Ecodesign preparatory study
Light Sources, Lot 8/9/19

Final presentation for the
Ecodesign Consultation Forum
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Assignment

Preparatory study on Light Sources:

- Prepare further and/or **more advanced** ecodesign and/or labelling **requirements**.
- **Build upon and advance existing** Regulations.
- Aim at setting **more ambitious targets for all** lighting products currently regulated.
- Identify **other lighting products to be included** in the study.
- Explore feasibility to **unify all four existing regulations into one** (or only the three ecodesign regulations)
- **Harmonise projections for past and future lighting energy use** (also considering parallel Lot 37 study on Lighting Systems)

Existing

Ecodesign Directive 2009/125/EC

Method/conditions for ecodesign
Eligibility criteria
Least Life Cycle Cost (LLCC) target
No negative impacts (art. 15)

Implementations for lighting

CR (EC) No. 244/2009
amend. CR (EU) No. 2015/1428

CR (EC) No. 245/2009
amend. CR (EC) No. 347/2010

CR (EU) No. 1194/2012

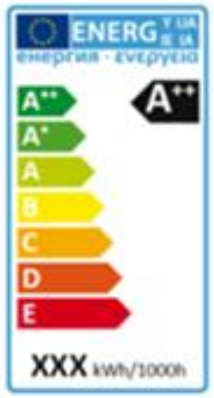
Labelling Directive 2010/30/EU

Method/conditions/responsibilities for (energy) labelling and other product information
(similar criteria) (revision ongoing)

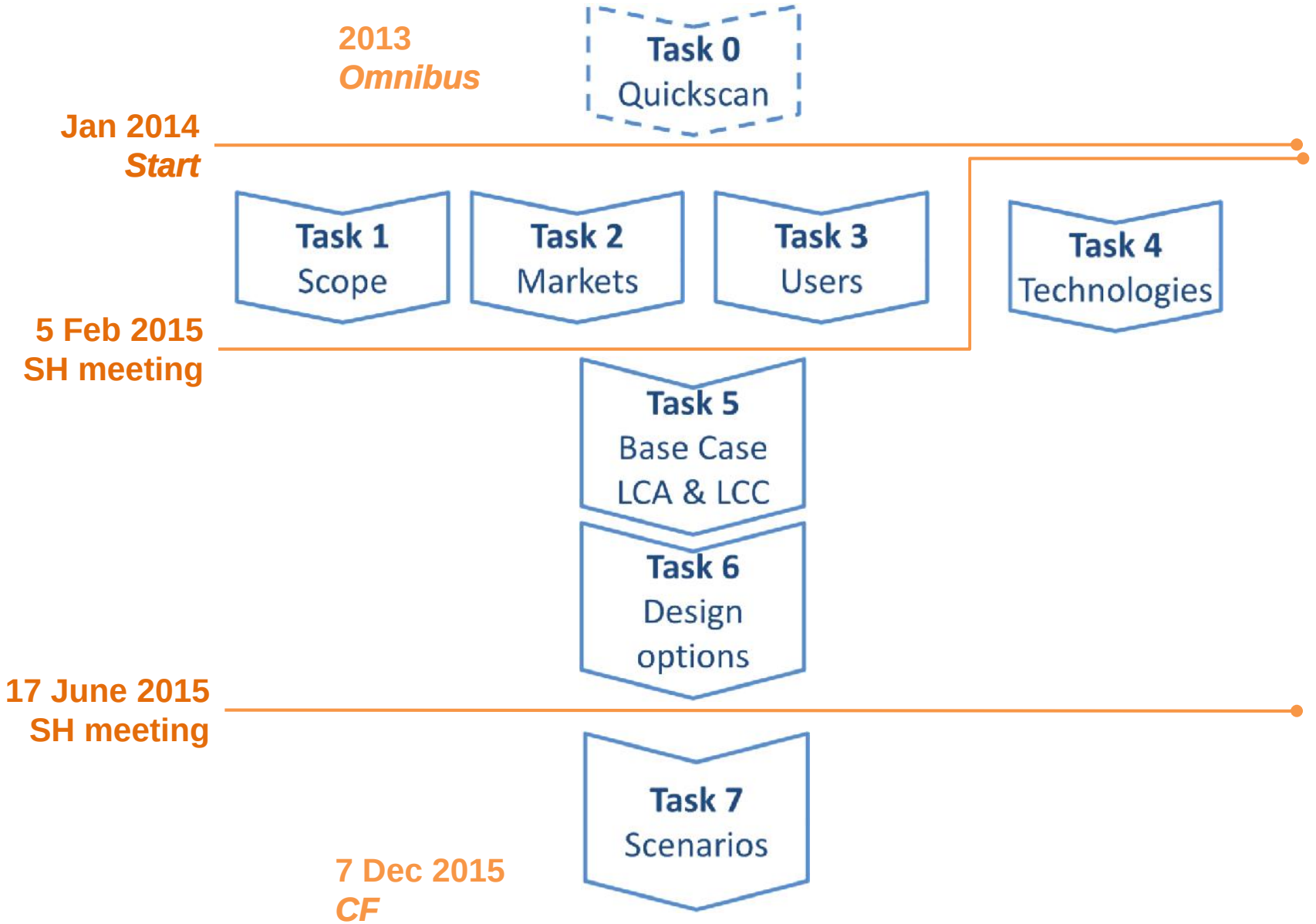
Implementations for lighting

CDR (EU) 874/2012
Amend. CDR (EU) No. 518/2014

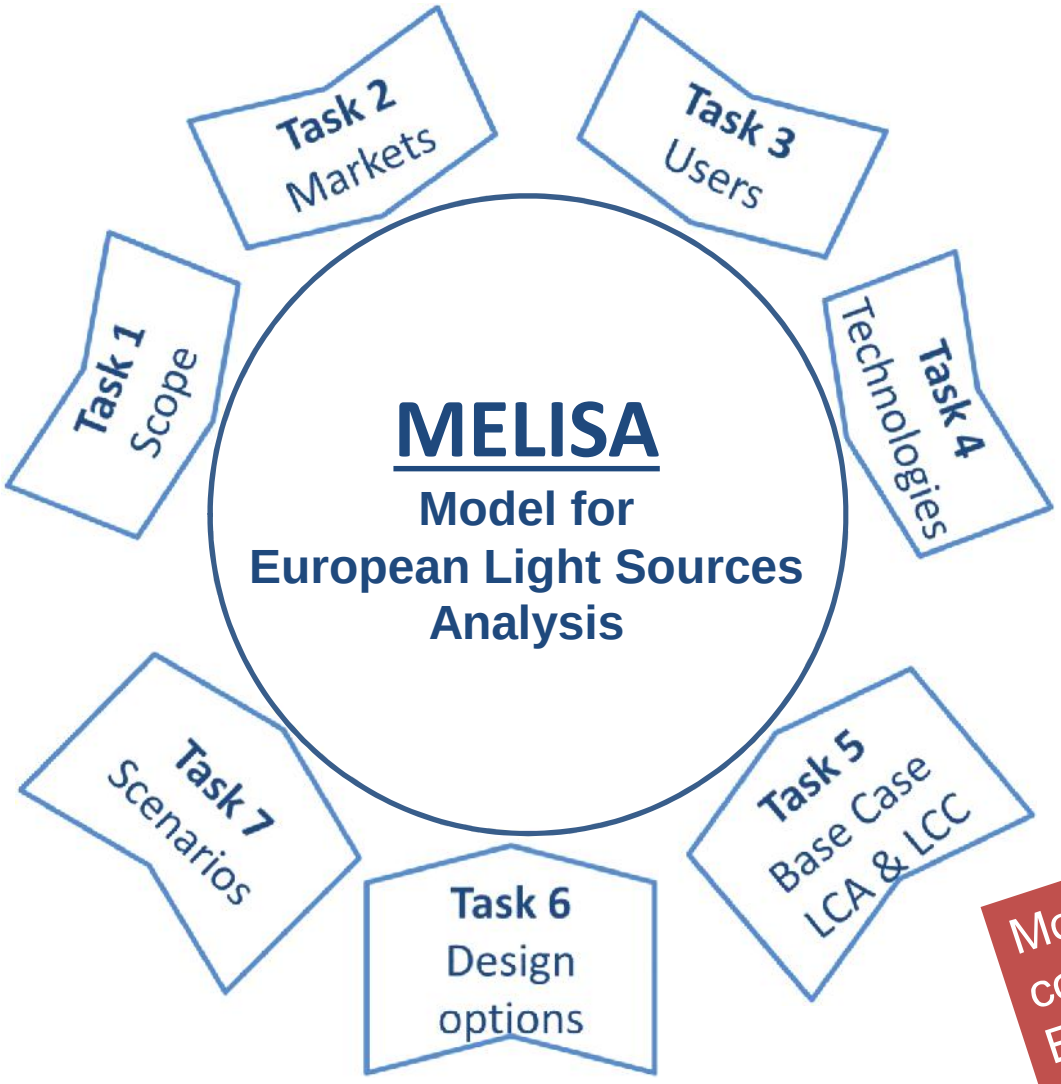
CR = Commission Regulation
CDR= Commission Delegated Regulation



Project Structure & Stakeholder involvement



Data analysis



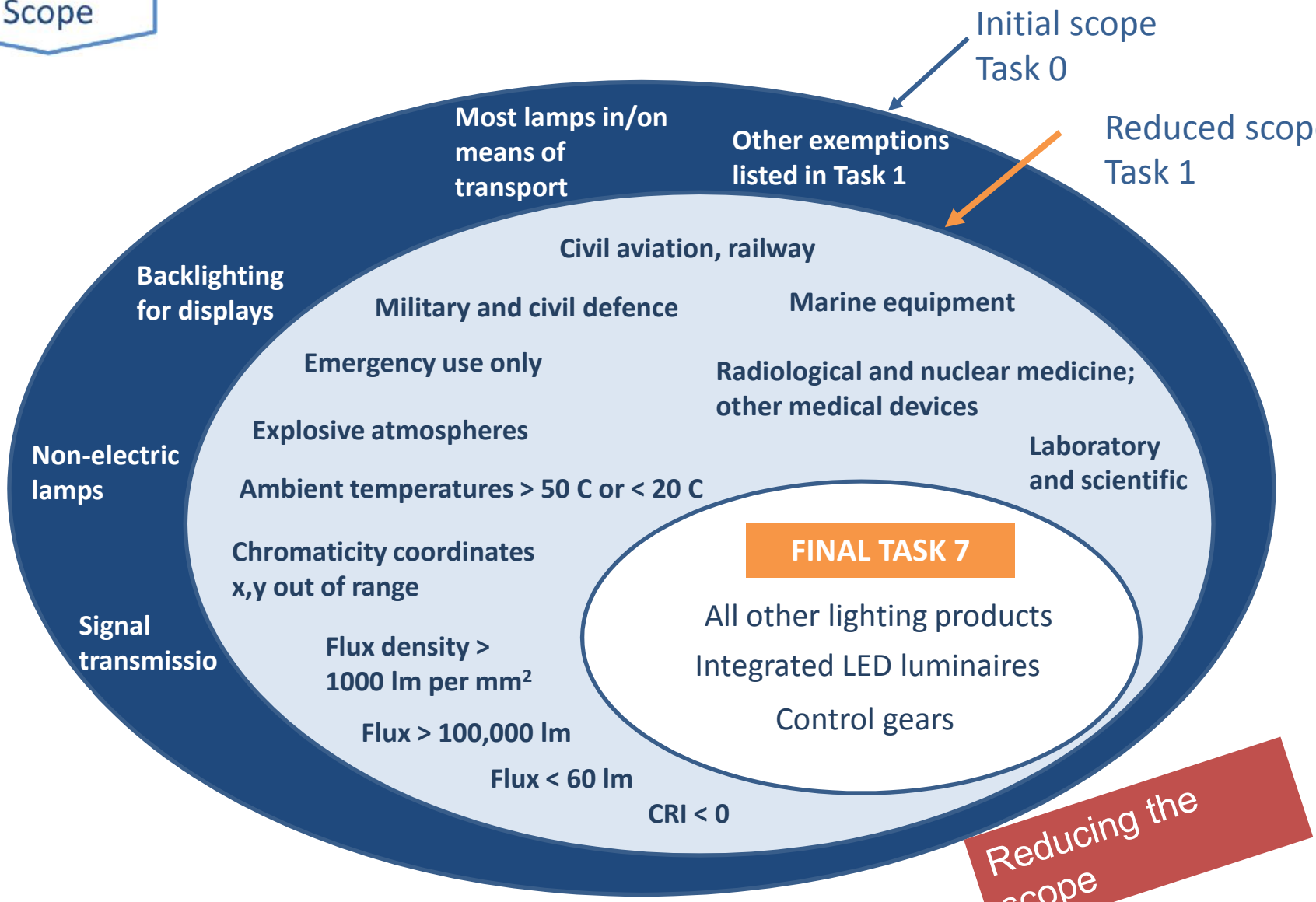
Most comprehensive EU light sources model ever..

MELISA parameters

Model Input data (per BC)	Intermediate results	Output data (EU-28 total)
Sales in EU-28 per year	Stock in EU-28 per year	
Avg. useful lifetime (hours)	Avg. useful lifetime (years)	
Avg. annual operating hours (h/a)		EU-28 total installed capacity (Tlm)
Avg. unit capacity (lm)	Avg. unit power (W)	EU-28 total installed power (GW)
Avg. sales efficiency (lm/W)	Avg. stock efficiency (lm/W)	Electric Energy (TWh/a)
Avg. unit price (euros)		
Taxes (VAT 20% residential)	Purchase costs (billion euros)	
Avg. unit install cost (euros)		Acquisition costs (billion euros)
Electricity rates (euros/kWh)	Electricity costs (billion euros)	
Escalation rate (4% /a)		Running costs (billion euros)
Avg. unit maintenance (euros/a)		Total consumer expense (bn euros)

Task 1/7
Scope

SCOPE



Task 1/7
Scope

Standards

- Potential issues for **mandates** to ESO's:
  - LED lumen maintenance & life (**accelerated testing**)
  - **dimmer compatibility** (work ongoing, expected 2018)
  - **colour rendering metrics** across lamp types (new CRI)
  - goniophotometric **testing of directional lamps** or not (costs)
- Reliable and practical **tests** for **special purpose lamps and other exemptions**.
-
- Tests and calculation methods **flickering/ stroboscopic** effect

Task 1/7
Scope

Legislation

TASK 1 (ca. Jan. 2015):

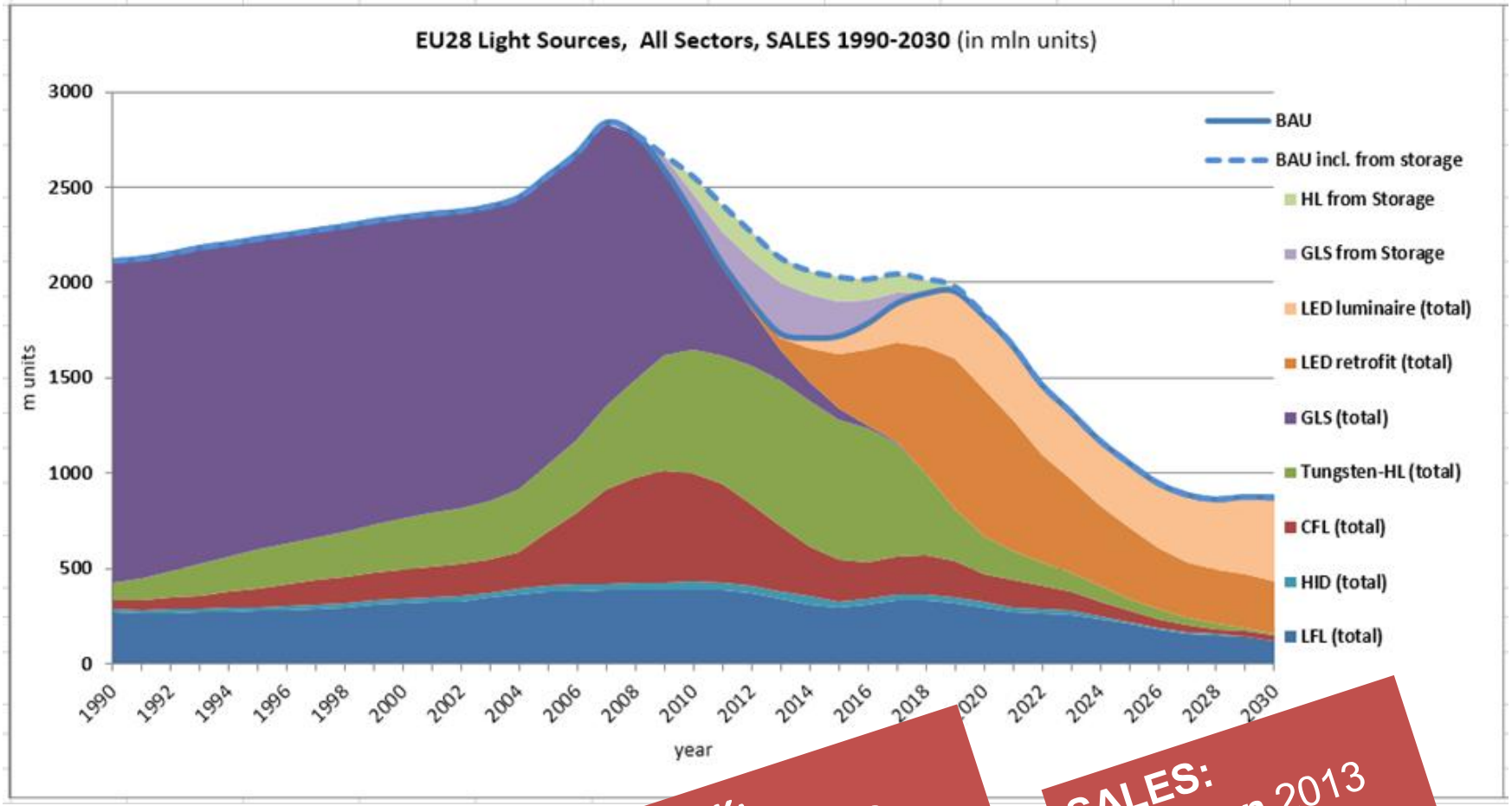
- **EU**-legislation has the **broadest scope**
- Overall EU-legislation has **most stringent** requirements
- EU Energy labelling covers **most lamp types**
- EU **labelling/information** requirements are very **comprehensive** compared to some other countries.

UPDATE: 26 Nov. 2015

- **Japan** is going to ban all bulbs and fluorescents by 2020, only LED;
- EU no longer leading and danger of dumping if the current situation persists.

Task 2
Market

Sales [BAU]



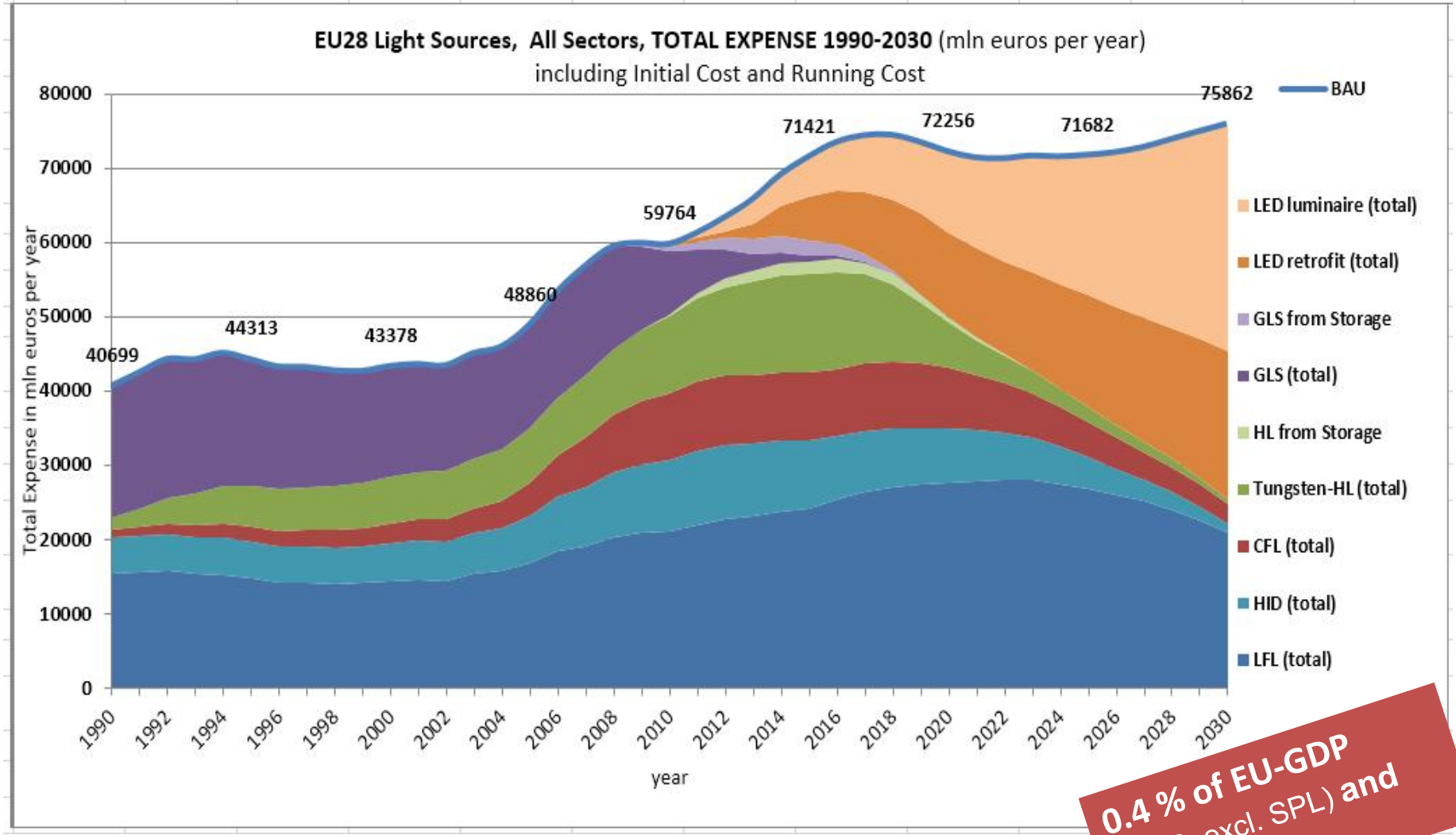
residential 62% (2013)

STOCK:
11 billion 2013
~15 billion 2030

SALES:
2.1 billion 2013
0.9 billion 2030

Task 2/7
Market

Consumer expenditure [BAU]

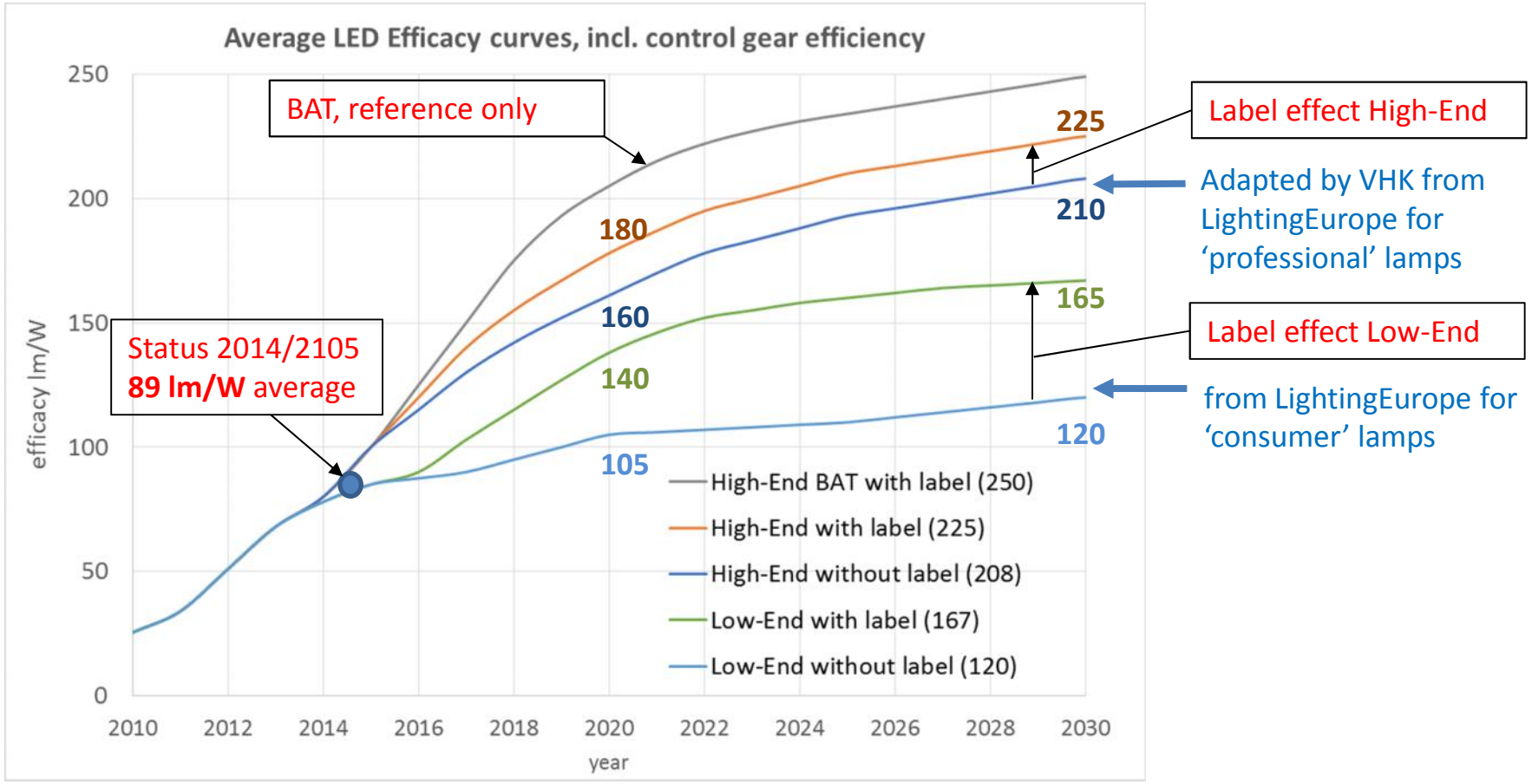


Residential 43%, €118 /household [2013]

0.4 % of EU-GDP (2013, excl. SPL) and rising

Task 4/7
Technologies

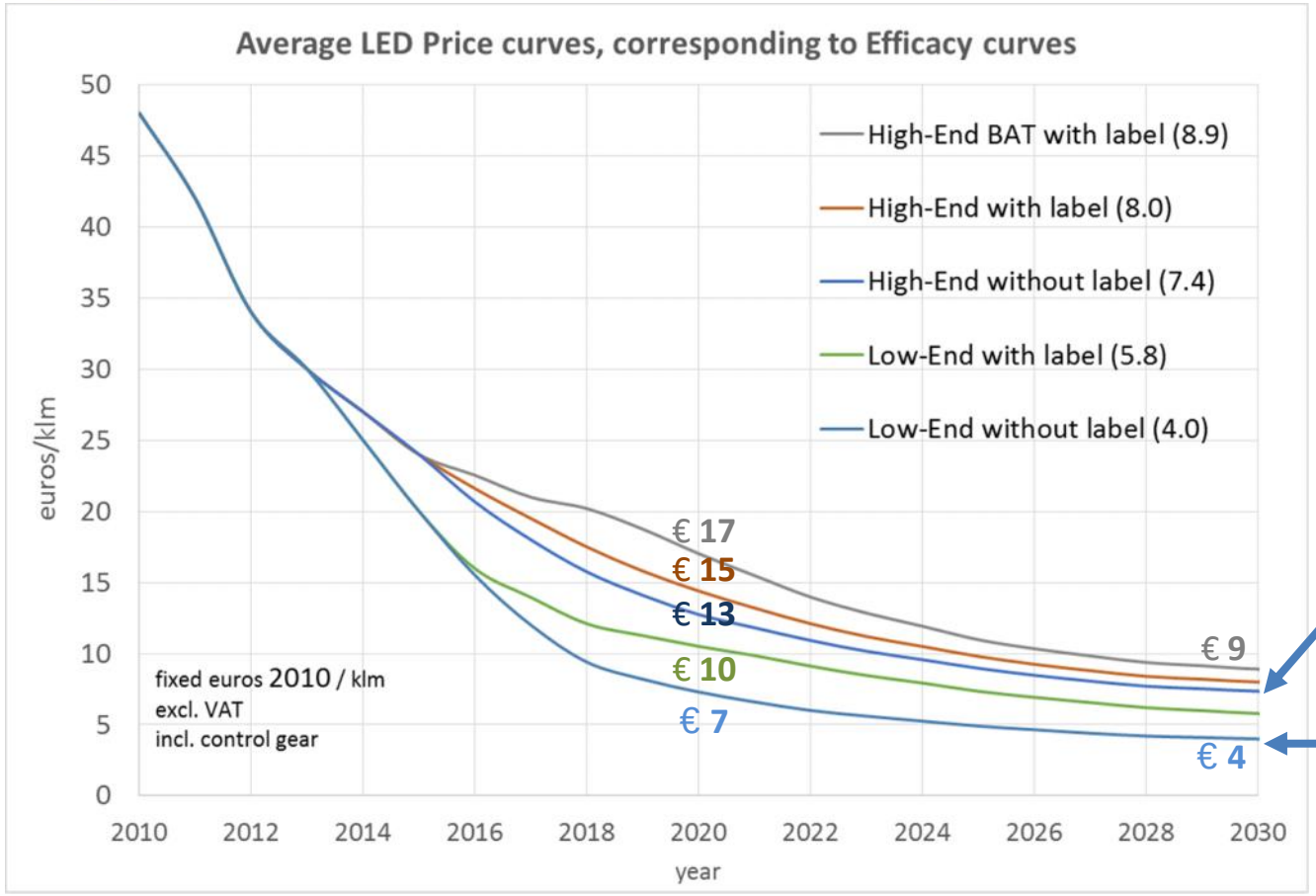
Efficacy projection LED



High-End = LED replacing LFL, CFLni, HID-lamps in non-residential sector.
Low-End = LED replacing GLS, HL, CFLi in all sectors and LFL, CFLni in residential.

Task 4/7
Technologies

Price projection LED



from LightingEurope for 'professional' lamps, 2x price ' consumer'

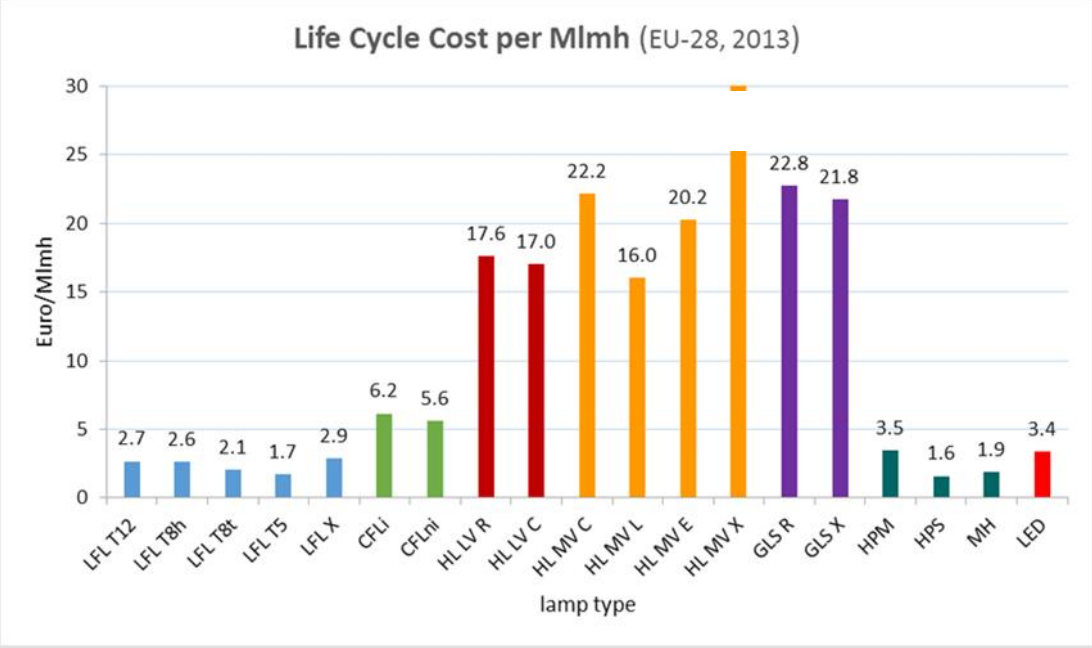
from VHK Task 4, agreed by LightingEurope for 'consumer' lamps

Price curves apply to efficacy curves with same name, i.e. price increases linearly with efficacy

Task 5/7
Base Case
LCA & LCC

Life-cycle costs

- Functional unit of million lumen output per hour (Mlmh)
- calculated for lamps sold in 2013
- escalation rate electricity 4%



- 2013: **GLS** and **HL** **16 - 23** euros/Mlmh
  CFLs **5.6 - 6.2** euros/Mlmh.
  LEDs **3.4** euros/Mlmh (2.8 in 2015, 1.3 in 2020)
  LFL, **HID** **1.6 - 3** euros/Mlmh, but HID low CRI, not indoor

- Total consumer expenditure for lighting in 2013 was **54.8 billion** euros, of which **67% are electricity costs**. **LFLs** account for **38%** of the total expenditure.

Task 6/7
Design options

LLCC & Payback LED

Results valid only for analysed conditions (reference power/lumen, operating hours per year), under the assumptions made, and for the prices and costs considered. NOT valid for every lighting situation, but indicative for the average EU-28 situation.

Base case (BC) (analysis conditions)	Available option with **lowest LCC/Mlmh**	Available option with **lowest kWh/Mlmh**	**Payback** for LED **2015** vs. best classic (years)	**Payback** for LED **2020** vs. best classic technology (years)
LFL T8 tri-phosphor (2400 lm, 2017 h/a)	Long life LFL T8t	LED 2015	maybe never	**4**
LFL T5 (2275 lm, 2099 h/a)	High-efficacy T5	LED 2015	maybe never	**4**
LFL T8 halo-phosphor (2400 lm, 1398 h/a)	T8 tri-phosphor	LED 2015	maybe never	**3**
LFL T12 (2450 lm, 1623 h/a)	T8 tri-phosphor	LED 2015	maybe never	**2.5**
CFLni (633 lm, 1197 h/a)	LED 2015	LED 2015	no pay back in CFLni life	**3.5**
HPM (12000 lm,4000 h/a)	HPS BAT	HPS BAT	**5**	**1**
HPS & MH (13200 lm, 4000 h/a)	HPS BAT, MH BAT	HPS BAT	maybe never	**2.5**
MV NDLS (GLS-X, HL-E, CFLi) (500 lm, 450h)	LED 2015	LED 2015	**3.5-4 (GLS, HL) >12 (CFLi)**	**1**
MV DLS (GLS-R, HL-X) (450 lm, 450 h/a)	LED 2015	LED 2015	**2**	**0**
HL-LV-R (MR16) (490 lm, 450 h/a)	LED 2015	LED 2015	**4.5**	**< 1**
HL-LV-Capsules (490 lm, 450 h/a)	LED 2015	LED 2015	**3**	**2**
HL-MV-Capsules (420 lm, 450 h/a)	LED 2015	LED 2015	**1**	**< 1**
HL-MV-Linear (R7s) (3000 lm, 450 h/a)	LED 2015	LED 2015	**1**	**< 1**

Payback LED 1-4 years:
GLS and HL in 2015
LFL, HID, CFL in 2020

Policy options and scenarios

Opportunities/Barriers

Main opportunities/barriers found in the study:

- Strong, **unforeseen technological progress in LED-lighting** and decreasing prices
- Availability of **new testing equipment and test standards**
- **Improve market surveillance**, speeding up test procedures, removing ambiguities, …
- **Improve effectiveness** of energy **labelling** (size, visibility) (awaiting revision of Framework Directive)
- **barrier** to ambitious timing: compatibility between **dimmers** and new LED light sources; new standards foreseen in **2018**.

Options Considered

- **No new measures** → BAU (baseline)
- **Self-regulation** (Voluntary Agreement) → no initiative
- **Energy-labelling only** → no advantage in excluding ecodesign
- **Ecodesign only** → no advantage in excluding label
- **Ecodesign and Energy-labelling** → OK → study sub-options for different ecodesign ambition levels and a much improved label

Label Opportunities & Barriers

- **Now**: LED or classic ?
- **Future** : **which** LED? → more ambitious scale

85 - 210 lm/W

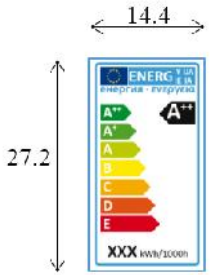
→ rescaling required (in context of revised Framework)

- Current label :
  - can be **small**
  - can be **black and white**
  - usually **not visible in display** (back of blister)

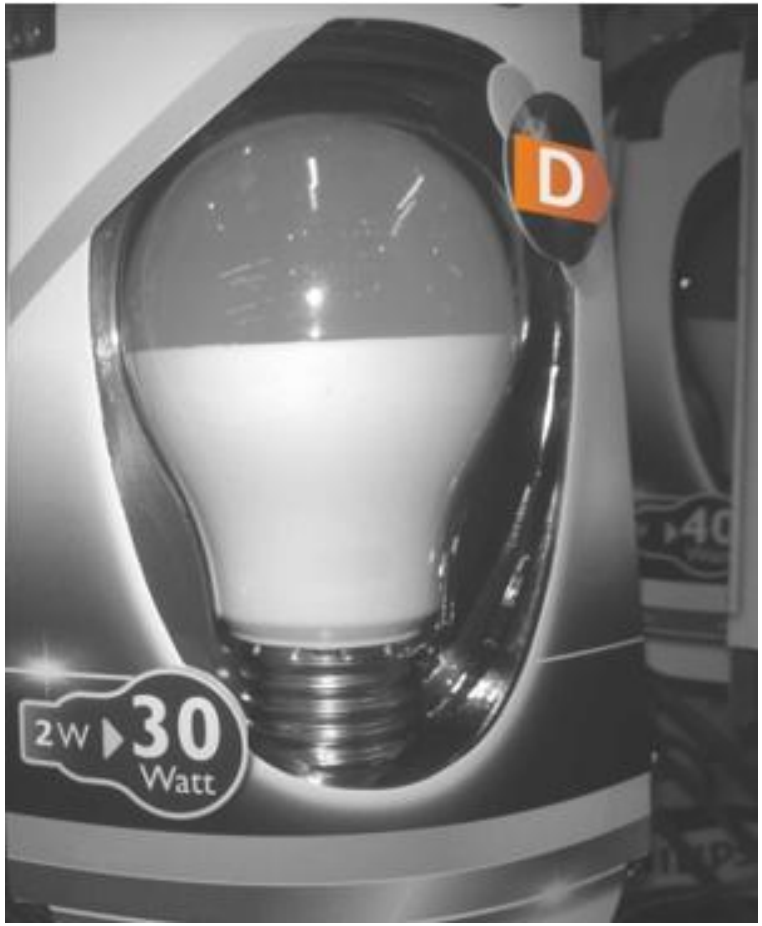
	lm_{tot} / W_{mains}	
Class	min	max
A	210	
B	185	210
C	160	185
D	135	160
E	110	135
F	85	110
G		85

Proposal in Task report

Minimum allowed label size today



Proposal: A at front -  at back



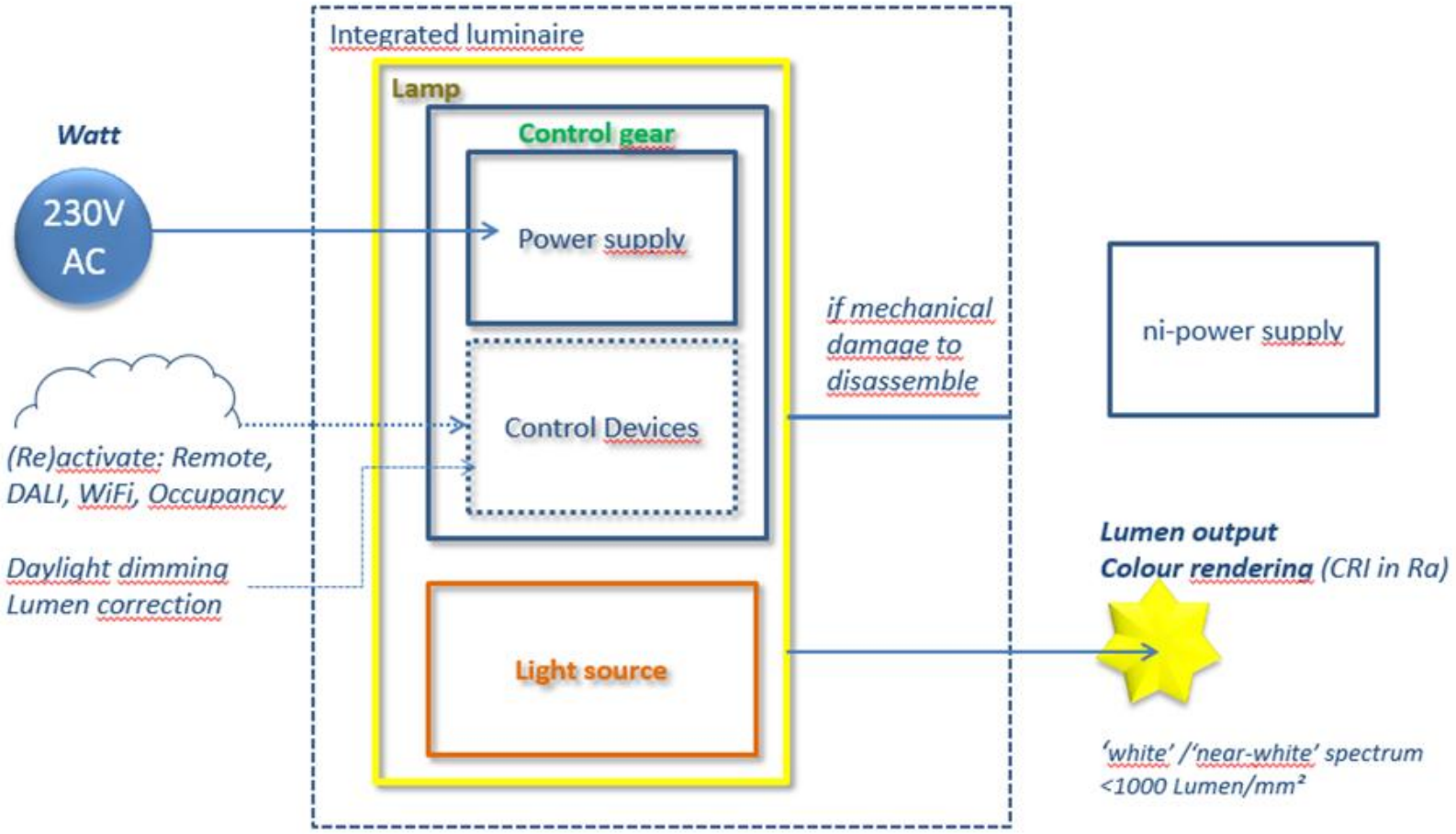
Ecodesign only

Main characteristics:

- **Single** Ecodesign light-source **regulation**
- **Technology neutral**
- Lighting product **efficacy = lumen output/mains** W input (always with control gear losses, also for LFL/HID)
- **Scope:** 'white' light + health, safety exemptions. **Functional exemptions** based on measured parameters (lumen, spectrum x-y, emitter-size, CRI)
- **Time** for stakeholders to anticipate introduction (2020):
- **Maximum power** requirement based on **lm/W** + parasitic, CRI-correct
- **Testing**: **instantaneous** (CRI, lumen, CCT, x-y) within hours, **endurance** (lumen maintenance, switches) with accelerated tests (max. 1000h, 8wk); **no testing** (heat-up, ignition time)

Products in Scope

Lighting product = Light Source + Ballast/Control gear + Integrated Control devices

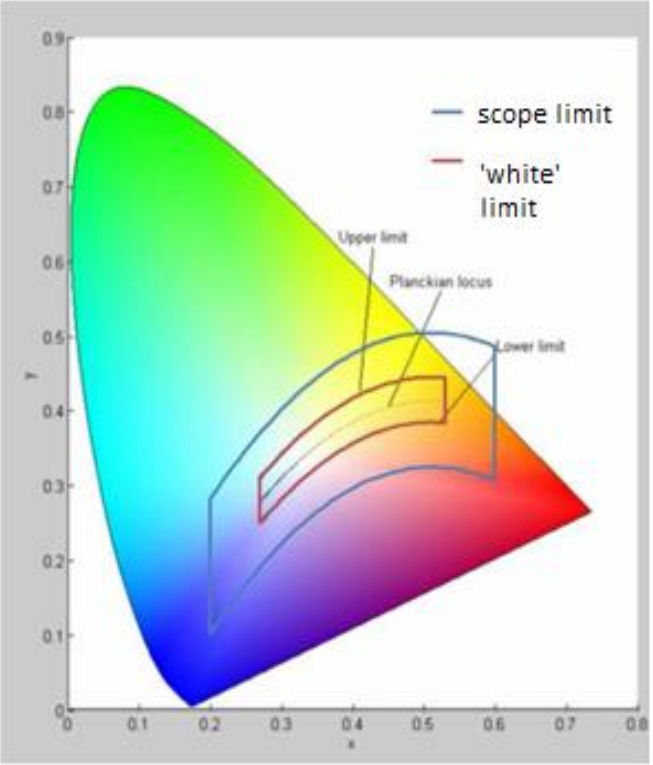


Spectrum

Chromaticity coordinates x,y in scope:

0,200 < x < 0,600 and

$-2{,}3172\ x^2 + 2{,}3653\ x - 0{,}2800 < y < -2{,}3172\ x^2 + 2{,}3653\ x - 0{,}1000$;



- Intentionally wider than 'white light'
- Easy to measure criterion
- Gives manufacturers the possibility to exclude IR (red, gold), UV (blue), grow lights (purple), collagen (pink), etc.

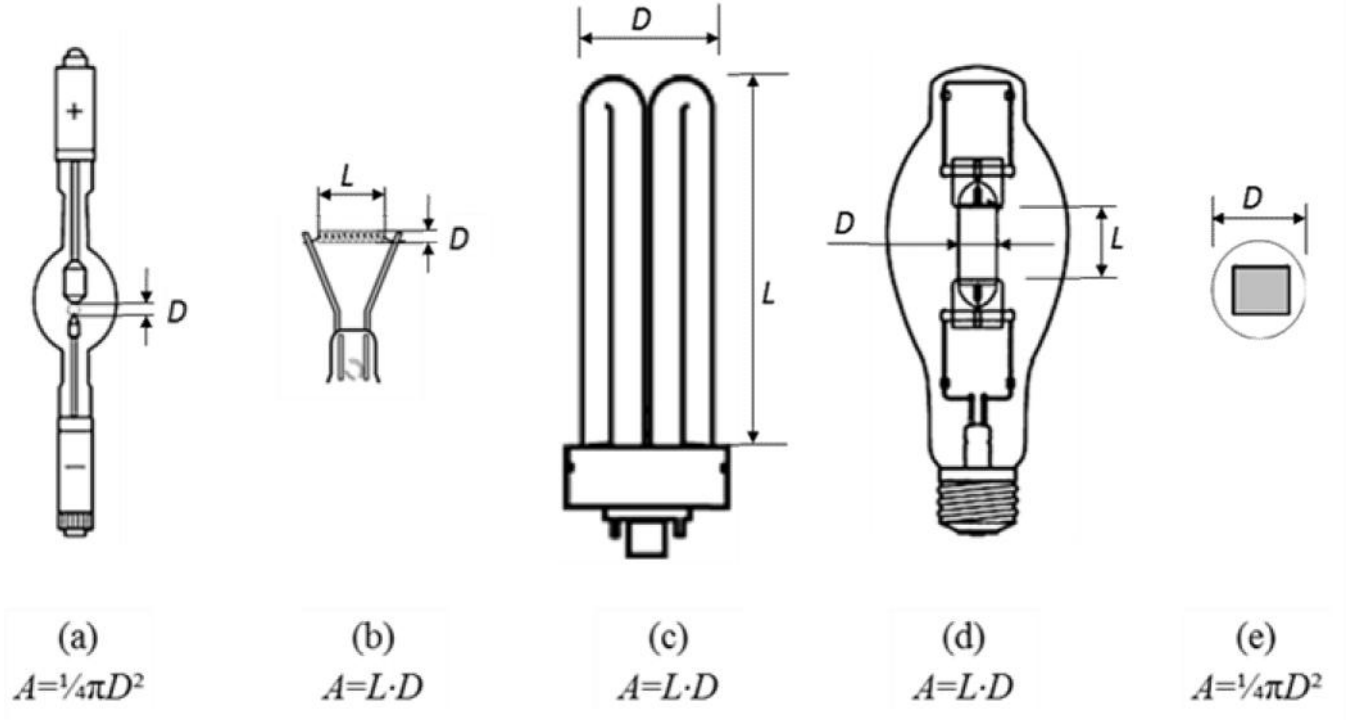
Chromaticity coordinates x,y to qualify as 'white light':

$0{,}270 < x < 0{,}530$ and $-2{,}3172\ x^2 + 2{,}3653\ x - 0{,}2199 < y < -2{,}3172\ x^2 + 2{,}3653\ x - 0{,}1595$;

Emitter size

Emitter size criterion: in scope if flux density < 1000 lm per mm²

- mainly intends to exempt light projection and light guidance sources (have lm/mm² as yet unattainable by LED-lamps).



Examples of projected light-emitting surface areas

Formula

Maximum power requirement formula:

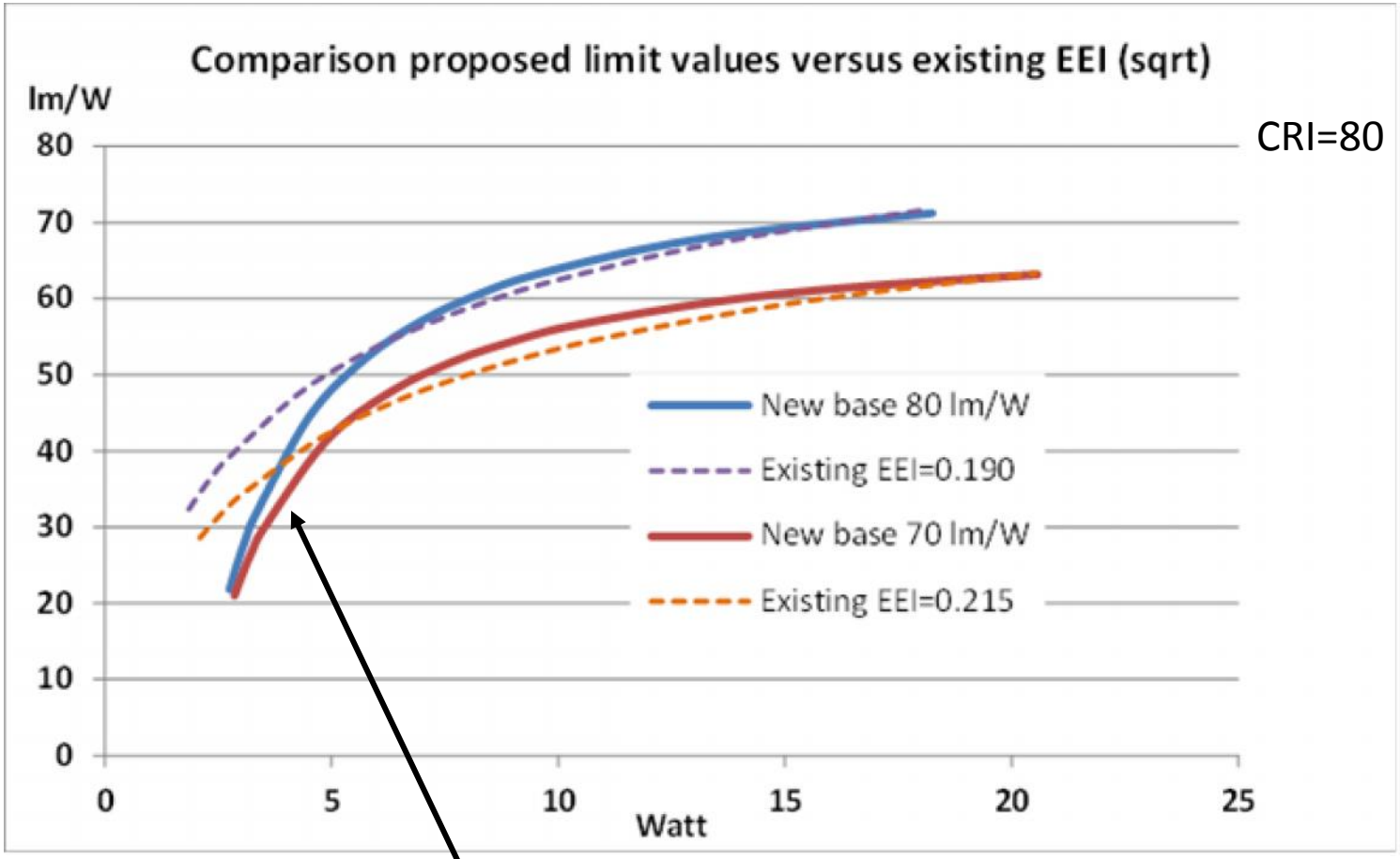
Power (on) ≤ (Constant + Flux/Target Efficacy)* CRI correction

- Power [W mains]
  - 2 W [Account for parasitic power of control- and network devices, fixed electrode losses in discharge lamps, lower efficacy for lower lumen lamps, makes result similar to square-root formula for EEI]
    - Flux [lumen] is total measured luminous flux (not in cone)
      - Target Efficacy [lumen] pertaining to Power mains Watt for Lighting Product, including gear [gear 90% minimum and default], e.g. from 70 - 80 - 120 lm/W

        (CRI+240)/320 [Bonus high CRI lamps; penalty low CRI lamps; CRI=80→ 1.0; CRI=90→ 1.03; CRI=60→ 0.94; CRI=25→0.83]

Curves

Comparison with square-root formula of existing regulations:



For low power, new requirements are less severe than existing

Non-efficacy requirements (all options)

Other requirements proposed in study:

- Pstandby ≤ 1 W if one/more control devices integrated
- Pstandby ≤ 0,5 W no control devices; only reactivation function

- Special requirement when claiming to emit 'white light'. Suitable for general purpose lighting: 'White light', CRI >80 colour rendering and a colour temperature (CCT) between limits

- lumen maintenance (after accelerated tests), failure rate switches (after acc. test)

- If marked 'dimmable': compatible with new standard from 2018.

- No requirement on Warm-up and ignition-time (CFLs phased out)

- Power factor: > 0.5 if output<500 lm, > 0.9 for output 0.5-10 klm, no requirement for output >10 klm.

- Colour consistency: within a six-step MacAdam ellipse.

Scenarios

- ***BAU*** scenario (incl. future effect current regulations & LED trends) (reference scenario; incl. savings with respect to 2015 situation)

- ***ECO70+LBL*** *scenario*
  P(on) ≤ (2 + Ø/70)*((CRI+240)/320) in 2020

- ***ECO80+120*** *scenario*

- ***ECO80+120+LBL*** *scenario*
  P(on) ≤ (2 + Ø/80)*((CRI+240)/320) in 2020 (stage 1)
  P(on) ≤ (2 + Ø/120)*((CRI+240)/320) in 2024 (stage 2)

- ***ECO120+LBL*** *scenario*
  P(on) ≤ (2 + Ø/120)*((CRI+240)/320) in 2020
  (approximate reference for highest savings that could be theoretically obtained, technical feasibility uncertain)

Comparison results 2030

impact	*unit*	absolute		relative vs. BAU 2030			
		BAU 2015	BAU 2030	ECO70+ LBL	ECO80+ 120	ECO80+ 120+LBL	ECO120 +LBL
Electricity	*TWh/yr*	324	214	-28	-43	-61	-65
GHG emissions	*Mt CO_2 eq.*	128	73	-10	-14	-21	-22
Acquisition costs	*bn. euros*	18.2	14.4	+0.8	-0.3	+1.1	+1.1
Energy costs	*bn. euros*	53.2	61.5	-7.4	-9.9	-14.9	-15.9
Total expenditure	*bn. euros*	71.4	75.9	-6.6	-10.2	-13.8	-14.7
Business revenu	*bn. euros*	10	8.6	+0.9	+0.2	+1.3	+1.3
Jobs (in+out EU)	*000 jobs*	199	172	+18	+4	+26	+26

Comparison: Electricity savings 2030