Free dissemination

(Contract TREN/07/D3/390-2006/S07.72702)
Preparatory Studies for Eco-design Requirements of EuPs

Lot 19: Domestic lighting
Part 1 - Non-Directional Light Sources

Draft final task reports
Task 8: Scenario- Policy- Impact- and Sensitivity Analysis

Study for European Commission DGTREN unit D3, contact: Andras Toth

Contractor:

Project performed in cooperation with:

Contact Vito: Paul Van Tichelen, info@eup4light.net

2007/ETE/R/

VITO

October 2008

Project team

Vito:
Paul Van Tichelen
An Vercalsteren
Bio Intelligence Service:
Shailendra Mudgal
Benoît Tinetti
Lea Turunen
Energy Piano:
Casper Kofod
Kreios:
Lieven Vanhooydonck
Laborelec (reflector lamp tests):
Jean-Michel Deswert

Important disclaimer:
The authors accept no liability for any material or immaterial direct or indirect damage resulting from the use of this report or its content.
Important note:
This report contains the final results of research by the authors and is not to be perceived as the opinion of the European Commission.

TABLE OF CONTENTS

0 PREFACE 5
1 PRODUCT DEFINITION 7
2 ECONOMIC AND MARKET ANALYSIS 7
3 CONSUMER BEHAVIOUR AND LOCAL INFRASTRUCTURE .. 7
4 TECHNICAL ANALYSIS EXISTING PRODUCTS 7
5 DEFINITION OF BASE-CASE 7
6 TECHNICAL ANALYSIS BAT 7
7 IMPROVEMENT POTENTIAL 7
8 SCENARIO- POLICY- IMPACT- AND SENSITIVITY ANALYSIS 9
8.1 Policy- and scenario analysis 9
8.1.1 Eco-design requirements 9
8.1.2 Scenario analysis 19
8.1.3 Sensitivity analysis 62
8.1.4 Suggested additional requirements for the appropriate implementation 67
8.1.5 Suggested additional research 74
8.1.6 Required new or updated measurement or product standards 75
8.2 Impact analysis for industry and consumers 75
8.3 Annexes 79

LIST OF TABLES

LIST OF FIGURES

0 PREFACE

VITO and its partners are performing the preparatory study for the new upcoming eco-design directive for Energy Using Products (EuP) related to domestic lighting, on behalf of the European Commission (more info http://ec.europa.eu/enterprise/eco_design/index_en.htm).

The environmental impacts of Energy-using Products such as domestic lighting take various forms, including: energy consumption and the related negative contribution to climate change, consumption of materials and natural resources, waste generation and release of hazardous substances. Eco-design, which means the integration of environmental considerations at the design phase, is arguably the best way to improve the environmental performance of products.

The creation of a coherent framework for environmental product policy avoids the adoption of uncoordinated measures that could lead to an overall negative result; for example eliminating a toxic substance from a product, such as mercury from lamps, might lead to increased energy consumption, which could in total have a negative impact on the environment. A Community framework also ensures that divergent national or regional measures, which could hinder the free movement of products and reduce the competitiveness of businesses, are not taken. It is not the intention to decrease the quality of domestic lighting.

You can follow the progress of our study and find general information related to lot 19 on the project website when you register as stakeholder: http://www.eup4light.net
Please, also consult the website for timing and organisation of the tasks.

1 PRODUCT DEFINITION

2 ECONOMIC AND MARKET ANALYSIS

3 CONSUMER BEHAVIOUR AND LOCAL INFRASTRUCTURE

4 TECHNICAL ANALYSIS EXISTING PRODUCTS

5 DEFINITION OF BASE-CASE

6 TECHNICAL ANALYSIS BAT

7 IMPROVEMENT POTENTIAL

For more info see website www.eup4light.net.

8 SCENARIO- POLICY- IMPACT- AND SENSITIVITY ANALYSIS

Important remark: This preliminary chapter 8 only discusses part 1 of the study concerning non directional light sources. Directional light sources, such as reflector lamps, and luminaires will be treated in part 2 of the study.

Scope: This chapter summarizes and totals the outcomes of all previous tasks. It looks at suitable policy means to achieve the improvement potential e.g. implementing LLCC as a minimum and BAT as a promotional target, using legislative or voluntary agreements, labelling and promotion. It draws up scenarios 2007 – 2020 quantifying the improvements that can be achieved vs. Business-as-Usual. It makes an estimate of the impact on consumers and industry as explicitly described in Annex 2 of the Directive.
Finally, in a sensitivity analysis of the main parameters and robustness of the outcomes is studied.

It has to be kept in mind that the conclusions represent solely the point of view of the consortium and they do not reflect the opinion of the European Commission in any way. Unlike chapters 1-7, which will serve as the baseline data for the future work (impact assessment, further discussions in the EuP Consultation Forum, and development of implementing measures, if any) conducted by the European Commission, the chapter 8 simply serves as a summary of policy implications as seen by the consortium. Further, some elements of this chapter may be analysed again in a greater depth during the impact assessment.

8.1 Policy- and scenario analysis

8.1.1 Eco-design requirements

In this chapter generic and specific product related eco-design requirements are described that can be used as suitable policy means to achieve BAT or LLCC scenario targets.
Please note that there are finalised preparatory studies on 'street' (lot 9) and 'office' (lot 8) lighting that include mainly topics related to HID lamps and fluorescent lamps with non integrated ballasts. In this study (lot 19) horizontal measures are recommended for any lamp type or light source, including in principle also office and/or street lighting products. The proposed minimum requirements formulated for street and office lighting are normally higher and related implementing measures are already under consideration by the EC.
Because domestic lighting products can also be used in many other general lighting applications, the proposed measures hereafter obviously have a wider scope. Therefore, it is important to assess the potential negative impact beyond domestic lighting sector (see 8.2).

8.1.1.1 Generic Eco-design requirements on the supply of information

Optimal use of domestic lighting starts with adequate information on existing products. Therefore, it is proposed that the manufacturers provide information on the following 'most relevant' eco-design parameters and follow the proposals for the appropriate means for communicating these parameters to the consumer. The provision of information on these 'most relevant' parameters should satisfy article 15.4 (f) to reduce unnecessary administrative burden and allow verifying compliance with proposed specific implementing measures.
In many cases it is impossible to distinguish, at the 'placing on the market' stage, lamps and luminaires that are intended for 'domestic' lighting from other indoor lighting applications as in restaurants, hotels, etc. It is therefore recommended to define a broader scope for lamps and luminaires within the specific eco-design requirements.
Lamps, luminaires and ballasts for office lighting can also be used in certain domestic applications but they were already discussed in the dedicated preparatory study on office lighting (lot 8), and thus will not be considered again. Street and office lighting products have other needs for the provision of information, see preparatory study on lot 8 and lot 9. In order to distinguish these products, it is recommended to exclude certain light sources, e.g. by light source (above 2000 lumen) or by lamp type (HID and LFL lamps).

Information available to the end-users at the moment of purchase and on free access websites for any white light source (Annex 11.1.1) within the scope of this study:

a) When the nominal lamp power is displayed outside the energy label in accordance with Directive 98/11/EC, the nominal luminous flux of the lamp shall be also displayed separately in a font at least twice as large as the nominal lamp power display outside the label *(the nominal luminous flux shall never be higher than the rated luminous flux)*;
b) Nominal life time of the lamp in hours *(not higher than the rated life time)*;
c) Number of switching cycles before premature lamp failure;
d) Colour temperature *(does not need to be expressed as a value)*;
e) Colour rendering *(does not need to be expressed as a value)*. Only CRI = 100 can be shown as excellent or perfect, only CRI ≥ 90 can be shown as good or improved, and CRI < 80 must be shown as poor;
f) Warm-up time up to 80% of the full light output *(may be indicated as "instant full light" if less than 1 second)*;
g) A warning if the lamp cannot be dimmed or can be dimmed only on specific dimmers;
h) If designed for optimal use in non-standard conditions (such as ambient temperature Ta ≠ 25 °C), information on those conditions;
i) Lamp dimensions in millimetres (length and diameter);
j) If equivalence with an incandescent lamp is claimed on the packaging, the claimed equivalent incandescent lamp power (rounded to 1W) shall be at least that corresponding in Table 8.1 to the default values for rated luminous flux(Φ_{100})or the average luminous flux(Φav) of the lamp contained in the packaging. The average luminous flux can only be used when test data about the lumen maintenance factor is available and shall be equivalent to the initial luminous flux multiplied by the lumen maintenance factor at half its rated lifetime. The intermediate values of both the luminous flux and the claimed incandescent lamp power (rounded to 1W) have to be calculated by linear interpolation between the two adjacent values. Values below 15 W and above 200 W shall not be claimed. It is not obligatory to put the equivalence on the package (because GLS could become obsolete in the future).

The values for the average luminous flux of the standard GLS-C lamp used for comparison can also be taken from Table 8.1 and corresponding graph in Figure 8.1.

Table 8.1: Average Luminous Flux any lamp in relation to Φ_{100} for a GLS-lamp and a CFLi

Rated lamp luminous flux CFLi Default Φ_{100} [lm]	**Rated lamp luminous flux Halogen Default Φ_{100} [lm]**	**Rated lamp luminous flux Solid State LED Default Φ_{100} [lm]**	**Average lamp luminous flux All Φ_{av} [lm]**	**Claimed equivalent incandescent lamp power [W]**
125	119	136	116	15
229	217	249	212	25
432	410	470	400	40
741	702	806	685	60
970	920	1055	897	75
1398	1326	1521	1293	100
2253	2137	2452	2084	150
3172	3009	3452	2934	200

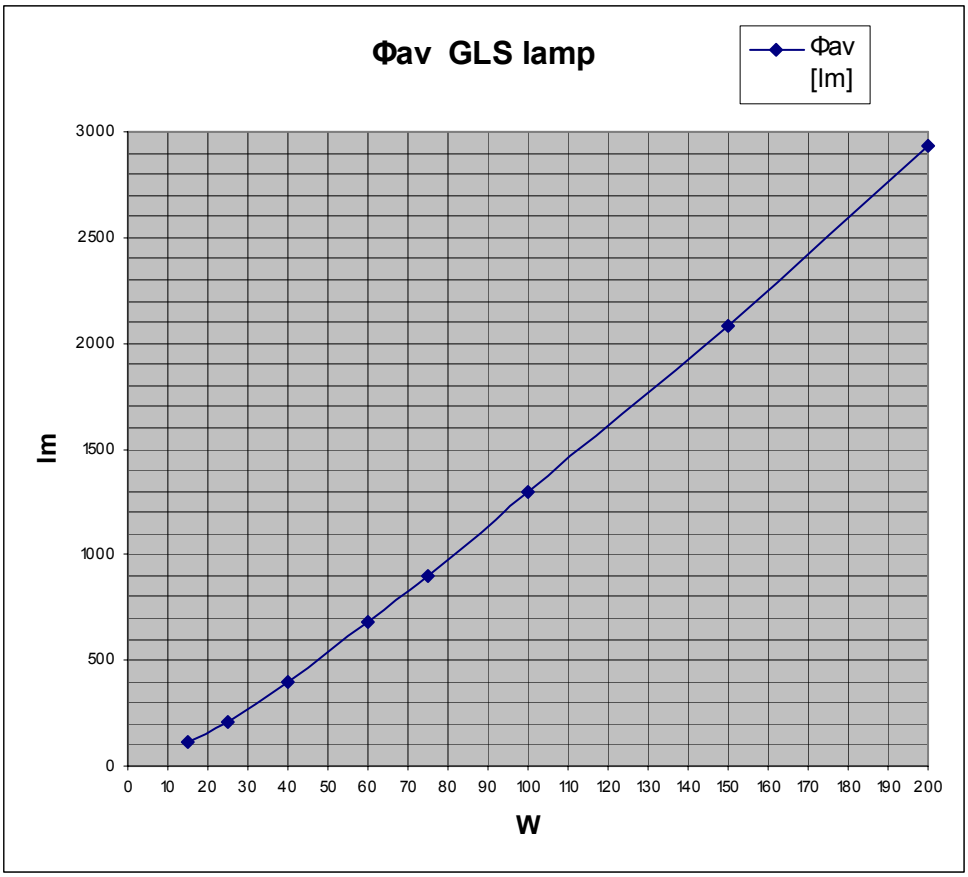


Figure 8.1: Diagram of Φ_{av} for a GLS-C lamp

The term "energy saving lamp":
This can only be provided if the lamp meets the class A efficacy requirements taking into account the correction factors in Table 8.3.

Information to be made publicly available on free-access websites:

The information shall also be expressed as values.
a) The information specified above in points a-j;
b) Rated wattage (0.1 W precision);
c) Rated luminous flux;
d) Rated lamp life time (from Stage 2 if lifetime > 2000 h);
e) Lamp power factor;
f) Lumen maintenance factor at the end of the nominal life
g) Starting time (seconds);

If the lamp contains mercury:
i) Lamp mercury content as X,X mg;
j) Instructions on how to clean up the lamp debris in case of accidental lamp breakage.

+ for directional light sources: Information on the light distribution of the lamp (e.g. beam angle) (part 2 of the study).

Proposed timing for this measure:

As soon as possible, except for the new energy labelling, which requires an update of the relevant Directive.

8.1.1.2 Specific eco-design requirements for reducing losses in the electrical distribution grid due to a poor power factor

The lamp power factor (see chapter 4) should be at least[1] 0,5 in Tier 1; a staged requirement on enhanced power factor is proposed in Table 8.2. The value of Tier 2 is equivalent to Lamp specification Version 6 (2007) of the Energy Saving Trust (UK). The power factor of several CFLi lamps was measured and this showed that above 0.6 is realistic, see chapter 4. Please note also that additional losses due to a poor power factor were taken into account in the assessment in chapter 4, 5, and 7.

Table 8.2: Staged requirements for the power factor

Performance parameter	Tier 1	Tier 2	Tier 3	Benchmark
Lamp power factor	> 0,50[2]	> 0,50	> 0,60	≥ 0,95 (> 0,65)

8.1.1.3 Specific ecodesign requirement for increasing lamp efficacy

The proposed ecodesign requirement is to set minimum efficacy level (ηlamp) for all lamps as a horizontal entry requirement for all lamps to the EU market, independent of technology and application as far as possible. It is proposed to use the existing household lamp labelling values that are connected to lamp efficacy and where appropriate, correction factors should be applied. It is also proposed to have significant lower requirements (label B) for dimmable bright point sources below 1000 lm (see Annex).

To enable manufacturers and distributors to reorganize, a tiered approach is proposed in the section with the scenarios (see 8.1.2). This also gradually enables the users and distributors to adapt the switch to more efficient light sources. A Life Cycle Cost (LCC) based gradual phase out is proposed in 8.1.2, which means that high wattage inefficient light sources should be phased out first because the payback period or LCC is better as the lamp price is poorly related to lamp power (see chapter 4).
The reason and the proposed corrections factors on the minima are displayed in Table 8.3.

[1] A higher value in Tier 3 would require a more complicated electronic input circuit that compromises the efficiency of the integrated ballast.
[2] In line with 'EcoProfile 070924 CFLi' for ELC federation

Table 8.3: Proposed correction factors for the minimum criteria on label values

Correction factors	
Scope of the correction	**Maximum rated power (W)**
filament lamp requiring external power supply for mains connection	P_{max} / 1.06
CFLi lamp with colour rendering index ≥ 90	P_{max} / 0.85
CFLi lamp with colour rendering index ≥ 90 and Tc >=5000K	P_{max} / 0.75
CFLi lamp with second envelope	P_{max} / 0.95
CFLi with cap GX53	P_{max} / 0.75
light emitting diode requiring external power supply	P_{max} / 1.1

The following lamp types are outside the scope of general illumination and should be excluded from this efficacy requirement:

- Lamps that don't satisfy the 'White light source' criterion (see Annex 11.1.1);
- Lamps with less than 200 lumen in bright point sources (as the light output is too low for general illumination) or else 150 lumen;

Some lamp caps are nowadays frequently used in general illumination but have no energy efficient alternative with an efficacy level equivalent to label B or A. It is connected to the so-called luminaire lock-in effect (see 8.1.1.5). Phasing out these lamps would repeal retrofit lamps from the market for existing luminaires. Therefore in certain scenarios it is proposed to phase out these luminaires first and to introduce special luminaire requirements (see 8.1.1.5) for the time being (see section 8.1.2). It is also possible to announce this phase out and allow people to stock sufficient retrofit lamps for existing luminaires (see 8.1.4.2). The lamp types are:

Lamp type	**Lamp cap**	**Lamp power [W]**	**Minimum label**
Halogen mains voltage (HL-MV)	R7s or Rx7s	50 ≤ W ≤ 300	C
Halogen mains voltage (HL-MV)	G9	all wattages	C

- Minimum level for lamps with cap R7s or Rx7s is label C, for linear HL-MV lamps with a wattage from 150 till 300W the minimum label C. (Comment: The reason for this exception is that these lamps are often used in outdoor lighting with presence detection switches for security application. For such applications, there are currently few efficient alternatives with short warm up time. As a consequence, the ecodesign requirement for luminaires with cap R7s is recommended, see 8.1.1.5.). If luminaire and lamp manufacturers come up with alternative solutions, this requirement might be reviewed in future.
- HL-MV lamps with lamp cap G9, because as of today no label B energy efficient solutions exist with similar dimensions;

Further considerations for setting the level of the requirements::

- For lumen output below 1000 lm, fully dimmable bright point sources may have to remain available with existing technology. Therefore, the proposed minimum level may have to be kept at label B for such lamps as currently no technology exists that could match these requirements. For the 'Bright point source' definition see Annex 11.1.4. These sources are often needed for decorative purposes. It is assumed that fully dimmable lamps for decorative purposes, that have an higher lumen output and that satisfy the 'Bright point source' (see Annex 11.1.4) criterion, are less needed; the reason is that they would cause too much glare in the field of view. HID lamps can provide a very efficient 'Bright point source' but are not fully dimmable. For high lumen outputs it is still possible to use luminaires with several lamps or to install several luminaires. HID lamps need an extra ballast or control gear to be installed in the luminaire, therefore in exceptional cases, some users will need to change luminaires on the long run. Dimming as such can also be achieved with dimmable CFLi (see chapter 6).
- Please note that the mains voltage halogen lamps with xenon (see also chapter 6) have label D below 450 lumen and label C above.
- The most critical known efficient GLS lamp application are oven lamps, however a 200 lumen version still remains available for domestic application in existing ovens. According to our knowledge, the 40 Watt oven lamp is not useful in domestic ovens. However, in industrial ovens it is used and only lamps with special caps (e.g. BA20s) have to be used. Such usage is possible only after replacement of the sockets which is not a complicated measure in the professional market or one could install a transformer to use low voltage filament lamps that are available with label B efficacy.
- Inefficient halophosphate fluorescent lamps have a Colour Rendering Index below 80 and could also be phased out by this proposal (see the Working Document on office lighting lot 8). The proposed 'Bright point source' criterion is needed to prevent phasing out HPS lamps with a clear envelope (see working document on street lighting lot 9).
- The reason for the exception on lamps with cap R7s is that halogen main voltage lamps with R7s cap are often applied in luminaires with presence detection and they have to give instant light, what other lamp types cannot for the moment. Lamps above 300 W are mainly used for general lighting where warm-up time is no problem; as a consequence lamps can be replaced by HID-lamps in appropriate luminaires. The lot 9 study on street lighting already revealed that for high wattage solutions an efficient HID based replacement including the luminaire is justified for LCC and ecological impact; the very low efficacy of HL-MV compared to HID justifies this even more.
- The reason for the exception on lamps with cap G9 is that no label B energy efficient solutions exist nowadays with G9 socket and the same lamp dimensions. This socket is mainly used for HL-MV lamps. It is recommended to review this requirement as soon as existing luminaires are outdated and consumers hopefully move towards luminaires that can host more efficient lamps. (e.g. in Tier 3 or later).
- Lamps that satisfy the 'Directional light source' or 'reflector lamp' criterion (Annex 11.1.2) will be subjected to derating factors that will be elaborated in part 2 of this study (e.g. halogen reflector lamps, LEDs, luminaires with permanently integrated lamps).

8.1.1.4 Specific ecodesign requirements for minimum lamp performance and mercury content

For Tier 1 values Table 8.4 were chosen in accordance with the ELC Federation Eco-Profile (EcoProfile 070924 CFLi). In Tier 2, these values may not significantly increase as there will be a possible temporary overshoot in CFLi demand due to the phase out of GLS lamps. The Tier 3 requirements are based on evaluation of existing products and from different quality charters:

- The European Compact Fluorescent Lamps Quality Charter (draft version 2008);
- Lamp specification Version 6 (2007) of the Energy Saving Trust (UK);
- Directive (2002/747/EC) on ecological criteria for the award of the Community eco-label to light bulbs;
- ELI Voluntary Technical Specification for Self-Ballasted Compact Fluorescent Lamps (CFLs) (First edition 2006-03-01); and
- Draft (December 2007) Australian MEPS on CFLs and proposals.

The values in parenthesis in Table 8.4 indicate the requirements for mercury-containing lamps if they are different from the requirements on all lamps. For HID, CFLni and LFL lamps, specific criteria were elaborated in the street lighting preparatory study (lot 9) or office lighting preparatory study (lot 8).
Lifetime should be tested according to lamp related EN standards (see chapter 1), please note that this includes the standard on/off switching cycle and hence a minimum amount of on/off switching cycles is requested (e.g. for CFLi this is 2h45 on and 0h15 off). For the fast cycle test please consult Directive (2002/747/EC).

Table 8.4: Staged performance requirements

Performance parameter	Tier 1	Tier 2	Tier 3	Benchmark
Minimum rated lamp lifetime & lamp survival factor (LSF)	1000h&LSF=0.5 (6000h&LSF=0,5)	1000h&LSF=0.5 (6000h&LSF=0.5)	2000h&LSF=0.5 (6000h&LSF=0.7)	4000h&LSF=0.5 (15000h&LSF=0.5)
Lumen maintenance	85% at 1000h (85% at 2000h or 80% at 2000h for lamps with second lamp envelope)	85% at 1000h (85% at 2000h or 80% at 2000h for lamps with second lamp envelope)	85% at 1000h (88% at 2000h and 83% at 2000h for lamps with second lamp envelope))	90% at the minimum lamp lifetime
Number of switching cycles[3]	≥ four times the rated lamp life expressed in hours (≥ half the lamp lifetime expressed in hours ≥ 10,000 if lamp starting time > 0,3s)	≥ four times the rated lamp life expressed in hours (≥ half the lamp lifetime expressed in hours ≥ 10,000 if lamp starting time > 0,3s)	≥ four times the rated lamp life expressed in hours (≥ lamp lifetime expressed in hours ≥ 50,000 if lamp starting time > 0,3)s	As defined in EN lamp test standards (Unlimited with versions that have a start delay)
Starting time	<0,2s (< 2,0s)	<0,2s (< 2,0s)	<0,2s (< 1,0s)	< 0,2s
Lamp warm-up time to 60% Φ	1,0s (120s)	1,0s (60s or < 120s if the diameter is less than 65mm and the length below 108mm for lamp flux ≥ 400 lm[4])	1,0s (60s or < 120s if the diameter is less than 65mm and the length below 108mm for lamp flux ≥ 400 lm[4])	1,0s (15s or 4s for special mixed CFLi+HL lamps)
Maximum premature failure rate	5,0%@100h (2%@200h)	2,0%@100h (1%@200h)	2,0%@100h (1%@200h)	
Maximum UVA+UVB radiation[5]	2mW/klm	2mW/klm	2mW/klm	

A proposal for requirements on mercury content in CFLi lamps is included in Table 8.5.
It is the current value in the RoHS Directive for Tier 1 and on the value of the Community Decision (2002/747/EC) for Tier 2.
For Tier 3, it is based on measurements made by VITO on CFLi's that are currently available on the market (see chapter 4) and confirmed by the statement of ELC at the stakeholder meeting in Brussels on 23rd November 2007 that 'a maximum of 1mg of mercury for CFLi's is possible'.

[3] Switching cycles for CFLi's as defined in the method for fast cycle testing, proposed by ELC.
[4] Lamps with the dimension of a standards GLS form A, because amalgam technology is used.
[5] In line with the International Commission on Non-Ionizing Radiation protection (http://www.icnirp.de)

Table 8.5: Requirements on mercury content in CFLi lamps

Tier 1	Tier 2	Tier 3	Benchmark
Hg ≤ 5,0 mg	Hg ≤ 4,0 mg	Hg ≤ 2,0 mg (or 3,0 mg if lamp life > 15000 h or 4,0 mg if lamp life > 20000 h)[6]	Hg ≤ 1,0 mg

8.1.1.5 Specific ecodesign requirements for household luminaires with sockets (e.g. R7s, Rx7s, G9, ..) with special luminaire application requirements

Requirements for any luminaire with socket R7s or Rx7s:

The sales of all luminaires with holders R7s or FA4 without an incorporated presence detector and an ingress protection below IP65 should be prohibited from Tier 1 because these lamps were exempted from the minimum lamp efficacy criteria, see also section 8.1.1.4.
Also all luminaires with RX7s can only be brought on the market if they have a build-in HID ballast.

Requirements for any luminaire with socket G9:

This socket is used for HL-MV lamps and no label B energy efficient retrofit solutions exist nowadays. This will force luminaire manufacturers to move to GY6.35 luminaires that can host efficacy label B HL-LV lamps.

Timing: Tier 1 (in order to avoid that consumers buy luminaires for which no efficient lamps are available)

Other luminaire requirements will be proposed in part 2 of the study.

8.1.1.6 Specific ecodesign requirements for wall-mounted dimmers and electronic control switches

See section 8.1.4.3 on recommendations.
More information might be included in part 2 of this study.

[6] Mercury consumption depends - among others - also from lamp life. There are two main loss mechanisms:
(1) First loss mechanism is related to the formation of Ba-Amalgams, process happening with sputtered and/or evaporated emission mix (mainly Ba atoms) on the glass tube close to the electrode. As long life lamps have in general more emission mix on the coil there is more Ba sputtered/evaporated on the wall, which needs then more mercury for compensation.
(2) Second loss mechanism is the diffusion of Hg into the glass, which is also related to lamp life. To minimize this effect, the glass can be coated with a protective layer like Alumina oxide, slowing down this process.
Other factors affecting mercury consumption are lamp start (preheated or instant start), glass temperature and gas purity.

8.1.2 Scenario analysis

Different policy scenarios 2007-2020 are drawn up to illustrate quantitatively the improvements that can be achieved through the replacement of the base-cases with lamps with higher energy efficiency at EU level by 2020 versus a business-as-usual scenario (reference scenario).

Eight scenarios listed below have been analysed in order to provide an assessment of various alternative policy options as close as possible within the limits of the model of this study to three options presented in the Working Document and discussed during the Consultation Forum held in Brussels on the 28th March 2008, they are:

- Business-as-Usual (BAU)
- Best Available Technology
- Option 1 Fast (with 3 Tiers: 2009, 2011 and 2013)
- Option 1 Fast B (with 3 Tiers: 2009, 2011 and 2013)
- Option 2 Clear B Fast (with 3 Tiers: 2009, 2011 and 2013)
- Option 2 Clear B Slow (with 5 Tiers: 2009, 2011, 2013, 2015 and 2017)
- Option 2 Clear C Fast (with 3 Tiers: 2009, 2011 and 2013)
- Option 3 Slow (with 5 Tiers: 2009, 2011, 2013, 2015 and 2017)

These scenarios are presented and analysed in the following sections. For each of them, results are presented for each year between 2007 and 2020 per lamp technology (i.e. GLS-F, GLS-C, HL-MV-LW, HL-MV-HW, HL-LV and CFLi) in terms of stock, sales, electricity consumption (during the use phase), CO_2 emissions[7] (during the use phase), and mercury emissions (due to electricity generation during the use phase and emissions at end-of-life for CFLi).

Finally, a comparison of scenarios is presented in section 8.1.2.11 as variation of environmental impacts in reference with the BAU scenario both for the specific year 2020, and for the cumulated total between 2009 (i.e. entry into force of the implementing measure) and 2020.

General remarks:

- **The first Tier for an implementing measure was supposed in 2009 because this was the earliest possible date. In reality, however, a time shift will occur depending on the real timing of implementation measures.**
- **Scenarios are calculated not for the domestic sector only but for all sectors; they are based on the lamp technology and not the end application.**
- **The scenarios analysis is based on outcomes of chapters 1 to 7, and one has to keep in mind than they are average results based on assumptions (e.g. annual burning hours, wattage, and lamp efficacy).**

[7] The emissions factor used is 0.43kg/kWh according to the MEEuP methodology.

- **The used model is a simplification of reality based on 'discrete' base-cases as defined in chapter 5 and connected discrete improvement options as defined in chapter 7. This discrete base-case model approach is reflected in abrupt changes in calculated energy consumption and lamp sales. In reality, this will be smoother due to spreading in lamp wattages, operational hours, new products, and proactive user behaviour (storing phase out lamps, green procurement, promotional campaigns, choice of retrofit options, etc.). These items will be discussed qualitatively in sections 8.1.4 and 8.2.**
- **In some scenarios, a base-case is replaced with a lamp that also requires luminaire replacement, e.g. the base-case HL-MV-LW (socket G9) with a CFLi. Environmental impacts due to the luminaire replacement are not assessed and thus not taken into account in the scenario analysis. This will be done in the Part 2 of the study.**
- **In some scenarios, a base-case is replaced with a lamp, identified as an improvement option for reducing life cycle cost and environmental impacts, whereas the light quality is not exactly similar, e.g. a GLS-F replaced with a CFLi. Therefore, the scenario analysis is done in a quantitative way as the qualitative assessment was already done in chapter 3.**
- **In the tables presenting the scenarios (except for the BAU), minimum requirements (i.e. minimum energy class) are set for each tier. In order to analyse these scenarios, a specific lamp technology is used as replacement lamp, e.g. HL-LV IRC (infrared coating technology) replacing the base-case HL-LV in the first tier (2009-2011) for the scenario 'Option 2 Clear B Fast'. This assumption, based on improvement options identified in chapter 7, does not mean that this technology (HL-LV IRC) is the only possible way to meet the requirement (i.e. energy class C).**
- **The tables should be interpreted from the point of view of the defined base-cases and improvement options. For this reason, it was not required to discuss upper or lower lamp lumen limits for future legislation in this section.**
- **In some scenarios, sales of an improvement option for base-case are similar for several years (e.g. sales of the improvement option 'CFLi combination 1' for the base-case CFLi in 2018 and 2019 in the scenario 'Option 2 Clear B Fast'). This is due to an assumed linear increase of stocks between 2017 and 2020 for all base-cases in the BAU scenario. Therefore, when replacing a base-case with an improvement option, sales are constant (e.g. in 2018 and 2019 in the previous example) as the gaps between the stocks are also constant. This is not fully realistic but results from the limits of the model used for the scenarios analysis.**
- **In some scenarios, sales of CFLi are lower than those forecasted in the BAU scenario for a specific year. For instance, sales of CFLi in 2020 in the scenario 'Option 2 Clear B Fast' are about 45 million units whereas they are assumed to be about 307 million units in the BAU scenario. This difference is due to a high increase of CFLi sales in the previous years (e.g. 605 million units in 2010 for the 'Option 2 Clear B Fast' scenario compared 335 million units in the BAU scenario) for replacing other base-cases (e.g. GLS-F) which compensates the**

demand in 2020 as the lifetime of a CFLi is much longer than the lifetime of a GLS-F.

8.1.2.1 Assumptions used for the scenarios analysis

Several assumptions had to be made in order to define scenarios and to assess economic and environmental impacts:

- As the scenario analysis concerned all sectors, annual burning hours used for each base-case are those defined in chapter 5 (section 5.5, Table 5-16): 505 h for GLS-C, 551 h for GLS-F, 538 h for HL-MV-LW, 536 h for HL-MV-HW, 705 h for HL-LV and 800 h for CFLi). These values were based on a weighted average of sales and annual burning hours for both the "domestic sector" and "other sectors". Please note also that the same annual burning hours were used for the improvement options (see chapter 7) as for the base-case, e.g. even if we replace a GLS with a CFLi as an improvement option, the original annual burning hours were used.
- When a lamp with a specific technology is removed from the market, for the year 'n' ('n' being any year after the removal from the market), the stock of this lamp was calculated with the following formula, assuming that the lamp lifetime is X.YZ years:

  *Stock (n) = Stock (n-1) - 0.YZ*Sales (n-1-X) - (1-0.YZ)*Sales (n-X)*

  When the result of this calculation is null or negative, it means that no more lamp is operating in EU-27.
- Mercury emissions to air due to electricity consumption were calculated using the emission factor of 0.016 mg Hg/kWh, as in chapters 5 and 7.
- For CFLi, we assumed that only 20% of lamps are recycled for all years and that the mercury content is 4 mg in the base-case and 2 mg in the CFLi-combination 1 (high lamp efficacy and less mercury content, as defined in chapter 7).
- Mercury emissions occurring at the end-of-life (EoL) for CFLi sold during the year 'n' were integrated in the calculation of mercury emissions for the year 'n' and not for the year 'n+CFLi lifetime', in order to facilitate the model. This assumption may have an influence when looking at mercury emissions for a specific year, but has a negligible impact when looking at total, cumulative mercury emissions from 2009 to 2020. Therefore, the formula for CFLi is:

  *Mercury emissions (n) = 0.016*Electricity consumption (n) + 80%*4*Sales (n),*

  where mercury emissions is in kg, electricity consumption in GWh and sales in million units. For CFLi-combination 1, the number 4 (mg) is replaced with 2 (mg).
- Sales and stock data (and therefore environmental impacts) are similar for all scenarios (including the BAU) for the years 2007 and 2008, as the entry into force of any legislation is assumed to be in 2009.
- It was assumed that the share of HL-MV-LW lamps being frosted was negligible, and therefore 100% of this lamp technology was assumed to be clear with a socket type G9.
- In some scenarios ('Option 2 Clear B Slow' and 'Option 3 Slow'), minimum requirements only concern the lumen output higher than 450 lm or 1000 lm (only for base-cases GLS-F, GLS-C and HL-MV-LW). Based on sales data provided in chapter

2 per wattage for each lamp technology, the following market shares, average wattage and average lumen output according to the lumen output were assumed:

		X < 450 lm	450 lm < X < 1000 lm	1000 lm < X
GLS-F	Market share	48.4 %	38.8 %	12.8 %
	Wattage	35 W	62 W	102 W
	Lumen output	322 lm	694 lm	1284 lm
GLS-C	Market share	48.4 %	38.8 %	12.8 %
	Wattage	35 W	62 W	102 W
	Lumen output	339 lm	718 lm	1333 lm
HL-MV-LW	Market share	55.0 %	35.0 %	10.0 %
	Wattage	28 W	50 W	75 W
	Lumen output	302 lm	645 lm	1046 lm

For some scenarios ('Option 1 Fast', 'Option 1 Slow', 'Option 2 Clear B Fast', and 'Option 2 Clear C Fast'), a separation was made only at a lumen output of 450 lm and following assumptions were used:

		X < 450 lm	450 lm < X
GLS-F	Market share	48.4 %	51.6 %
	Wattage	35 W	72 W
	Lumen output	322 lm	855 lm
GLS-C	Market share	48.4 %	51.6 %
	Wattage	35 W	72 W
	Lumen output	339 lm	878 lm
HL-MV-LW	Market share	55.0 %	45.0 %
	Wattage	28 W	60 W
	Lumen output	302 lm	798 lm

Furthermore, it was assumed that the annual burning hours were similar for a base-case, whatever the lumen output. For instance, GLS-F with a lumen output lower or higher than 450 lm have an annual burning hours of 505 h.

8.1.2.2 Calculation principle used for the scenarios analysis

The general principle of the environmental analysis for 7 scenarios (excluding the BAU) is that the total annual lumen needed for each base-case (obtained in the BAU scenario) has to be kept constant and it is the key parameter to estimate changes in sales when switching from a base-case to its improvement option(s). For a specific year 'n' the annual lumen needed for a base-case A is calculated in the BAU as follow:

$$Annual\ lumen\ needed_A\ (n) = Stock_A\ (n)\ x\ Annual\ Burning\ hours_A\ x\ Lumen\ output_A$$

Therefore, when analysing one of the 7 scenarios, for the year 'n', for the base-case A with its improvement options (i.e. replacement lamps) A_1, A_2, A_3, the following formula was used:

$$Annual\ lumen\ needed_A\ (n) = Annual\ lumen\ provided_A\ (n) + Annual\ lumen\ provided_{A1}\ (n) + Annual\ lumen\ provided_{A2}\ (n) + Annual\ lumen\ provided_{A3}\ (n)$$

And the 'Annual lumen $provided_{Ai}$' for the lamp Ai is computed with the following formula:

$$Annual\ lumen\ provided_{Ai}\ (n) = Stock_{Ai}\ (n)\ x\ Annual\ Burning\ hours_{Ai}\ x\ Lumen\ output_{Ai}$$

Until the base-case A is removed from the market, and therefore not replaced with an improvement option, the following equality has to be verified:

$$Annual\ lumen\ needed_A\ (n) = Annual\ lumen\ provided_A\ (n)$$

When the base-case is replaced with an improvement option (e.g. GLS-F < 450 lm with CFLi) in the year 'n', the total amount of annual lumen provided by the GLS-F < 450lm, i.e. the base-case GLS-F, decreases gradually from the year 'n' onwards, until the stock of this specific lamp reaches zero. At the same time, the amount of annual lumen provided by the improvement option CFLi is rising year by year in order to compensate decrease GLS-F sales and to keep the 'Annual lumen $needed_{GLS\text{-}F}$' constant.

In some scenarios, the replacement of the base-cases GLS-F and GLS-C (with CFLi or Xenon HL-MV-LW), may lead to an excess lumen output compared to the annual lumen needs of these base-cases in the BAU. On one hand, this is due to the constant reduction of the 'Annual lumen needed' for these base-cases from 2009 to 2020, as their stocks decrease, and on the other hand, to the higher lifetime of the replacement lamps, mainly with the CFLi. In this case, the 'lumen surplus' is compensated by adjusting the sales of the corresponding base-case(s). For instance, when the base-case GLS-F is replaced with a CFLi (combination 1), which some years after the replacement provides more annual lumen than needed by the GLS-F according to the BAU, e.g. difference of 100 billion lumen, the number of new CFLi (combination 1) used as replacement lamp for the base-case CFLi is adjusted so as to provide 100 billion lumen less that needed for this base-case in BAU. Therefore, the total annual lumen needed for all base-cases remains constant.

DISCLAIMER: The statements, figures and graphs provided on this page have to be read in the context set out in the beginning of section 8.1.2 and in sections 8.1.2.1 and 8.1.2.2

8.1.2.3 Scenario "BAU"

The first step required in order to build scenarios, is to define the Business-as-Usual scenario that will serve as reference.

First, the number of NDLS lamps per household (i.e. in the domestic sector) per lamp type for the year 2011 and 2020 was estimated as specified in chapter 2, section 2.2.6. Moreover, data in 2006 is already know and provided in chapter 2.

Data presented in Table 8.6 show that the total number of lamps in the domestic sector was assumed to constantly increase (+31% in 2020 compared to 2006).

Table 8.6: Forecasts of number of lamps per household in the domestic sector (BAU)

	GLS-F	GLS-C	HL-MV-LW	HL-MV-HW	HL-LV	CFLi	TOTAL
	Nb/hh	Nb/hh	Nb/hh	Nb/hh	Nb/hh	Nb/hh	Nb/hh
2006	9.11	2.61	0.34	0.39	2.19	3.54	**18.21**
2007	7.89	2.42	0.60	0.59	2.24	4.81	**18.48**
2008	6.89	2.22	0.86	0.72	2.30	5.85	**18.80**
2009	6.08	2.03	1.12	0.84	2.37	6.70	**19.13**
2010	5.43	1.84	1.39	0.97	2.43	7.40	**19.45**
2011	4.87	1.65	1.65	1.10	2.50	8.00	**19.77**
2012	4.47	1.64	1.76	1.13	2.55	8.47	**20.00**
2013	4.26	1.62	1.86	1.16	2.59	8.75	**20.24**
2014	4.07	1.61	1.97	1.19	2.64	9.00	**20.47**
2015	3.95	1.59	2.07	1.22	2.68	9.19	**20.71**
2016	3.83	1.58	2.18	1.25	2.73	9.38	**20.94**
2017	3.73	1.56	2.28	1.28	2.77	9.55	**21.18**
2018	3.64	1.55	2.39	1.31	2.82	9.70	**21.41**
2019	3.56	1.54	2.49	1.34	2.86	9.85	**21.65**
2020	3.48	1.52	2.60	1.37	2.91	10.00	**21.88**

Based on these lamp stocks per household, the stock and the sales per lamp type were calculated for the years from 2007 to 2020 for the domestic sector. In chapter 5 (section 5.5) sales and stock data were also computed for 2007 for all sectors (i.e. domestic sector + other sectors). For the total stock and sales from 2007 to 2020, it was assumed that the share of the domestic sector remains constant in order to calculate data for all sectors. These estimates are presented in Table 8.7., and are similar to those presented in chapter 2 (see Table 2.28 in section 2.2.7), and detailed results are presented in Annexe 8-1.

Several observations can be made from this table:

- As expected, even without any legislation, the market share and the stock of incandescent lamps (GLS-F and GLS-C) decrease in line with the chapter 2

assumptions. Between 2009 and 2020 the stock and the sales of GLS-F are assumed to be reduced by 41% (i.e. about 576 million units) and 29% (i.e. about 218 million units) respectively. For the base-case GLS-C, the decrease of the stock and sales are about 25% and 21% respectively.

Sales and stock decrease of GLS-F and GLS-C are very significant between 2007 and 2011, and less noticeable between 2011 and 2020 as highlighted in Figure 8.3 and Figure 8.5. The reasons of these trends are detailed in chapter 2, section 2.3.1.

- According to the assumptions made in chapter 2, it is expected that HL-MV-LW lamps represent a significant market share in 2020, with a 131% increase of the stock, and a 69% increase of the sales in comparison to 2009.
- Being the most energy efficient and cost-effective lamp over the whole life cycle, the stock of CFLi will increase, especially between 2007 and 2011 as explained in chapter 2, section 2.3.1. However, sales of CFLi are not assumed to increase continuously. CFLi sales is expected to peak in 2007-2008 and hereafter to decrease to a constant level around 2013 and then increase very slowly – this is a conservative forecast as the manufactures are actually inventive in order to keep the actual level of CFLi sales as described in section 2.3. However, the stock of CFLi will constantly grow as the sales in that period will be new sales - replacement sales will be delayed due to the long lifetime of this lamp type.

Sales and stock data are presented in Figure 8.2 to Figure 8.5 both in % and in units.

DISCLAIMER: The statements, figures and graphs provided on this page have to be read in the context set out in the beginning of section 8.1.2 and in sections 8.1.2.1 and 8.1.2.2

Table 8.7: Market data for the BAU scenario (for all sectors)

		Base-case GLS-F	Base-case GLS-C	Base-case HL-MV-LW	Base-case HL-MV-HW	Base-case HL-LV	Base-case CFLi
2007	Total stock (mln)	1,800.1	568.5	134.4	119.4	558.3	1,010.1
	Total sales (mln)	767.4	297.0	97.4	84.1	147.0	353.0
2008	Total stock (mln)	1,580.0	523.5	193.5	151.3	571.5	1,228.5
	Total sales (mln)	687.9	273.1	115.2	89.8	149.3	353.1
2009	Total stock (mln)	1,399.9	478.4	252.5	183.1	584.7	1,407.0
	Total sales (mln)	624.9	249.2	133.0	95.5	151.5	342.3
2010	Total stock (mln)	1,251.3	433.4	311.6	214.9	597.9	1,554.0
	Total sales (mln)	573.7	225.3	150.7	101.1	153.8	334.6
2011	Total stock (mln)	1,123.7	388.3	370.6	246.8	611.1	1,680.0
	Total sales (mln)	527.8	201.5	168.5	106.8	156.0	333.2
2012	Total stock (mln)	1,038.3	385.0	394.3	253.5	622.2	1,778.7
	Total sales (mln)	444.8	200.8	174.8	107.6	158.2	322.7
2013	Total stock (mln)	992.8	381.6	418.1	260.2	633.3	1,837.5
	Total sales (mln)	446.3	200.2	181.0	108.4	160.4	296.0
2014	Total stock (mln)	953.6	378.3	441.8	267.0	644.5	1,890.0
	Total sales (mln)	434.3	199.6	187.2	109.3	162.6	297.5
2015	Total stock (mln)	927.1	374.9	465.5	273.7	655.6	1,929.9
	Total sales (mln)	431.7	199.0	193.5	110.1	164.8	291.9
2016	Total stock (mln)	900.5	371.6	489.2	280.4	666.7	1,969.8
	Total sales (mln)	423.0	198.3	199.7	110.9	166.9	297.2
2017	Total stock (mln)	878.1	368.2	512.9	287.2	677.9	2,005.5
	Total sales (mln)	418.4	197.7	206.0	111.7	169.1	298.3
2018	Total stock (mln)	859.9	364.8	536.6	293.9	689.0	2,037.0
	Total sales (mln)	416.0	197.1	212.2	112.5	171.3	298.9
2019	Total stock (mln)	841.7	361.5	560.3	300.6	700.1	2,068.5
	Total sales (mln)	411.4	196.5	218.4	113.3	173.5	303.1
2020	Total stock (mln)	823.6	358.1	584.0	307.4	711.3	2,100.0
	Total sales (mln)	406.9	195.8	224.7	114.2	175.7	307.3

DISCLAIMER: The statements, figures and graphs provided on this page have to be read in the context set out in the beginning of section 8.1.2 and in sections 8.1.2.1 and 8.1.2.2

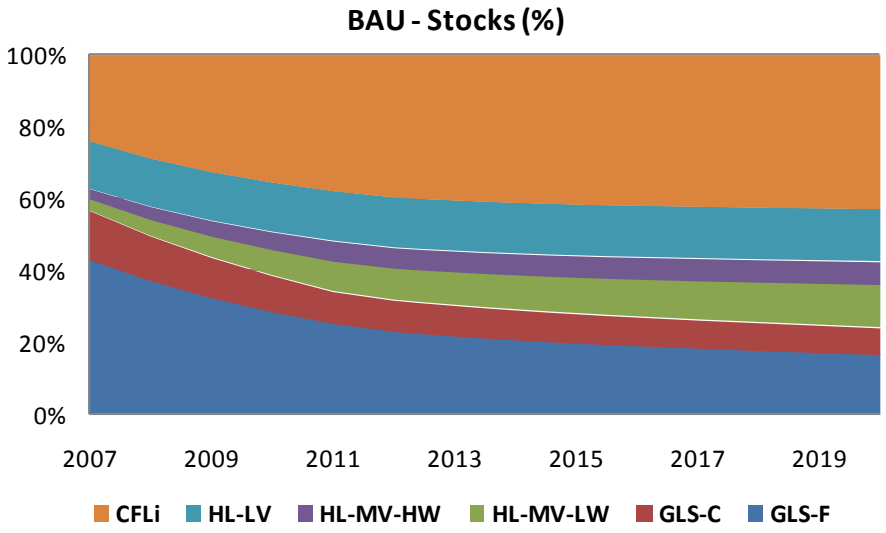


Figure 8.2: BAU – Evolution of lamps stocks (in %)

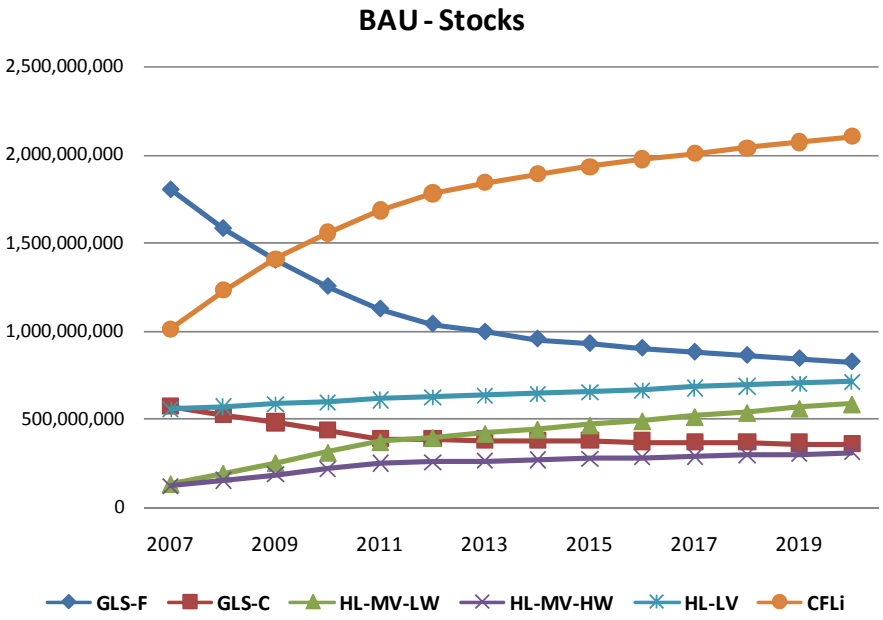


Figure 8.3: BAU – Evolution of lamps stocks (in units)

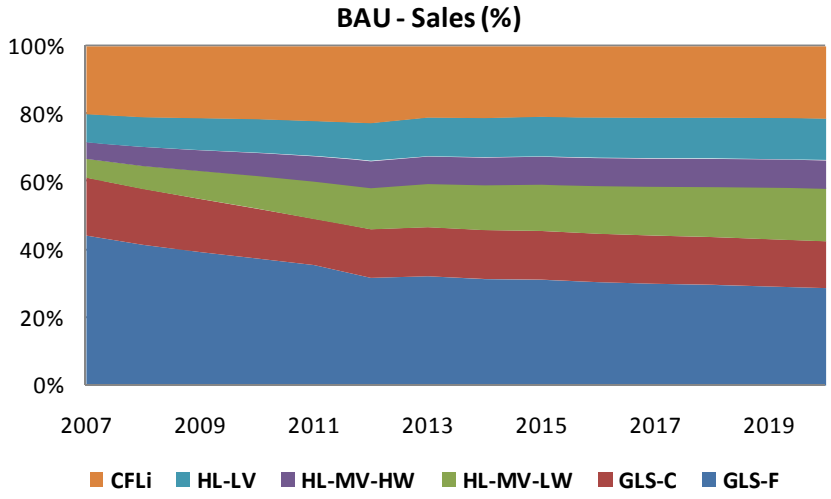


Figure 8.4: BAU – Evolution of lamps sales (in %)

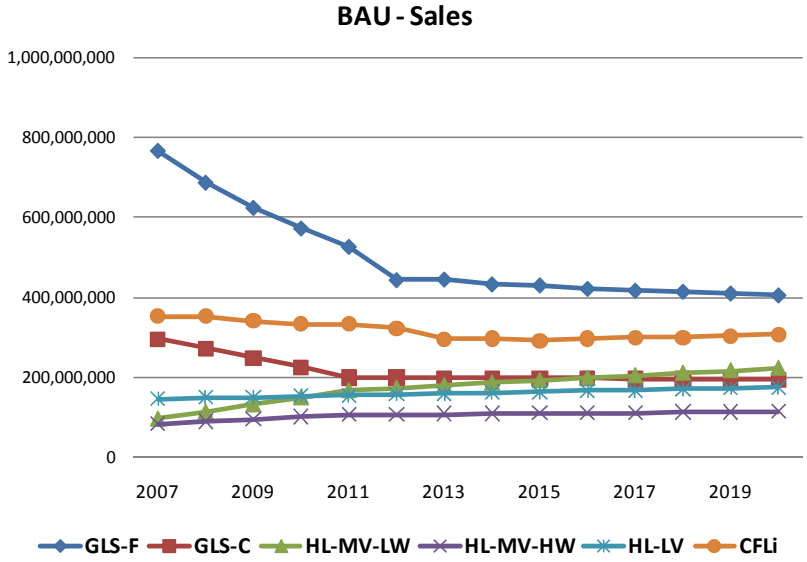


Figure 8.5: BAU – Evolution of lamps sales (in units)

The previous stock and sales analysis is required in order to proceed with the environmental analysis. Three environmental impacts were assessed:

- Electricity consumption during the use phase (this stage represents at least 91% of the total electricity consumption over the whole life cycle for the six base-cases);
- CO_2 emissions due to the electricity consumption during the use phase (proportional to the electricity consumption); and
- Mercury emissions to air due to the electricity consumption during the use phase and the end-of-life phase for CFLi, as this lamp type contains mercury.

The evolution of these environmental impacts is presented in Figure 8.6 from 2007 to 2020. It can be seen that in the Business-as-Usual scenario, the total electricity consumption will increase despite the slow replacement of GLS lamps with more efficient lamps (CFLi and HL-MV-LW) because of an increasing use of lamps (in the domestic sector from 24.3

lamps/households in 2007 to 31 lamps/household in 2020. Thus, in 2020, the electricity consumption (during the use phase) would reach a level of 134.7 TWh owing to the use of these six lamp types whatever the sector, i.e. an increase of about 20% compared to 2007. The increase of CO_2 emissions is similar (57.9 Mton in 2020 compared to 48.3 Mton in 2007).

Regarding mercury emissions to air, after a growth between 2007 and 2011 (+3.5%), the level decrease until 2013 and then increase continuously until 2020. This evolution is due to the high increase of CFLi sales between 2007 and 2011, and the method chosen to account mercury emissions for CFLi during the EoL (see section 8.1.2.1).

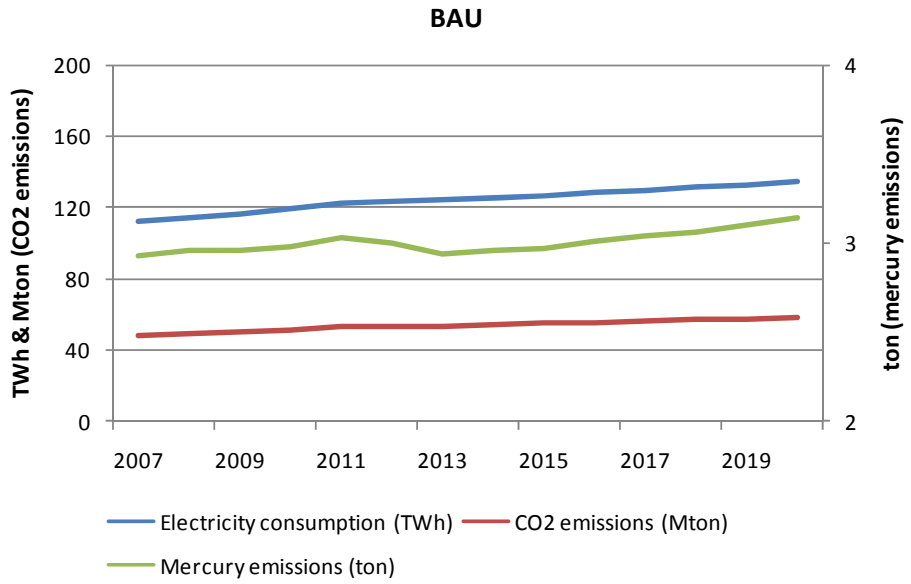


Figure 8.6: BAU – Evolution of annual environmental impacts

For the environmental impact 'Electricity consumption', Figure 8.7 presents the contribution of each lamp technology from 2007 to 2020. Due to its high wattage, and its consequently high electricity consumption per lamp, the lamp technology HL-MV-HW is the major contributor in 2020 to this impact (36.7%) followed by CFLi (17.0%) and GLS-F (16.7%).

DISCLAIMER: The statements, figures and graphs provided on this page have to be read in the context set out in the beginning of section 8.1.2 and in sections 8.1.2.1 and 8.1.2.2

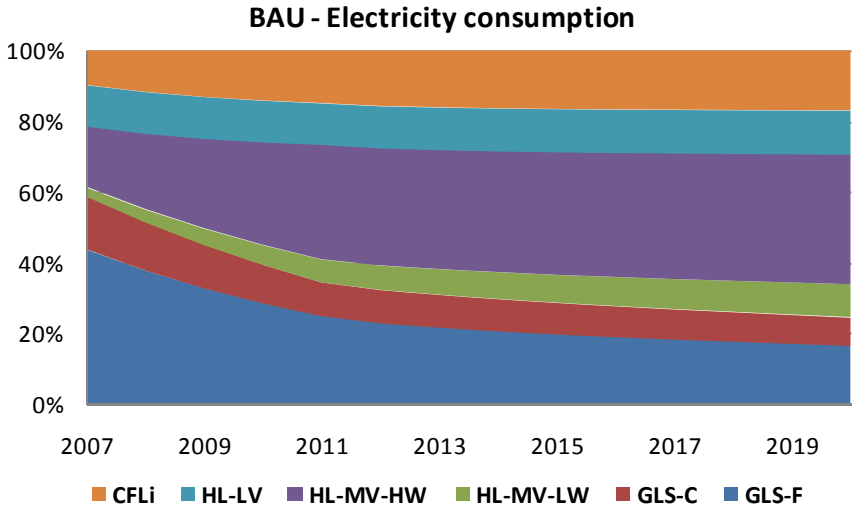


Figure 8.7: BAU - Evolution of the contribution of the lamp types to the electricity consumptions of the total lamp stock

The following sections present the analysis of the 7 scenarios setting minimum lamp efficacy requirements. For each section, the presentation of the analysis is similar and divided in three parts:

a) Presentation of the scenario with the requirements and the Tiers,

b) Presentation of sales and stocks data both in % and in units from 2007 to 2020,

c) Presentation of the environmental impact from 2007 to 2020.

For each scenario, detailed data (sales, stock and electricity consumption) are presented in Annexe.

8.1.2.4 Scenario "BAT"

The 'BAT' scenario is the most ultimate and a hypothetic scenario, as from 2009, all base-cases are replaced with CFLi (combination 1), i.e. a CFLi with high lamp efficacy and reduced mercury content (2 mg). As highlighted red in Table 8.8, the replacement of halogen lamps with CFLi (combination 1) would also probably require the replacement of the luminaires. As explained in chapter 3, CFLi lamps do not necessary offer the same level of light quality as phased out lamps.

Table 8.8: BAT – Replacement lamps for each tier

present	2009
requirements	**A (with CFL combination1)**
Base case	**Assumed replacing base-case**
GLS-C	CFLi (combination 1)
GLS-F	CFLi (combination 1)
HL-MV-LW (G9)	CFLi (combination 1)
HL-MV-HW (R7s)	CFLi (combination 1)
HL-LV	CFLi (combination 1)
CFLi	CFLi (combination 1)

Note: in yellow = change from previous phase; in red = change that requires luminaire change

As in chapter 7, CFLi was not assessed as an improvement option for halogen lamps and following assumptions were used in the analysis of the BAT scenario.

Table 8.9: BAT – Assumptions of CFLi replacing halogen lamps

	Base-case HL-MV-LW	**Base-case HL-MV-HW**	**Base-case HL-LV**
	CFLi (comb. 1)	**CFLi (comb. 1)**	**CFLi (comb. 1)**
Wattage	10 W	55 W	10 W
Lamp lifetime	10000 h	10000 h	10000 h
Lumen output	466 lm	4662 lm	466 lm

The BAT scenario would imply that CFLi would represent 100% of the stocks from 2012 when HL-LV lamps, which have the longest lifetime (4.26 years) excluding CFLi, are phased out. In 2020, the stock of CFLi lamps was estimated to be about 4.74 billion units. Detailed results of the analysis of the BAT scenario are presented in Annexe 8-2.

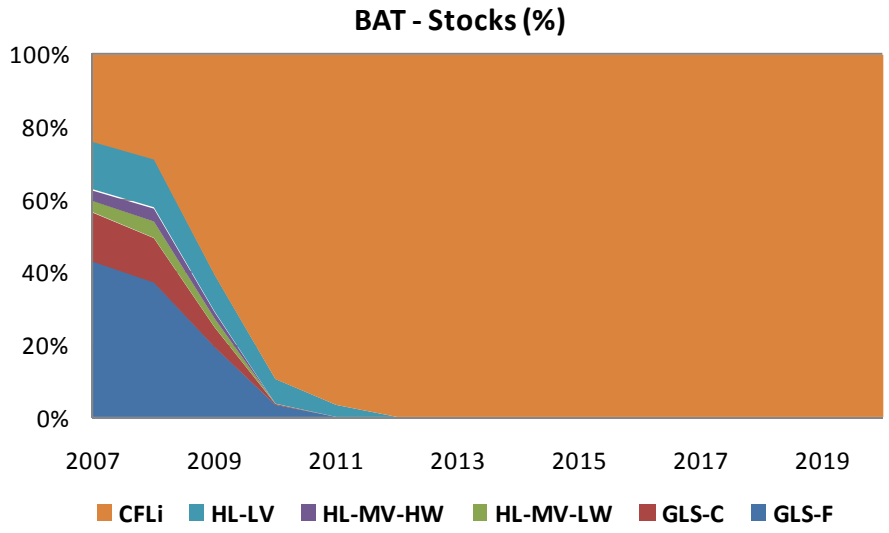


Figure 8.8: BAT - Evolution of lamps stocks (in %)

DISCLAIMER: The statements, figures and graphs provided on this page have to be read in the context set out in the beginning of section 8.1.2 and in sections 8.1.2.1 and 8.1.2.2

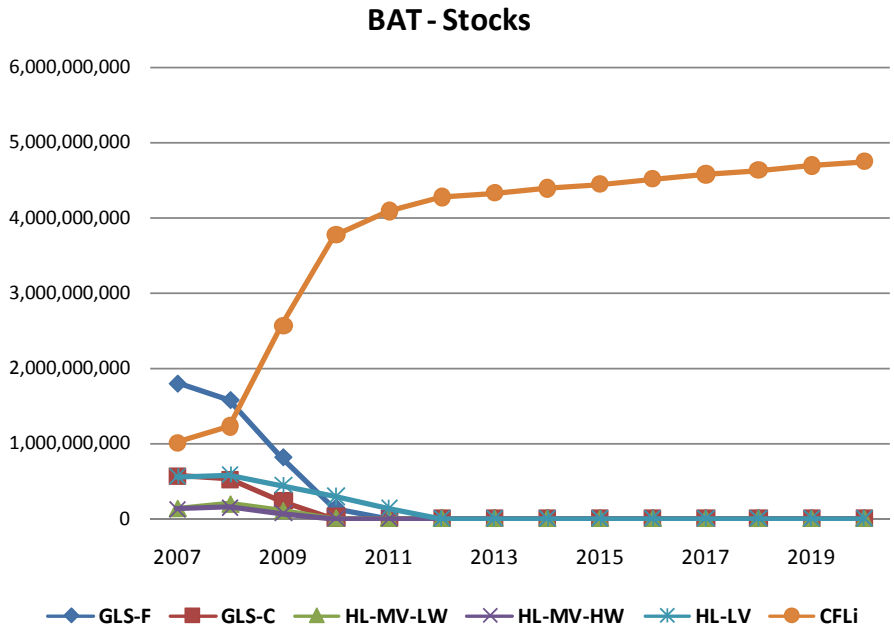


Figure 8.9: BAT - Evolution of lamps stocks (in units)

Obviously, as CFLi is the only lamp type meeting the requirements and consequently sold in the EU-27 market after 2009 in the BAT scenario, it represents 100% of the market from this year onwards (see Figure 8.10).

CFLi sales strongly increase in 2009 compared to 2008 (+349%) in order to compensate the total annual lumen needed for the five base-cases that are removed from the market. After all replacement is over, the yearly CFLi sales are much lower and stay quite constant from 2015 onwards (60.7 million units). Indeed, as the lamp lifetime of CFLi (combination 1) is much longer than the base-cases (10000 h for CFLi combination 1), replacement sales for each year are lower. Some years after 2020, CFLi sales will increase when the 10000 h lifetime is reached for the large replacement sales occurring in the first Tier.

DISCLAIMER: The statements, figures and graphs provided on this page have to be read in the context set out in the beginning of section 8.1.2 and in sections 8.1.2.1 and 8.1.2.2

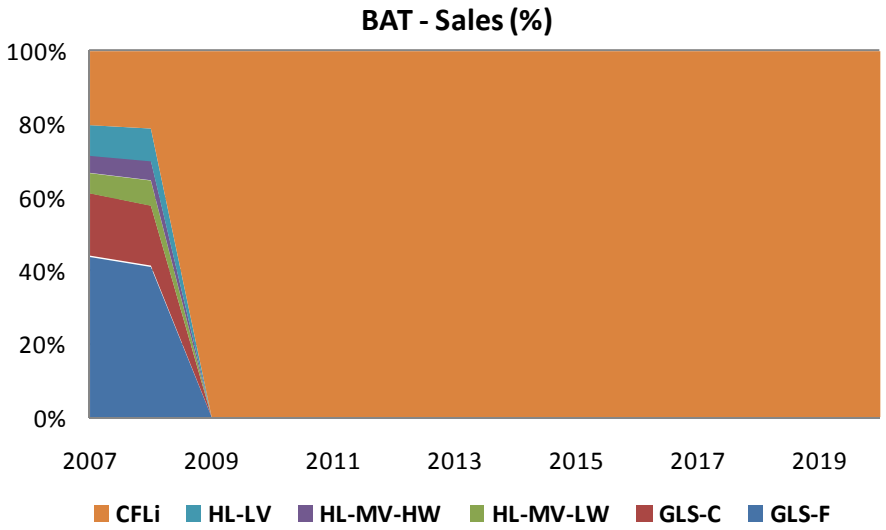


Figure 8.10: BAT - Evolution of lamps sales (in %)

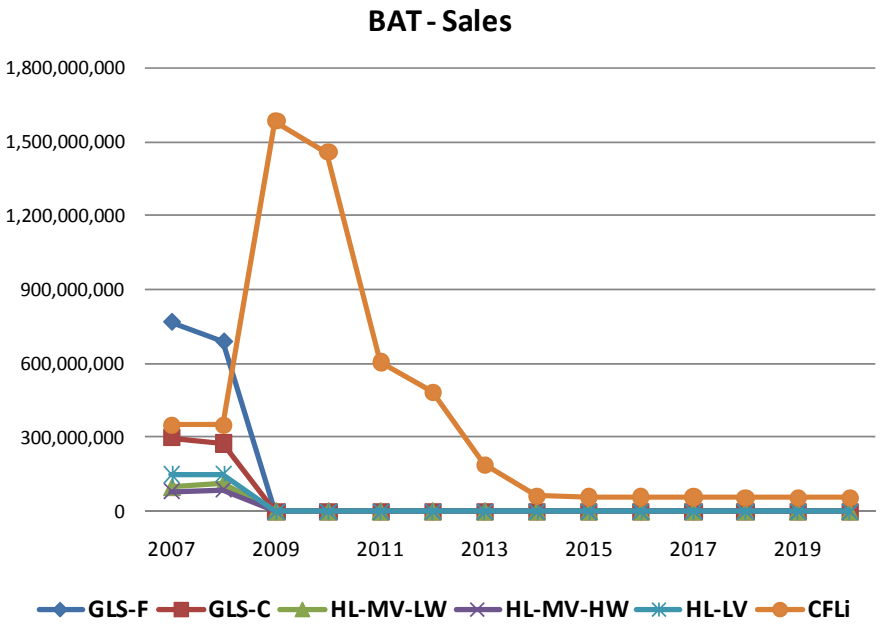


Figure 8.11: BAT - Evolution of lamps sales (in units)

From 2009 onwards, total electricity consumption (and therefore total CO_2 emissions) decreases until 2012 and then increases slightly until 2020, at about the same rate as the CFLi stock (about +1.5% per year).

In 2020, total electricity consumption is expected to be about 47.5 TWh, i.e. 64.7% lower than in the BAU scenario. The reduction is the same for CO_2 emissions (20.4 Mton in 2020).

Regarding mercury emissions, the total amount increases in 2009 due to the high increase of CFLi sales (since mercury emissions occurring at their end-of-life are attributed to the sales year). Then, the emissions decrease until 2014 and afterwards stay relatively constant. In 2020, total mercury emissions to air due to the electricity consumption of lamps during to the

use phase, and due to emissions occurring at EoL of CFLi are about 853 kg, which means a reduction of about 72.8% compared to the BAU scenario.

Figure 8.13 shows that after 2012, electricity consumption is only due to CFLi, as at this date the other lamp types have been phased out.

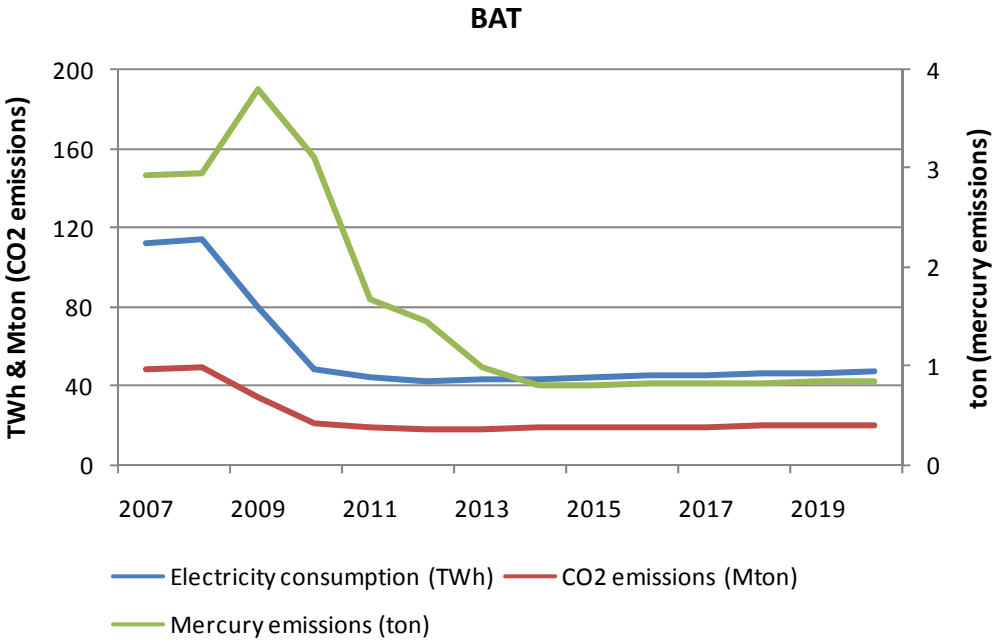


Figure 8.12: BAT – Evolution of annual environmental impacts

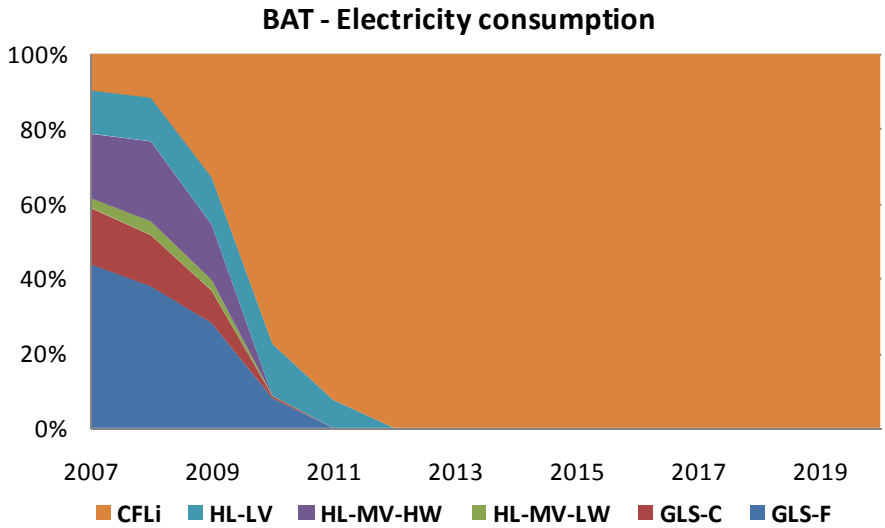


Figure 8.13: BAT - Evolution of the contribution of the lamp types to the electricity consumptions of the total lamp stock

DISCLAIMER: The statements, figures and graphs provided on this page have to be read in the context set out in the beginning of section 8.1.2 and in sections 8.1.2.1 and 8.1.2.2

8.1.2.5 Scenario "Option 1 Fast"

The 'Option 1 Fast' scenario is based on Option 1 presented in the Working Document of the European Commission, and minimum lamp efficacy requirements becoming more and more restrictive with the time, 3 Tiers are defined.

As highlighted in Table 8.10, the replacement of halogen lamps with CFLi or CFLi (combination 1) would also probably require the replacement of the luminaires (in 2009 for HL-MV-LW under 450lm and for HL-MV-HW, in 2001 for HL-MV-LW below 450lm, and in 2013 for HL-LV).

Table 8.10: Option 1 Fast – Replacement lamps for each tier

present	2009	2011	2013
requirements:	**C except below 450lm**	**C (with CFL combination1)**	**A (with CFL combination1)**
Base case	**Assumed replacing base-case**	**Assumed replacing base-case**	**Assumed replacing base-case**
GLS-C	CFLi (except below 450 lm)	CFLi (combination 1)	CFLi (combination 1)
GLS-F	CFLi (except below 450 lm)	CFLi (combination 1)	CFLi (combination 1)
HL-MV-LW (G9)	CFLi (except below 450 lm)	CFLi (combination 1)	CFLi (combination 1)
HL-MV-HW (R7s)	CFLi	CFLi (combination 1)	CFLi (combination 1)
HL-LV	HL-LV	HL-LV	CFLi (combination 1)
CFLi	CFLi	CFLi (combination 1)	CFLi (combination 1)

Note: in yellow = change from previous phase; in red = change that requires luminaire change

HL-MV-LW and HL-MV-HW were assumed to be replaced by CFLi already in 2009 (in spite of a C-class requirement only) because it was assumed that industry would not introduce an improved halogen lamp of that category just for 4 years, i.e. until 2013 as from this year the required level would be A-class.

As in chapter 7, CFLi was not assessed as an improvement option for halogen lamps. The following assumptions were used in the analysis of the 'Option 1 Fast' scenario.

Table 8.11: Option 1 Fast – Assumptions of CFLi replacing halogen lamps

	Base-case HL-MV-LW > 450 lm	**Base-case HL-MV-LW**	**Base-case HL-MV-HW**		**Base-case HL-LV**
	CFLi	**CFLi (comb. 1)**	**CFLi**	**CFLi (comb. 1)**	**CFLi (comb. 1)**
Wattage	15 W	10 W	55 W	55 W	10 W
Lamp lifetime	6000 h	10000 h	6000 h	10000 h	10000 h
Lumen output	694 lm	466 lm	4163 lm	4662 lm	466 lm

This scenario would imply that CFLi would represent 100% of the stock from 2018 onwards when HL-LV lamps would be removed from the EU-27 market. In 2020, the stock of CFLi lamps (including CFLi and CFLi-combination 1) was estimated to be about 4.4 billion units. Detailed outcomes of the analysis of 'Option 1 Fast' scenario are presented in Annexe 8-3.

DISCLAIMER: The statements, figures and graphs provided on this page have to be read in the context set out in the beginning of section 8.1.2 and in sections 8.1.2.1 and 8.1.2.2

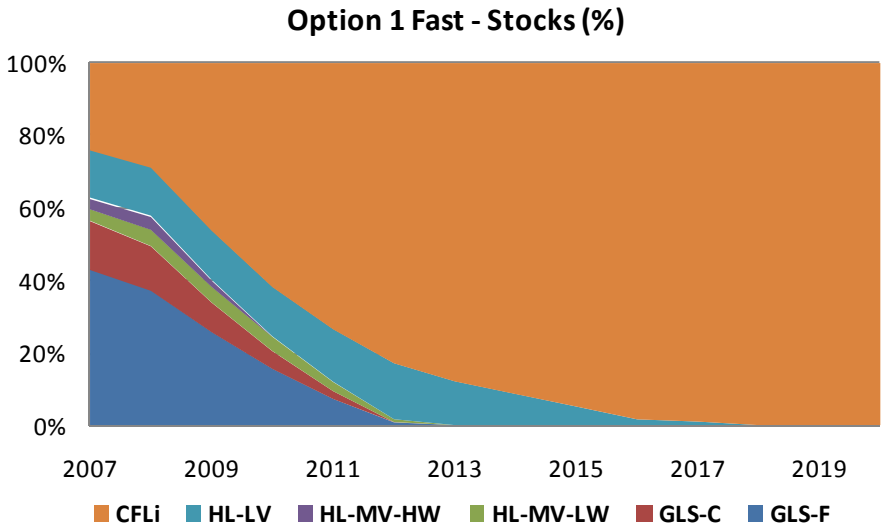


Figure 8.14: Option 1 Fast - Evolution of lamps stocks (in %)

As CFLi is the only lamp type meeting the requirements after 2018 in the 'Option 1 Fast' scenario, it represents 100% of the market (see Figure 8.14) from this date onwards. Previously, there is a continuous decrease of the stocks of the other lamp types that are phased out earlier.

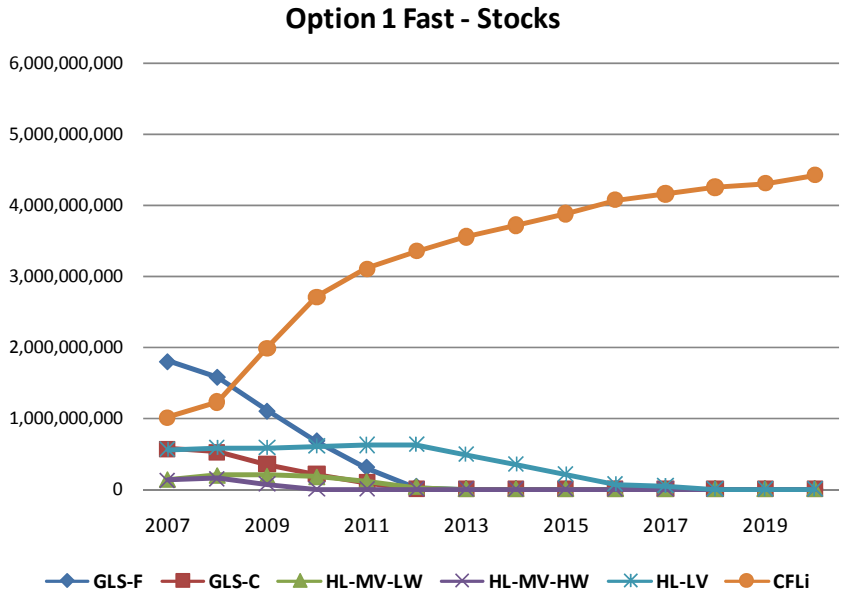


Figure 8.15: Option 1 Fast - Evolution of lamps stocks (in units)

Due to the minimum requirements set from 2009 onwards, CFLi present the highest share of the sales from this date. In Figure 8.16, the market share of HL-LV grows in 2012, the reason being that this figure presents relative distribution of sales: the higher market share of HL-LV is due to a decrease of CFLi sales in 2012 while HL-LV sales stay constant.

In 2020, CFLi sales increase (see Figure 8.17) as some of these lamps which were sold in 2009 to replace GLS and HL-MV are in their end-of-life stage and therefore have to be

replaced with new CFLi in order to keep the parameter 'annual lumen needed' similar to the BAU scenario.

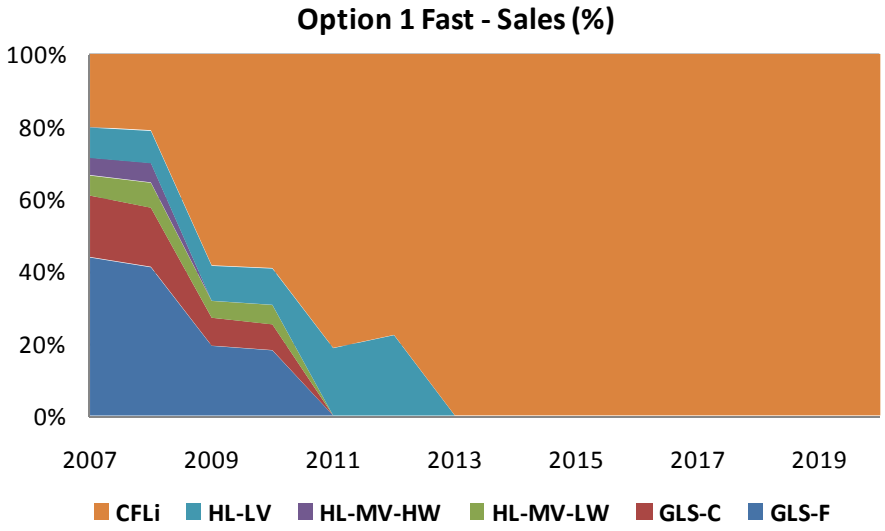


Figure 8.16: Option 1 Fast - Evolution of lamps sales (in %)

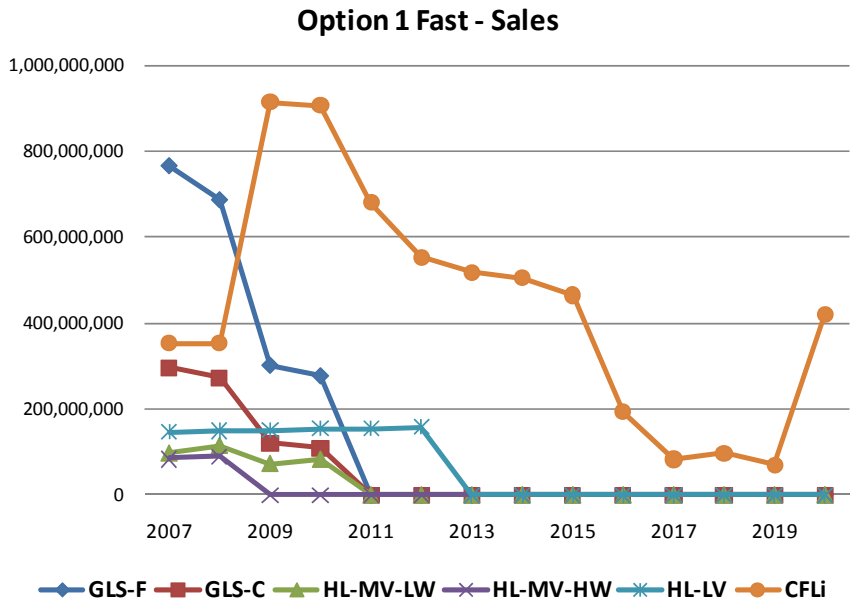


Figure 8.17: Option 1 Fast - Evolution of lamps sales (in units)

After 2009, total electricity consumption (and therefore total CO_2 emissions) decreases until 2016 and then remains quite constant until 2020. In 2020, total electricity consumption is expected to be about 48.3 TWh, i.e. 64.2% lower than in the BAU scenario. The reduction is the same for CO_2 emissions (20.8 Mton in 2020).

Regarding mercury emissions, the total amount increases in 2009 due to the high increase of CFLi sales to replace GLS and HL-MV lamps (the lamp mercury being attributed to the sales year). Then, this total decreases until 2019 and then further slightly increases in 2020 corresponding to the CFLi sales raise at this date. In 2020, total mercury emissions to air due to the electricity consumption of lamps during to the use phase, and due to emissions

occurring at EoL of CFLi is about 1444 kg, i.e. a reduction of about 54.0% compared to the BAU scenario.

Figure 8.19 shows that after 2010, CFLi are the major contributor to the electricity consumption due to the phasing-out of GLS-F, and become the only contributor from 2018 as all other lamps are removed from the EU-27 market.

Please note that the abrupt changes in lamp sales are in part due to the discrete model used (see general remarks).

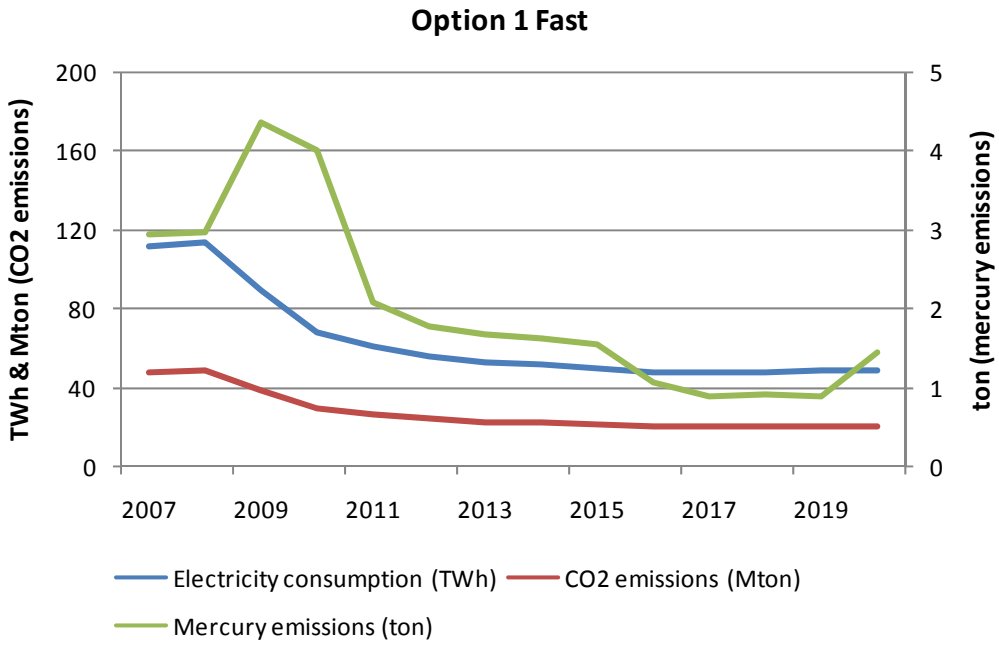


Figure 8.18: Option 1 Fast – Evolution of annual environmental impacts

DISCLAIMER: The statements, figures and graphs provided on this page have to be read in the context set out in the beginning of section 8.1.2 and in sections 8.1.2.1 and 8.1.2.2

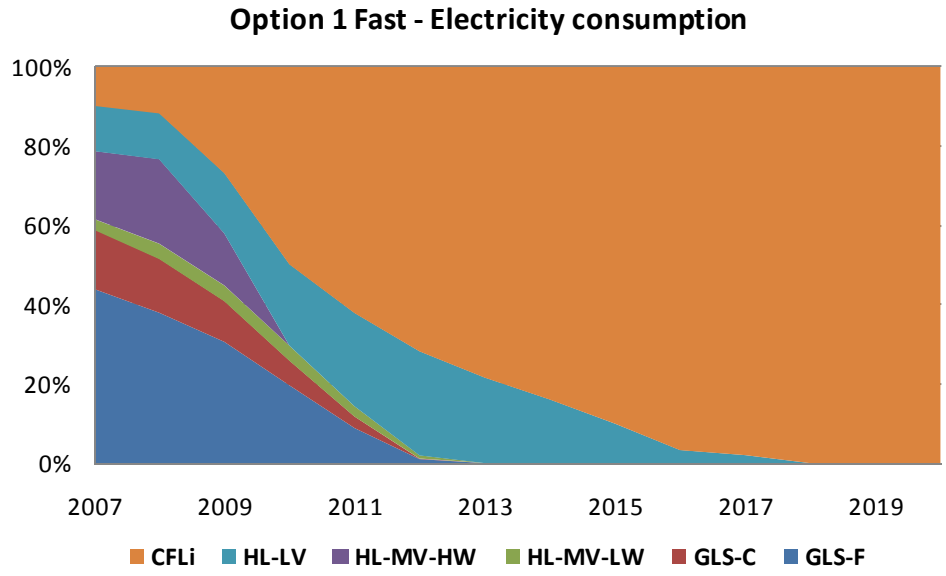


Figure 8.19: Option 1 Fast - Evolution of the contribution of the lamp types to the electricity consumptions of the total lamp stock

8.1.2.6 Scenario "Option 1 Fast B"

Compared to 'Option 1 Fast' scenario, 'Option 1 Fast B' scenario presents some differences for halogen lamps: HL-MV-LW and HL-MV-HW are only replaced with CFLi lamps in the last Tier (i.e. 2013), and are improved from 2009 (in 2009 only for lumen output above 450 lm, and in 2011 for all HL-MV lamps) until 2013 with the Xenon technology.

Further, in the first Tier, the HL-LV base-case is replaced with HL-LV with infrared coating. Requirements set for GLS and CFLi are similar to those defined in 'Option 1 Fast'.

In the last Tier of this 'Option 1 Fast B' scenario (i.e. 2013) the minimum level of both clear and frosted lamps is A.

Table 8.12: Option 1 Fast B – Replacement lamps for each tier

present	2009	2011	2013
requirements:	**C except below 450lm**	**C (with CFL combination1)**	**A (with CFL combination1)**
Base case	**Assumed replacing base-case**	**Assumed replacing base-case**	**Assumed replacing base-case**
GLS-C	CFLi (except below 450 lm)	CFLi (combination 1)	CFLi (combination 1)
GLS-F	CFLi (except below 450 lm)	CFLi (combination 1)	CFLi (combination 1)
HL-MV-LW (G9)	Xenon HL-MV-LW	Xenon HL-MV-LW	CFLi (combination 1)
HL-MV-HW (R7s)	Xenon HL-MV-HW	Xenon HL-MV-HW	CFLi (combination 1)
HL-LV	HL-LV IRC	HL-LV IRC	CFLi (combination 1)
CFLi	CFLi	CFLi (combination 1)	CFLi (combination 1)

Note: in yellow = change from previous phase; in red = change that requires luminaire change

Characteristics of replacement lamps used in this scenario are those presented in chapter 7.

Stock trends for the six lamp technologies shown in Figure 8.20 and Figure 8.21 are very close to those of the 'Option 1 Fast' scenario, with a constant decrease of incandescent and halogen lamps: GLS-F and GLS-C are removed from the market in 2013, HL-MV in 2017 and HL-LV in 2018, in line with their lifetimes.

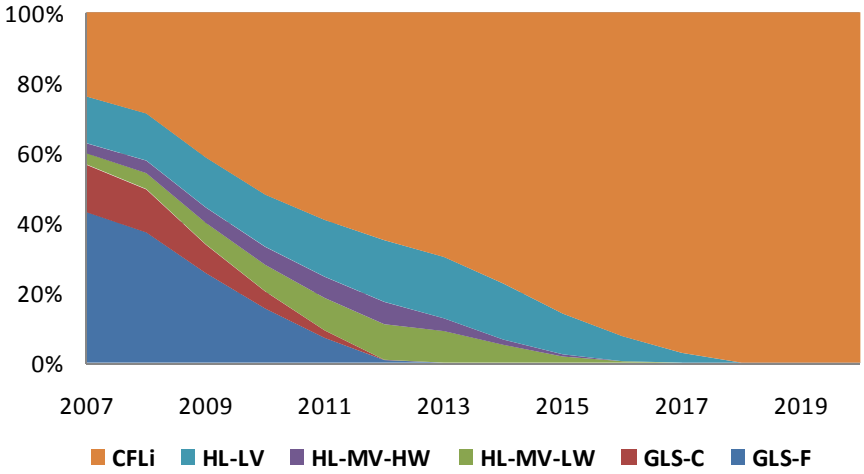


Figure 8.20: Option 1 Fast B - Evolution of lamps stocks (in %)

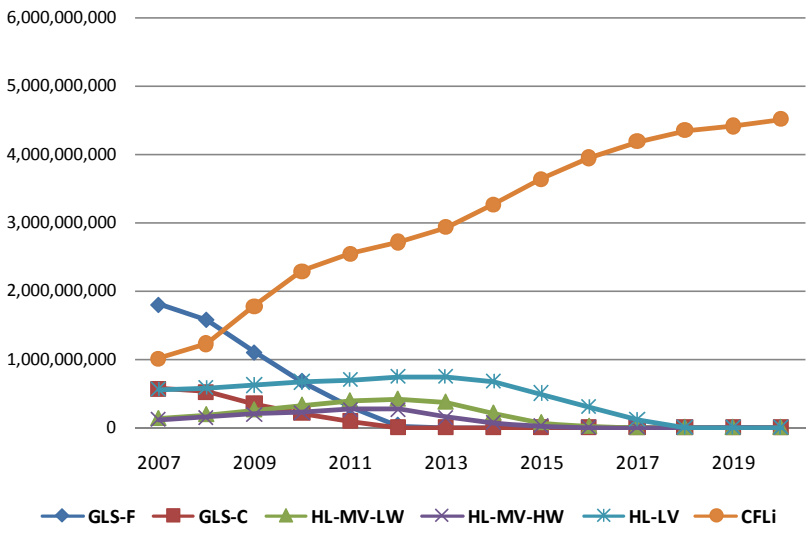


Figure 8.21: Option 1 Fast B - Evolution of lamps stocks (in units)

Figure 8.22 and Figure 8.23 clearly show the progressive phasing-out of incandescent and halogen lamps: in two stages for GLS-F, GLS-C, HL-MV-LW and HL-MV-HW and in three stages for HL-LV.

HL-LV sales slightly increase in 2009, as this base-case is replaced with a more energy efficient lamp variant, HL-LV IRC. The lumen output of this improvement option is lower than its base-case as the wattage is lower (30W-435lm for the base-case and 20W-369lm for the HL-LV IRC). Therefore, to keep the 'annual lumen needed for HL-LV' constant, more HL-LV IRC lamps are required, and therefore sales (in units) of this lamp technology increase.

CFLi sales clearly rise in 2009 as this lamp type replace GLS lamps (with lumen output above 450 lm), and in 2014 to compensate the phasing-out of halogen lamps. Moreover, as in the 'Option 1 Fast' scenario, CFLi sales see a new increase in 2020 corresponding to the replacement of lamps that were sold in 2009.

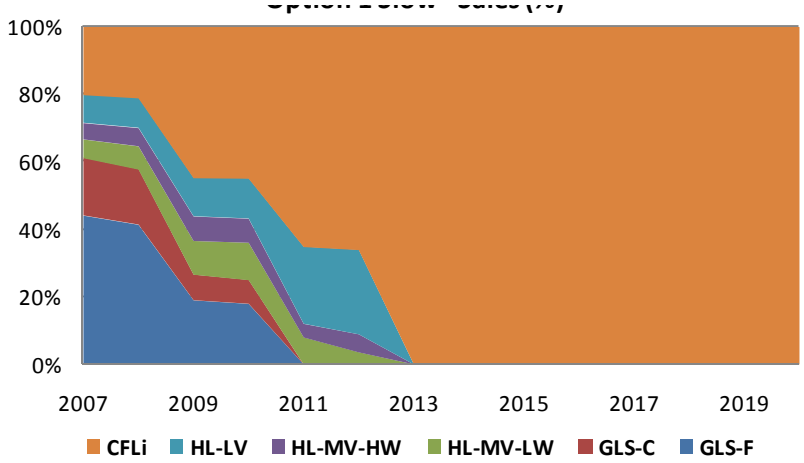


Figure 8.22: Option 1 Fast B – Evolution of lamps sales (in %)

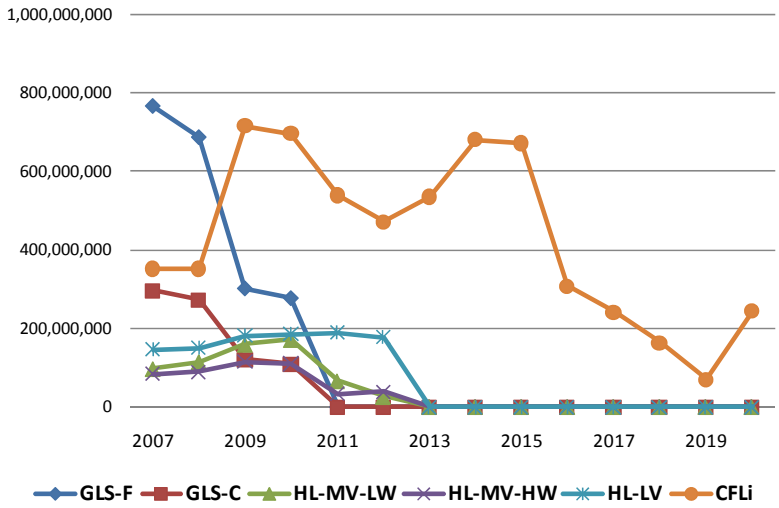


Figure 8.23: Option 1 Fast B – Evolution of lamps sales (in units)

Requirements set in the context of the 'Option 1 Fast B' scenario allow a reduction of environmental impacts in 2020 compared to 2007. Indeed, electricity consumption and CO_2 emissions are 56.9% lower (48.3 TWh and 20.8 Mton in 2020), and mercury emissions are 60.2% lower (1165 kg in 2020).

As in the other scenarios, CFLi lamps become gradually the major and then the sole contributor to the electricity consumption and other environmental impacts. An increase in the contribution of HL-MV-HW lamps is noticeable in Figure 8.25 in 2012, due to an increase in the stock (in units and in %) of this lamp technology in this year. Even a small increase of the stock of HL-MV-HW has significant impacts in terms of electricity consumption, as the average wattage is 230W for the improvement option (Xenon HL-MV-HW).

Please note that the abrupt changes in lamp sales are partly due to the discrete model used (see general remarks).

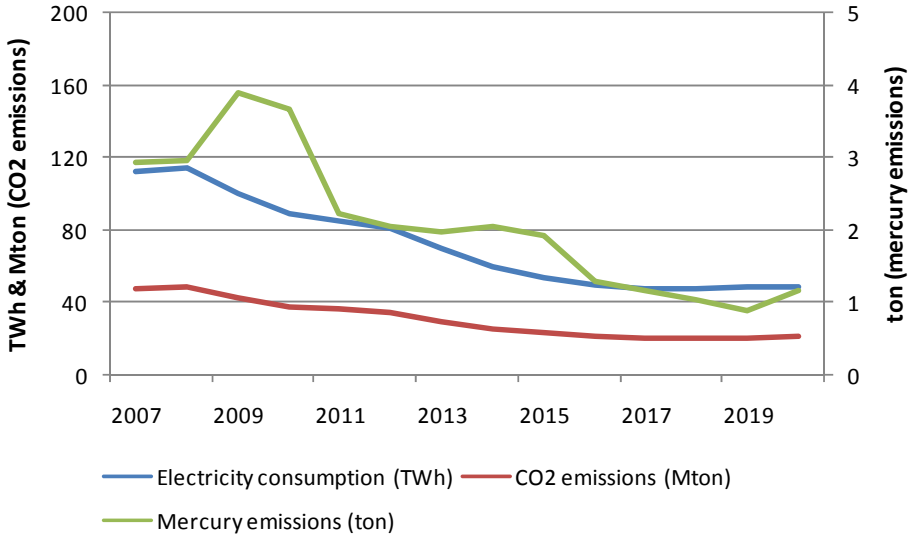


Figure 8.24: Option 1 Fast B – Evolution of annual environmental impacts

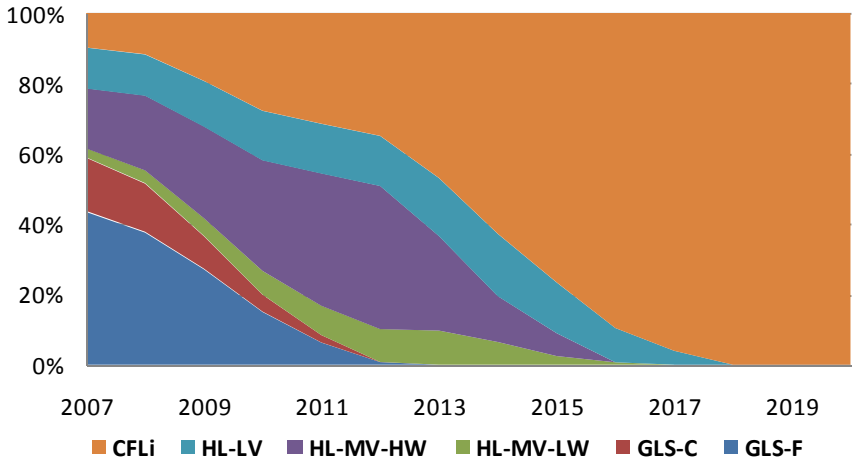


Figure 8.25: Option 1 Fast B - Evolution of the contribution of the lamp types to the electricity consumptions of the total lamp stock

8.1.2.7 Scenario "Option 2 Clear B Fast"

This scenario is less ambitious in terms of reducing life cycle cost and environmental impacts than the previous ones, which is clearly visible in the requirements set in each Tier and the replacement options proposed for each base-case (see Table 8.13). Indeed, amongst incandescent and halogen lamps, only the base-case GLS-F has to be replaced with a CFLi, as it was assumed that this is the only frosted lamp. These options "2" simulate, to the extent possible in the model of this study, a more constant light quality for a replacement option. Issues related to light quality are discussed in chapter 3.

In the last Tier (i.e. 2013), the minimum level of lamp is set to B for clear lamps and A for frosted lamps.

Further, a difference of this scenario in comparison to the previous ones is that 'Option 2 Clear B Fast' does not require any luminaire change.

Table 8.13: Option 2 Clear B Fast – Replacement lamps for each tier

present	2009	2011	2013
requirements:	**C except below 450lm**	**clear: C; frosted: A (CFL combination1)**	**clear: B; frosted: A (CFL combination1)**
Base case	**Assumed replacing base-case**	**Assumed replacing base-case**	**Assumed replacing base-case**
GLS-C	Xenon HL-MV-LW (except below 450 lm)	Xenon HL-MV-LW	HL-MV IRC with integrated electronic transformer
GLS-F	CFLi (except below 450 lm)	CFLi (combination 1)	CFLi (combination 1)
HL-MV-LW (G9)	Xenon HL-MV-LW	Xenon HL-MV-LW	Xenon HL-MV-LW
HL-MV-HW (R7s)	Xenon HL-MV-HW	Xenon HL-MV-HW	Xenon HL-MV-HW
HL-LV	HL-LV IRC	HL-LV IRC	HL-LV IRC
CFLi	CFLi	CFLi (combination 1)	CFLi (combination 1)

Note: in yellow = change from previous phase

Replacement lamps used in this 'Option 2 Clear B Fast' scenario are described in chapter 7.

In this 'Option 2 Clear B Fast' scenario, only incandescent lamps (i.e. GLS-F and GLS-C) are removed from the market. Therefore, in 2020 the stock of lamps comprises of CFLi and halogen lamps; CFLi representing 54.1% of the stock, HL-LV 25.5%, HL-MV-LW 13.5%, and HL-MV-HW 6.9%.

The share of CFLi in the stock is the highest in 2012 with 57.1%, and then slightly decreases until 2020 to the benefit of HL-LV, as this lamp technology is also used to replace GLS-C in 2013 with the infrared coating technology and an integrated electronic transformer. However, this reflects a relative change and does not mean that the stock of CFLi in units decreases from 2013 to 2020, as shown in Figure 8.27.

Detailed data of this scenario is presented in Annexe 8-5.

DISCLAIMER: The statements, figures and graphs provided on this page have to be read in the context set out in the beginning of section 8.1.2 and in sections 8.1.2.1 and 8.1.2.2

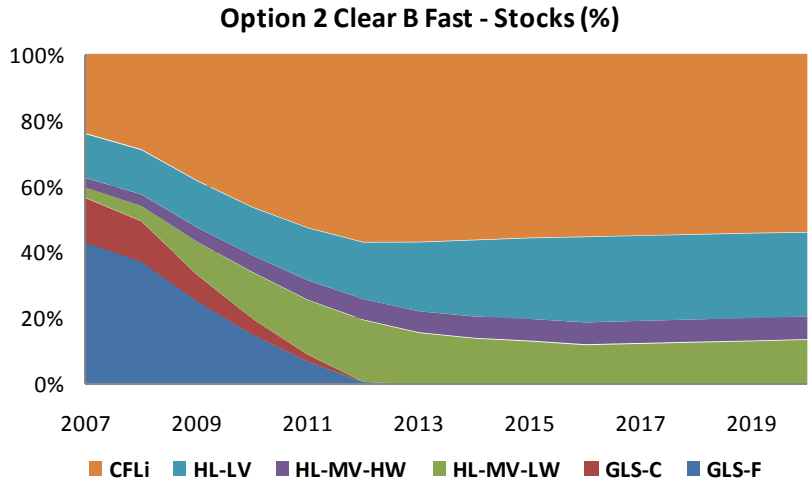


Figure 8.26: Option 2 Clear B Fast - Evolution of lamps stocks in (%)

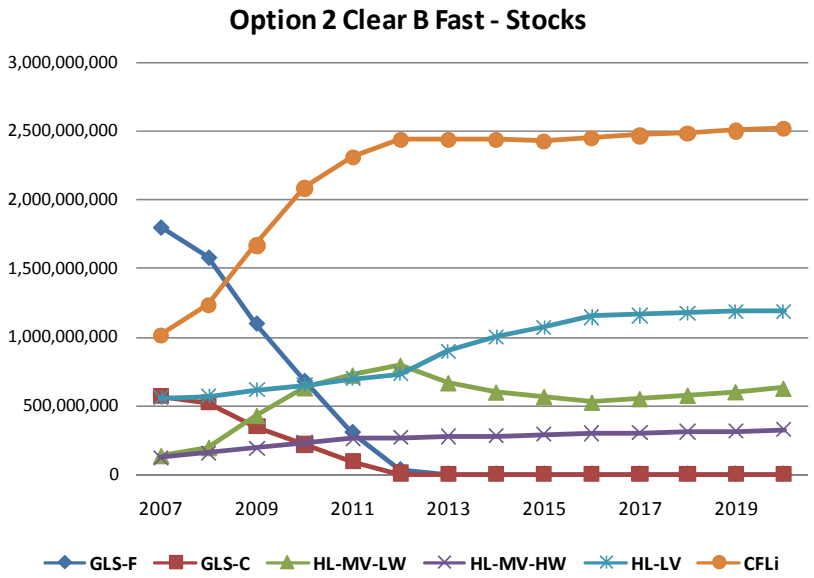


Figure 8.27: Option 2 Clear B Fast - Evolution of lamps stocks (in units)

Market shares of lamp types are quite variable over time, especially after 2011. This is mainly due to the replacement sales which vary from one lamp technology to another as their lamp lifetimes differ significantly.

DISCLAIMER: The statements, figures and graphs provided on this page have to be read in the context set out in the beginning of section 8.1.2 and in sections 8.1.2.1 and 8.1.2.2

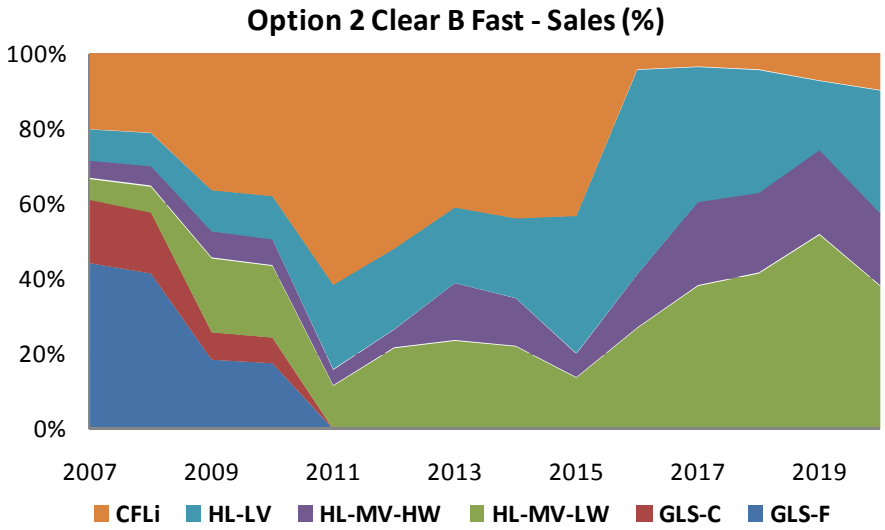


Figure 8.28: Option 2 Clear B Fast - Evolution of lamps sales (in %)

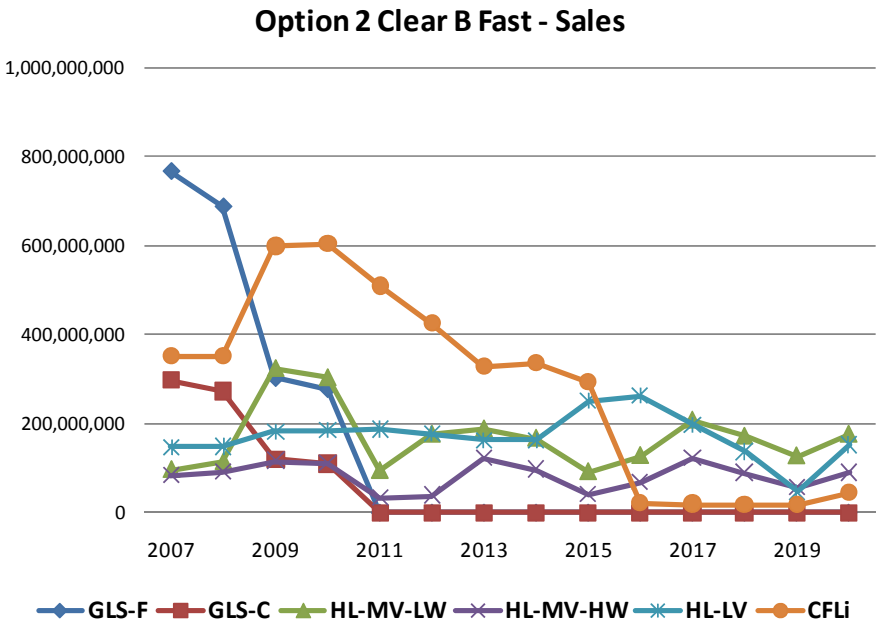


Figure 8.29: Option 2 Clear B Fast - Evolution of lamps sales (in units)

In 2020, electricity consumption and CO_2 emissions are expected to be about 28.8% lower than in the BAU scenario (96.0 TWh and 41.3 Mton CO_2). This reduction is more modest than in the previously analysed scenarios, as CFLi, which is the most energy efficient lamp, are not the only ones existing on the EU-27 market in 2020.

Further, these environmental impacts slightly rise from 2012 onwards as it was shown that the CFLi share of lamps stock decrease from this date (see Figure 8.26).

After a high increase in 2009 due to a peak in CFLi sales, mercury emissions reduce until 2017, then slowly increase until 2020 due to the growth of CFLi sales. In 2020, the amount of mercury emissions to air is about 1609 kg in this scenario.

Please note that the abrupt changes in lamp sales are in part due to the discrete model used (see general remarks), e.g. in reality CFLi sales will not drop to zero.

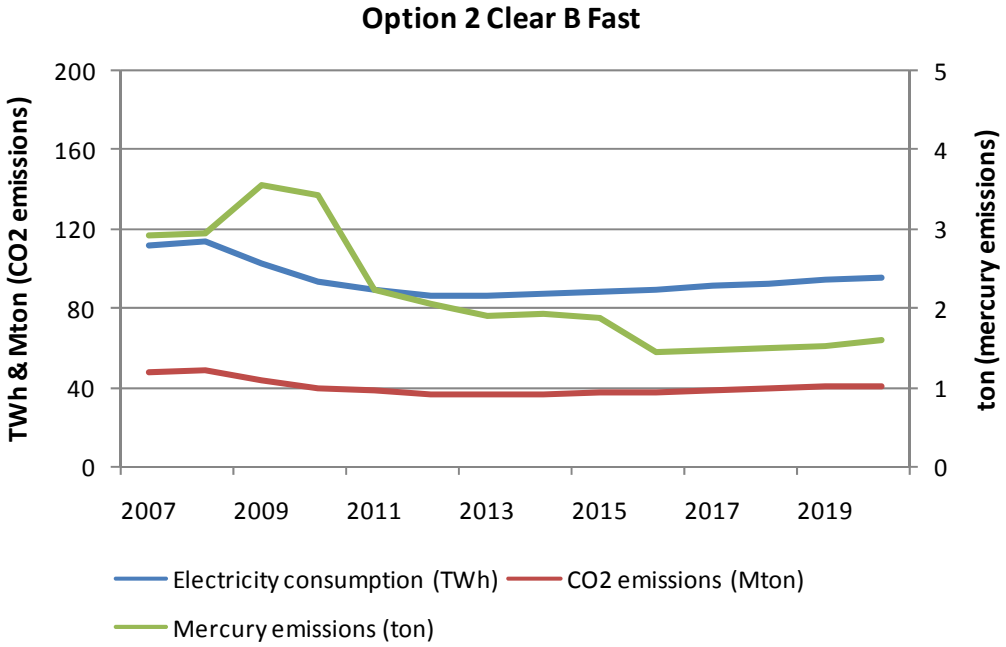


Figure 8.30: Option 2 Clear B Fast – Evolution of annual environmental impacts

Due to the high wattage of HL-MV-HW compared to the other lamp types, this technology is responsible of about 41.4% of the total electricity consumption (and of total CO_2 emissions) in 2020, followed by CFLi (27.3%) and HL-LV (19.6%).

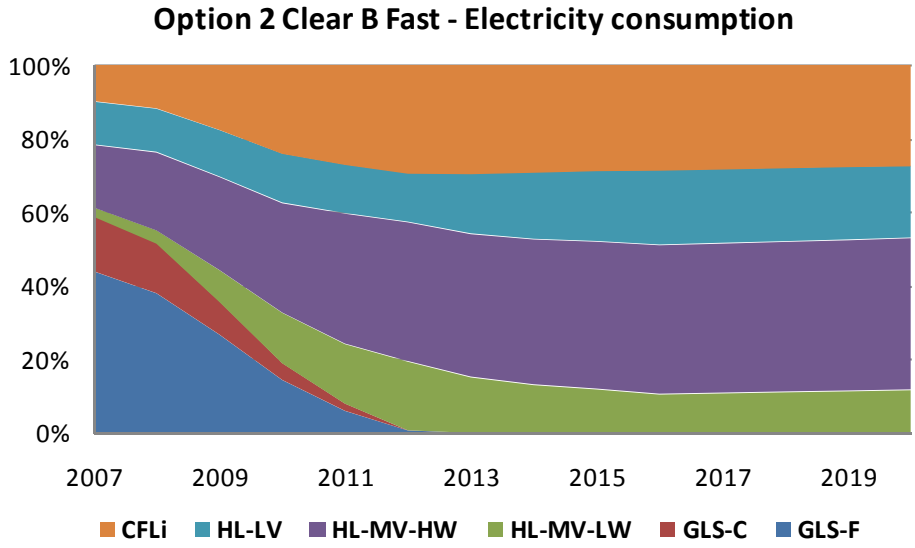


Figure 8.31: Option 2 Clear B Fast - Evolution of the contribution of the lamp types to the electricity consumptions of the total lamp stock

DISCLAIMER: The statements, figures and graphs provided on this page have to be read in the context set out in the beginning of section 8.1.2 and in sections 8.1.2.1 and 8.1.2.2

8.1.2.8 Scenario "Option 2 Clear B Slow"

As specified in its title, the 'Option 2 Clear B Slow' scenario is derived from the 'Option 2 Clear B Fast' scenario presented above. The difference is mainly in the number of Tiers: 5 in this scenario and 3 in the previous 'Fast' one. Further, in the last Tier (i.e. 2017), HL-MV-LW are replaced with HL-LV IRC (infrared coating technology), and HL-MV-HW with CFLi (combination 1). These replacements would require luminaire changes. These options "2" simulate, to the extent possible in the model of this study, a more constant light quality for a replacement option. Issues related to light quality are discussed in chapter 3.

With 'Option 2 Clear B Slow', in 2017, the minimum level required for all clear lamps would be B, and level A for frosted lamps (i.e. GLS-F).

As in chapter 7, some of the replacement lamps were not assessed as an improvement option. The following assumptions were used in the analysis of the 'Option 2 Clear B Slow' scenario.

Table 8.14: Option 2 Clear B Slow – Assumptions of replacement lamps

	Base-case HL-MV-LW	**Base-case HL-MV-HW**
	HL-LV IRC	**CFLi (comb. 1)**
Wattage	25 W	55 W
Lamp lifetime	4000 h	10000 h
Lumen output	488 lm	4662 lm

Detailed outcomes of the analysis of 'Option 2 Clear B Slow' scenario are presented in Annexe 8-6.

Table 8.15: Option 2 Clear B Slow – Replacement lamps for each tier

present	2009	2011	2013	2015	2017
requirements:	**C except below 1000 lm**	**C except below 450lm**	**clear: C (GLS); clear: B (HL-MV); frosted: A (CFL combination1)**	**clear: C (GLS); clear: B (HL-MV); frosted: A (CFL combination1)**	**clear: B; frosted: A (CFL combination1)**
Base case	**Assumed replacing base-case**	**Assumed replacing base-case**	**Assumed replacing base-case**	**Assumed replacing base-case**	**Assumed replacing base-case**
GLS-C	Xenon HL-MV-LW (except below 1000 lm)	Xenon HL-MV-LW (except below 450 lm)	HL-MV IRC with integrated electronic transformer	HL-MV IRC with integrated electronic transformer	HL-MV IRC with integrated electronic transformer
GLS-F	Xenon HL-MV-LW (except below 1000 lm)	Xenon HL-MV-LW (except below 450 lm)	CFLi (combination 1)	CFLi (combination 1)	CFLi (combination 1)
HL-MV-LW (G9)	Xenon HL-MV-LW (except below 1000 lm)	Xenon HL-MV-LW (except below 450 lm)	Xenon HL-MV-LW	Xenon HL-MV-LW	HL-LV IRC
HL-MV-HW (R7s)	Xenon HL-MV-HW	Xenon HL-MV-HW	Xenon HL-MV-HW	Xenon HL-MV-HW	CFLi (combination 1)
HL-LV	HL-LV	HL-LV IRC	HL-LV IRC	HL-LV IRC	HL-LV IRC
CFLi	CFLi	CFLi	CFLi (combination 1)	CFLi (combination 1)	CFLi (combination 1)

Note: in yellow = change from previous phase; in red = change that requires luminaire change

As in the last Tier, only HL-LV and CFLi lamps will be available on the EU-27 market, they would make up the lamps stock with respectively, 36.7% and 63.3%. From 2009 onwards, the shares of these two technologies would continuously grow as highlighted in Figure 8.32 and Figure 8.33.

In 2012, HL-MV-LW lamps would represent a high share of the stock (29.4%), behind CFLi, as this lamp type would replace both GLS-F and GLS-C. Then, in 2013 GLS-C and GLS-F would be replaced with HL-LV IRC with integrated electronic ballast and with CFLi (combination 1), respectively.

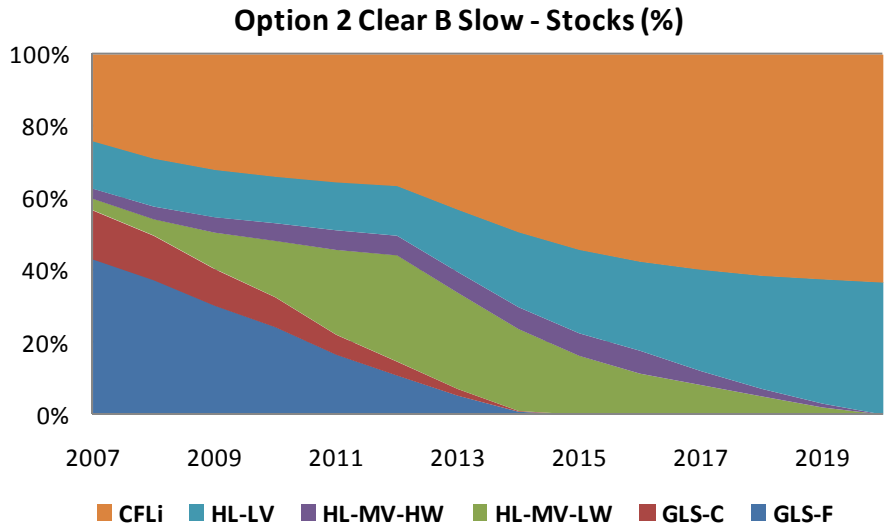


Figure 8.32: Option 2 Clear B Slow - Evolution of lamps stocks (in %)

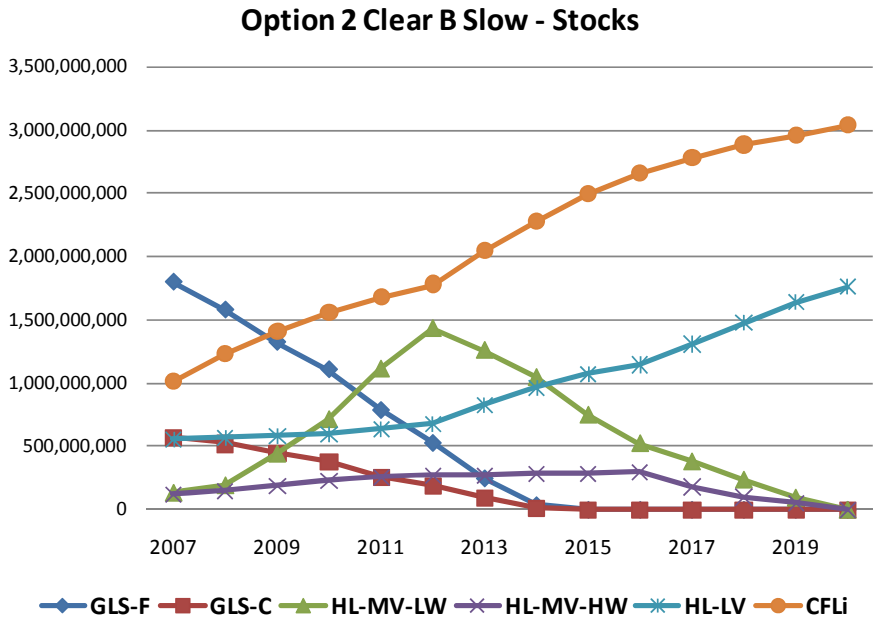


Figure 8.33: Option 2 Clear B Slow - Evolution of lamps stocks (in units)

As mentioned before, from 2017 onwards, only HL-LV and CFLi would be sold. Thus, in 2020 the market share of HL-LV would be about 78.7%, and CFLi (combination 1) 'only' 21.3%, as the lifetime of the latter (10000 h) is 2.5 longer than the lifetime of the HL-LV IRC (4000 h).

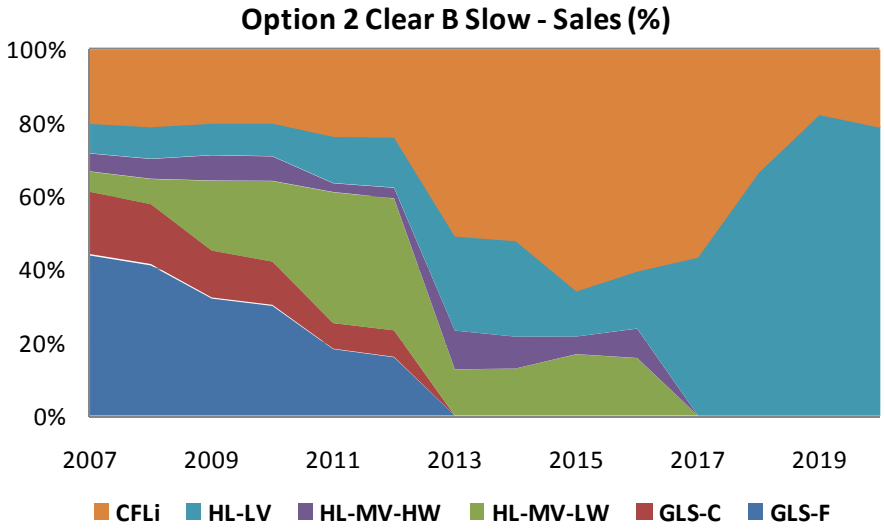


Figure 8.34: Option 2 Clear B Slow - Evolution of lamps sales (in %)

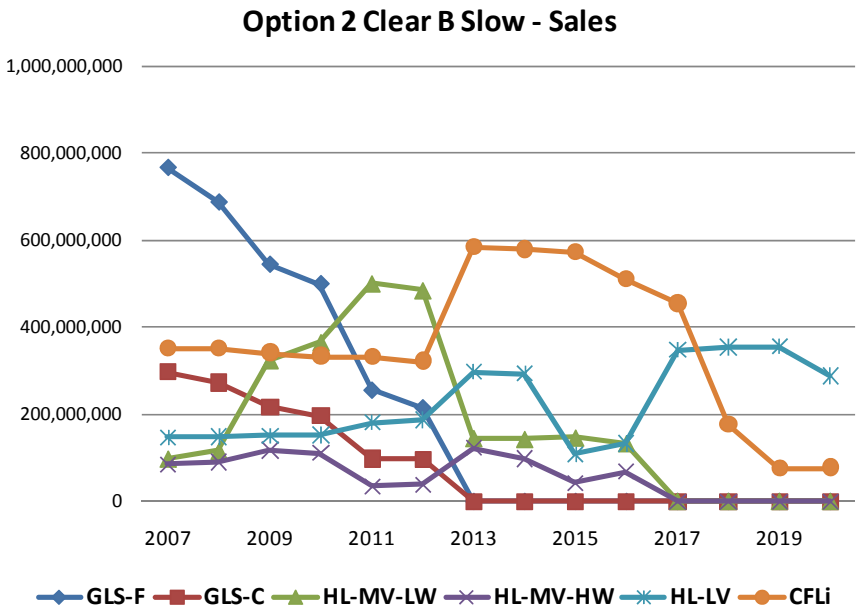


Figure 8.35: Option 2 Clear B Slow - Evolution of lamps sales (in units)

Energy savings as well as the reduction of CO_2 and mercury emissions are greater with the 'Option 2 Clear B Slow' scenario than with the 'Option 2 Clear B Fast' scenario in 2020. Indeed, in 'Option 2 Clear B Slow' compared to the BAU scenario, electricity consumption and CO_2 emissions are 37.8% lower and mercury emissions are 53.3% lower. This may seem surprising, as the 'Slow' scenario is considered less ambitious. However, the cumulative environmental impacts from 2009 (i.e. the entry into force of the legislation) to 2020, provide

a more logical comparison and the Fast scenario allows more environmental benefits than the Slow scenario.
Please note that the abrupt changes in lamp sales are in part due to the discrete model used (see general remarks), e.g. CFLi sales in reality will not drop to zero.

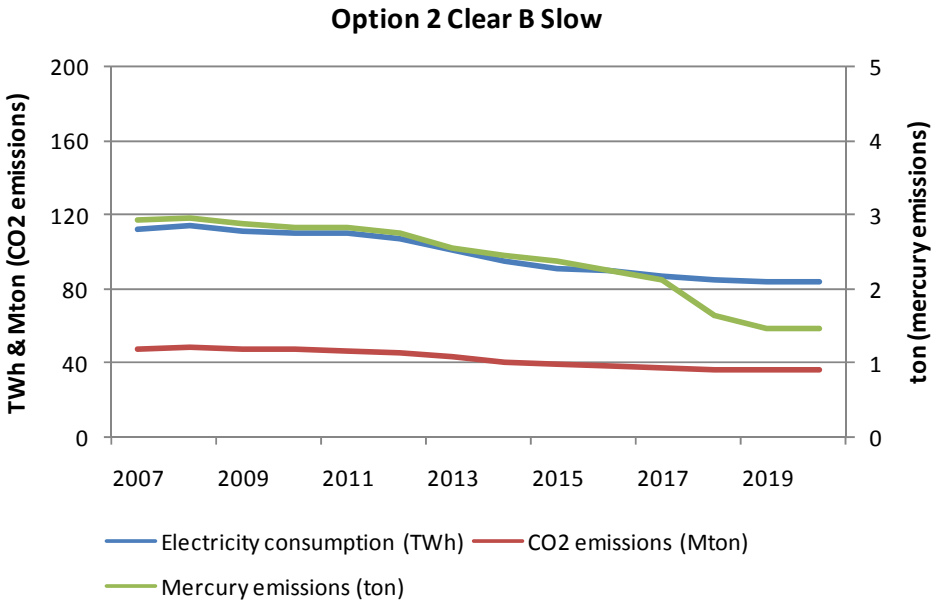


Figure 8.36: Option 2 Clear B Slow – Evolution of annual environmental impacts

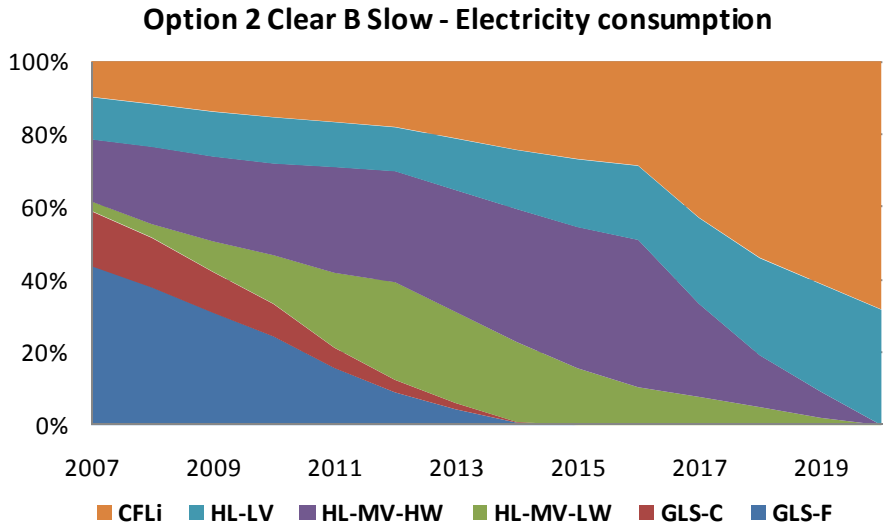


Figure 8.37: Option 2 Clear B Slow - Evolution of the contribution of the lamp types to the electricity consumptions of the total lamp stock

8.1.2.9 Scenario "Option 2 Clear C Fast"

In this scenario, lumen output is taken into account for incandescent lamps (i.e. GLS-F and GLS-C) for the setting of minimum requirements. Further, in the first Tier, HL-MV-LW and

CFLi are not replaced with an improvement option. Moreover, the notable difference of this scenario compared to the others is that the base-case HL-LV is not improved as there is no requirement for this lamp type. These options "2" simulate, in the extend possible in the model of this study, a more constant light quality for a replacement option. Issues related to light quality are discussed in chapter 3.

Table 8.16: Option 2 Clear C Fast – Replacement lamps for each tier

present	2009	2011	2013
requirements:	**C except below 450 lm + G9**	**C with CFLi combi1**	**clear: C; frosted: A (CFL combination1)**
Base case	**Assumed replacing base-case**	**Assumed replacing base-case**	**Assumed replacing base-case**
GLS-C	Xenon HL-MV-LW (except below 450 lm)	Xenon HL-MV-LW	Xenon HL-MV-LW
GLS-F	Xenon HL-MV-LW (except below 450 lm)	Xenon HL-MV-LW	CFLi (combination 1)
HL-MV-LW (G9)	HL-MV-LW	Xenon HL-MV-LW	Xenon HL-MV-LW
HL-MV-HW (R7s)	Xenon HL-MV-HW	Xenon HL-MV-HW	Xenon HL-MV-HW
HL-LV	HL-LV	HL-LV	HL-LV
CFLi	CFLi	CFLi (combination 1)	CFLi (combination 1)

Note: in yellow = change from previous phase

As presented in Figure 8.38, HL-MV-LW would represent a significant share of the stock (and of sales), especially in 2011 and 2012, as this technology would replace all GLS-F and GLS-C during this period. Therefore, the stock of HL-MV-LW would represent 35.5 % in 2011 and 39.9% in 2012 of the total lamp stock. For these same years, the stock of CFLi would be 36.5% and 39.0%, respectively.

Afterwards, in 2013, HL-MV-LW that were used to replace GLS-F in Tier 1 and 2, would be replaced with CFLi (combination 1), which would imply a decrease of the stock of HL-MV-LW to the benefit of CFLi.

Figure 8.38 and Figure 8.39 also show that starting from 2016, the growth of the stock of HL-MV-LW, HL-MV-HW, HL-LV and CFLi would be similar and constant.

Detailed data for the ‘Option 2 Clear C Fast’ scenario is presented in Annexe 8-7.

DISCLAIMER: The statements, figures and graphs provided on this page have to be read in the context set out in the beginning of section 8.1.2 and in sections 8.1.2.1 and 8.1.2.2

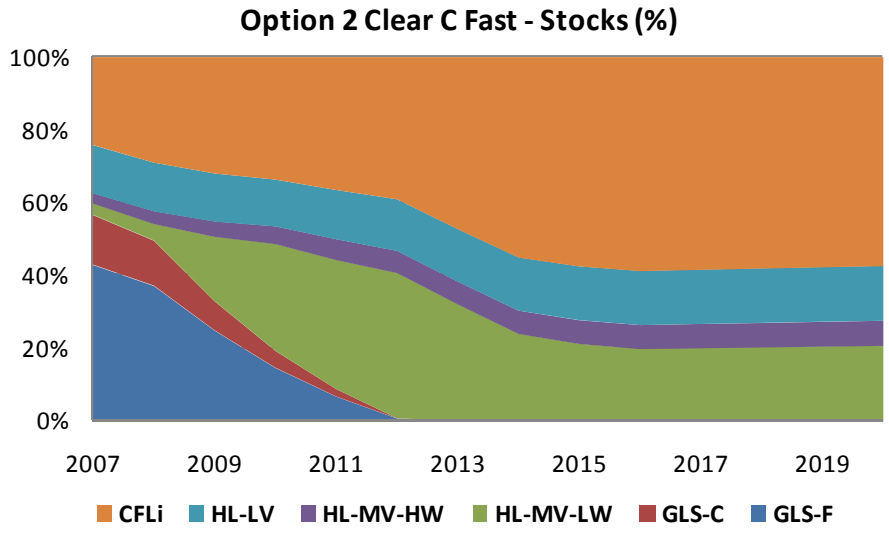


Figure 8.38: Option 2 Clear C Fast - Evolution of lamps stocks (in %)

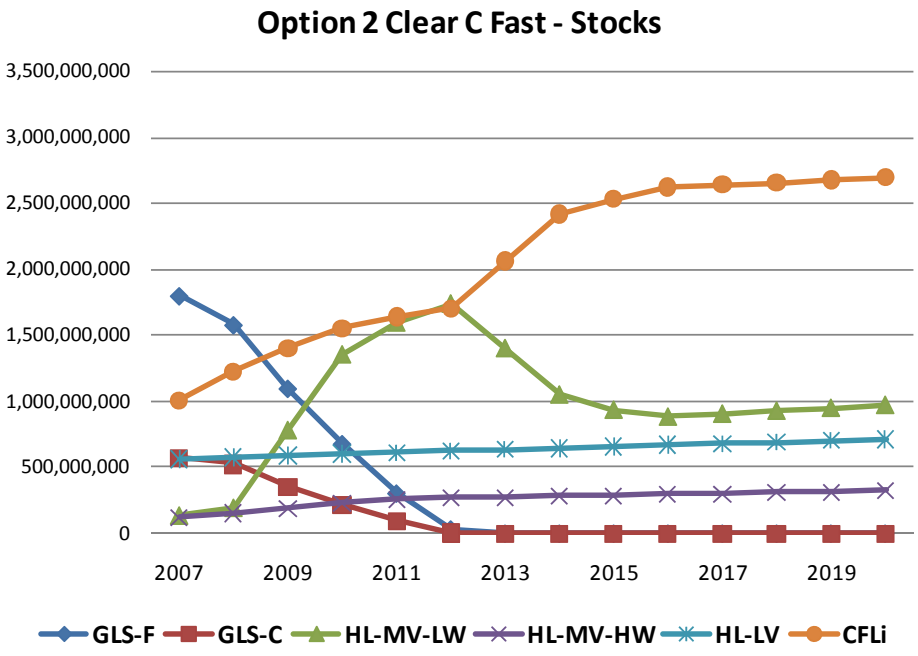


Figure 8.39: Option 2 Clear C Fast - Evolution of lamps stocks (in units)

Sales data are calculated according to the principle detailed in section 8.1.2.2 and are presented both in % and in units in Figure 8.40 and Figure 8.41. In 2020, the EU-27 market is made up as follows: 51.4% of lamp sales are HL-MV-LW (299 million units), 30.2% HL-LV (176 million units), 15.3% HL-MV-HW (89 million units) and 3.1% CFLi (18 million units).

DISCLAIMER: The statements, figures and graphs provided on this page have to be read in the context set out in the beginning of section 8.1.2 and in sections 8.1.2.1 and 8.1.2.2

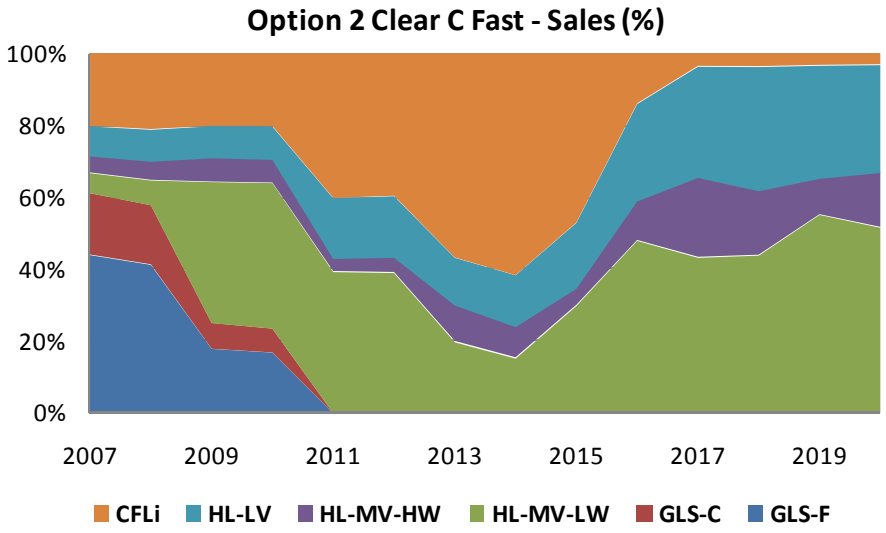


Figure 8.40: Option 2 Clear C Fast - Evolution of lamps sales (in %)

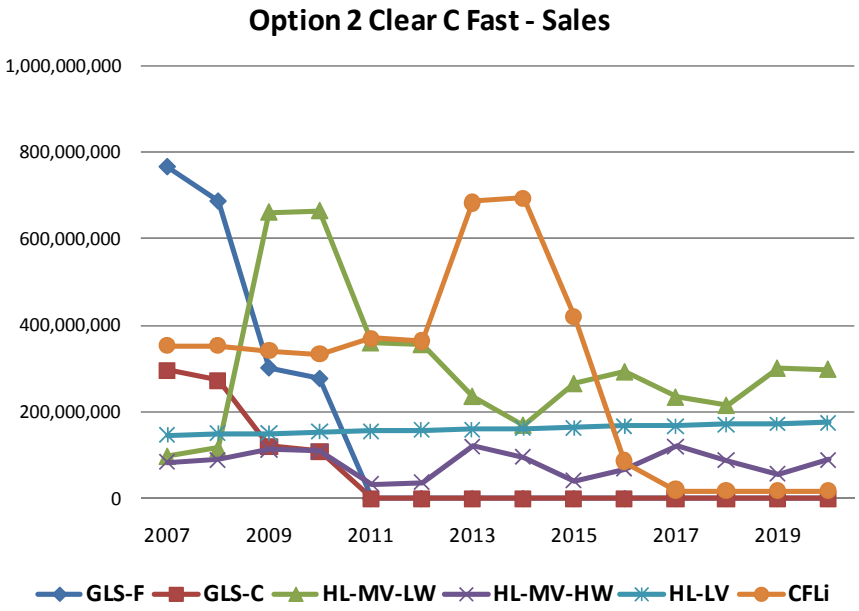


Figure 8.41: Option 2 Clear C Fast - Evolution of lamps sales (in units)

In 2020, reduction of environmental impacts in the 'Option 2 Clear C Fast' scenario compared to the BAU scenario is as follows:

- -24.5% for electricity consumption (101.7 TWh in 2020);
- -24.5% for CO_2 emissions (43.7 Mton in 2020);
- -46.6% for mercury emissions to air (1656 kg in 2020).

HL-MV-HW lamps are mainly responsible of the electricity consumption since 2013, and in 2020, the contribution of this lamp type is about 39.1%, followed by CFLi (25.6%) and HL-MV-LW (18.8%).

Please note that the abrupt changes in lamp sales are in part due to the discrete model used (see general remarks), e.g. CFLi sales in reality will not drop to zero

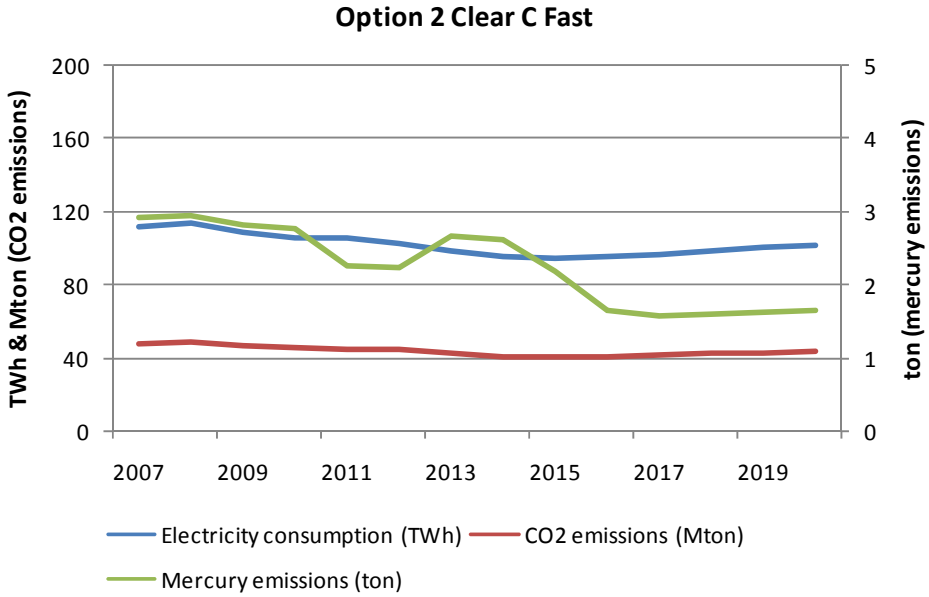


Figure 8.42: Option 2 Clear C Fast – Evolution of annual environmental impacts

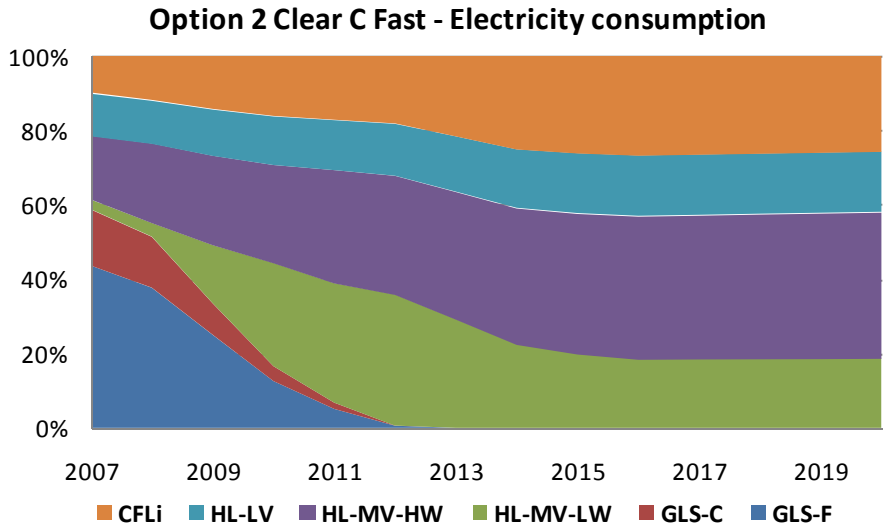


Figure 8.43: Option 2 Clear C Fast - Evolution of the contribution of the lamp types to the electricity consumptions of the total lamp stock

8.1.2.10 Scenario "Option 3 Slow"

'Option 3 Slow' scenario is the least ambitious scenario and is composed of five Tiers. In 2017, the minimum level required would be C for both clear and frosted lamps. Furthermore, this scenario sets requirements according to the lumen output for incandescent lamps and HL-

MV-LW lamps. Two thresholds values are set for the lumen output: 1000 lm in 2009 and 450 lm in 2015.

As in 'Option 2 Clear C Fast', no minimum requirement is set for HL-LV.

Table 8.17: Option 3 Slow – Replacement lamps for each tier

present	2009	2011	2013	2015	2017
requirements:	**C except below 1000lm + G9/R7s**	**C except below 1000lm + G9/R7s**	**C except below 1000lm + G9/R7s**	**C except below 450lm**	**clear: C**
Base case	**Assumed replacing base-case**	**Assumed replacing base-case**	**Assumed replacing base-case**	**Assumed replacing base-case**	**Assumed replacing base-case**
GLS-C	Xenon HL-MV-LW (except below 1000 lm)	Xenon HL-MV-LW (except below 1000 lm)	Xenon HL-MV-LW (except below 1000 lm)	Xenon HL-MV-LW (except below 450 lm)	Xenon HL-MV-LW
GLS-F	Xenon HL-MV-LW (except below 1000 lm)	Xenon HL-MV-LW (except below 1000 lm)	Xenon HL-MV-LW (except below 1000 lm)	Xenon HL-MV-LW (except below 450 lm)	Xenon HL-MV-LW
HL-MV-LW (G9)	Xenon HL-MV-LW (except below 1000 lm)	Xenon HL-MV-LW (except below 1000 lm)	Xenon HL-MV-LW (except below 1000 lm)	Xenon HL-MV-LW (except below 450 lm)	Xenon HL-MV-LW
HL-MV-HW (R7s)	HL-MV-HW	HL-MV-HW	HL-MV-HW	Xenon HL-MV-HW	Xenon HL-MV-HW
HL-LV	HL-LV	HL-LV	HL-LV	HL-LV	HL-LV
CFLi	CFLi	CFLi	CFLi	CFLi (combination 1)	CFLi (combination 1)

Note: in yellow = change from previous phase

As highlighted in Table 8.17, HL-MV-LW (with Xenon) would be considered as the replacement lamp for incandescent lamp. Therefore, it is logical to see the continuous growth of this lamp type in Figure 8.44 and in Figure 8.45.

This trend is also visible when looking at market shares (see Figure 8.46), where HL-MV-LW lamps represent about 46.4% of total lamps sold in 2020.

Stock shares of CFLi, HL-MV-HW and HL-LV stay quite constant after 2012, even if Figure 8.45 shows that stocks of these two halogen lamp types slowly increase beyond this date.

In this scenario, incandescent lamps are totally removed from the market in 2019, where GLS-F and GLS-C with a lumen output below 450 lm would be totally replaced with Xenon HL-MV-LW.

Detailed data is presented in Annexe 8-8 for this scenario.

DISCLAIMER: The statements, figures and graphs provided on this page have to be read in the context set out in the beginning of section 8.1.2 and in sections 8.1.2.1 and 8.1.2.2

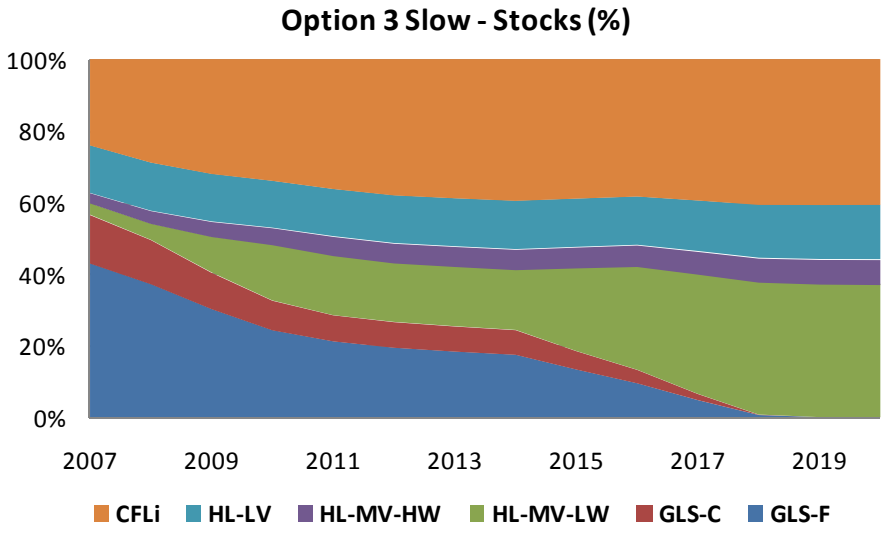


Figure 8.44: Option 3 Slow - Evolution of lamps stocks (in %)

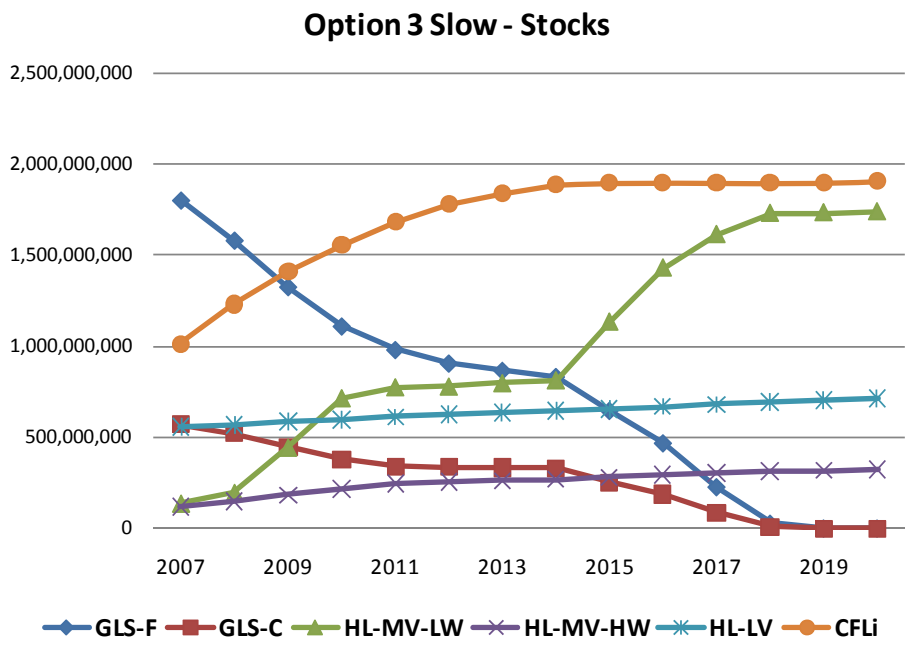


Figure 8.45: Option 3 Slow - Evolution of lamps stocks (in units)

DISCLAIMER: The statements, figures and graphs provided on this page have to be read in the context set out in the beginning of section 8.1.2 and in sections 8.1.2.1 and 8.1.2.2

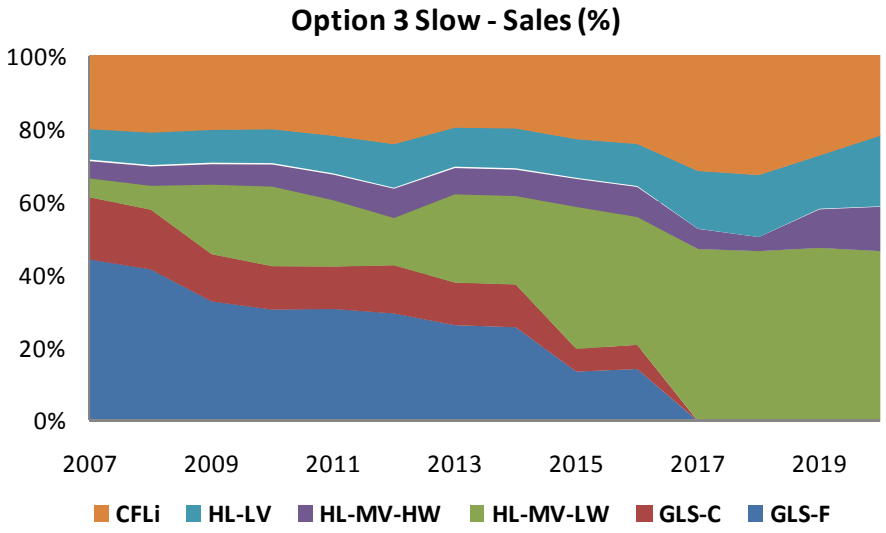


Figure 8.46: Option 3 Slow - Evolution of lamps sales (in %)

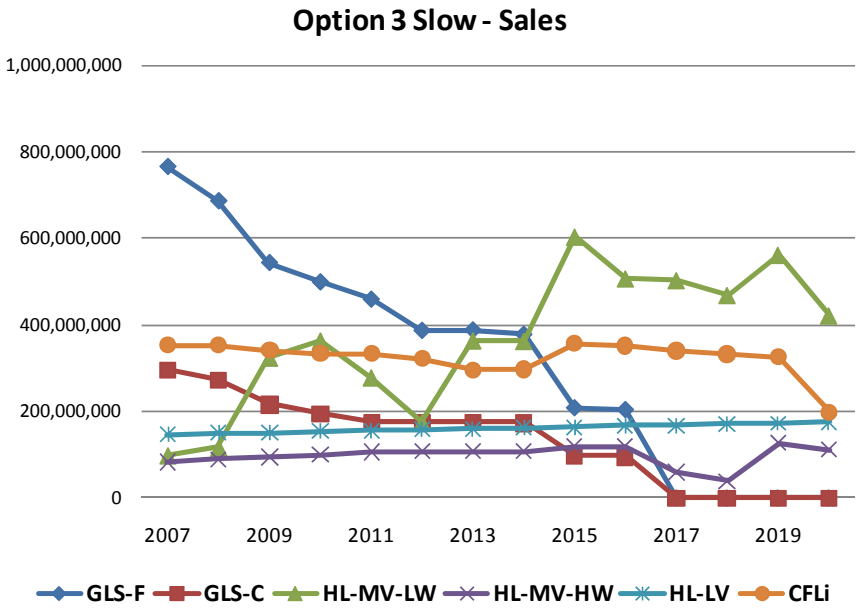


Figure 8.47: Option 3 Slow - Evolution of lamps sales (in units)

Variation of the total electricity consumption, and thus of total CO_2 emissions, are low from 2009 to 2020. Compared to the BAU scenario, 'Option 3 Slow' scenario allows in 2020 a reduction of 16.4% for these environmental impacts (112.7 TWh and 48.5 Mton CO_2 in 2020). These values are slightly higher than those in 2007 (112.2 TWh and 48.3 Mton).

Contributors to these two impacts are, in descending order: HL-MV-HW (35.3%), HL-MV-LW (31.4%), CFLi (18.5%), and HL-LV (14.8%).

However, this scenario implies a significant decrease of mercury emissions in 2020, with a reduction of about 32.4% compared to the BAU scenario (2123 kg in 'Option 3 Slow' and 3139 kg in BAU).

DISCLAIMER: The statements, figures and graphs provided on this page have to be read in the context set out in the beginning of section 8.1.2 and in sections 8.1.2.1 and 8.1.2.2

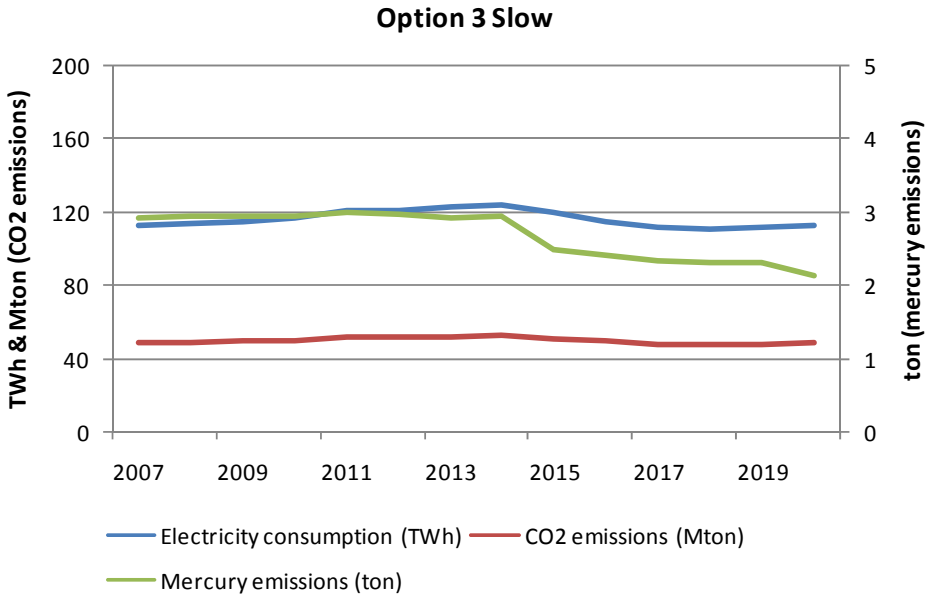


Figure 8.48: Option 3 Slow – Evolution of annual environmental impacts

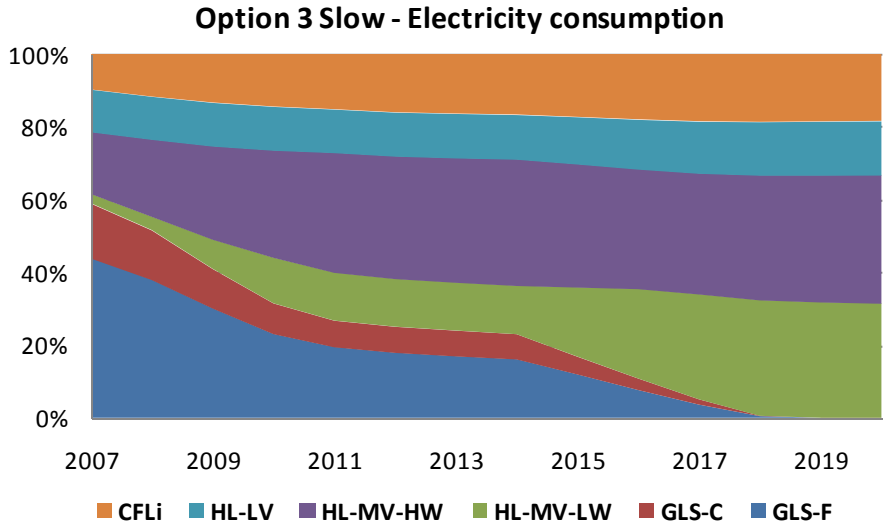


Figure 8.49: Option 3 Slow - Evolution of the contribution of the lamp types to the electricity consumptions of the total lamp stock

8.1.2.11 Comparison of scenarios

Based on the analysis of the eight scenarios (BAU + 7 'improvement' scenarios), environmental impacts in 2020 are presented in the following table, including variations both in units and in % with reference to the BAU scenario, and illustrated in Figure 8.50.

DISCLAIMER: The statements, figures and graphs provided on this page have to be read in the context set out in the beginning of section 8.1.2 and in sections 8.1.2.1 and 8.1.2.2

Table 8.18: Environmental impacts in 2020 for each scenario

		Electricity consumption (GWh) in 2020	CO2 emissions (kton) in 2020	Mercury emissions (kg) in 2020
BAU	**Value**	134,736	57,936	3,139
	Difference to BAU	*0.0%*	*0.0%*	*0.0%*
BAT	**Value**	47,544	20,444	853
	Difference to BAU (units)	*-87,192*	*-37,493*	*-2,286*
	Difference to BAU (%)	*-64.7%*	*-64.7%*	*-72.8%*
Option 1 Fast	**Value**	48,270	20,756	1,444
	Difference to BAU (units)	*-86,465*	*-37,180*	*-1,695*
	Difference to BAU (%)	*-64.2%*	*-64.2%*	*-54.0%*
Option 1 Slow	**Value**	48,336	20,784	1,165
	Difference to BAU (units)	*-86,400*	*-37,152*	*-1,974*
	Difference to BAU (%)	*-64.1%*	*-64.1%*	*-62.9%*
Option 2 Clear B Fast	**Value**	95,999	41,279	1,609
	Difference to BAU (units)	*-38,737*	*-16,657*	*-1,530*
	Difference to BAU (%)	*-28.8%*	*-28.8%*	*-48.8%*
Option 2 Clear B Slow	**Value**	83,841	36,052	1,466
	Difference to BAU (units)	*-50,894*	*-21,885*	*-1,673*
	Difference to BAU (%)	*-37.8%*	*-37.8%*	*-53.3%*
Option 2 Clear C Fast	**Value**	101,677	43,721	1,656
	Difference to BAU (units)	*-33,058*	*-14,215*	*-1,484*
	Difference to BAU (%)	*-24.5%*	*-24.5%*	*-47.3%*
Option 3 Slow	**Value**	112,681	48,453	2,123
	Difference to BAU (units)	*-22,055*	*-9,484*	*-1,016*
	Difference to BAU (%)	*-16.4%*	*-16.4%*	*-32.4%*

DISCLAIMER: The statements, figures and graphs provided on this page have to be read in the context set out in the beginning of section 8.1.2 and in sections 8.1.2.1 and 8.1.2.2

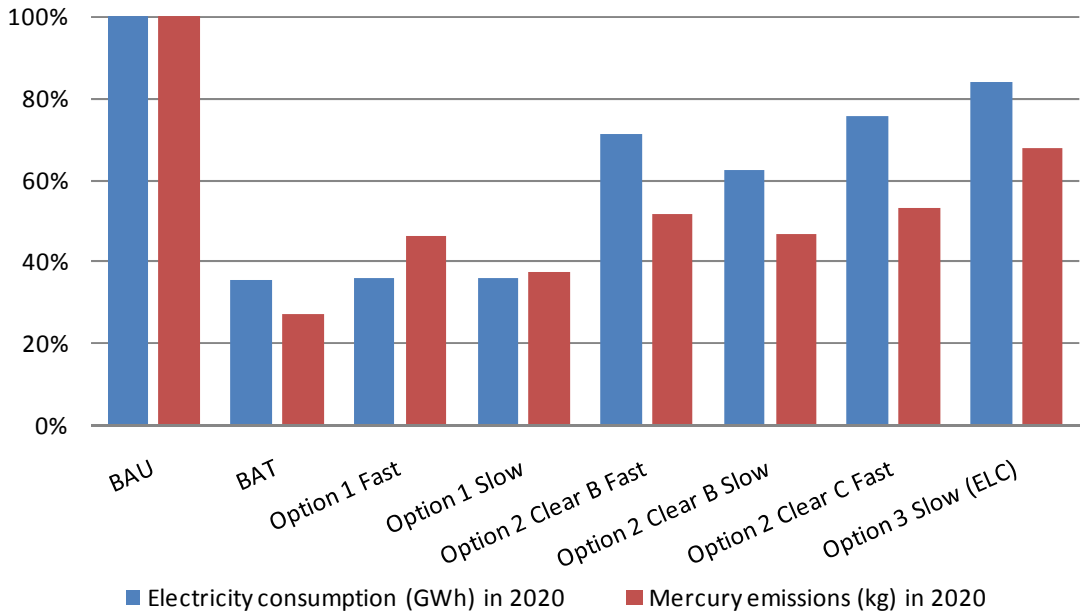


Figure 8.50: Comparison of scenarios in 2020

As already mentioned, looking only at the environmental impacts in 2020 can be confusing. For instance, 'Option 2 Clear B Slow' presents higher energy savings in 2020 than 'Option 2 Clear B Fast', although the previous was considered a less ambitious scenario. Therefore, in order to allow a 'fair' comparison, cumulated environmental impacts from 2009 (assumed as the entry into force of the legislation) to 2020 need to be analysed. Such a comparison presents more logical results and the resulting ranking of 'the most environmental friendly scenario' is as expected: the BAT scenario allowing for the highest reductions of environmental impacts, and 'Option 3 Slow' scenario being the least efficient one.

DISCLAIMER: The statements, figures and graphs provided on this page have to be read in the context set out in the beginning of section 8.1.2 and in sections 8.1.2.1 and 8.1.2.2

Table 8.19: Cumulated environmental impacts from 2009 to 2020 for each scenario

		Electricity consumption (GWh) from 2009 until 2020	CO2 emissions (kton) from 2009 until 2020	Mercury emissions (kg) from 2009 until 2020
BAU	**Value**	1,515,593	651,705	36,163
	Difference to BAU	*0.0%*	*0.0%*	*0.0%*
BAT	**Value**	577,408	248,285	16,828
	Difference to BAU (units)	*-938,185*	*-403,419*	*-19,335*
	Difference to BAU (%)	*-61.9%*	*-61.9%*	*-53.5%*
Option 1 Fast	**Value**	665,953	286,360	22,216
	Difference to BAU (units)	*-849,639*	*-365,345*	*-13,947*
	Difference to BAU (%)	*-56.1%*	*-56.1%*	*-38.6%*
Option 1 Slow	**Value**	775,259	333,361	23,223
	Difference to BAU (units)	*-740,334*	*-318,343*	*-12,940*
	Difference to BAU (%)	*-48.8%*	*-48.8%*	*-35.8%*
Option 2 Clear B Fast	**Value**	1,096,319	471,417	24,628
	Difference to BAU (units)	*-419,274*	*-180,288*	*-11,535*
	Difference to BAU (%)	*-27.7%*	*-27.7%*	*-31.9%*
Option 2 Clear B Slow	**Value**	1,154,534	496,450	27,597
	Difference to BAU (units)	*-361,059*	*-155,255*	*-8,566*
	Difference to BAU (%)	*-23.8%*	*-23.8%*	*-23.7%*
Option 2 Clear C Fast	**Value**	1,201,422	516,612	25,702
	Difference to BAU (units)	*-314,170*	*-135,093*	*-10,461*
	Difference to BAU (%)	*-20.7%*	*-20.7%*	*-28.9%*
Option 3 Slow (ELC)	**Value**	1,399,616	601,835	31,605
	Difference to BAU (units)	*-115,977*	*-49,870*	*-4,558*
	Difference to BAU (%)	*-7.7%*	*-7.7%*	*-12.6%*

DISCLAIMER: The statements, figures and graphs provided on this page have to be read in the context set out in the beginning of section 8.1.2 and in sections 8.1.2.1 and 8.1.2.2

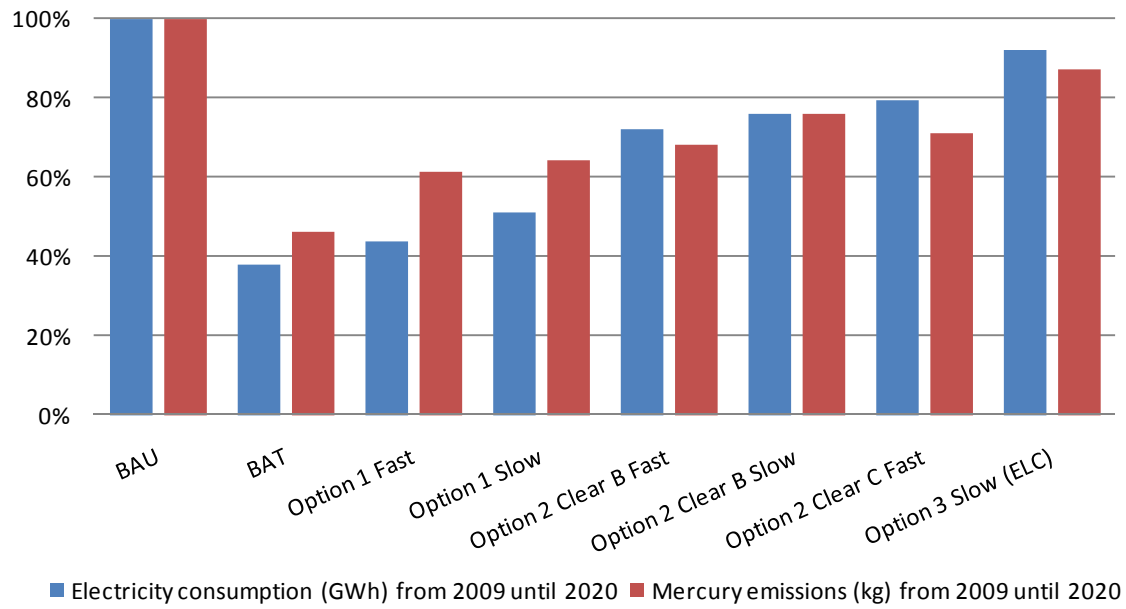


Figure 8.51: Comparison of scenarios between 2009 and 2020

8.1.3 Sensitivity analysis

The robustness of the outcomes of the study depends on the underlying assumptions. These assumptions have been explicitly mentioned at the relevant steps of the study. In this section, the sensitivity of the results to the most critical parameters and assumptions is tested, related namely to:

- The economic data, such as the electricity tariff which has an influence on the LCC when implementing improvement options,
- The assumption made on mercury emissions for CFLi at their end-of-life (80% of CFLi not recycled),
- The electricity consumption which for the purposes of the scenario analysis was considered for the use phase alone and not for the whole life cycle. In Chapters 5 and 7 the whole life cycle was considered.

8.1.3.1 Assumptions related to the electricity tariff

For the base-cases, an average EU-27 electricity tariff of 0.1528 €/kW was used, based on the data from Eurostat (see chapter 2, section 2.4.2). However, if the lowest electricity tariff (i.e. 0.0658 €/kW in Latvia) and the highest electricity tariff (i.e. 0.2580 €/kW in Denmark) are applied, this could lead to different LCC for the base-cases.

As shown in Table 8.20, the modifications in the electricity tariff have a strong impact on the LCC. Indeed, the major part of the LCC is due to the electricity costs during the use phase of the six lamp types as specified in chapter 5 (section 5.3). With lower electricity price the

savings in LCC of the improvement options are more modest, but they remain greater than the additional costs of these options, thus bringing net benefits regardless of the electricity price.

Table 8.20: Impacts of the electricity tariff on the LCC of the base-cases

Electricity tariff (€/kWh)		**GLS-C**	**GLS-F**	**HL-MV-LW**	**HL-MV-HW**	**HL-LV**	**CFLi**
0.1528	**LCC**	8.60 €	8.60 €	14.32 €	69.16 €	17.35 €	16.23 €
	LCC per lumen per hour	*14.47 10^{-6} €*	*15.02 10^{-6} €*	*19.89 10^{-6} €*	*8.91 10^{-6} €*	*13.29 10^{-6} €*	*4.84 10^{-6} €*
0.0658	**LCC**	4.07 €	4.07 €	9.32 €	31.53 €	9.27 €	9.62 €
	LCC per lumen per hour	*6.85 10^{-6} €*	*7.11 10^{-6} €*	*12.94 10^{-6} €*	*4.06 10^{-6} €*	*7.10 10^{-6} €*	*2.87 10^{-6} €*
0.2580	**LCC**	14.19 €	14.19 €	20.47 €	115.24 €	27.60 €	24.23 €
	LCC per lumen per hour	*23.89 10^{-6} €*	*24.79 10^{-6} €*	*28.43 10^{-6} €*	*14.84 10^{-6} €*	*21.15 10^{-6} €*	*7.22 10^{-6} €*

8.1.3.2 Assumptions related to mercury emissions of CFLi EoL

In chapters 5 and 7, it was assumed that 80% of the used CFLi's are not collected and as a consequence 80% of the mercury present in lamps is emitted during the end-of-life (EoL) processing, i.e. 3.2 mg for the base-case CFLi (= 4 mg x 80% per lamp).

The following table shows the impact of the EoL assumptions on the total mercury emitted over the whole life cycle of a lamp (i.e. the use phase for all base-cases and EoL for CFLi), with two extremes: 100% CFLi not recycled (pessimistic assumption) and 30% (optimistic assumption in line with the objective set by the WEEE Directive).

With a pessimistic assumption, the base-case CFLi is the one emitting the highest amount of mercury to air per lumen and per hour (+4.9% compared to the base-case GLS-F). On the contrary, when assuming that only 30% of CFLi are not recycled, and therefore that 30% mercury is dumped at the end-of-life stage, the base-case CFLi becomes the most "environmental friendly" lamp type regarding this impact (-50.4% compared to the base-case GLS-F).

DISCLAIMER: The statements, figures and graphs provided on this page have to be read in the context set out in the beginning of section 8.1.2 and in sections 8.1.2.1 and 8.1.2.2

Table 8.21: Impacts of the share of CFLi recycled on total mercury emissions

share of CFLi not recycled		GLS-C	GLS-F	HL-MV-LW	HL-MV-HW	HL-LV	CFLi
80%	**Mercury emissions over lifetime per lumen per hour (ng)**	1.45	1.51	1.33	0.93	1.22	1.34
	Variation with the base-case GLS-F	*-3.6%*	*0.0%*	*-11.7%*	*-38.6%*	*-18.9%*	*-10.9%*
100%	**Mercury emissions over lifetime per lumen per hour (ng)**	1.45	1.51	1.33	0.93	1.22	1.58
	Variation with the base-case GLS-F	*-3.6%*	*0.0%*	*-11.7%*	*-38.6%*	*-18.9%*	*+4.9%*
30%	**Mercury emissions over lifetime per lumen per hour (ng)**	1.45	1.51	1.33	0.93	1.22	0.75
	Variation with the base-case GLS-F	*-3.6%*	*0.0%*	*-11.7%*	*-38.6%*	*-18.9%*	*-50.4%*

8.1.3.3 Assumptions related to the life cycle stage considered in the scenario analysis

The scenario analysis carried out in section 8.1.2 presents the electricity consumption during the use phase for each year and for each scenario. The limitation of the energy consumption during this specific stage was decided based on outcomes of the environmental assessments of the six base-cases in chapter 5. Indeed, the share of the use phase for the indicator "energy consumption" is:

- GLS-F & GLS-C: 91.3%
- HL-MV-LW: 92.4%
- HL-MV-HW:98.9%
- HL-LV: 95.3%
- CFLi: 93.0%

However, when taking into account for the scenario analysis the total energy consumption over the whole life-cycle, the variations of energy consumption (in %) of the seven scenarios analysed with the BAU scenario are quite similar to those observed when only looking at the use phase. Results are presented in the Table 8.22 and Figure 8.52.

DISCLAIMER: The statements, figures and graphs provided on this page have to be read in the context set out in the beginning of section 8.1.2 and in sections 8.1.2.1 and 8.1.2.2

Table 8.22: Energy consumption in 2020 for each scenario(use phase and life-cycle)

		Electricity consumption (GWh) during the use phase in 2020	Total energy consumption (GWh) over the life-cycle in 2020
BAU	**Value**	134,736	142,024
	Variation with the BAU	*0.0%*	*0.0%*
BAT	**Value**	47,544	51,122
	Variation with the BAU (units)	*-87,192*	*-90,902*
	Variation with the BAU	*-64.7%*	*-64.0%*
Option 1 Fast	**Value**	48,270	51,904
	Variation with the BAU (units)	*-86,465*	*-90,121*
	Variation with the BAU	*-64.2%*	*-63.5%*
Option 1 Slow	**Value**	48,336	51,974
	Variation with the BAU (units)	*-86,400*	*-90,050*
	Variation with the BAU	*-64.1%*	*-63.4%*
Option 2 Clear B Fast	**Value**	95,999	100,262
	Variation with the BAU (units)	*-38,737*	*-41,762*
	Variation with the BAU	*-28.8%*	*-29.4%*
Option 2 Clear B Slow	**Value**	83,841	89,462
	Variation with the BAU (units)	*-50,894*	*-52,562*
	Variation with the BAU	*-37.8%*	*-37.0%*
Option 2 Clear C Fast	**Value**	101,677	106,480
	Variation with the BAU (units)	*-33,058*	*-35,544*
	Variation with the BAU	*-24.5%*	*-25.0%*
Option 3 Slow	**Value**	112,681	118,426
	Variation with the BAU (units)	*-22,055*	*-23,599*
	Variation with the BAU	*-16.4%*	*-16.6%*

DISCLAIMER: The statements, figures and graphs provided on this page have to be read in the context set out in the beginning of section 8.1.2 and in sections 8.1.2.1 and 8.1.2.2

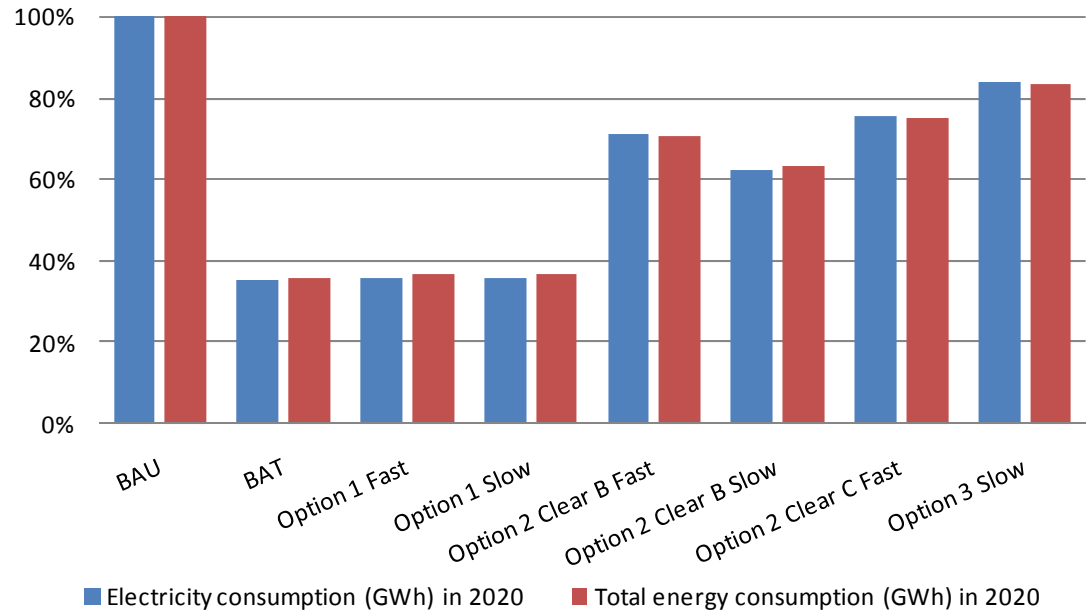


Figure 8.52: Comparison of scenarios in 2020 considering the energy consumption during the use phase (in blue) and over the whole life cycle (in red)

8.1.4 Suggested additional requirements for the appropriate implementation

8.1.4.1 Additional recommendations for the lamp labelling (Directive 98/11/EC)

It is recommended that the labelling also includes:

- lamps not operated on the mains voltage
- reflector lamps or directional light sources (part 2 of this study). *(As in principle, LED's are 'directional light sources', it is also recommended to include them and the luminaires with integrated LED's in the labelling scheme in part 2 of this study).*

It is recommended to switch to a new, dynamic labelling scheme, e.g. similar with the CECED[8] proposal and to redefine the label minimum requirements in order to:

- introduce a label between the current B and A as the gap between both is too large (see Figure 8.53: Defined lamp efficacy levels 4 - 9
- where level 5 = B and level 7 = A),
- streamline the A-label formula with the B label formula,
- have more ambitious labels compared to A .

In the new, dynamic labelling system, it is proposed to use lamp efficacy levels[9] that are as far as possible compatible with the existing household labelling Directive 98/11/EC levels.
The newly proposed lamp efficacy levels and the current energy labels are presented in Table 8.23 and they are graphically shown in Figure 8.53 and Figure 8.54.

[8] Conseil Européen de la Construction d'appareils Domestiques, see www.ceced.org, position 4 December 2007.
[9] The levels used in this study are subject to the ongoing revision of the Energy Labelling Framework Directive (92/75/EEC). The discussion at this stage should focus on the values behind the levels.

Table 8.23: New definition of lamp efficacy levels (lamps above 34 lm) compared to existing labels of Directive 98/11/EC

Level (this study	Label (Directive 98/11/EC)	Maximum system power demand (P_{system}) related to lamp luminous flux (Φ) [W]		Minimum light source efficacy (including control gear losses) $\eta_{source} = \Phi / P_{system}$ [lm/W]	
0	G	>1,30			
1	F	1,30		Φ / 1,30	
2	E	1,10		Φ / 1,10	
3	D	0,95		Φ / 0,95	
4	C	0,80		Φ / 0,80	
5	B	0,6		Φ / 0,6	
6	B (B+)*	0,4	x (0,88√Φ+0,049Φ)	Φ / 0,4	x 1/(0,88√Φ + 0,049Φ)
7	***A** *	0,225		Φ / 0,225	
8	***A (A+)****	0,209		Φ / 0,209	
9 =BAT level	***A (A++)****	0,178		Φ / 0,178	
10	***A (A+++)****	0,116		Φ / 0,116	

***** *It must be noted that the formula for the current label **A** as defined in Directive 98/11/EC does not completely corresponds with the proposed new formula, but the difference is very small (the current formula is 0.24√Φ+0.0103Φ).*
It must also be noted that in the proposed formula, system power (= lamp + control gear / power supply) is used. As a consequence the same formula can be used for all lamps GLS-lamps, CFLi's, HL-MV as well as fluorescent lamps, HL-LV and HID-lamps.

The values should be measured in compliance with EN and CIE standards (see chapter 1) (i.e. lamp lumen output (@100 h operation) with the following additional corrections:

- for low voltage lamps (HL-LV, LED) the correction factors proposed in 8.1.1.3 should be taken into account,
- for lamps that have an optimum working temperature above 25°C, lumen output should be corrected[10] for the optimum working temperature up to 60°C (e.g. most T5 lamps have their optimum working temperature at 35°C where the efficacy is about 10 % more compared to the efficacy at 25°C),
- for fluorescent lamps without integrated ballast the wattage has to be corrected for the ballast losses by the correction factor of 1,12 ,
- for HID lamps without integrated ballast, the wattage has to be corrected for the ballast losses by the correction factor LWFe =1,1 for wattages > 100 W and 1,12 for wattages ≤ 100W.

The highest levels are useful for green procurement or proportional targets.

[10] Because these lamps are typically designed for indoor luminaires that optimise the lamp working temperature above the ambient temperature.

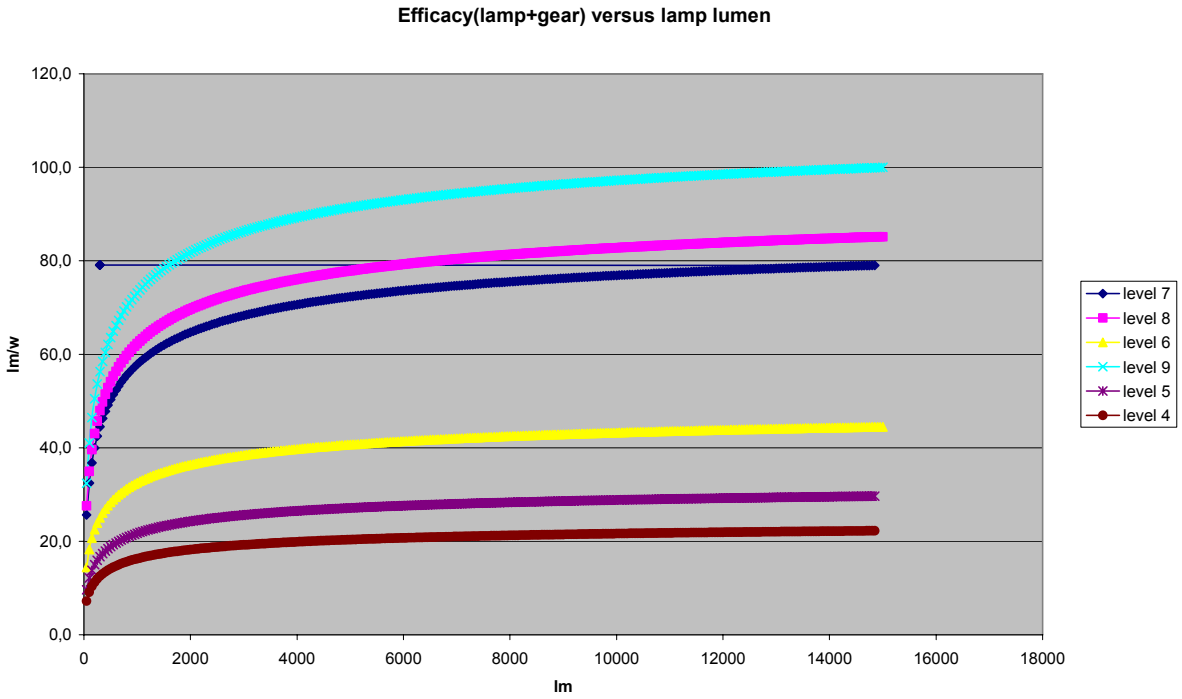


Figure 8.53: Defined lamp efficacy levels 4 - 9

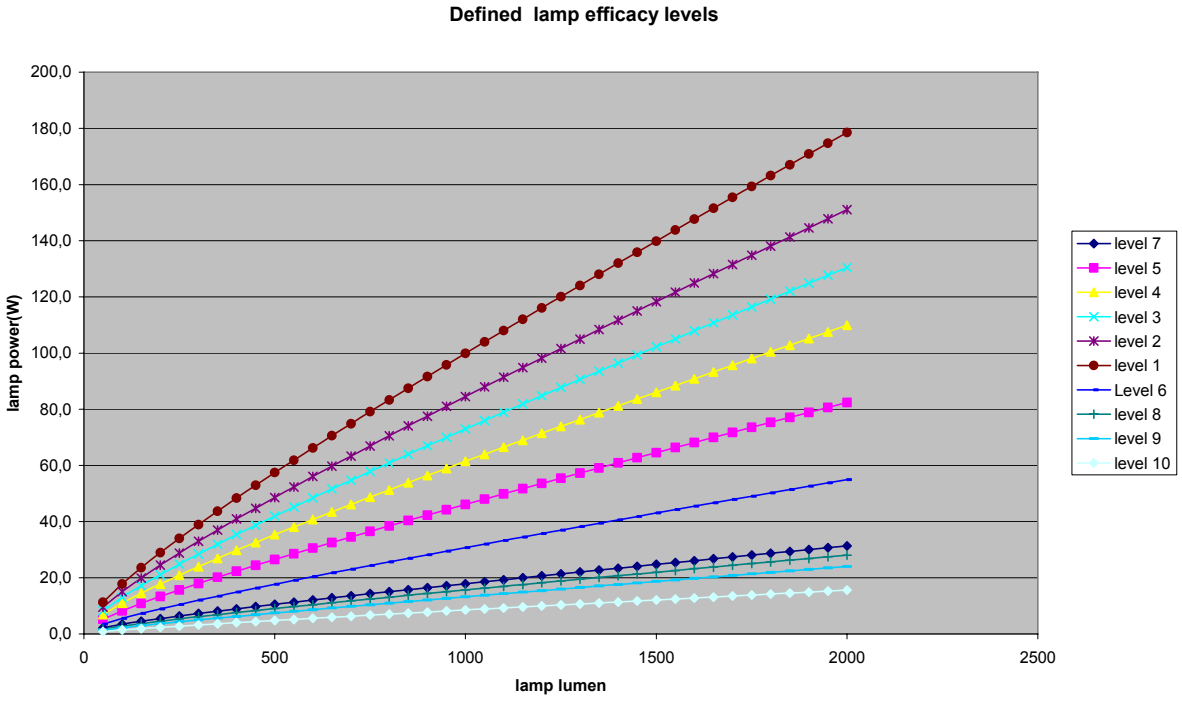


Figure 8.54: Power demand for the defined lamp efficacy levels (except level 0)

A table with corresponding values per defined lamp efficacy level is included in Annex 11.X.X.

Table 8.24: Examples of efficacy levels and labels for existing lamp types

Level (this study)	Label (Directive 98/11/EC)	Example for domestic lighting	
0	G		
1	F		
2	E		GLS-C or GLS-F (Incandescent lamp)
3	D		HL-MV (halogen lamps with xenon gas, some types)
4	C		HL-MV (halogen lamps with xenon gas, some types)
5	B		HL-MV BAT level (= halogen lamp with low voltage transformer and infrared coating) or HL-LV BAT level
6	B (B+)*		CFLi certain types (often those with second envelope) and some CFLi with magnetic ballast
7	A	 (Halo phosphate)	CFLi most types and some CFLni with ballast, LFL halo phosphate lamps.
8	A (A+)*		CFLni + electronic ballast (EEI=A2) (Equivalent to A+ in working document lot 8 on office lighting)
9 =BAT level	A (A++)*	 (Triphosphor) 	LFL (@ optimum temperature) + electronic ballast or claimed as BNAT by LED manufacturers + certain HID lamps at high lumen output (Equivalent to A++ in working document lot 8 on office lighting)
10	A (A+++)*		Please note that low pressure sodium lamps or green linear fluorescent lamps currently achieve much higher efficacies, but they have a poor colour rendering and can therefore not be used in general indoor illumination. White LED manufacturers claim to achieve above 140 lm/W in future and an extension might be considered later.

8.1.4.2 Recommendations to prevent the luminaire socket and space lock-in effect

Some luminaires can not accept an energy efficient retrofit lamp due to the lack of space and/or socket types, as explained in chapter 3. This might especially be the case for very compact luminaires with G9/R7s sockets. Therefore luminaire requirements are needed (part 2 of the study).
Users of existing luminaires with lock-in effect should be informed in cases when replacement lamps will become obsolete. This would allow them to store sufficient replacements lamps in the cupboard. Although the cupboard store lifetime of these G9/R7s lamps is unlimited, this solution will not hold forever as also the lifetime of a luminaire is limited.

8.1.4.3 Recommendations to prevent the electrical wiring and control system lock-in effect

It is important to inform users on the compatibility and the possible lack of compatibility of dimmers/electronic switches with replacement lamps. This is especially the case when shifting from GLS-lamps to CFLi's (see related sections in chapters 3 and 6). To be updated in part 2 of the study.
There are also related 'Required new or updated measurement or product standards' in section 8.1.6.

8.1.4.4 Warning about a potential direct rebound effect caused by the introduction of new energy efficient lighting (e.g. LED)

In the case of shifting to more energy efficient lighting, a rebound effect might occur where less savings than expected are realised or the energy consumption might even increase. Availability of more efficient and flexible light sources has over centuries triggered off new applications, increased illumination or comfort levels. Attention should be paid to an 'inflation of illumination levels' as explained in chapter 3.
A current trend is to replace one or few LFL or GLS-lamps in kitchen and bathroom by a much higher number of halogen lamps (even the less efficient HL-MV); the result is an increase of energy consumption. Also LED or halogen lamps incorporated in furniture for decorative purposes can raise energy consumption.
Another example is the use of LED lighting in outdoor applications e.g. as lighting in the soil at the entrance, burning every night.
More R&D on this phenomenon is recommended.

8.1.4.5 Reduced impact caused by lack of market surveillance and loopholes in legislation

It is obvious that market surveillance is recommended with regard to the proposed minimum performance and the eco-design requirements on information in section 8.1.1 in order to achieve the calculated impact in the scenarios. It should be realised that any efficacy underperformance might lead to higher energy consumption and this parameter should be carefully monitored. Currently there is also a lack of test data, especially for halogen (both reflector as non reflector lamps) or incandescent lamps.
Besides this, it is recommended to implement a continuous monitoring on market data and technical requirements about 'exemptions on proposed eco-design requirements' (if any).

They might create serious loopholes in the market with the risk that calculated energy saving targets might not be met. For this reason, it is recommended to link product related eco-design requirements to technical criteria as much as possible, application based exemptions would create large loopholes in the market as the real application is very difficult to control.
A current application for GLS-lamps can be found in traffic lights, where B22d-caps are used to prevent unscrewing of the lamp due to vibrations. An exemption for these lamps would create an enormous loophole. This back-door can technologically be closed by using coloured lamps in traffic lights as coloured lamps are exempted from the scope of this study. Changing to LED-application is of course a better solution with lower energy consumption and much lower maintenance costs due to the very long lifetime of LED's compared to GLS-traffic lamps. But this better solution could cause substantial investments for public authorities as certain traffic controllers can't handle the safety requirements with the low electric currents for LED's and they need to be replaced. Coloured GLS-traffic lamps can only temporarily overcome this problem until the controllers can be replaced.
For domestic ovens there is no problem as these lamps (≤25W) are already exempted.
For industrial ovens, a suggested technical solution for this potential exemption is to adapt the oven for a E27 GLS Safety Extra-Low Voltage (SELV) lamp. A lower voltage GLS lamps shows a higher lamp efficacy (e.g. a 60 W/E27/710 lm clear GLS for 24 VAC has a 30 % higher lamp efficacy compared to a 60 W/E27/990 lm clear GLS for 230 VAC) equivalent to label D (with 1,06 correction factor). The extra losses in an electronic transformer are only about 6 % and the cost of about 15 Euro/100 VA are is acceptable. The risk that these low-voltage lamps are sold in the normal domestic sales channels is non-existing, because when people might plug in this lamp in a E27 socket on 230V, the lamp will be broken in a few minutes.
These low voltage lamps can also be used as reference lamps for colour rendering and other measurements.
Nevertheless, it is possible that there will stay some light sources that are marketed and used for other applications than general illumination for human vision might still be needed. These exemptions should be treated very carefully.

8.1.4.6 Complementary recommendations on users information, product developers and service providers skills

As explained in section 3.4.2. and section 3.4.3, there is, to some extent, a lack of skilled and informed users as well as a lack of skilled service providers. This problem could become worse when certain lamp types are phased out, therefore it is recommended to:

- Install 'help desks' to assist users, product developers and service providers with retrofit options (e.g. what to do for light sensitive people, dimmers, traffic signs, and horticulture applications).
- Familiarise people with 'lumen' instead of 'GLS lamp wattage' and other lamp parameters including lamp labelling.
- In general communication about CFLi versus GLS equivalence a 1 to 4 ratio should be recommended to avoid consumer dissatisfaction.
- Stimulate designers to take into account energy efficiency and eco-design in order to provide users with attractive and energy efficient designs.

8.1.4.7 Complementary recommendations on policy actions to smoothen market transformation and lamp sales

In section 8.2, the impact on industry is explained more qualitatively and measures are recommended to smoothen the volume of annual lamp sales. The annual lamp sales might be subjected to transients when minimum eco-design requirements are implemented and this might not be beneficial for the profitability of lamp production facilities.
It is recommended to:

- stimulate pre-phase outs by sectorial agreements on application and retrofitting of inefficient lamps (e.g. in the horeca sector, shops and retailers, public buildings)
- launch advanced public information campaigns on phase out (e.g. announce timely a phase out and allow people to stock spare lamps if needed for existing luminaires)
- implement the phase out gradual in time as already done to some extent in the calculated scenarios.

8.1.4.8 Complementary recommendations on policy actions to increase mercury recycling

It is recommended to stimulate users to return used CFLi's for recycling as they contain mercury. It is not enough to inform people that they can return the CFLi's at the recycling station (chapter 3). It is recommended to require that used CFLi's can be returned at the point of sale; this might be stimulated by a return of a deposit, paid when buying the lamp.
The same is of course true for the many other domestic products that contain often much more mercury, e.g.: flat screen TVs with CCFL lamps, LCD screens with CCFL lamps, beamer HID lamps, HID car headlights etc.

8.1.4.9 Warning on comparing US with EU minimum lamp efficacy targets

When comparing global energy saving policy options it should be noted that in the US incandescent lamps are about 10 - 20 % more efficient than in the EU. This is mainly because of a different line voltage, see also chapter 6. Incandescent lamp efficacy is related to life time and line voltage, e.g.: a typical EU lamp of 100 W-230 VAC (rated life time 1000 h) clear GLS has 1340 lm and a typical US lamp of 100 W-120 VAC (rated life time 750 h) (US available) has 1710 lm. A reason to go in EU targets for options "2" that involve a transformer for filament lamps.

8.1.4.10 Complementary recommendations to reduce energy losses in distribution due to power factor and harmonic current

This issue of 'power factor' and 'harmonic line current' is explained in more detail in section 3.2.5. Due to specific requirements in EN 61000-3-2 lighting equipment above 25 W has already to comply with much stronger requirements in comparison with other domestic products (TVs, PCs, modems, printers, set top boxes, appliances, etc.). There is also compensation between capacitive and inductive loads as explained in section 3.2.5. It is recommended to address this issue horizontally for all typical domestic loads and it might make more sense to address first more expensive and more energy consuming products to reduce these associated problems.

8.1.4.11 Complementary recommendations to reduce the sensitivity of lighting to line voltage variations

Especially GLS and HL-MV lamps without an electronic transformer with voltage control are sensitive to line voltage fluctuations to flicker and reduced life time in case of overvoltages (see related section in chapter 3). When more distributed energy resources (DER) are installed in the future grid by 2020 it can be expected that it will become more difficult to control line voltage fluctuations. In this case, the minimum requirements for the most line voltage sensitive lamps that influence standard EN 50160 (2007) on 'Voltage characteristics of electricity supplied by public distribution networks' should be critically reviewed as well as the standard itself (if those lamps are not yet phased out).

8.1.4.12 Complementary recommendations to reduce negative impact from UV radiation

It can be considered to include limits on UV radiation to reduce impact on light sensitive people and to make an exception concerning use of low wattage (≤25W) GLS and lumen output ≤200lm.

8.1.4.13 Complementary recommendations to reduce barriers for SMEs and market surveillance authorities by improving access to EN standards and standards development related to eco-design requirements

Making the application of standards related to eco-design mandatory might create additional costs that could be significant for SMEs and people involved in market surveillance. It should be noted that international standards as defined in chapter 1 (e.g. CIE and IEC standards) and related to eco-design are not freely available and are copyright protected. These standards are sold electronically for about 1 euro per page and refer in many cases to many other standards. The trade in copies of these standards provides the main source of income to CIE and IEC. These standards are very technical and sometimes difficult to understand. It is recommended that the authorities would make this information free and easy available in electronic standard application guides.

8.1.4.14 Recommendations for the revision

A revision period of 4 years is recommended and special attention should be given to exemptions and potential loopholes in the legislation.

8.1.5 Suggested additional research

The most obvious reason for a lack of market surveillance is the lack of financial resources. Some test verifications according to the current standard methods are time consuming and hence expensive (e.g. 100 h burn in, complete goniophotometer measurement in all angles for reflector lamps, life time and the need for a large set of samples). It is recommended to research for accelerated market surveillance techniques.

It is also recommended to continue the research and consultation of stakeholders for a more universal system based lighting products regulation. This would be more independent from

the light source technology compared to what currently has been proposed. Such an approach was studied and would require to link the efficacy levels to technical benefits or disadvantages with a kind of Bonus-Malus System (BMS). The main benefit is that it includes new technologies and could potentially create less loopholes in the legislation. Nevertheless it would require that all lighting component manufacturers approach their product from a system way of thinking. Therefore a good stakeholder consultation and information campaign would be need.

8.1.6 Required new or updated measurement or product standards

Increased compatibility between lamp and control switches:
The purpose is to prevent and reduce the electrical wiring and control system lock-in effect, see also section 8.1.4.3 and related sections in chapters 3 and 6.
With the increasing use of CFLi's it is necessary to provide the manufacturers of control equipment with a reliable and reproducible basis of electrical lamp behaviour parameters in order to develop compatible control switches.
This can be done by updating and extending existing EN standards, more in particular standard EN 60669-2-1 on 'Electronic switches for households and similar use', standard EN 60969 on CFLi's and EN 61047 (2004) on 'D.C. or A.C. supplied electronic step-down converters for filament lamps. Performance requirements'.
A cooperation between the control switch manufacturers (CECAPI), lamp manufacturers (ELC), and luminaire manufacturers(CELMA) is therefore recommended.

CFLi testing (EN 60969):
Include the fast cycling test in EN 60969.
Thermal requirements to provide compatibility with luminaires. (If any, to be included in part 2 of the study).

Luminaire compatibility with CFLi lamps:
If any, part 2 of the study.
Therefore, further work should be initiated in order to align relevant EN-standards for lamps and electronic switches. Manufacturers of lamps, luminaires and installation equipment need to work together and agree on relevant quality levels and safe operating criteria.

8.2 Impact analysis for industry and consumers

Implementing measures might affect light sources marketed for other applications than general illumination for human vision.

It is important to be fully aware that 'efficacy' in lumen is linked to human vision (see chapter 3) and that a light source with a low 'efficacy' is not de facto 'inefficient' for other tasks that involve light. Banning of products or technology from the market based on its 'efficacy' could therefore cause serious negative side effects for other light source applications. The background for this paradox is linked to the universal physical law of the conservation of energy that means that there is simply no energy 'loss' in a 'closed system' without a 'defined

output' or target application. As a consequence this eco-design study was inevitably linked to a 'defined output' or a functional unit (lumen) as defined in chapter 1.

Hereafter is a generic description of other applications that involve 'light sources':

- Artificial light sources are also used *for non human species* such as plants and animals. These light sources are not optimised for lumen but for other light spectra or colours that correspond more to the light sensitivity of those species. Applications include plant growth (flowers, vegetables, fruit, etc.) in green houses[11]. There is also a trend to keep pets that need special light sources (including UV lighting) for living outside their natural environment. Also in animal farming, artificial light sources are widely used to increase the production of milk and eggs. Light sources used in this area are often gas discharge lamps (e.g. HID, LFL).
- *Infrared and UV light sources* have also several *non vision or technical applications*. Infrared is next to red and UV is next to blue in the visible light spectrum and they cannot avoid the emission of a small amount of visible light and vice versa. Hence these lamps have some lumen output however with a very low efficacy. Infrared light finds many applications as a deliberate heating source by providing radiated heat. They are used in many industrial applications such as food processing and domestic applications such as instant bath room heaters or ovens. Infrared light sources often use the same technology as incandescent lamps. The visible light produced by typical infrared and UV lamps have normally saturated colours (red, blue) that do not satisfy the 'white light source definition (see chapter 1). UV light sources include: sun tanning, black lights, disinfection, sterilisation, scientific and technical instrumentation, chemical reactors, pet care and chemical processing. This lamp technology is very close to LFL and CFL lamps.
- Some applications are linked to certain sockets or a socket should be reserved for an application, e.g. car headlights. If everything else fails, the last method is to prohibit the light sources intended for non-vision applications from being linked to general lighting in marketing or package information. However this could be insufficient as people could recognise easily a 'phased' out incandescent lamp in a shop in spite of contrary information on the package about the intended application. Please read also the related recommendations in section 8.1.4.5.

Global CFLi production capacity:

Part 8.1.2 informs about projected trends in lamp sales and lamp types related to policy scenario options. Below these sales are related to the global production capacity.

The very latest statistics (Eurostat, Oct. 2008) informs that the EU production of CFL is 277 M, import is 408 M and export 56 M. This gives an apparent consumption of 629 M and with subtraction of estimated sales of 110 M CFLni the current sales of CFLi is around 520 M/year. This is 167 M more than the former statistical sales number 353 M which is used in the BAU (see Annex 8.8). In 2006, China produced [12] about 2400 M CFLi and it estimated that their production capacity is currently around 3 billion CFLi.

[11] Please note that it is paradoxical to the objective of increasing the share of renewable energy while previously these flowers and vegetables did grow direct in the sun, nevertheless not with the same properties

[12] Chen (2006): 'CFL in China ',CHEN Yansheng', China Association of Lighting Industry (2006)

In the BAT option, the projected yearly sales peaks at about 1600 M in 2009 and it seems unrealistic to meet this sales volume with the current global production capacity.

In policy option "1" the projected yearly sales peaks in the two scenarios at respectively 900 M and 700 M. In policy option “2” the projected yearly sales peaks in both scenarios at 600 M. In all of these four scenarios, it is very likely that China can fill up the extra demand of 80-280 M CFLi lamps being equal to 3-13% of the Chinese production capacity. In reality, the peaks might not be so sharp and high as calculated in the scenarios because the penetration might be slowed by the consumers have GLS in stock and that there is a lock-in effect created by luminaries that simply do not accept CFLi, see 8.1.4.2. Please also read the next section on annual sales projections.

About the projected EU27 annual sales peak and/or periodic waves :

In the proposed policy scenarios, the annual lamp sales might be subjected to a one time annual sales peak and/or even periodic “waves”. This peak or the periodic sales waves might also not be beneficial for the profitability of lamp production facilities or lamp sales channels. The annual lamp sales changes due differences in lamp life time together with phase out implementations, this can be seen in part in section 8.1.2. Please note that the lamp sales figures in section 8.1.2 are partially due to the simplified model based on 'discrete' base-cases as defined in chapter 5 and connected discrete improvement options as defined in chapter 7. This discrete base-case model approach was reflected in abrupt changes in calculated energy consumption and lamp sales. In reality, this will be more smooth due to spreading in lamp wattages, different operational hours for products in use, new products and user behaviour. The user behaviour is difficult to predict and related to: proactive storing phase out lamps, impact of green procurement, impact of promotional campaigns and also the choice of retrofit options (e.g. buy new luminaire with reflector lamp, CFLi or efficient halogen,...). As a consequence, the real annual sales are mathematically difficult to predict. Nevertheless to smoothen these annual sales please read also the recommendations in 8.1.4.7. Finally this can also be absorbed by global sales, as GLS phase-out is expected to appear over a longer period worldwide it is likely there will be a market elsewhere in the world. When the lamps have a longer life time the final annual sales will decrease because of lower replacement sales in the first years after.

A potential negative impact on EU27 GLS lamp producers, transporters and distributors:

A strong reduction of GLS lamps sales will appear in all the proposed scenarios. As a consequence less transport and distribution is needed in certain scenarios and these activities will be reduced.. These lamps are mainly produced in EU27 (see chapter 2) and these production facilities would have to close down or should shift towards the production of efficient low voltage halogen lamps with infrared coating (HL-LV) in case of options 2 (see 8.1.2).

Positive impact on lamp producers, secondary suppliers to lamp producers, niche retrofit equipment producers, retrofit installers and consultants:

Beside the negative impact described above one should realise that there will be also be a positive impact on certain lamp producers, secondary suppliers to lamp producers, niche retrofit equipment producers, retrofit installers and consultants:

- producers of power electronic components, because there will be significant more need for these components in option 1 and 2 (several of them in EU27 even when CFLi assembly is outside EU 27).
- the secondary suppliers to power electronic component manufacturer (several of them are located within the EU27 even when CFLi assembly is outside EU 27).
- the secondary suppliers to new or upgraded lamp production lines (several of them are loacted within the EU27 even when CFLi assembly is outside EU 27), among them the producers of advanced infrared coating equipment in options 2.
- producers of luminaires that accept energy efficient lamps in certain options that stimulate luminaire changes (options 1 and 2).
- consultants, designers and installers to assist phase out.

Potential barriers created by protected intellectual property:
All the proposed scenarios rely on basic technology already available for above 20 years. Hence the related basic patents and IP should be expired, for more details please read chapter 6.

Background information about the impact of mercury brought into circulation with household lamps:
About mercury pollution cited from the WHO Air Quality Guidelines - Second Edition chapter 6.2: 'Mercury is emitted to the atmosphere by natural degassing of the earth's surface and by re-evaporation of mercury vapour previously deposited on the earth's surface. Mercury is emitted in the form of elemental vapour. Annual natural emissions are estimated to be between 2700 and 6000 tonnes, some of which originate from previous anthropogenic activity. Anthropogenic sources of mercury are numerous and worldwide. Mercury is produced by the mining and smelting of cinnabar ore. It is used in chloralkali plants (producing chlorine and sodium hydroxide), in paints as preservatives or pigments, in electrical switching equipment and batteries, in measuring and control equipment (thermometers, medical equipment), in mercury vacuum apparatus, as a catalyst in chemical processes, in mercury quartz and luminescent lamps, in the production and use of high explosives using mercury fulminate, in copper and silver amalgams in tooth-filling materials (currently being phased out by several countries), and as fungicides in agriculture (especially as seed dressings). The Almaden mercury mine in Spain, which accounts for 90% of the total output of the European Union, produces more than 1000 tonnes per year, but the amount of mercury released to the environment is unknown. In total, human activities have been estimated to add 2000–3000 tonnes to the total annual release of mercury to the global environment.' Mercury is an atom existing on earth since existence that cannot be destroyed nor be created by a chemical reaction. As a consequence it should be noted that as long as measured mercury was present in water and air and this is not due to lamp mercury alone.
500 M annual sales of CFLi will contains about 1 ton mercury (2 mg per lamp), more detailed information on projected CFLi sales can be found in section 8.1.2 see also recommendation in section 8.1.4.8 on recycling.

About the potential negative impact on consumers from luminaire replacement (if needed):

In some scenarios consumers are forced to replace luminaries. This might require an initial investment that might be a barrier in regions with a less wealthy population. However this seems to be unlikely, because an efficient luminaire with fluorescent lamp can be procured from as low as 5-10 euro and the pay back is very fast. This is connected to part 2 of the study.

8.3 Annexes

DISCLAIMER: The figures provided on this page have to be read in the context set out in the beginning of section 8.1.2 (General remarks) and in sections 8.1.2.1 and 8.1.2.2

Annexe 8-1: Main economic and environmental data for the scenario "BAU"

		BAU													
		GLS-F		GLS-C		HL-MV-LW		HL-MV-HW		HL-LV		CFLi		TOTAL	
2007	Total stock (mln)	1,800.1	43.0%	568.5	13.6%	134.4	3.2%	119.4	2.9%	558.3	13.3%	1,010.1	24.1%	4,191	100%
	Total sales (mln)	767.4	44.0%	297.0	17.0%	97.4	5.6%	84.1	4.8%	147.0	8.4%	353.0	20.2%	1,746	100%
	Electricity consumption (TWh)	49.1	43.7%	16.9	15.1%	2.9	2.6%	19.2	17.1%	13.1	11.7%	11.0	9.8%	112	100%
2008	Total stock (mln)	1,580.0	37.2%	523.5	12.3%	193.5	4.6%	151.3	3.6%	571.5	13.5%	1,228.5	28.9%	4,248	100%
	Total sales (mln)	687.9	41.2%	273.1	16.4%	115.2	6.9%	89.8	5.4%	149.3	8.9%	353.1	21.2%	1,668	100%
	Electricity consumption (TWh)	43.1	37.8%	15.6	13.7%	4.2	3.7%	24.3	21.3%	13.4	11.8%	13.4	11.8%	114	100%
2009	Total stock (mln)	1,399.9	32.5%	478.4	11.1%	252.5	5.9%	183.1	4.3%	584.7	13.6%	1,407.0	32.7%	4,306	100%
	Total sales (mln)	624.9	39.1%	249.2	15.6%	133.0	8.3%	95.5	6.0%	151.5	9.5%	342.3	21.4%	1,596	100%
	Electricity consumption (TWh)	38.2	32.8%	14.2	12.2%	5.4	4.7%	29.4	25.3%	13.7	11.8%	15.4	13.2%	116	100%
2010	Total stock (mln)	1,251.3	28.7%	433.4	9.9%	311.6	7.1%	214.9	4.9%	597.9	13.7%	1,554.0	35.6%	4,363	100%
	Total sales (mln)	573.7	37.3%	225.3	14.6%	150.7	9.8%	101.1	6.6%	153.8	10.0%	334.6	21.7%	1,539	100%
	Electricity consumption (TWh)	34.1	28.6%	12.9	10.8%	6.7	5.6%	34.6	29.0%	14.0	11.8%	17.0	14.2%	119	100%
2011	Total stock (mln)	1,123.7	25.4%	388.3	8.8%	370.6	8.4%	246.8	5.6%	611.1	13.8%	1,680.0	38.0%	4,420	100%
	Total sales (mln)	527.8	35.3%	201.5	13.5%	168.5	11.3%	106.8	7.1%	156.0	10.4%	333.2	22.3%	1,494	100%
	Electricity consumption (TWh)	30.6	25.0%	11.6	9.4%	8.0	6.5%	39.7	32.4%	14.3	11.7%	18.3	15.0%	123	100%
2012	Total stock (mln)	1,038.3	23.2%	385.0	8.6%	394.3	8.8%	253.5	5.7%	622.2	13.9%	1,778.7	39.8%	4,472	100%
	Total sales (mln)	444.8	31.6%	200.8	14.3%	174.8	12.4%	107.6	7.6%	158.2	11.2%	322.7	22.9%	1,409	100%
	Electricity consumption (TWh)	28.3	23.0%	11.5	9.3%	8.5	6.9%	40.8	33.1%	14.6	11.9%	19.4	15.8%	123	100%
2013	Total stock (mln)	992.8	21.9%	381.6	8.4%	418.1	9.2%	260.2	5.8%	633.3	14.0%	1,837.5	40.6%	4,524	100%
	Total sales (mln)	446.3	32.1%	200.2	14.4%	181.0	13.0%	108.4	7.8%	160.4	11.5%	296.0	21.3%	1,392	100%
	Electricity consumption (TWh)	27.1	21.8%	11.4	9.1%	9.0	7.2%	41.8	33.7%	14.9	12.0%	20.1	16.2%	124	100%
2014	Total stock (mln)	953.6	20.8%	378.3	8.3%	441.8	9.7%	267.0	5.8%	644.5	14.1%	1,890.0	41.3%	4,575	100%
	Total sales (mln)	434.3	31.2%	199.6	14.4%	187.2	13.5%	109.3	7.9%	162.6	11.7%	297.5	21.4%	1,390	100%
	Electricity consumption (TWh)	26.0	20.7%	11.3	9.0%	9.5	7.6%	42.9	34.2%	15.1	12.1%	20.6	16.4%	125	100%

DISCLAIMER: The figures provided on this page have to be read in the context set out in the beginning of section 8.1.2 (General remarks) and in sections 8.1.2.1 and 8.1.2.2

2015	**Total stock (mln)**	927.1	20.0%	374.9	8.1%	465.5	10.1%	273.7	5.9%	655.6	14.2%	1,929.9	41.7%	4,627	100%
	Total sales (mln)	431.7	31.0%	199.0	14.3%	193.5	13.9%	110.1	7.9%	164.8	11.8%	291.9	21.0%	1,391	100%
	Electricity consumption (TWh)	25.3	19.9%	11.2	8.8%	10.0	7.9%	44.0	34.7%	15.4	12.1%	21.1	16.6%	127	100%
2016	**Total stock (mln)**	900.5	19.2%	371.6	7.9%	489.2	10.5%	280.4	6.0%	666.7	14.3%	1,969.8	42.1%	4,678	100%
	Total sales (mln)	423.0	30.3%	198.3	14.2%	199.7	14.3%	110.9	7.9%	166.9	12.0%	297.2	21.3%	1,396	100%
	Electricity consumption (TWh)	24.6	19.1%	11.1	8.6%	10.5	8.2%	45.1	35.1%	15.7	12.2%	21.5	16.8%	128	100%
2017	**Total stock (mln)**	878.1	18.6%	368.2	7.8%	512.9	10.8%	287.2	6.1%	677.9	14.3%	2,005.5	42.4%	4,730	100%
	Total sales (mln)	418.4	29.9%	197.7	14.1%	206.0	14.7%	111.7	8.0%	169.1	12.1%	298.3	21.3%	1,401	100%
	Electricity consumption (TWh)	23.9	18.4%	11.0	8.4%	11.0	8.5%	46.2	35.5%	15.9	12.2%	21.9	16.9%	130	100%
2018	**Total stock (mln)**	859.9	18.0%	364.8	7.6%	536.6	11.2%	293.9	6.1%	689.0	14.4%	2,037.0	42.6%	4,781	100%
	Total sales (mln)	416.0	29.5%	197.1	14.0%	212.2	15.1%	112.5	8.0%	171.3	12.2%	298.9	21.2%	1,408	100%
	Electricity consumption (TWh)	23.4	17.8%	10.9	8.3%	11.5	8.8%	47.3	35.9%	16.2	12.3%	22.2	16.9%	132	100%
2019	**Total stock (mln)**	841.7	17.4%	361.5	7.5%	560.3	11.6%	300.6	6.2%	700.1	14.5%	2,068.5	42.8%	4,833	100%
	Total sales (mln)	411.4	29.1%	196.5	13.9%	218.4	15.4%	113.3	8.0%	173.5	12.2%	303.1	21.4%	1,416	100%
	Electricity consumption (TWh)	23.0	17.2%	10.8	8.1%	12.1	9.1%	48.3	36.3%	16.4	12.3%	22.6	17.0%	133	100%
2020	**Total stock (mln)**	823.6	16.9%	358.1	7.3%	584.0	12.0%	307.4	6.3%	711.3	14.6%	2,100.0	43.0%	4,884	100%
	Total sales (mln)	406.9	28.6%	195.8	13.7%	224.7	15.8%	114.2	8.0%	175.7	12.3%	307.3	21.6%	1,425	100%
	Electricity consumption (TWh)	22.5	16.7%	10.7	7.9%	12.6	9.3%	49.4	36.7%	16.7	12.4%	22.9	17.0%	135	100%

DISCLAIMER: The figures provided on this page have to be read in the context set out in the beginning of section 8.1.2 (General remarks) and in sections 8.1.2.1 and 8.1.2.2

Annexe 8-2: Main economic and environmental data for the scenario "BAT"

		BAT													
		GLS-F		GLS-C		HL-MV-LW		HL-MV-HW		HL-LV		CFLi		TOTAL	
2007	Total stock (mln)	1,800.1	43.0%	568.5	13.6%	134.4	3.2%	119.4	2.9%	558.3	13.3%	1,010.1	24.1%	4,190.8	100%
	Total sales (mln)	767.4	44.0%	297.0	17.0%	97.4	5.6%	84.1	4.8%	147.0	8.4%	353.0	20.2%	1,745.9	100%
	Electricity consumption (TWh)	49.1	43.7%	16.9	15.1%	2.9	2.6%	19.2	17.1%	13.1	11.7%	11.0	9.8%	112.2	100%
2008	Total stock (mln)	1,580.0	37.2%	523.5	12.3%	193.5	4.6%	151.3	3.6%	571.5	13.5%	1,228.5	28.9%	4,248.2	100%
	Total sales (mln)	687.9	41.2%	273.1	16.4%	115.2	6.9%	89.8	5.4%	149.3	8.9%	353.1	21.2%	1,668.4	100%
	Electricity consumption (TWh)	43.1	37.8%	15.6	13.7%	4.2	3.7%	24.3	21.3%	13.4	11.8%	13.4	11.8%	114.0	100%
2009	Total stock (mln)	814.2	19.3%	231.0	5.5%	103.5	2.5%	72.9	1.7%	430.1	10.2%	2,570.3	60.9%	4,222.0	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	1,584.8	100.0 %	1,584.8	100%
	Electricity consumption (TWh)	22.2	28.0%	6.9	8.7%	2.2	2.8%	11.7	14.8%	10.1	12.7%	26.2	33.0%	79.3	100%
2010	Total stock (mln)	140.1	3.3%	9.8	0.2%	2.4	0.1%	0.0	0.0%	286.3	6.8%	3,764.8	89.6%	4,203.3	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	1,457.5	100.0 %	1,457.5	100%
	Electricity consumption (TWh)	3.8	7.9%	0.3	0.6%	0.1	0.1%	0.0	0.0%	6.7	13.8%	37.6	77.6%	48.5	100%
2011	Total stock (mln)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	139.9	3.3%	4,088.4	96.7%	4,228.3	100%
	Total sales (mln)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%	606.6	100.0 %	606.6	100%
	Electricity consumption (TWh)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	3.3	7.4%	41.0	92.6%	44.3	100%
2012	Total stock (mln)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	4,270.3	100.0 %	4,270.3	100%
	Total sales (mln)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	484.9	100.0 %	484.9	100%
	Electricity consumption (TWh)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	42.5	100.0 %	42.5	100%
2013	Total stock (mln)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	4,324.4	100.0 %	4,324.4	100%
	Total sales (mln)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	190.5	100.0	190.5	100%

DISCLAIMER: The figures provided on this page have to be read in the context set out in the beginning of section 8.1.2 (General remarks) and in sections 8.1.2.1 and 8.1.2.2

													%		
	Electricity consumption (TWh)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	43.1	100.0 %	43.1	100%
2014	**Total stock (mln)**	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	4,389.1	100.0 %	4,389.1	100%
	Total sales (mln)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	64.7	100.0 %	64.7	100%
	Electricity consumption (TWh)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	43.8	100.0 %	43.8	100%
2015	**Total stock (mln)**	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	4,449.7	100.0 %	4,449.7	100%
	Total sales (mln)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	60.7	100.0 %	60.7	100%
	Electricity consumption (TWh)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	44.4	100.0 %	44.4	100%
2016	**Total stock (mln)**	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	4,510.4	100.0 %	4,510.4	100%
	Total sales (mln)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	60.7	100.0 %	60.7	100%
	Electricity consumption (TWh)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	45.1	100.0 %	45.1	100%
2017	**Total stock (mln)**	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	4,569.7	100.0 %	4,569.7	100%
	Total sales (mln)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	59.3	100.0 %	59.3	100%
	Electricity consumption (TWh)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	45.7	100.0 %	45.7	100%
2018	**Total stock (mln)**	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	4,627.6	100.0 %	4,627.6	100%
	Total sales (mln)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	58.0	100.0 %	58.0	100%
	Electricity consumption (TWh)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	46.3	100.0 %	46.3	100%
2019	**Total stock (mln)**	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	4,685.6	100.0 %	4,685.6	100%

DISCLAIMER: The figures provided on this page have to be read in the context set out in the beginning of section 8.1.2 (General remarks) and in sections 8.1.2.1 and 8.1.2.2

	Total sales (mln)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	58.0	100.0 %	58.0	100%
	Electricity consumption (TWh)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	46.9	100.0 %	46.9	100%
2020	**Total stock (mln)**	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	4,743.6	100.0 %	4,743.6	100%
	Total sales (mln)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	58.0	100.0 %	58.0	100%
	Electricity consumption (TWh)	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	47.5	100.0 %	47.5	100%

DISCLAIMER: The figures provided on this page have to be read in the context set out in the beginning of section 8.1.2 (General remarks) and in sections 8.1.2.1 and 8.1.2.2

Annexe 8-3: Main economic and environmental data for the scenario "Option 1 Fast"

		Option 1 Fast													
		GLS-F		GLS-C		HL-MV-LW		HL-MV-HW		HL-LV		CFLi		TOTAL	
2007	Total stock (mln)	1,800.1	44.0%	568.5	17.0%	134.4	5.6%	119.4	4.8%	558.3	8.4%	1,010.1	20.2%	4,190.8	100%
	Total sales (mln)	767.4	43.7%	297.0	15.1%	97.4	2.7%	84.1	17.1%	147.0	11.6%	353.0	9.8%	1,745.9	100%
	Electricity consumption (TWh)	49.2	43.7%	16.9	15.1%	3.1	2.7%	19.2	17.1%	13.1	11.6%	11.0	9.8%	112.5	100%
2008	Total stock (mln)	1,580.0	41.2%	523.5	16.4%	193.5	6.9%	151.3	5.4%	571.5	8.9%	1,228.5	21.2%	4,248.2	100%
	Total sales (mln)	687.9	37.8%	273.1	13.6%	115.2	3.9%	89.8	21.3%	149.3	11.7%	353.1	11.7%	1,668.4	100%
	Electricity consumption (TWh)	43.2	37.8%	15.6	13.6%	4.4	3.9%	24.3	21.3%	13.4	11.7%	13.4	11.7%	114.3	100%
2009	Total stock (mln)	1,097.7	19.4%	350.8	7.7%	185.5	4.7%	72.9	0.0%	584.7	9.7%	1,978.5	58.5%	4,270.0	100%
	Total sales (mln)	302.5	30.5%	120.6	10.3%	73.1	4.0%	0.0	13.1%	151.5	15.3%	913.8	26.8%	1,561.6	100%
	Electricity consumption (TWh)	27.3	30.5%	9.2	10.3%	3.6	4.0%	11.7	13.1%	13.7	15.3%	24.0	26.8%	89.5	100%
2010	Total stock (mln)	677.9	18.1%	214.8	7.1%	172.4	5.4%	0.0	0.0%	597.9	10.0%	2,698.3	59.3%	4,361.3	100%
	Total sales (mln)	277.7	19.5%	109.1	6.2%	82.9	3.8%	0.0	0.0%	153.8	20.6%	907.4	49.9%	1,530.8	100%
	Electricity consumption (TWh)	13.3	19.5%	4.2	6.2%	2.6	3.8%	0.0	0.0%	14.0	20.6%	34.0	49.9%	68.3	100%
2011	Total stock (mln)	303.7	0.0%	91.3	0.0%	106.0	0.0%	0.0	0.0%	611.1	18.7%	3,095.0	81.3%	4,207.0	100%
	Total sales (mln)	0.0	8.8%	0.0	2.9%	0.0	2.6%	0.0	0.0%	156.0	23.5%	679.7	62.1%	835.7	100%
	Electricity consumption (TWh)	5.4	8.8%	1.8	2.9%	1.6	2.6%	0.0	0.0%	14.3	23.5%	37.9	62.1%	60.9	100%
2012	Total stock (mln)	31.5	0.0%	3.0	0.0%	30.8	0.0%	0.0	0.0%	622.2	22.2%	3,345.2	77.8%	4,032.7	100%
	Total sales (mln)	0.0	1.0%	0.0	0.1%	0.0	0.8%	0.0	0.0%	158.2	26.2%	553.2	71.8%	711.4	100%
	Electricity consumption (TWh)	0.6	1.0%	0.1	0.1%	0.5	0.8%	0.0	0.0%	14.6	26.2%	40.0	71.8%	55.7	100%
2013	Total stock (mln)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	486.2	0.0%	3,540.3	100.0 %	4,026.5	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	21.6%	518.1	78.4%	518.1	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	11.4	21.6%	41.5	78.4%	52.9	100%
2014	Total stock (mln)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	348.2	0.0%	3,701.9	100.0 %	4,050.0	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	16.0%	504.6	84.0%	504.6	100%

DISCLAIMER: The figures provided on this page have to be read in the context set out in the beginning of section 8.1.2 (General remarks) and in sections 8.1.2.1 and 8.1.2.2

	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	8.2	16.0%	42.8	84.0%	51.0	100%
2015	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	208.1	0.0%	3,865.2	100.0 %	4,073.2	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	10.0%	465.3	90.0%	465.3	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	4.9	10.0%	44.1	90.0%	49.0	100%
2016	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	66.0	0.0%	4,058.4	100.0 %	4,124.4	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	3.3%	193.2	96.7%	193.2	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	1.6	3.3%	45.8	96.7%	47.3	100%
2017	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	40.7	0.0%	4,141.3	100.0 %	4,182.0	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	2.0%	82.9	98.0%	82.9	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	1.0	2.0%	46.6	98.0%	47.5	100%
2018	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	4,237.2	100.0 %	4,237.2	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	96.0	100.0 %	96.0	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	47.5	100.0 %	47.5	100%
2019	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	4,294.9	100.0 %	4,294.9	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	70.4	100.0 %	70.4	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	48.1	100.0 %	48.1	100%
2020	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	4,407.4	100.0 %	4,407.4	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	419.6	100.0 %	419.6	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	48.3	100.0 %	48.3	100%

DISCLAIMER: The figures provided on this page have to be read in the context set out in the beginning of section 8.1.2 (General remarks) and in sections 8.1.2.1 and 8.1.2.2

Annexe 8-4: Main economic and environmental data for the scenario "Option 1 Slow"

		Option 1 Slow													
		GLS-F		GLS-C		HL-MV-LW		HL-MV-HW		HL-LV		CFLi		TOTAL	
2007	Total stock (mln)	1,800.1	44.0%	568.5	17.0%	134.4	5.6%	119.4	4.8%	558.3	8.4%	1,010.1	20.2%	4,190.8	100%
	Total sales (mln)	767.4	43.7%	297.0	15.1%	97.4	2.7%	84.1	17.1%	147.0	11.6%	353.0	9.8%	1,745.9	100%
	Electricity consumption (TWh)	49.2	43.7%	16.9	15.1%	2.9	2.7%	19.2	17.1%	13.1	11.6%	11.0	9.8%	112.4	100%
2008	Total stock (mln)	1,580.0	41.2%	523.5	16.4%	193.5	6.9%	151.3	5.4%	571.5	8.9%	1,228.5	21.2%	4,248.2	100%
	Total sales (mln)	687.9	37.8%	273.1	13.6%	115.2	3.9%	89.8	21.3%	149.3	11.7%	353.1	11.7%	1,668.4	100%
	Electricity consumption (TWh)	43.2	37.8%	15.6	13.6%	4.2	3.9%	24.3	21.3%	13.4	11.7%	13.4	11.7%	114.1	100%
2009	Total stock (mln)	1,097.7	19.4%	350.8	7.7%	263.5	4.7%	188.6	0.0%	612.5	9.7%	1,780.8	58.5%	4,293.8	100%
	Total sales (mln)	302.5	30.5%	120.6	10.3%	160.0	4.0%	115.7	13.1%	182.4	15.3%	716.1	26.8%	1,597.2	100%
	Electricity consumption (TWh)	27.3	30.5%	9.2	10.3%	5.1	4.0%	26.0	13.1%	13.0	15.3%	19.2	26.8%	99.7	100%
2010	Total stock (mln)	677.9	18.1%	214.8	7.1%	334.3	5.4%	225.6	0.0%	654.0	10.0%	2,291.3	59.3%	4,397.8	100%
	Total sales (mln)	277.7	19.5%	109.1	6.2%	171.9	3.8%	109.9	0.0%	185.3	20.6%	698.1	49.9%	1,552.0	100%
	Electricity consumption (TWh)	13.3	19.5%	4.2	6.2%	5.9	3.8%	27.8	0.0%	12.5	20.6%	24.6	49.9%	88.4	100%
2011	Total stock (mln)	303.7	0.0%	91.3	0.0%	397.8	0.0%	259.0	0.0%	695.9	18.7%	2,547.6	81.3%	4,295.3	100%
	Total sales (mln)	0.0	8.8%	0.0	2.9%	65.9	2.6%	33.4	0.0%	188.3	23.5%	539.3	62.1%	826.9	100%
	Electricity consumption (TWh)	5.4	8.8%	1.8	2.9%	7.1	2.6%	31.9	0.0%	12.0	23.5%	26.7	62.1%	84.8	100%
2012	Total stock (mln)	31.5	0.0%	3.0	0.0%	423.3	0.0%	266.0	0.0%	734.3	22.2%	2,717.1	77.8%	4,175.2	100%
	Total sales (mln)	0.0	1.0%	0.0	0.1%	25.4	0.8%	38.3	0.0%	178.3	26.2%	472.5	71.8%	714.5	100%
	Electricity consumption (TWh)	0.6	1.0%	0.1	0.1%	7.5	0.8%	32.8	0.0%	11.5	26.2%	28.2	71.8%	80.6	100%
2013	Total stock (mln)	0.0	0.0%	0.0	0.0%	378.5	0.0%	151.9	0.0%	734.3	0.0%	2,930.3	100.0 %	4,195.0	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	21.6%	536.2	78.4%	536.2	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	6.7	0.0%	18.7	0.0%	11.5	21.6%	32.7	78.4%	69.6	100%
2014	Total stock (mln)	0.0	0.0%	0.0	0.0%	215.2	0.0%	62.7	0.0%	674.1	0.0%	3,268.7	100.0 %	4,220.7	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	16.0%	681.4	84.0%	681.4	100%

DISCLAIMER: The figures provided on this page have to be read in the context set out in the beginning of section 8.1.2 (General remarks) and in sections 8.1.2.1 and 8.1.2.2

	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	3.8	0.0%	7.7	0.0%	10.6	16.0%	37.2	84.0%	59.3	100%
2015	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	72.9	0.0%	28.0	0.0%	490.7	0.0%	3,638.1	100.0 %	4,229.8	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	10.0%	671.4	90.0%	671.4	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	1.3	0.0%	3.4	0.0%	7.7	10.0%	40.7	90.0%	53.1	100%
2016	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	18.3	0.0%	0.0	0.0%	304.4	0.0%	3,947.0	100.0 %	4,269.7	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	3.3%	308.9	96.7%	308.9	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	0.3	0.0%	0.0	0.0%	4.8	3.3%	43.8	96.7%	48.9	100%
2017	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	119.4	0.0%	4,188.9	100.0 %	4,308.4	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	2.0%	241.9	98.0%	241.9	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	1.9	2.0%	45.7	98.0%	47.6	100%
2018	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	4,353.9	100.0 %	4,353.9	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	165.0	100.0 %	165.0	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	47.1	100.0 %	47.1	100%
2019	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	4,412.8	100.0 %	4,412.8	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	71.6	100.0 %	71.6	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	47.8	100.0 %	47.8	100%
2020	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	4,513.4	100.0 %	4,513.4	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	245.0	100.0 %	245.0	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	48.3	100.0 %	48.3	100%

DISCLAIMER: The figures provided on this page have to be read in the context set out in the beginning of section 8.1.2 (General remarks) and in sections 8.1.2.1 and 8.1.2.2

Annexe 8-5: Main economic and environmental data for the scenario "Option 2 Clear B Fast"

		Option 2 Clear B Fast													
		GLS-F		GLS-C		HL-MV-LW		HL-MV-HW		HL-LV		CFLi		TOTAL	
2007	Total stock (mln)	1,800.1	44.0%	568.5	17.0%	134.4	5.6%	119.4	4.8%	558.3	8.4%	1,010.1	20.2%	4,190.8	100%
	Total sales (mln)	767.4	43.7%	297.0	15.1%	97.4	2.7%	84.1	17.1%	147.0	11.6%	353.0	9.8%	1,745.9	100%
	Electricity consumption (TWh)	49.2	43.7%	16.9	15.1%	2.9	2.7%	19.2	17.1%	13.1	11.6%	11.0	9.8%	112.4	100%
2008	Total stock (mln)	1,580.0	41.2%	523.5	16.4%	193.5	6.9%	151.3	5.4%	571.5	8.9%	1,228.5	21.2%	4,248.2	100%
	Total sales (mln)	687.9	37.8%	273.1	13.6%	115.2	3.9%	89.8	21.3%	149.3	11.7%	353.1	11.7%	1,668.4	100%
	Electricity consumption (TWh)	43.2	37.8%	15.6	13.6%	4.2	3.9%	24.3	21.3%	13.4	11.7%	13.4	11.7%	114.1	100%
2009	Total stock (mln)	1,097.7	19.4%	350.8	7.7%	427.7	4.7%	188.6	0.0%	612.5	9.7%	1,664.8	58.5%	4,342.0	100%
	Total sales (mln)	302.5	30.5%	120.6	10.3%	324.2	4.0%	115.7	13.1%	182.4	15.3%	600.1	26.8%	1,645.5	100%
	Electricity consumption (TWh)	27.3	30.5%	9.2	10.3%	8.9	4.0%	26.0	13.1%	13.0	15.3%	18.0	26.8%	102.2	100%
2010	Total stock (mln)	677.9	18.1%	214.8	7.1%	630.2	5.4%	225.6	0.0%	654.0	10.0%	2,082.4	59.3%	4,484.8	100%
	Total sales (mln)	277.7	19.5%	109.1	6.2%	303.6	3.8%	109.9	0.0%	185.3	20.6%	605.2	49.9%	1,590.7	100%
	Electricity consumption (TWh)	13.3	19.5%	4.2	6.2%	12.8	3.8%	27.8	0.0%	12.5	20.6%	22.3	49.9%	92.9	100%
2011	Total stock (mln)	303.7	0.0%	91.3	0.0%	722.9	0.0%	259.0	0.0%	695.9	18.7%	2,309.6	81.3%	4,382.4	100%
	Total sales (mln)	0.0	8.8%	0.0	2.9%	95.0	2.6%	33.4	0.0%	188.3	23.5%	510.3	62.1%	827.0	100%
	Electricity consumption (TWh)	5.4	8.8%	1.8	2.9%	14.6	2.6%	31.9	0.0%	12.0	23.5%	24.2	62.1%	89.8	100%
2012	Total stock (mln)	31.5	0.0%	3.0	0.0%	793.9	0.0%	266.0	0.0%	734.3	22.2%	2,433.7	77.8%	4,262.4	100%
	Total sales (mln)	0.0	1.0%	0.0	0.1%	176.6	0.8%	38.3	0.0%	178.3	26.2%	427.1	71.8%	820.2	100%
	Electricity consumption (TWh)	0.6	1.0%	0.1	0.1%	16.1	0.8%	32.8	0.0%	11.5	26.2%	25.3	71.8%	86.3	100%
2013	Total stock (mln)	0.0	0.0%	0.0	0.0%	667.1	0.0%	273.1	0.0%	898.0	0.0%	2,440.8	100.0 %	4,279.0	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	188.8	0.0%	121.2	0.0%	163.8	21.6%	330.0	78.4%	803.7	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	13.0	0.0%	33.7	0.0%	14.2	21.6%	25.4	78.4%	86.3	100%
2014	Total stock (mln)	0.0	0.0%	0.0	0.0%	598.8	0.0%	280.2	0.0%	1,001.7	0.0%	2,433.5	100.0 %	4,314.2	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	167.7	0.0%	96.3	0.0%	163.8	16.0%	335.8	84.0%	763.6	100%

DISCLAIMER: The figures provided on this page have to be read in the context set out in the beginning of section 8.1.2 (General remarks) and in sections 8.1.2.1 and 8.1.2.2

	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	11.3	0.0%	34.5	0.0%	15.9	16.0%	25.3	84.0%	87.0	100%
2015	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	566.6	0.0%	287.2	0.0%	1,069.2	0.0%	2,426.1	100.0 %	4,349.1	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	92.6	0.0%	41.8	0.0%	250.9	10.0%	294.5	90.0%	679.9	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	10.4	0.0%	35.4	0.0%	17.0	10.0%	25.2	90.0%	88.1	100%
2016	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	525.1	0.0%	294.3	0.0%	1,146.1	0.0%	2,446.7	100.0 %	4,412.2	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	128.9	0.0%	67.7	0.0%	263.2	3.3%	20.6	96.7%	480.4	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	9.3	0.0%	36.3	0.0%	18.3	3.3%	25.5	96.7%	89.3	100%
2017	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	550.5	0.0%	301.4	0.0%	1,159.3	0.0%	2,465.9	100.0 %	4,477.1	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	208.3	0.0%	121.5	0.0%	198.1	2.0%	19.3	98.0%	547.2	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	9.8	0.0%	37.2	0.0%	18.5	2.0%	25.7	98.0%	91.1	100%
2018	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	576.0	0.0%	308.4	0.0%	1,172.4	0.0%	2,483.8	100.0 %	4,540.6	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	172.1	0.0%	88.6	0.0%	136.9	0.0%	17.9	100.0 %	415.6	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	10.2	0.0%	38.0	0.0%	18.7	0.0%	25.9	100.0 %	92.8	100%
2019	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	601.4	0.0%	315.5	0.0%	1,185.6	0.0%	2,501.7	100.0 %	4,604.2	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	128.2	0.0%	55.9	0.0%	46.1	0.0%	17.9	100.0 %	248.1	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	10.7	0.0%	38.9	0.0%	18.9	0.0%	26.1	100.0 %	94.5	100%
2020	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	626.9	0.0%	322.5	0.0%	1,185.7	0.0%	2,516.3	100.0 %	4,651.4	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	176.6	0.0%	89.3	0.0%	153.3	0.0%	45.5	100.0 %	464.7	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	11.1	0.0%	39.8	0.0%	18.9	0.0%	26.2	100.0 %	96.0	100%

DISCLAIMER: The figures provided on this page have to be read in the context set out in the beginning of section 8.1.2 (General remarks) and in sections 8.1.2.1 and 8.1.2.2

Annexe 8-6: Main economic and environmental data for the scenario "Option 2 Clear B Slow"

		Option 2 Clear B Slow													
		GLS-F		GLS-C		HL-MV-LW		HL-MV-HW		HL-LV		CFLi		TOTAL	
2007	Total stock (mln)	1,800.1	44.0%	568.5	17.0%	134.4	5.6%	119.4	4.8%	558.3	8.4%	1,010.1	20.2%	4,190.8	100%
	Total sales (mln)	767.4	43.7%	297.0	15.1%	97.4	2.7%	84.1	17.1%	147.0	11.6%	353.0	9.8%	1,745.9	100%
	Electricity consumption (TWh)	49.3	43.7%	17.0	15.1%	2.9	2.7%	19.2	17.1%	13.1	11.6%	11.0	9.8%	112.5	100%
2008	Total stock (mln)	1,580.0	41.2%	523.5	16.4%	193.5	6.9%	151.3	5.4%	571.5	8.9%	1,228.5	21.2%	4,248.2	100%
	Total sales (mln)	687.9	37.8%	273.1	13.6%	115.2	3.9%	89.8	21.3%	149.3	11.7%	353.1	11.7%	1,668.4	100%
	Electricity consumption (TWh)	43.2	37.8%	15.6	13.6%	4.2	3.9%	24.3	21.3%	13.4	11.7%	13.4	11.7%	114.2	100%
2009	Total stock (mln)	1,325.0	19.4%	446.7	7.7%	441.8	4.7%	188.6	0.0%	584.7	9.7%	1,407.0	58.5%	4,393.7	100%
	Total sales (mln)	544.9	30.5%	217.3	10.3%	323.8	4.0%	115.7	13.1%	151.5	15.3%	342.3	26.8%	1,695.6	100%
	Electricity consumption (TWh)	34.4	30.5%	12.5	10.3%	9.2	4.0%	26.0	13.1%	13.7	15.3%	15.4	26.8%	111.2	100%
2010	Total stock (mln)	1,109.1	18.1%	379.2	7.1%	714.4	5.4%	225.6	0.0%	597.9	10.0%	1,554.0	59.3%	4,580.1	100%
	Total sales (mln)	500.2	19.5%	196.5	6.2%	365.3	3.8%	109.9	0.0%	153.8	20.6%	334.6	49.9%	1,660.2	100%
	Electricity consumption (TWh)	26.9	19.5%	9.9	6.2%	14.7	3.8%	27.8	0.0%	14.0	20.6%	17.0	49.9%	110.3	100%
2011	Total stock (mln)	787.3	0.0%	261.2	0.0%	1,112.8	0.0%	259.0	0.0%	638.7	18.7%	1,680.0	81.3%	4,739.0	100%
	Total sales (mln)	255.5	8.8%	97.5	2.9%	500.5	2.6%	33.4	0.0%	181.4	23.5%	333.2	62.1%	1,401.4	100%
	Electricity consumption (TWh)	17.3	8.8%	6.1	2.9%	22.5	2.6%	31.9	0.0%	13.6	23.5%	18.3	62.1%	109.8	100%
2012	Total stock (mln)	527.8	0.0%	188.7	0.0%	1,432.5	0.0%	266.0	0.0%	678.7	22.2%	1,778.7	77.8%	4,872.4	100%
	Total sales (mln)	215.3	1.0%	97.2	0.1%	484.7	0.8%	38.3	0.0%	188.6	26.2%	322.7	71.8%	1,346.8	100%
	Electricity consumption (TWh)	9.7	1.0%	3.7	0.1%	28.8	0.8%	32.8	0.0%	13.0	26.2%	19.4	71.8%	107.4	100%
2013	Total stock (mln)	247.9	0.0%	88.9	0.0%	1,260.7	0.0%	273.1	0.0%	826.0	0.0%	2,040.3	100.0 %	4,736.7	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	144.6	0.0%	121.2	0.0%	298.2	21.6%	584.6	78.4%	1,148.6	100%
	Electricity consumption (TWh)	4.4	0.0%	1.7	0.0%	25.1	0.0%	33.7	0.0%	14.3	21.6%	21.3	78.4%	100.5	100%
2014	Total stock (mln)	36.9	0.0%	10.1	0.0%	1,046.6	0.0%	280.2	0.0%	966.2	0.0%	2,277.1	100.0 %	4,617.0	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	142.6	0.0%	96.3	0.0%	293.4	16.0%	579.8	84.0%	1,112.0	100%

DISCLAIMER: The figures provided on this page have to be read in the context set out in the beginning of section 8.1.2 (General remarks) and in sections 8.1.2.1 and 8.1.2.2

	Electricity consumption (TWh)	0.7	0.0%	0.2	0.0%	20.7	0.0%	34.5	0.0%	15.3	16.0%	23.0	84.0%	94.5	100%
2015	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	749.7	0.0%	287.2	0.0%	1,071.6	0.0%	2,497.3	100.0 %	4,605.8	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	145.6	0.0%	41.8	0.0%	109.9	10.0%	573.3	90.0%	870.6	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	14.3	0.0%	35.4	0.0%	17.0	10.0%	24.5	90.0%	91.3	100%
2016	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	525.1	0.0%	294.3	0.0%	1,146.1	0.0%	2,661.3	100.0 %	4,626.8	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	132.7	0.0%	67.7	0.0%	134.4	3.3%	511.7	96.7%	846.6	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	9.3	0.0%	36.3	0.0%	18.3	3.3%	25.7	96.7%	89.6	100%
2017	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	381.0	0.0%	179.8	0.0%	1,310.6	0.0%	2,777.7	100.0 %	4,649.1	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	348.2	2.0%	454.8	98.0%	803.1	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	6.8	0.0%	22.2	0.0%	20.5	2.0%	37.3	98.0%	86.7	100%
2018	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	237.6	0.0%	98.3	0.0%	1,474.5	0.0%	2,882.6	100.0 %	4,692.9	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	353.3	0.0%	178.4	100.0 %	531.7	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	4.2	0.0%	12.1	0.0%	22.7	0.0%	46.0	100.0 %	85.1	100%
2019	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	95.6	0.0%	49.5	0.0%	1,637.0	0.0%	2,959.6	100.0 %	4,741.7	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	354.7	0.0%	77.0	100.0 %	431.8	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	1.7	0.0%	6.1	0.0%	24.9	0.0%	51.6	100.0 %	84.3	100%
2020	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	1,760.8	0.0%	3,037.3	100.0 %	4,798.1	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	287.6	0.0%	77.7	100.0 %	365.3	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	26.6	0.0%	57.2	100.0 %	83.8	100%

DISCLAIMER: The figures provided on this page have to be read in the context set out in the beginning of section 8.1.2 (General remarks) and in sections 8.1.2.1 and 8.1.2.2

Annexe 8-7: Main economic and environmental data for the scenario "Option 2 Clear C Fast"

		Option 2 Clear C Fast													
		GLS-F		GLS-C		HL-MV-LW		HL-MV-HW		HL-LV		CFLi		TOTAL	
2007	Total stock (mln)	1,800.1	44.0%	568.5	17.0%	134.4	5.6%	119.4	4.8%	558.3	8.4%	1,010.1	20.2%	4,190.8	100%
	Total sales (mln)	767.4	43.7%	297.0	15.1%	97.4	2.7%	84.1	17.1%	147.0	11.6%	353.0	9.8%	1,745.9	100%
	Electricity consumption (TWh)	49.2	43.7%	16.9	15.1%	2.9	2.7%	19.2	17.1%	13.1	11.6%	11.0	9.8%	112.4	100%
2008	Total stock (mln)	1,580.0	41.2%	523.5	16.4%	193.5	6.9%	151.3	5.4%	571.5	8.9%	1,228.5	21.2%	4,248.2	100%
	Total sales (mln)	687.9	37.8%	273.1	13.6%	115.2	3.9%	89.8	21.3%	149.3	11.7%	353.1	11.7%	1,668.4	100%
	Electricity consumption (TWh)	43.2	37.8%	15.6	13.6%	4.2	3.9%	24.3	21.3%	13.4	11.7%	13.4	11.7%	114.1	100%
2009	Total stock (mln)	1,097.7	19.4%	350.8	7.7%	781.9	4.7%	188.6	0.0%	584.7	9.7%	1,407.0	58.5%	4,410.6	100%
	Total sales (mln)	302.5	30.5%	120.6	10.3%	662.3	4.0%	115.7	13.1%	151.5	15.3%	342.3	26.8%	1,694.9	100%
	Electricity consumption (TWh)	27.3	30.5%	9.2	10.3%	17.0	4.0%	26.0	13.1%	13.7	15.3%	15.4	26.8%	108.5	100%
2010	Total stock (mln)	677.9	18.1%	214.8	7.1%	1,355.8	5.4%	225.6	0.0%	597.9	10.0%	1,554.0	59.3%	4,625.9	100%
	Total sales (mln)	277.7	19.5%	109.1	6.2%	665.6	3.8%	109.9	0.0%	153.8	20.6%	334.6	49.9%	1,650.5	100%
	Electricity consumption (TWh)	13.3	19.5%	4.2	6.2%	29.4	3.8%	27.8	0.0%	14.0	20.6%	17.0	49.9%	105.8	100%
2011	Total stock (mln)	303.7	0.0%	91.3	0.0%	1,596.7	0.0%	259.0	0.0%	611.1	18.7%	1,642.0	81.3%	4,503.7	100%
	Total sales (mln)	0.0	8.8%	0.0	2.9%	359.9	2.6%	33.4	0.0%	156.0	23.5%	371.0	62.1%	920.3	100%
	Electricity consumption (TWh)	5.4	8.8%	1.8	2.9%	33.9	2.6%	31.9	0.0%	14.3	23.5%	17.9	62.1%	105.2	100%
2012	Total stock (mln)	31.5	0.0%	3.0	0.0%	1,740.7	0.0%	266.0	0.0%	622.2	22.2%	1,703.3	77.8%	4,366.8	100%
	Total sales (mln)	0.0	1.0%	0.0	0.1%	356.1	0.8%	38.3	0.0%	158.2	26.2%	364.4	71.8%	916.9	100%
	Electricity consumption (TWh)	0.6	1.0%	0.1	0.1%	36.4	0.8%	32.8	0.0%	14.6	26.2%	18.6	71.8%	103.0	100%
2013	Total stock (mln)	0.0	0.0%	0.0	0.0%	1,402.9	0.0%	273.1	0.0%	633.3	0.0%	2,065.5	100.0 %	4,374.8	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	236.1	0.0%	121.2	0.0%	160.4	21.6%	685.2	78.4%	1,202.9	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	28.9	0.0%	33.7	0.0%	14.9	21.6%	21.2	78.4%	98.6	100%
2014	Total stock (mln)	0.0	0.0%	0.0	0.0%	1,051.7	0.0%	280.2	0.0%	644.5	0.0%	2,417.0	100.0 %	4,393.3	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	169.4	0.0%	96.3	0.0%	162.6	16.0%	694.5	84.0%	1,122.8	100%

DISCLAIMER: The figures provided on this page have to be read in the context set out in the beginning of section 8.1.2 (General remarks) and in sections 8.1.2.1 and 8.1.2.2

	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	21.4	0.0%	34.5	0.0%	15.1	16.0%	23.7	84.0%	94.7	100%
2015	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	936.6	0.0%	287.2	0.0%	655.6	0.0%	2,537.3	100.0 %	4,416.7	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	265.6	0.0%	41.8	0.0%	164.8	10.0%	422.3	90.0%	894.4	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	18.8	0.0%	35.4	0.0%	15.4	10.0%	24.5	90.0%	94.2	100%
2016	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	884.3	0.0%	294.3	0.0%	666.7	0.0%	2,623.0	100.0 %	4,468.4	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	292.8	0.0%	67.7	0.0%	166.9	3.3%	85.7	96.7%	613.2	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	17.6	0.0%	36.3	0.0%	15.7	3.3%	25.3	96.7%	94.8	100%
2017	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	906.6	0.0%	301.4	0.0%	677.9	0.0%	2,642.3	100.0 %	4,528.0	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	234.3	0.0%	121.5	0.0%	169.1	2.0%	19.3	98.0%	544.2	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	18.0	0.0%	37.2	0.0%	15.9	2.0%	25.5	98.0%	96.6	100%
2018	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	928.8	0.0%	308.4	0.0%	689.0	0.0%	2,660.2	100.0 %	4,586.3	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	215.3	0.0%	88.6	0.0%	171.3	0.0%	17.9	100.0 %	493.2	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	18.4	0.0%	38.0	0.0%	16.2	0.0%	25.7	100.0 %	98.3	100%
2019	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	951.0	0.0%	315.5	0.0%	700.1	0.0%	2,678.1	100.0 %	4,644.7	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	301.3	0.0%	55.9	0.0%	173.5	0.0%	17.9	100.0 %	548.6	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	18.8	0.0%	38.9	0.0%	16.4	0.0%	25.9	100.0 %	100.0	100%
2020	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	973.2	0.0%	322.5	0.0%	711.3	0.0%	2,696.0	100.0 %	4,703.0	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	299.2	0.0%	89.3	0.0%	175.7	0.0%	17.9	100.0 %	582.1	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	19.1	0.0%	39.8	0.0%	16.7	0.0%	26.1	100.0 %	101.7	100%

DISCLAIMER: The figures provided on this page have to be read in the context set out in the beginning of section 8.1.2 (General remarks) and in sections 8.1.2.1 and 8.1.2.2

Annexe 8-8: Main economic and environmental data for the scenario "Option 3 Slow"

		Option 3 Slow													
		GLS-F		GLS-C		HL-MV-LW		HL-MV-HW		HL-LV		CFLi		TOTAL	
2007	Total stock (mln)	1,800.1	44.0%	568.5	17.0%	134.4	5.6%	119.4	4.8%	558.3	8.4%	1,010.1	20.2%	4,190.8	100%
	Total sales (mln)	767.4	43.7%	297.0	15.1%	97.4	2.7%	84.1	17.1%	147.0	11.6%	353.0	9.8%	1,745.9	100%
	Electricity consumption (TWh)	49.3	43.7%	17.0	15.1%	2.9	2.7%	19.2	17.1%	13.1	11.6%	11.0	9.8%	112.5	100%
2008	Total stock (mln)	1,580.0	41.2%	523.5	16.4%	193.5	6.9%	151.3	5.4%	571.5	8.9%	1,228.5	21.2%	4,248.2	100%
	Total sales (mln)	687.9	37.8%	273.1	13.6%	115.2	3.9%	89.8	21.3%	149.3	11.7%	353.1	11.7%	1,668.4	100%
	Electricity consumption (TWh)	43.2	37.8%	15.6	13.6%	4.2	3.9%	24.3	21.3%	13.4	11.7%	13.4	11.7%	114.2	100%
2009	Total stock (mln)	1,325.0	19.4%	446.7	7.7%	441.8	4.7%	183.1	0.0%	584.7	9.7%	1,407.0	58.5%	4,388.3	100%
	Total sales (mln)	544.9	30.5%	217.3	10.3%	323.8	4.0%	95.5	13.1%	151.5	15.3%	342.3	26.8%	1,675.4	100%
	Electricity consumption (TWh)	34.4	30.5%	12.5	10.3%	9.2	4.0%	29.4	13.1%	13.7	15.3%	15.4	26.8%	114.7	100%
2010	Total stock (mln)	1,109.1	18.1%	379.2	7.1%	713.4	5.4%	214.9	0.0%	597.9	10.0%	1,554.0	59.3%	4,568.5	100%
	Total sales (mln)	500.2	19.5%	196.5	6.2%	363.5	3.8%	101.1	0.0%	153.8	20.6%	334.6	49.9%	1,649.8	100%
	Electricity consumption (TWh)	26.9	19.5%	9.9	6.2%	14.7	3.8%	34.6	0.0%	14.0	20.6%	17.0	49.9%	117.1	100%
2011	Total stock (mln)	979.8	0.0%	338.6	0.0%	773.7	0.0%	246.8	0.0%	611.1	18.7%	1,680.0	81.3%	4,630.0	100%
	Total sales (mln)	460.3	8.8%	175.7	2.9%	278.2	2.6%	106.8	0.0%	156.0	23.5%	333.2	62.1%	1,510.1	100%
	Electricity consumption (TWh)	23.3	8.8%	8.8	2.9%	15.9	2.6%	39.7	0.0%	14.3	23.5%	18.3	62.1%	120.4	100%
2012	Total stock (mln)	905.4	0.0%	335.7	0.0%	777.4	0.0%	253.5	0.0%	622.2	22.2%	1,778.7	77.8%	4,672.9	100%
	Total sales (mln)	387.9	1.0%	175.1	0.1%	173.9	0.8%	107.6	0.0%	158.2	26.2%	322.7	71.8%	1,325.4	100%
	Electricity consumption (TWh)	21.5	1.0%	8.7	0.1%	15.9	0.8%	40.8	0.0%	14.6	26.2%	19.4	71.8%	121.0	100%
2013	Total stock (mln)	865.7	0.0%	332.8	0.0%	796.2	0.0%	260.2	0.0%	633.3	0.0%	1,837.5	100.0 %	4,725.7	100%
	Total sales (mln)	389.2	0.0%	174.6	0.0%	363.9	0.0%	108.4	0.0%	160.4	21.6%	296.0	78.4%	1,492.4	100%
	Electricity consumption (TWh)	20.6	0.0%	8.6	0.0%	16.2	0.0%	41.8	0.0%	14.9	21.6%	20.1	78.4%	122.2	100%
2014	Total stock (mln)	831.6	0.0%	329.8	0.0%	811.9	0.0%	267.0	0.0%	644.5	0.0%	1,890.0	100.0 %	4,774.7	100%
	Total sales (mln)	378.7	0.0%	174.0	0.0%	362.6	0.0%	109.3	0.0%	162.6	16.0%	297.5	84.0%	1,484.6	100%

DISCLAIMER: The figures provided on this page have to be read in the context set out in the beginning of section 8.1.2 (General remarks) and in sections 8.1.2.1 and 8.1.2.2

	Electricity consumption (TWh)	19.8	0.0%	8.6	0.0%	16.5	0.0%	42.9	0.0%	15.1	16.0%	20.6	84.0%	123.5	100%
2015	**Total stock (mln)**	645.6	0.0%	250.6	0.0%	1,134.5	0.0%	279.4	0.0%	655.6	0.0%	1,893.4	100.0 %	4,859.1	100%
	Total sales (mln)	209.0	0.0%	96.3	0.0%	604.5	0.0%	120.2	0.0%	164.8	10.0%	356.4	90.0%	1,551.1	100%
	Electricity consumption (TWh)	14.1	0.0%	5.9	0.0%	22.7	0.0%	40.4	0.0%	15.4	10.0%	20.7	90.0%	119.2	100%
2016	**Total stock (mln)**	467.7	0.0%	186.2	0.0%	1,431.8	0.0%	291.8	0.0%	666.7	0.0%	1,897.2	100.0 %	4,941.4	100%
	Total sales (mln)	204.7	0.0%	96.0	0.0%	507.7	0.0%	121.0	0.0%	166.9	3.3%	351.6	96.7%	1,447.9	100%
	Electricity consumption (TWh)	8.7	0.0%	3.7	0.0%	28.3	0.0%	37.9	0.0%	15.7	3.3%	20.7	96.7%	115.0	100%
2017	**Total stock (mln)**	227.0	0.0%	83.6	0.0%	1,615.7	0.0%	301.4	0.0%	677.9	0.0%	1,898.1	100.0 %	4,803.6	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	503.6	0.0%	60.1	0.0%	169.1	2.0%	339.4	98.0%	1,072.2	100%
	Electricity consumption (TWh)	4.0	0.0%	1.6	0.0%	32.3	0.0%	37.2	0.0%	15.9	2.0%	20.7	98.0%	111.8	100%
2018	**Total stock (mln)**	26.3	0.0%	5.8	0.0%	1,732.0	0.0%	308.4	0.0%	689.0	0.0%	1,895.7	100.0 %	4,657.3	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	469.1	0.0%	39.5	0.0%	171.3	0.0%	331.4	100.0 %	1,011.4	100%
	Electricity consumption (TWh)	0.5	0.0%	0.1	0.0%	35.2	0.0%	38.0	0.0%	16.2	0.0%	20.7	100.0 %	110.7	100%
2019	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	1,735.3	0.0%	315.5	0.0%	700.1	0.0%	1,893.8	100.0 %	4,644.7	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	562.2	0.0%	127.5	0.0%	173.5	0.0%	326.0	100.0 %	1,189.2	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	35.4	0.0%	38.9	0.0%	16.4	0.0%	20.7	100.0 %	111.4	100%
2020	**Total stock (mln)**	0.0	0.0%	0.0	0.0%	1,740.6	0.0%	322.5	0.0%	711.3	0.0%	1,904.8	100.0 %	4,679.1	100%
	Total sales (mln)	0.0	0.0%	0.0	0.0%	421.6	0.0%	111.7	0.0%	175.7	0.0%	200.0	100.0 %	908.9	100%
	Electricity consumption (TWh)	0.0	0.0%	0.0	0.0%	35.4	0.0%	39.8	0.0%	16.7	0.0%	20.8	100.0 %	112.7	100%