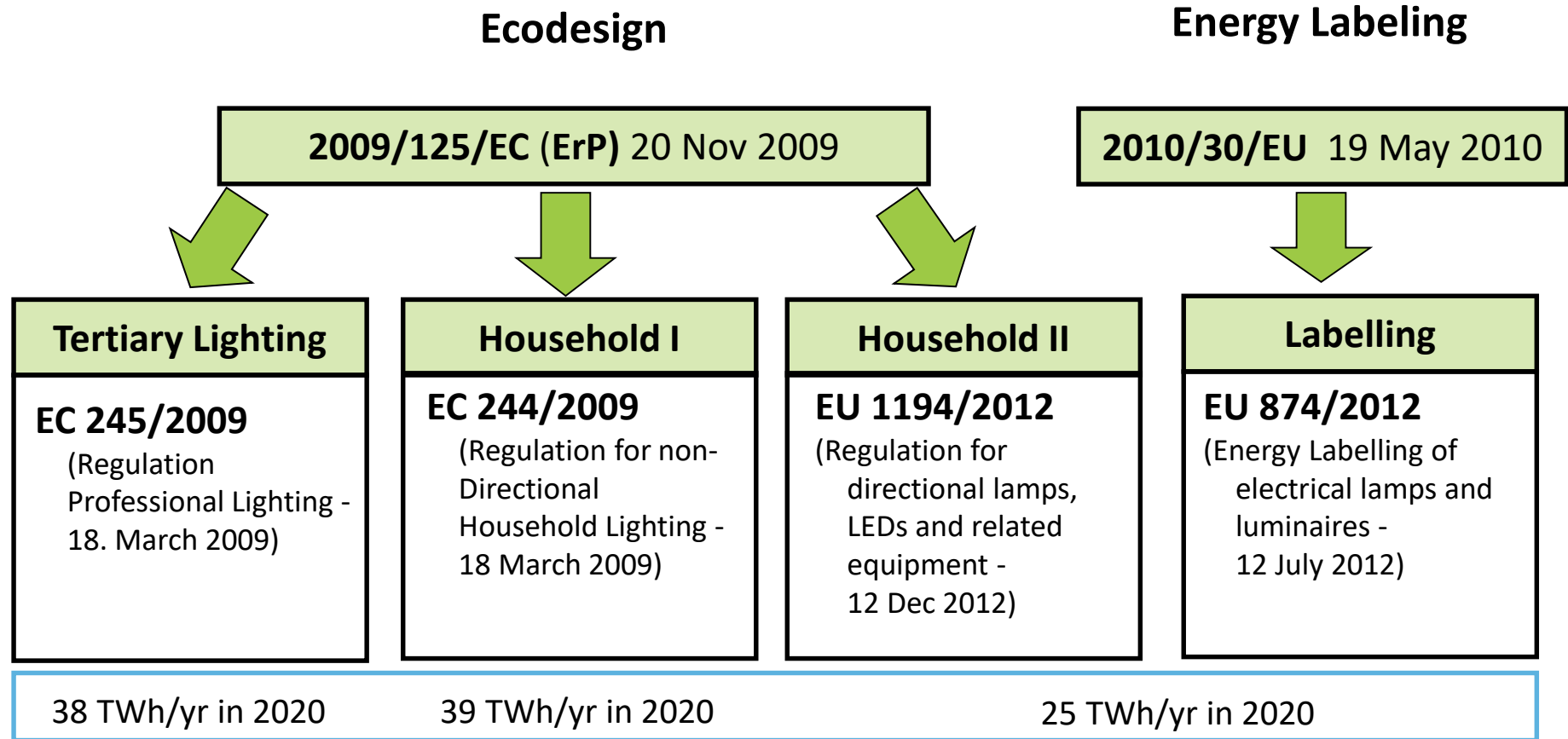


High-Level Overview of European Lighting Policy...

- All light sources and equipment is covered and regulation, except for special purpose (exempted)
- Set mandatory labelling requirements on lighting technologies starting in 1998 (EU Directive 98/11/EC), revised in 2012
- Set mandatory ecodesign requirements on lighting products starting in 2009
- Four policies: 3 Ecodesign (244/2009, 245/2009, 1194/2012) and 1 Energy Labelling (874/2012) – all are still in effect today
- DG Energy led a review which culminated in “one lighting regulation” under Ecodesign for all products
 - Member States voted to adopt it in December 2018
 - OJEU will publish it in October 2019
 - Two tiers, starts to take effect in September 2021



Current European Lighting Regulations



Savings:

38 TWh/yr in 2020

39 TWh/yr in 2020

25 TWh/yr in 2020

- Total estimate of savings in 2020 from these regulatory policies: **102 TWh/yr**

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Future EU Lighting Regulations

Overview of Process and Documents

- European Commission worked for >3 years on this review, involving Member States, the industry, the public and NGOs
- Policy decision to establish one regulation for all light sources, including all technologies and applications
- December 2018, Member States voted to adopt the ecodesign regulation and advised on the energy labelling regulation
- Regulations are presented across four documents:
 - Ecodesign regulation + Annexes to Ecodesign regulation
 - Energy Labelling regulation + Annexes to Energy Labelling regulation
- Finalised in October 2019 when they are published in the Official Journal of the European Union (OJEU)



New Regulation: 1 Ecodesign and 1 Energy Labelling

[Click here](#) to download the two ecodesign requirements:

1. 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
2. **ANNEXES** to 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

The two energy labelling files:

3. [Click here](#) for: COMMISSION DELEGATED REGULATION (EU) .../... of XXX 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
4. [Click here](#) for: **ANNEXES** to the Commission Delegated Regulation 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

Articles in the new Ecodesign Regulation for Lighting



Brussels, XXX
D059564/02
[...] (2019) XXX draft

COMMISSION REGULATION (EU) .../...

of XXX

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

(Text with EEA relevance)

EN

EN

- Preambles (*explaining the background and the content in principle*)
- Article 1: Subject matter and scope
- Article 2: Definitions
- Article 3: Ecodesign requirements (*go to the Annexes*)
- Article 4: Removal of light sources and separate control gears
- Article 5: Conformity assessment
- Article 6: Verification procedure for market surveillance purposes
- Article 7: Circumvention
- Article 8: Indicative benchmarks
- Article 9: Review
- Article 10: Repeal
- Article 11: Entry into force and application

Scope of Coverage

- Sets requirements for light sources and separate control gears for light sources, including those placed on the market in a containing product

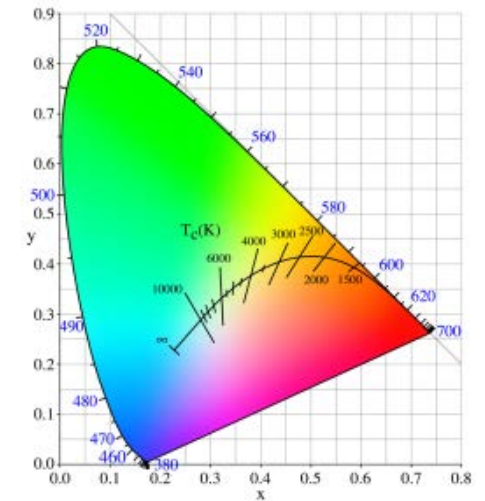
Article 2 Definitions

For the purpose of this Regulation, the following definitions shall apply:

- (1) 'light source' means an electrically operated product intended to emit, or, in the case of a non-incandescent light source, intended to be possibly tuned to emit, light, or both, with all of the following optical characteristics:
 - (a) chromaticity coordinates x and y in the range
 $0,270 < x < 0,530$ and
 $-2,3172 x^2 + 2,3653 x - 0,2199 < y < -2,3172 x^2 + 2,3653 x - 0,1595$;
 - (b) a luminous flux < 500 lumen per mm^2 of projected light-emitting surface area as defined in Annex I;
 - (c) a luminous flux between 60 and 82 000 lumen;
 - (d) a colour rendering index (CRI) > 0 ;

using incandescence, fluorescence, high-intensity discharge, inorganic light emitting diodes (LED) or organic light emitting diodes (OLED), or their combinations as lighting technology, and that can be verified as a light source according to the procedure of Annex IV.

High-pressure sodium (HPS) light sources that do not fulfil condition (a) are considered light sources for the purposes of this Regulation.



Ecodesign – *One Equation* instead of a lot of equations and tables...

1. Energy efficiency requirements:
 - (a) From 1 September 2021, the declared power consumption of a light source P_{on} shall not exceed the maximum allowed power P_{onmax} (in W), defined as a function of the declared useful luminous flux Φ_{use} (in lm) and the declared colour rendering index CRI (-) as follows:

$$P_{onmax} = C \cdot (L + \Phi_{use} / (F \cdot \eta)) \cdot R;$$

where:

- The values for threshold efficacy (η in lm/W) and end loss factor (L in W) are specified in Table 1, depending on the light source type. They are constants used for computations and do not reflect true parameters of light sources. The threshold efficacy is not the minimum required efficacy; the latter can be computed by dividing the useful luminous flux by the computed maximum allowed power.
- Basic values for correction factor (C) depending on light source type, and additions to C for special light source features are specified in Table 2.
- Efficacy factor (F) is:
 - 1,00 for non-directional light sources (NDLS, using total flux)
 - 0,85 for directional light sources (DLS, using flux in a cone)
- CRI factor (R) is:
 - 0,65 for $CRI \leq 25$;
 - $(CRI+80)/160$ for $CRI > 25$, rounded to two decimals.

Ecodesign – One Equation

$$P_{\text{onmax}} = C \cdot (L + \Phi_{\text{use}} / (F \cdot \eta)) \cdot R$$

- The Threshold efficacy (η) and end loss factor (L) for various light sources are given in Table 1.
- Additional power allowances are given in Table 2 for directional lamps, special light colour and technologies, etc.
- Key points:
 - CFLi and T12 Fluorescent phased out from 1 September 2021
 - Certain halogen and T8 fluorescent phased out from 1 September 2023
 - LED regulation $\sim 90.7 \text{ lm/W}$ (800 lm non-directional lamp, mains voltage, CRI 80)

Table 1 — Threshold efficacy (η) and end loss factor (L)

<u>Light source description</u>	η	L
	[lm/W]	[W]
LFL T5-HE	98,8	1,9
LFL T5-HO, $4000 \leq \Phi \leq 5000 \text{ lm}$	83,0	1,9
LFL T5-HO, other lm output	79,0	1,9
FL T5 circular	79,0	1,9
FL T8 (including FL T8 U-shaped)	89,7	4,5
From 1 September 2023, for FL T8 of 2-, 4- and 5-foot	120,0	1,5
Magnetic induction light source, any length/flux	70,2	2,3
CFLni	70,2	2,3
FL T9 circular	71,5	6,2
HPS single-ended	88,0	50,0
HPS double-ended	78,0	47,7
MH $\leq 405 \text{ W}$ single-ended	84,5	7,7
MH $> 405 \text{ W}$ single-ended	79,3	12,3
MH ceramic double-ended	84,5	7,7
MH quartz double-ended	79,3	12,3
Organic light-emitting diode (OLED)	65,0	1,5
Until 1 September 2023: HL G9, G4 and GY6.35	19,5	7,7
HL R7s $\leq 2700 \text{ lm}$	26,0	13,0
Other light sources in scope not mentioned above	120,0	1,5*

* For connected light sources (CLS) a factor $L=2,0$ shall be applied.

Ecodesign – Functional Requirements

All from 1 September 2021:

- Colour rendering
- Displacement factor (DF, $\cos \phi$)
- Lumen maintenance factor ✓
- Survival factor
- Colour consistency
- Flicker (PstLM) ✓
- Stroboscopic effect (SVM) ✓

Information requirements – for the lamp, packaging and documentation.

Table 4 — Functional requirements for light sources

Colour rendering	CRI ≥ 80 (except for HID with $\Phi_{\text{use}} > 4 \text{ klm}$ and for light sources intended for use in outdoor applications, industrial applications or other applications where lighting standards allow a CRI <80 , when a clear indication to this effect is shown on the light source packaging and in all relevant printed and electronic documentation)
Displacement factor (DF, $\cos \phi_1$) at power input P_{on} for LED and OLED MLS	No limit at $P_{\text{on}} \leq 5 \text{ W}$, DF $\geq 0,5$ at $5 \text{ W} < P_{\text{on}} \leq 10 \text{ W}$, DF $\geq 0,7$ at $10 \text{ W} < P_{\text{on}} \leq 25 \text{ W}$ DF $\geq 0,9$ at $25 \text{ W} < P_{\text{on}}$
Lumen maintenance factor (for LED and OLED)	The lumen maintenance factor $X_{\text{LMF}}\%$ after endurance testing according to Annex V shall be at least $X_{\text{LMF,MIN}}\%$ calculated as follows: $X_{\text{LMF,MIN}}\% = 100 * e^{\frac{(3\ 000 * \ln(0,7))}{L_{70}}}$ where L_{70} is the declared $L_{70}B_{50}$ lifetime (in hours) If the calculated value for $X_{\text{LMF,MIN}}$ exceeds 96,0 %, an $X_{\text{LMF,MIN}}$ value of 96,0 % shall be used
Survival factor (for LED and OLED)	Light sources should be operational as specified in row “Survival factor (for LED and OLED)” of Annex IV, Table 6, following the endurance testing given in Annex V.
Colour consistency for LED and OLED light sources	Variation of chromaticity coordinates within a six-step MacAdam ellipse or less.
Flicker for LED and OLED MLS	Pst LM $\leq 1,0$ at full-load
Stroboscopic effect for LED and OLED MLS	SVM $\leq 0,4$ at full-load (except for HID with $\Phi_{\text{use}} > 4 \text{ klm}$ and for light sources intended for use in outdoor applications, industrial applications or other applications where lighting standards allow a CRI <80)

Lumen Maintenance Factor – a new test method (see Annex V)

- 3600 hours – long duration switching cycles: 2.5h on and 0.5h off
- 1200 switching cycles
- Measure light output before and after, lumen maintenance requirement that corresponds to declared lifetime
- Over 26,200 hr lifetime simply use 96.0%

$$X_{LMF,MIN}\% = 100 \times e^{\frac{(3000 \times \ln(0.7))}{L_{70}}}$$

Lumen maintenance factor (for LED and OLED)	<p>The lumen maintenance factor $X_{LMF}\%$ after endurance testing according to Annex V shall be at least $X_{LMF,MIN}\%$ calculated as follows:</p> $X_{LMF,MIN}\% = 100 * e^{\frac{(3\ 000 * \ln (0.7))}{L_{70}}}$ <p>where L_{70} is the declared $L_{70}B_{50}$ lifetime (in hours) If the calculated value for $X_{LMF,MIN}$ exceeds 96,0 %, an $X_{LMF,MIN}$ value of 96,0 % shall be used</p>
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Flicker and Stroboscopic effect

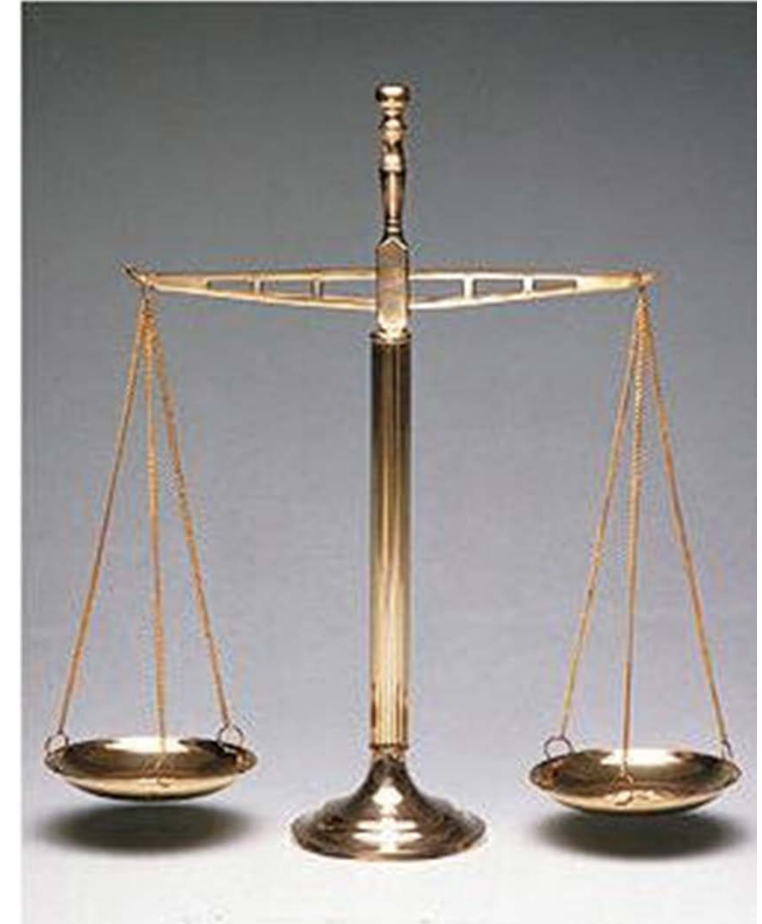
- Many publications define a **visible flicker metric** (IEC, IEEE, LRC, CEC) whereas other publications reference one of these (CIE, NEMA)
- Some include **stroboscopic effects** (CIE, IEEE, NEMA)
- Only one covers most **known health effects**. (IEEE 1789: 2015)
- Non-visual effects have been reported as physiological and psychological manifestations including (1) Migraine; (2) Eyestrain; (3) Seizures; (4) Vertigo; (5) Anxiety; (6) Autistic behaviour; (7) Reduction in task performance

Flicker for LED and OLED MLS	$P_{st} LM \leq 1,0$ at full-load
Stroboscopic effect for LED and OLED MLS	$SVM \leq 0,4$ at full-load (except for HID with $\Phi_{use} > 4$ klm and for light sources intended for use in outdoor applications, industrial applications or other applications where lighting standards allow a CRI<80)

Measurement Uncertainty and Verification Tolerances

Table 6 Verification tolerances

Parameter	Sample size	Verification tolerances
Full-load on-mode power P_{on} [W]:		
$P_{on} \leq 2W$	10	The determined value shall not exceed the declared value by more than 0,20 W.
$2W < P_{on} \leq 5W$	10	The determined value shall not exceed the declared value by more than 10 %.
$5W < P_{on} \leq 25W$	10	The determined value shall not exceed the declared value by more than 5 %.
$25W < P_{on} \leq 100W$	10	The determined value shall not exceed the declared value by more than 5 %.
$100W < P_{on}$	10	The determined value shall not exceed the declared value by more than 2,5 %.
Displacement factor [θ-I]	10	The determined value shall not be less than the declared value minus 0,1 units.
Useful luminous flux Φ_{use} [lm]	10	The determined value shall not be less than the declared value minus 10 %.
No-load power P_{no}, Standby power P_{sb} and Networked standby power P_{net} [W]	10	The determined value shall not exceed the declared value by more than 0,10 W.
CRI [θ-100]	10	The determined value shall not be less than the declared value by more than 2,0 units.
Flicker [Pst LM] and stroboscopic effect [SVM]	10	The determined value shall not exceed the declared value by more than 10 %.
Colour consistency [MacAdam ellips steps]	10	The determined number of steps shall not exceed the declared number of steps. The centre of the MacAdam ellipse shall be the centre declared by the supplier with a tolerance of 0,005 units.
Beam angle (degrees)	10	The determined value shall not deviate from the declared value by more than 25 %.
Control gear efficiency [0-1]	3	The determined value shall not be less than the declared value minus 0,05 units.
Lumen maintenance factor (for LED and OLED)	10	The determined X_{LMF} % of the sample following the test in Annex V of this Regulation shall not be less than $X_{LMF, MIN}$ % ²¹ .
Survival factor (for LED and OLED)	10	At least 9 light sources of the test sample must be operational after completing the test in Annex V of this Regulation.
Excitation purity [%]	10	The determined value shall not be less than the declared value minus 5 %.
Correlated colour temperature [K]	10	The determined value shall not deviate from the declared value by more than 10 %.



New requirements promoting a circular economy

The concept of "containing product" is introduced to cope with integrated luminaires.

In case the light source and/or driver can't be removed or replaced, *the whole product is considered* a light source and has to meet all requirements.

Article 4

Removal of light sources and separate control gears

1. Manufacturers, importers or authorised representatives of containing products shall ensure that light sources and separate control gears can be replaced with the use of common available tools and without permanent damage to the containing product, unless a technical justification related to the functionality of the containing product is provided in the technical documentation explaining why the replacement of light sources and separate control gear is not appropriate.

The technical documentation shall also provide instructions on how light sources and separate control gears can be removed without being permanently damaged for verification purposes by market surveillance authorities.
2. Manufacturers, importers or authorised representatives of containing products shall provide information about the replaceability or non-replaceability of light sources and control gears by end-users or qualified persons without permanent damage to the containing product. Such information shall be available on a free-access website. For products sold directly to end-users, this information shall be on the packaging, at least in the form of a pictogram, and in the user instructions.
3. Manufacturers, importers or authorised representatives of containing products shall ensure that light sources and separate control gears can be dismantled from containing products at end of life. Dismantling instructions shall be available on a free access website.



Thank you

Any questions?

<https://ssl.iea-4e.org/>
SSL.Annex@gmail.com