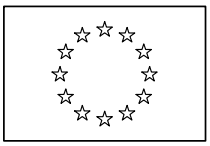

EUROPEAN COMMISSION

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GREEN PAPER

Lighting the Future

Accelerating the deployment of innovative lighting technologies

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Lighting the Future

Accelerating the deployment of innovative lighting technologies

Lighting accounts for 19% of electricity consumption worldwide and 14% in the EU[1]. As incandescent lamps are being phased out in Europe[2], new energy efficient and eco-friendly lighting technologies start to replace them. Solid State Lighting (SSL) is the most innovative technology emerging in the market. It is based on light-emitting semi-conducting materials that convert electricity into light and comprises LED and OLED lighting[3].

SSL was first introduced in traffic lights and car lights. It is already widely used for lighting displays and TVs and is now entering the general lighting market. In the next few years, SSL will become the most energy-efficient and versatile technology for general lighting and will provide high-quality light and visual performance together with new architectural and design options for enhanced comfort and well-being[4].

The wide-scale uptake of SSL could contribute substantially to the objectives of the Europe 2020 strategy for smart, sustainable and inclusive growth and in particular to its energy efficiency improvement target[5]. This will have substantial impact on European users (both consumers and professional users) and on the competitiveness of the European lighting industry. However, current SSL products face a number of challenges for wider market uptake: they are expensive; users are unfamiliar with this new technology and need to develop trust in its use; the technology is subject to rapid innovation; and there is a lack of standards.

Europe already has a wide range of policy instruments in place to stimulate the uptake of energy-efficient technologies, including lighting, which are subject to regular reviews and updates. Europe has also acknowledged the key role that the public sector can play to accelerate market penetration of such technologies through public procurement[6]. Therefore the question is whether new or additional measures are necessary and feasible at the European level that could help stimulate the rapid uptake of SSL. If so, which ones?

Europe's lighting industry has a clear role to play in the transition to SSL. It is large and world-class, and is ready to build upon its strengths in conventional lighting in order to capitalise on this emerging technology. However, SSL market uptake is slow in Europe, and SSL related research, innovation and cooperation activities are fragmented[4]. In contrast, in other regions of the world, especially Asia and the USA,

1 Guide on the Importance of Lighting, 2011, www.celma.org

2 Commission Regulation (EC) 244/2009. The phase-out will be completed by 1 September 2012. About 8 billion bulbs in the homes of European citizens are expected to be replaced in the next few years

3 LED = light emitting diode; OLED = organic LED

4 Second Strategic Research Agenda of the European Technology Platform PHOTONICS21, 2010

5 By 2020: increase by 20% energy efficiency (compared to 1990 levels)

6 COM(2011) 109 final

the lighting industry is moving ahead quickly, with the help of significant government support[7].

To keep pace with the rapidly developing technology and global competition and to address the above issues, action is needed now at European level in order to achieve two closely interlinked key objectives:

(1) in relation to ***European users*** *(the demand side)*: raise awareness and demonstrate to consumers, professional users and public procurers that this new lighting technology is of high quality and saves energy and money over its long lifetime, helping Europe meet its energy efficiency targets, and propose new initiatives to prevent early market failure

(2) in relation to the ***European lighting industry*** *(the supply side)*: propose policies which foster the competitiveness and global leadership of the lighting industry and contribute to the creation of growth and jobs in Europe.

This Green Paper is part of the Digital Agenda for Europe flagship initiative[8] under the Europe 2020 Strategy for smart, sustainable and inclusive growth[9]. The Green Paper sets out the key issues to be addressed in a European strategy aiming to accelerate the deployment of high-quality SSL for general lighting. It is designed to help Europe achieve its key energy efficiency, industrial and innovation policy objectives of Europe 2020.

The Green Paper proposes to **launch** a number of new **policy initiatives and a public debate** in Europe with all interested parties for accelerating the pace of SSL deployment. It has the ambition to pro-actively define **a coherent set of strategic objectives in the Union addressing both the demand and the supply side, as well as to lay down the generic conditions for achieving these objectives as a basis for future action for all involved players**.

The research and business stakeholders, governments, civil society communities and citizens are called upon to engage in this debate.

Since the Digital Agenda for Europe is a cross-cutting initiative, this Green Paper has important links to several other flagship initiatives of Europe 2020. For example, it is proposing to apply several of the general policy goals the Union has defined in its new Innovation[10] and Industrial policy[11] in the field of SSL. It also proposes a framework of actions related to some more specific initiatives of the Union such as the Energy Efficiency 2011 Plan[6], the upcoming new framework for research and innovation, 'Horizon 2020'[12], the Thematic Strategy on Prevention and Recycling of

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7 The USA in 2009 put in place a long-term SSL strategy (from research to commercialisation). China is implementing a municipal showcase programme for LED street lighting involving more than 21 cities; it is granting significant subsidies to LED manufacturing plants and aims to create 1 million related jobs in the next 3 years. South Korea has defined a national LED strategy with the goal to become a top-3 world player in the LED business by 2012

8 COM(2010) 245 final/2

9 http://ec.europa.eu/europe2020/index_en.htm

10 COM(2010) 546 final

11 COM(2010) 614

12 http://ec.europa.eu/research/horizon2020/index_en.cfm

Waste[13], the Key Enabling Technologies initiative[14] and the Regional Policy Funds[15].

1. SSL: A NEW WAY TO LOOK AT LIGHTING

SSL technologies for general lighting applications comprise LED and OLED light sources, luminaires[16] and control gear. They produce white light in different colour tones and variations, from warm to cold white. LED lamps and luminaires integrate high-brightness LED point light sources. OLED devices are based on organic light sources (e.g. polymers) that emit light homogeneously from a two-dimensional surface and can be made in arbitrary shapes and sizes, including as transparent panels.

LEDs are now a mature technology. OLEDs are not yet mature[17] and only high-end small batch products are currently available on the market. Their importance will increase in the next few years when OLED devices will enter the general lighting market and will open the door to a range of new lighting applications.

SSL is a breakthrough in general lighting in several key aspects:

- Energy efficiency: New SSL products are as energy efficient as their most advanced counterparts (fluorescent or halogen lamps), which are close to their optimum performance level. In the next few years, SSL will outpace any existing lighting technology in terms of energy efficiency. It will allow significant energy savings[18] in well designed, installed and operated smart lighting installations[19] and result in a significant contribution to CO_2 reduction at European level[20].

- Lighting quality and visual comfort: SSL offers high-quality lighting[21] and visual comfort in terms of colour rendering (vivid saturated colours of illuminated objects) and dynamic control (light spectrum, instantaneous switching and dimming). It has long lifetimes[22] with decreased maintenance costs and does not contain mercury. It is easily controllable in intensity and colour, allowing adjustment of the lighting according to the application demands or users' personal wishes. Ongoing studies also show that the ambient lighting conditions which some LED lamps create contribute to well-being and

13 COM(2011) 13 final
14 COM(2009) 512
15 COM(2011) 615 final
16 i.e. lighting fixtures and lamps
17 OLEDs are expected to become a mature technology in the next 3-5 years
18 According to reference 4, **SSL sources can push potential energy savings up to 50% and combined with intelligent light management systems up to 70% compared to today's consumption**
19 SSL lighting combined with intelligent controls that permit presence detection, daylight control etc. SSL lighting can be more flexibly controlled in terms of beam angle, light colour, dimming or frequent switching compared to other energy-saving lamps such as compact fluorescent lamps (CFL)
20 In 2009 the total electricity consumption in the EU 27 amounted to 2719 TWh (Eurostat), of which 14% for lighting. Up to 266 TWh could be saved assuming up to 70% energy savings
21 Lighting quality includes: colour quality (including appearance, colour rendering, and colour consistency); illuminance levels (the amount of light a light source provides for a task or on a surface); photometric distribution of the light source in a luminaire; lifetime; ease of maintenance; and cost
22 LED life expectancy is 25,000-50,000 hours (up to five times that of CFLs)

optimised learning and working conditions (e.g. in schools and offices), and positively influence people's vitality, concentration and alertness[23].

- Design and aesthetics: SSL technology gives lighting designers and industry an almost unlimited freedom to develop new lighting concepts and design parameters. It enables new forms of luminaires and lighting systems including their full integration into building elements (walls, ceilings, windows). OLEDs in particular will pave the way to completely new lighting applications and will be a key part for developing thin, highly efficient light panels allowing maximum design flexibility. By combining colour and shape, LEDs and OLEDs will create new opportunities for customising personal surroundings with light, thereby contributing to comfort and well-being.

- Innovation and new business opportunities: The combination and exploitation of the wide range of SSL characteristics and benefits will create many new business opportunities for the lighting industry and will lead to a change in business models: from selling light sources and luminaires to their integration into furnishing and buildings; from selling replacement lamps to selling intelligent lighting systems and solutions and to creating new utility-type markets for selling lighting as a service.

Intensive manufacturing and research activities all over the world promise to further improve SSL performance (i.e. energy efficiency and quality) and substantially reduce costs in the next few years. For example, state-of-the-art white LEDs have already reached 30-50% efficiency[24], have luminous efficacies[25] of 100-150 lumen/Watt (lm/W) and a colour rendering index (CRI)[26] of 80. Target values for warm white LEDs in the next 10 years are: 50-60% efficiency, more than 200 lm/W efficacy and a CRI of over 90. State-of-the-art OLED products are around 50 lm/W today. While their efficacy is expected to always stay below that of LEDs, the added value of OLED technology will come from its size, flexibility and opportunities for new applications.

In 2010, total market revenues of general lighting worldwide were around 52 billion euro of which close to 30% was spent in Europe. By 2020, the world market is projected to reach 88 billion euro with Europe's share decreasing to less than 25%[27]. Current market penetration of SSL in Europe is very low: the LED market share (in value) reached 6.2% in 2010. Several studies predict that SSL will account for more than 70% of Europe's general lighting market by 2020[27].

Europe faces the challenge of removing existing barriers to deliver SSL's potential while helping the European lighting industry to remain at the forefront of global competition.

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23 See e.g. report on "Lighting, Well-being and Performance at Work", J. Silvester and E. Konstantinou, Centre for Performance at Work at City University London (2011)

24 Efficiency is the percentage of electricity, which is converted into visible light. For incandescent light bulbs it is 2% and for CFLs around 25%

25 The efficacy of a light source is the ratio of the light output to the electric power consumed and is a measure for the energy efficiency of a lamp or lighting system

26 CRI is a measure reflecting how well a light source renders colours

27 E.g., "Lighting the way: Perspectives on the global lighting market", McKinsey & Company (2011)

2. SSL AND EUROPEAN USERS

2.1. A large potential for SSL deployment in Europe

Lighting is an essential service for domestic use, in public spaces and other applications, from advertising panels, automotive, traffic and street lights to public offices and buildings. In Europe, professional lighting (non-residential buildings and street lighting) accounts for 52% of the total market revenues and residential lighting for the rest[27]. Office buildings use up to 50% of their total electricity consumption for lighting, while this share is 20-30% in hospitals, 15% in factories, 10-15% in schools and 10-12% in residential buildings[28].

While LEDs have become available on the general lighting market as spotlights integrated in ceilings and as "retrofit" light bulb replacements, recent LED technology advancement has allowed their integration and use in far more demanding applications: street lighting, high-brightness indoor and outdoor lighting, retail displays, general merchandise lighting, etc. Shopping malls quickly followed the trend and some achieved energy savings of 60% and payback times of about 3 years[29]. LED lighting is also appreciated in hotels where refurbishments achieve up to 90% higher efficiencies compared to previous installations[30]. The potential for LED deployment in Europe is very large, as 75% of existing lighting installations are older than 25 years[31].

First studies on the full life cycle impacts of LED lighting compared to other lighting technologies have already been carried out[28]. The full life cycle impacts need to be further monitored as LED technology evolves. In the future, SSL applications may be widely deployed beyond the mere replacement of existing lighting systems, such as integration into furniture or buildings. In the long run, this could reduce the expected energy savings, an effect known as the *rebound effect*[32].

Lighting accounts for 50% of the electricity consumption of European cities[33]. Increasingly, cities are developing sustainable urban lighting strategies integrated with urban development policies and implemented in close cooperation with lighting designers, architects and town planners. The potential of SSL to become the replacement technology for more than 90 million traditional street lights in Europe and its fast evolution are motivating many European cities[34] to launch pilot actions to familiarise themselves with this technology, to experience its main benefits and to understand possible drawbacks. Some Member States are funding SSL pilots or

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28 Annex 45 Guidebook on Energy Efficient Electric Lighting for Buildings (2010), International Energy Agency (IEA)

29 "Lighting energy savings in 10 Shopping Malls", LED project UNIBAIL RODAMCO, (2011)

30 "The European GreenLight Programme - Efficient Lighting Project, Implementation Catalogue 2005-2009", JRC

31 http://www.celma.org/archives/temp/CELMA_ELC_LSL_Presentation_D.Zembrot_EP_25012011.pdf

32 "Addressing the rebound effect" – final report (2011), European Commission study contract ENV.G.4/FRA/2008/0112

33 "Énergie et patrimoine communal" (2005), ADEME

34 E.g. Amsterdam, Berlin, Bremen, Brussels, Budapest, Eindhoven, Haarlem, Leipzig, Lyon, Manchester, Oslo, Rotterdam, Tallinn, Tilburg, Toulouse and others

various innovation activities[35]. In other cases, public private partnerships are being set up and take the responsibility for public lighting over a period of 20 to 30 years[36].

2.2. Issues and challenges for SSL uptake by European users

A large range of SSL products tailored to the different needs of users already exists on the market. However many challenges still exist for SSL uptake by consumers, professional users and cities which require the adoption of a European approach. The following main issues must be addressed:

Issues for consumers and professional users

- ***Low-quality LED products**:* While there are already some good-quality LED products on the EU market, many LED products on offer are rather poorly designed and manufactured, emitting low-quality cold white light and are mainly serving as replacement lamps. Consumers also experience much shorter actual life times than those claimed on the package[37]. Minimum quality requirements for LED products are considered a key factor to guarantee consumer satisfaction in LED lighting and to grow the LED market. Member States are responsible for monitoring the performance and safety of products sold in the EU market holding the CE marking label (*market surveillance*). An efficient market surveillance scheme is a prerequisite for the uptake of high-quality LED products in the EU market.

- ***High initial purchase cost**:* Rapid advances in SSL technology components and manufacturing processes and heavy investment from various companies lead SSL costs to drop at a rate of 30% per year. However, in the foreseeable future LED lamps will continue to be more expensive than other existing lighting technologies[38]. As high-quality LEDs offer long lifetimes, they have reduced maintenance costs. Professional users need to make their purchasing decisions on a lighting product based on calculation of its total cost of ownership (TCO)[39].

- ***Users are generally not fully aware of advantages and capabilities of SSL technologies**:* They do not yet consider SSL as an important low-carbon technology and are not able to weigh up SSL costs against its advantages.

- ***Insufficient or poor product information**:* When consumers decide to buy SSL products, they have difficulty in buying the right one as they need to understand various technical properties, which are not provided or are often poorly explained on the product package (e.g. misleading equivalence claims about their light output, etc.).

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35 E.g. Germany is financing a series of pilots "Kommunen in neuem Licht"; France is supporting Cluster Lumière that offers a platform for innovation of LEDs

36 E.g., Birmingham City Council

37 "Consumer relevant Eco-design requirements for domestic lighting", BEUC – ANEC position paper (2011), http://www.beuc.eu

38 The retail price of a 60W incandescent lamp is less than 1 euro, while that of its CFL equivalent is around 5 euro and of its LED equivalent more than 30 euro. Current forecasts foresee CFL and LED market share parity only in 2015-16

39 TCO includes acquisition, maintenance and replacement as well as the energy costs

– ***Concerns for biological safety (the "blue light hazard"):*** Concerns have been raised concerning health effects of LED light on the retina caused by the light's blue spectral component[40]. However, the SCENIHR[41] draft report on "Health effects of artificial light" did not identify any evidence that blue light from artificial lighting (which includes LED lamps for consumers) would pose a particular risk. SCENIHR's preliminary recommendation is nevertheless to consider measures against the misuse of artificial lighting in general.

– ***Rapid technology obsolescence and missing standards****:* Users hesitate to invest in SSL in view of continuing price drops and speedy technological improvement (LED efficacy doubles in the labs every 18-24 months). Gaps, including safety gaps, currently exist in SSL technology standardisation.

In addition, the following challenges need to be addressed for SSL deployment in cities and private buildings:

Specific challenges for large SSL deployment in cities

– ***Cities are not aware of, hesitate or do not have enough incentives to replace old outdoor lighting technologies by more energy efficient SSL****:* Today many cities are reluctant to use SSL widely in outdoor lighting mainly because of the relatively high upfront investment cost, which clashes with tight annual city budgets (even if this is generally offset by significantly lower lifetime costs). Other reasons include lack of trust quality certification schemes and of standards to develop proper specifications.

Specific challenges for SSL deployment in private buildings

– ***The landlord-tenant conflict****:* This is the mismatch of interests that exists between the building owner, who pays the initial price of the lighting, and the user who usually pays the running costs[42]. This inhibits the adoption and energy saving opportunities afforded by energy efficient lighting[6].

2.3. Initiatives for the uptake of SSL by consumers and users

EU policy and legislative instruments applying to SSL products

A broad range of EU instruments, both voluntary and mandatory, already exist that are relevant to SSL and will tend to support its further deployment through minimum performance and safety requirements for SSL products. Main instruments include: *Ecodesign*[43], *Energy labelling*[44], *Ecolabel*[45], the *Low-Voltage Directive* or the

40 "Lighting systems using light-emitting diodes: health issues to be considered" (2010), ANSES

41 Scientific Committee on Emerging and Newly Identified Health Risks; it advises the Commission on scientific issues related to consumer safety, public health and the environment

42 Also known as "split incentives" conflict between investors and energy end-users or "principle agent" conflict. E.g., when comparing today's LEDs with fluorescent lamps, their TCO becomes superior after 5-6 years of usage.

43 **Ecodesign** (http://ec.europa.eu/energy/efficiency/ecodesign/eco_design_en.htm) aims at reducing the environmental impact of products, including the energy consumption throughout their entire life cycle

General Product Safety Directive[46], the Directives on the *Restriction of Hazardous Substances* (RoHS) and on *Waste Electrical and Electronic Equipment* (WEEE)[47], *Green Public Procurement* (GPP)[48] and *the New Legislative Framework*[49].

These instruments are reviewed at regular intervals to reflect technological progress and possibly new EU policy in the fields. In particular:

– Measures implementing the Ecodesign and Energy Labelling directives and the Ecolabel Regulation for light sources are currently under revision or development: The Commission intends to adopt a new Ecodesign regulation that will cover directional light sources (reflector lamps). It will introduce compulsory EU legislation on directional lamps with minimum functionality requirements for all LEDs (non-directional LEDs already have to comply with minimum energy efficiency requirements under an existing Ecodesign regulation)[50]. In the revised Energy labelling regulation, the Commission intends to include LEDs and all kinds of directional and professional lamps[51].

– The Low-Voltage Directive will be aligned with the New Legislative Framework[46].

– By the end of 2011 the new EU Green Public Procurement (GPP) criteria for "indoor lighting" will be adopted and the existing criteria for "street lighting & traffic signals" will be updated.

– Revised Ecolabel criteria for light sources in order to include specifically LEDs are under consideration for development in 2012.

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44 **Energy Labelling** (http://ec.europa.eu/energy/efficiency/labelling/energy_labelling_en.htm) sets the framework for developing product-specific energy labelling measures to allow end-users to choose more efficient products through standard product information on energy consumption

45 **Ecolabel** (http://ec.europa.eu/environment/ecolabel/) is a voluntary scheme which promotes products having high-level environmental performance

46 The **Low Voltage Directive** (http://ec.europa.eu/enterprise/sectors/electrical/lvd/) covers the safety of electric products operating under more than 50 volts and ensures that only safe electrical equipment is placed on the market. For products operating below 50 volts the safety issues are covered by the **General Product Safety Directive** (http://ec.europa.eu/consumers/safety/prod_legis/index_en.htm)

47 The Directive on the **Restriction of Hazardous Substances** aims at restricting the use of hazardous substances in electrical and electronic equipment, http://ec.europa.eu/environment/waste/rohs_eee/, while the Directive on **Waste Electrical and Electronic Equipment** aims at promoting the collection and recycling of such equipment, http://ec.europa.eu/environment/waste/weee/

48 **Green Public Procurement** (GPP) is a voluntary scheme at EU level. It is a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle. COM (2008) 400

49 Since 2010, the enforcement of performance and safety requirements contained in most of the above instruments can rely on the **New Legislative Framework (NLF)**. NLF consists of two complementary instruments: a Regulation and a Decision. Since 2010, the NLF regulation sets out a stronger framework for market surveillance of electrical equipment and lays down powers and duties of competent national authorities. They should carry out checks of products, both domestic and imported, on an adequate scale and stop products presenting a risk or otherwise not conforming to applicable requirements. The NLF Decision contains model provisions on economic operators obligations to which product harmonisation legislation should be aligned. See also: http://ec.europa.eu/enterprise/policies/single-market-goods/regulatory-policies-common-rules-for-products/new-legislative-framework/

50 http://ec.europa.eu/energy/efficiency/ecodesign/doc/meeting/ed_wd_dls_leds_hl_converter_v1.0.pdf

51 http://ec.europa.eu/energy/efficiency/ecodesign/doc/meeting/el_wd2_-_draft_regulation_on_a_lamp_energy_label_v1.0.pdf

In addition to the above:

– GreenLight[52] is a voluntary initiative encouraging non-residential electricity consumers (public and private) to reduce their lighting energy use by installing energy-efficient lighting technologies in their facilities;

– The International Energy Agency (IEA) is currently addressing the issue of SSL global quality by developing an SSL quality assurance scheme[53], contributing to harmonisation of performance testing and working to develop accreditation infrastructures[54].

In view of the identified challenges further action is needed to accelerate SSL deployment in Europe:

The Consumers perspective

– The lighting stakeholders and/or consumer associations are invited to organise awareness campaigns for increasing user awareness of SSL products and for helping them to understand how to choose the SSL products consumers need.

– Member States and the lighting industry need to ensure that SSL products sold in Europe conform to EU legislation on performance and safety requirements.

– The Commission will continue to monitor the developments regarding potential effects of LED lighting technology on consumers' health.

Questions:

(1)	How would you propose to overcome the challenges outlined above for the wider market penetration of SSL technologies in Europe?
(2)	Which additional challenges do you see for a wider SSL market penetration in Europe and which solutions would you propose to resolve them?
(3)	What can Member States do to reinforce market surveillance of product performance and safety in the area of SSL lighting products?
(4)	What could the lighting industry do to ensure the performance of SSL products?
(5)	What can be done to raise awareness of consumers and professional users to SSL technologies and which specific measures and incentives would you propose for accelerating SSL uptake?

Creating SSL lead markets for cities

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52 More than 650 public and private organisations have signed the GreenLight programme's commitment since its launch by the European Commission in 2000, http://www.eu-greenlight.org

53 The scheme includes product categories, minimum performance value and product declaration marks, and tested value reporting

54 "Implementing Agreement for a Co-operative Programme on Efficient Electrical End-Use Equipment (4E)", IEA Annual Report 2010, SSL Annex

Green Public Procurement (GPP) can be used by public authorities for supporting the wider deployment of energy-efficient lighting in cities or buildings. Many Member States have adopted their own approaches at national level for supporting green procurement.

A number of financial instruments already exist for cities to finance feasibility studies for investments in sustainable energy, including lighting, at local level. An example is the ELENA technical assistance facility[55] or the European Energy Efficiency Fund (EEE-F)[56].

Enabling cities to deploy SSL at an early stage would permit them to become the *leading markets* for SSL products in Europe. This would, however, require a close cooperation between responsible municipal authorities and the lighting industry. It would help cities understand the advantages of SSL and the range of existing choices tailored to their needs, benefit from best practice experience, and, define adequate instruments for the fast deployment of SSL.

In order to prepare for the creation of SSL lead markets in European cities, **the Commission is considering the following actions**:

– Invite representatives from cities, the SSL industry and other relevant actors to set up a dedicated Task Force with the mandate to propose a roadmap and an implementation plan for the creation of an SSL lead market in European cities. Such a mandate may include setting up innovative financial schemes and public private partnerships, as well as mechanisms for the sharing of information and best practice experience.

– Invite cities to use ELENA and EEE-F, existing structural funds and other financing mechanisms to plan SSL large scale deployment.

– From 2012, organise a number of dedicated awareness-raising events addressing European cities[57], in close cooperation with the CIP SSL pilot actions[58] and the Member States and Regions supporting SSL pilot actions addressing outdoor lighting along with all other interested stakeholders.

– Seek new mechanisms that can be used for the implementation of large scale pilots, demonstration and deployment actions involving smart lighting systems in European cities and regions. Such actions are included in the investment priorities of the new Cohesion Policy (2014-2020) and could be the basis to build up a potential European Innovation Partnership on Smart Cities[10].

Creating SSL lead markets for buildings

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55 ELENA (**E**uropean **L**ocal **EN**ergy **A**ssistance) was established by the Commission and the European Investment Bank

56 http://ec.europa.eu/energy/eepr/eeef/eeef_en.htm

57 Potential dissemination channels: The Covenant of Mayors; Eurocities; the GreenLight programme, the LUCI association; etc.

58 A call for SSL pilot actions took place under the CIP-ICT Work Programme 2011, with a budget of up to 10 million euro. As a result of this call, a few pilot actions will be launched in early 2012

Concerning ***public buildings***, policy and legislative instruments exist or will soon enter into force that can also support the deployment of SSL:

– Green Public Procurement can be used by public authorities for supporting the wider deployment of energy-efficient lighting in public buildings[59].

– The proposal of the Commission for a **Directive on Energy efficiency**[60], which is putting into practice key parts of the Energy Efficiency Plan, includes several elements that could foster the uptake of SSL technology and lighting services in public buildings. In particular, it proposes that Public Authorities shall purchase, in general, only products including lighting products, which belong to the highest energy efficiency class, as will soon be the case for LEDs. The uptake of energy efficient lighting technologies in buildings will be also fostered through the obligation for utilities to implement energy saving measures for end-users and the obligation for the public sector to renovate publicly-owned buildings.

– The **Energy Performance of Buildings Directive** (EPBD)[61] requires all new public buildings to become near-zero energy buildings by 2019 and will be extended to all new buildings by 2021. Under the Directive, Member States are responsible for setting minimum requirements for the energy performance of buildings. A regulation is under preparation providing a methodology for calculating cost-optimal levels of minimum energy performance requirements for new and existing buildings (both residential and non residential). The regulation also encourages Member States to calculate and set cost optimal requirements at a *systems level* for lighting systems for existing non-residential buildings or derive these from the calculations done at buildings level.

Concerning ***residential buildings***, there is also a need to put in place financial and other incentives for users to buy and install SSL technologies. Innovative contracting models could also be put in place, where e.g. lighting would be procured as a service from companies which carry the investment for the SSL installation and whose return is based on the energy savings achieved with the new lighting installation[62]. The proposed Directive on Energy Efficiency promotes such energy performance contracting models.

The following actions could accelerate the creation of SSL lead markets in public and residential buildings:

– Public authorities are invited to promote the wide deployment of SSL technologies when they renovate public buildings.

– Member States are invited to provide incentives to individual consumers to replace present lighting systems in their homes by SSL.

Questions:

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59 12% of all existing buildings in Europe are run by public authorities

60 COM(2011) 370 final

61 DIR 2010/31/EU

62 Similar models are already deployed for non-residential buildings and street lighting

(6)	What could be done to overcome the landlord-tenant conflict?
(7)	Which additional measures could help accelerate SSL deployment in buildings?

3. SSL AND THE EUROPEAN LIGHTING INDUSTRY

3.1. The European lighting industry and challenges for its further development

Europe's lighting industry is large and world-class: it employs 150,000 people and has an annual turnover of 20 billion euro. The sector is highly innovative, but highly fragmented along the value chain[4]. Alongside a number of large global players it consists of several thousand SMEs, primarily active in the luminaire sector.

In the area of SSL, Europe is home to two of the four largest global LED manufacturers[4], although actual production takes place only to a limited extent in Europe[63]. Europe is also well positioned in the emerging OLED lighting technology, but is struggling to turn R&D leadership into business success and put on the market innovative products that could be mass-produced in Europe using large-area manufacturing processes.

The wider deployment of SSL will impact *lighting as a business.* For the next 3-5 years, the retrofit business[64] is expected to dominate the SSL market underpinned by the ongoing phase-out of conventional incandescent light bulbs. As LED lamps become dominant, a gradual shift of business will take place from *selling replacement lamps* to *selling luminaires, and in particular to selling* ***intelligent lighting systems and lighting services***. The possibility to *customise lighting characteristics to specific users' requirements* will provide new business opportunities in response to the challenge of an active and healthy ageing population. Due to the high initial investment cost, SSL lighting systems and services will open the way for innovative financing models such as leasing or contracting, starting with large building installations and outdoor applications. Intelligent and communication systems *will gradually transform the industry to lighting system and service providers*.

This shift to intelligent lighting systems and services will have a major impact on the luminaire and services market. Increasingly, major players in the lighting industry are entering the market of lighting services, engendering consolidation of the lighting industry. Furthermore, tailor-made solutions will become a growth opportunity for the lighting industry, benefiting from LED technology's potential particularly when combined with intelligent light management systems for creative lighting design and large cost savings[65].

This change of business models will require enhanced cooperation of European lighting and luminaire manufacturers with many other players along *the extended*

63 Today, less than 10% of LED chip production is located in Europe

64 LED lamps replacing conventional incandescent, fluorescent or halogen lamps

65 "The European Lighting Industry's Considerations Regarding the need for an EU Green Paper on Solid State Lighting", ELC/CELMA 2011, www.celma.org

value chain including: wholesale and retail, urban planners, architects and lighting designers, electrical components/systems manufacturers and installers, facility management and building construction industry, and lighting service companies. Europe is leading the competition in building control systems and lighting services and can capitalise on a large, vibrant and renowned lighting architecture and design community. Vertical integration along the value chain is already taking place and is expected to continue.

The next 3-5 years will be pivotal in establishing leading SSL market players. European industry is in principle in an excellent position to build upon existing strengths so as to capitalise on the emerging SSL technology. However, the European lighting industry is already under significant pressure, as new –mainly Asian– players from the LED backlighting industry for flat panel displays and TVs enter the general LED lighting market. All these factors will significantly transform the global lighting industry for the next decades.

3.2. A European strategic approach for a competitive SSL industry in Europe

It is from this background that a European strategic approach for a competitive SSL industry is required. In particular, the following key issues related to the evolution and competitive development of the European SSL industry need to be addressed.

– ***The "valley of death"***: SSL is part of Photonics, a *Key Enabling Technology* (KET). A High Level Expert Group (HLG)[66] on KETs has identified the major difficulties Europe has in translating its ideas into marketable products[67]. To cross this "valley of death", it recommends a strategy comprising three pillars focusing on: (i) technological research; (ii) product development and demonstration; (iii) world-class, advanced manufacturing. Based on this three-pillar bridge model, the HLG has made a series of specific policy recommendations for more effective industrial development and deployment of KETs in Europe.

– ***Strengthening the SSL value chain*** (from raw materials to manufacturing and final products, including component and equipment suppliers): this is needed to overcome existing fragmentation in the lighting industry. OLEDs will further blur the borders between manufacturers of lighting sources and luminaires and will accelerate the ongoing consolidation in the lighting sector.

– ***Fostering the cooperation between the SSL industry and the other involved players along the extended value chain***. Enhanced cooperation is essential for the development of new business models and for moving from lighting products to lighting systems and services, where Europe has a lot of assets to become world market leader.

– ***The future of SSL manufacturing in Europe***: The European SSL industry will need to take strategic decisions on the future of SSL manufacturing in Europe, regarding both LED and in particular the emerging OLED lighting technology.

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66 http://ec.europa.eu/enterprise/sectors/ict/key_technologies/kets_high_level_group_en.htm

67 http://ec.europa.eu/enterprise/sectors/ict/files/kets/hlg_report_final_en.pdf

– ***Securing the supply of scarce raw materials and recycling of end-of-life SSL products***: In the years to come, European industry will be confronted with the challenge of securing the supply of scarce raw materials[68], which are required for SSL production but of limited availability due to existing quasi-monopolies and export restrictions[69]. This is mirrored by the challenge to improve the technology in order to reduce the input of scarce resources and by the challenge to recycle them, in line with the Raw Materials Flagship Initiative[70] and related roadmap[71].

The further development of the European SSL industry, its innovation capacity and global competitiveness will also critically depend on the following issues:

– ***Standardisation***: A strategic development and use of standardisation and the effective promotion of relevant standards worldwide[72] can help to position European industry as leader in global markets.

– ***IPR and innovation***: Access to intellectual property rights (IPR) is a key issue for SSL competition and innovation, for both industrial heavyweights and SMEs. SSL world players tend to cross-license IPR at favourable conditions. An increased cooperation between large industry and SMEs would help accelerate the development of innovative SSL products in Europe.

– ***Access to low cost routes of investment:*** Innovative SMEs often lack access to low cost routes of investment, which would enable them to grow and leverage their technology know-how. This has significant long term consequences for Europe as many SMEs will not be able to invest rapidly in new SSL technologies which are vital to establish a long term, vibrant supply chain with such a disruptive technology.

– ***Learning and Training***: There is an increased need for the lighting sector to attract and train new scientists and engineers in order to counter the foreseeable skills shortage problem[73]. On the uptake side, luminaire SMEs, electrical installers, resellers, urban lighting designers and planners and more generally public procurers of lighting require dedicated learning and training in SSL in order to understand how to best install or use them.

3.3. Initiatives for strengthening the SSL value chain

A research and innovation perspective

EU research and innovation funding and initiatives in the current programming period (2007-2013)

68 These include in particular Gallium and Indium as well rare earth materials that are used in phosphors (Yttrium, Cerium, Europium)

69 China currently controls 95% of the world's supply of rare earth materials and has taken measures to severely restrict their export

70 COM (2011) 21

71 COM (2011) 571 final

72 See overview report "Joint CELMA/ELC Guide on LED related standards" (2011), www.celma.org

73 See also ELECTRA initiative, COM(2009) 594 final

The seventh Framework Programme[74] (FP7) contributes more than 90 million euro to support research in SSL across the EU. Activities cover research in LEDs and OLEDs and in their manufacturing processes. The NMP Theme supports materials research for more efficient light sources. The ICT Theme supports research aiming at significantly improving the functionality, quality and performance of SSL-based lighting applications. The ENIAC Joint Undertaking[75] funds R&D addressing the development of affordable SSL solutions across the entire value chain. Further R&D opportunities for SSL are provided in the respective work-programmes of these themes for 2011-12.

The Competitiveness and Innovation Framework Programme (CIP)[76] supports i.a. lighting-related innovation activities and provides better access to finance. The CIP Intelligent Energy Europe (IEE)[77] Programme finances several support measures related to SSL for raising consumer awareness, supporting Member States in market surveillance activities or helping them implement intelligent lighting solutions. In 2012, the CIP ICT Policy Support Programme[78] will support several SSL pilot actions with about seven million euro with the aim of demonstrating the latest SSL technologies and to widely disseminate the results in Europe.

Through the Cohesion policy[79], Structural Funds are used by several European regions to enhance their capacity to change and innovate in SSL[80]. Their investment focuses on R&D and innovation activities, pilot manufacturing lines and human capital development e.g. in the emerging OLED area.

The Commission is considering the following actions:

– A mandate to the European Standard Organisations (ESOs) to develop standards[81] together with industry and relevant stakeholders, and in cooperation with international standardisation organisations.

– SSL pilot actions aimed at raising EU-wide awareness in SSL technologies by demonstrating their innovative character in public and commercial spaces. The pilots are planned to be launched in early 2012 and will work in close synergy with similar actions launched by some Member States to maximise their impact.

– Several initiatives of relevance to the KETs (and SSL) industry, whose launch is envisaged during 2011-2013. Examples include: Horizon 2020, the new framework programme for research and innovation (see below), the new cohesion policy for the period 2014-2020 (see below), the revision of state aid

74 http://ec.europa.eu/research/fp7/index_en.cfm
75 http://www.eniac.eu/web/index.php
76 http://ec.europa.eu/cip/
77 http://ec.europa.eu/energy/intelligent/
78 http://ec.europa.eu/information_society/activities/ict_psp
79 http://ec.europa.eu/regional_policy/themes/research/index_en.htm
80 E.g. Baden-Wuerttemberg and Saxony in Germany, Rhône-Alpes in France, Oulu in Finland
81 E.g. addressing existing safety and interfacing gaps, methodologies for measuring the performance and lifetime of SSL products and systems, the communication of stand-alone SSL products and systems with each other and with other energy systems

rules, the establishment of new financial instruments for supporting KETs, or the set-up of a scheme for monitoring progress in implementing KETs.

– In the last two years of FP7, the NMP and ICT themes will continue to fund R&D on new lighting sources and systems and on novel materials for the replacement of critical raw materials such as phosphors[82] or on full three-colour white LEDs. Particular emphasis will also be paid to standardisation and research of end-of-life, disposal and recyclability issues of organic lighting.

– In the last year of the FP7 ICT Theme, a dedicated action for SMEs could be introduced aiming at supporting innovation activities for SMEs (including lighting SMEs) and at facilitating their access to new knowledge and manufacturing capabilities.

– With Horizon 2020 a step change for Europe's research and innovation performance in photonics in general and in SSL in particular is proposed. Under Horizon 2020, the Commission shall consider supporting the creation of a Public Private Partnership (PPP) in Photonics. Such a PPP will put a clear emphasis on addressing the full research and innovation chain from materials to pilot actions. The Commission invites the SSL stakeholders to participate in the elaboration of the PPP's main focus and strategic objectives, its governance structure and role and responsibilities of the participating parties and, the industrial commitment and the monitoring of its impact through relevant indicators.

– In the investment priorities of the new Cohesion policy (2014-2020), the Commission has proposed to introduce KETs (including SSL) as part of regional smart specialisation strategies[83]. This will include mechanisms that can be used by the European regions for supporting KETs-related technological and applied research, pilot lines, early product validation and large scale demonstration actions, and advanced manufacturing capabilities.

Questions:

(8)	What measures, beyond the ones above, could further support research and innovation and the reinforcement of the SSL value chain in Europe?

The lighting industry's perspective

In order to overcome the challenges and shortcomings mentioned above, in particular the move to a whole value chain approach, the European SSL industry will also need to take action. In particular, industry is invited to:

– launch its own industrial initiatives that extend the present scope and existing business alliances; in particular, it should strive to create win-win cooperation platforms both along the conventional lighting value chain (including closer

[82] In line with COM(2008) 699 and COM(2011)25, http://ec.europa.eu/enterprise/policies/raw-materials/index_en.htm

[83] COM(2011) 614 and COM(2011) 615 final

cooperation between large lighting companies and SMEs) and along the extended value chain

– match public support to a Photonics PPP under "Horizon 2020" with a commitment to invest in Europe, including investing in SSL manufacturing

– work with consumers to develop new functionalities for lighting applications which would encourage faster uptake and influence peoples' well-being

– work with the European Standardisation Organisations to address the open issues related to SSL standardisation, including on safety issues, environmental aspects and procedures and common methodologies for measuring the performance of SSL products and systems

– further engage in assessing the full life cycle impact of SSL products

– use all existing mechanisms for launching vocational and lifelong learning and training of electrical installers and resellers and of other professional and public users, as well as to work towards amending university curricula in lighting technologies.

Questions:

(9) Which other actions could be taken by industry to reinforce sustainable SSL manufacturing capacity in Europe?

(10) Which additional actions can reinforce cooperation along the value chain, in particular with architects and lighting designers, electrical installers and with the construction and building industry? What should be the role of the Member States and the EU in making it happen?

(11) Are there gaps in standardisation today which hamper SSL innovation and deployment? If yes, where are such gaps and how can they be addressed?

(12) Which actions should Member States and industry take to support education, vocational and lifelong learning and training on SSL and to address the adaptation of educational curricula to include the latest lighting technologies?

Working further together to deliver the EU's approach to SSL

– A closer coordination of the efforts in the field between the Commission and representatives from the SSL lighting industry and the extended SSL value chain would be advantageous. The Commission therefore invites the representative SSL stakeholders to closely interact with the Commission in order to periodically review progress achieved, and propose launching new actions for achieving the ambitious objectives set out in this Green Paper.

4. PUBLIC DEBATE AND FURTHER STEPS

The Commission believes that the initiatives, issues and questions raised above are the key aspects to be considered in view of the policy target of accelerating the deployment of high-quality SSL.

Member States, the Parliament, and other countries are invited to promote the debate with their stakeholders. To support the debate on these questions, a variety of social media will be used, including a public consultation website: http://ec.europa.eu/information_society/digital-agenda/actions/ssl-consultation/index_en.htm

The Commission invites all interested parties to submit their contributions by **29 February 2012**. Contributions do not need to cover all of the questions raised in this Green Paper. They can be limited to questions of particular interest to you. Please indicate clearly the questions to which your contribution relates.

Received contributions, together with the identity of the contributor, will be published on the Internet unless a contributor requests otherwise. It is important to read the specific privacy statement attached to this Green Paper or information on how your personal data and contribution will be dealt with.

The results of the public consultation will be published on the Internet. They will feed into the reflection on the necessity for the Commission to take new measures in the future.