EUROPEAN COMMISSION

Directorate-General for Communications Networks, Content and Technology

# Lighting the Cities

## Accelerating the Deployment of Innovative Lighting in European Cities

# APPENDIX

*June 2013*

### About this document

This document presents a number of Annexes which provide complementary information to the contents of the Report on "Lighting the Cities: Accelerating the Deployment of Innovative Lighting in European Cities".

The Annexes have been prepared by a number of dedicated working groups comprising several Members of the EU Cities Task Force.

### Disclaimer

The information presented in this document is the sole responsibility of the authors and in no way represents the views of the European Commission and its services.

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# Contents

# ANNEX 1

## Building the Business Case for the wide Deployment of SSL in European cities

### *Introduction*

This Annex focuses on the following subjects:

- The deployment of outdoor and indoor lighting applications in European cities
- The concept of total cost of ownership (TCO)
- Calculations for different business cases
- Collecting & disseminating best practices

Before taking a look at the actual business cases it is necessary to embed the annex into a more holistic and general view. Business cases related to SSL can only be validly made if we understand exactly the factors that impact, foster or impede the deployment of SSL.

### *What Drives the Switch to Solid State Lighting?*

Recent years have shown an unprecedented disruption in the lighting world in Europe. SSL is gaining increasingly ground in a large variety of applications. Therefore, it is valuable to assess the driving factors that have so far shaped the uptake of SSL and to analyse in how far these factors can be reinforced to sustain future further acceptance and further market penetration of the technology.

First, we need to analyse socio-economic trends and facts that may directly impact on the take up of this new technology. We also have to distinguish such trends from actual facts, as trends may be used and influenced in order to accelerate the switch to SSL. As for the facts, these have to be analysed for their potential to become driving factor for the take up of SSL.

The following facts are identified as having the potential to become a driving factor:

- Population growth and the need for secure energy supply
- Urbanisation and the need to make cities more sustainable
- Demographic change and the need to supply adequate lighting to an ageing population

All these factors merit closer consideration.

The global population will increase to about 10 billion people by the middle of the 21st century[1]. Such growth of population will fundamentally challenge the security of energy supplies especially given that, for the foreseeable future, renewables might not yet become a feasible alternative to meet the energy demand from a growing global population. This brings energy efficiency in general to the core of each strategy to meet the energy challenge of the 21st century. From a lighting perspective, the need to bring energy efficient solutions to a growing population requires the accelerated switch to SSL as an integral part of any respective strategy on global, regional, national and municipal level.

Increased urbanization is a consequence resulting from such population growth. However, urbanization does not have an immediate impact on the need for energy efficient lighting solutions, as this need counts in the same way for rural areas. Urbanization and the need to make cities more

[1] Cf. http://www.un.org/esa/population for information on population development (25 September 2012).

sustainable, especially in those parts of the world, where this will have the most profound consequences (Asia, Africa and Latin America), adds a further dimension beyond the energy efficiency potential of SSL. Sustainable cities are cities that are safe, uncongested, clean and energy efficient. A switch to SSL can contribute to achieve a number of these. First, besides the energy efficiency, the high lifetime of SSL installations helps prevent the creation of waste. Second, urban horticulture may be developed in cities to help grow a significant amount of crops within the city limits. SSL can support such horticulture by providing the adequate light for the growing of plants. Third, only a well-lit city is a safe and liveable city. The design creativity that SSL gives is a direct contribution to making cities safe and lively. SSL is the only technology that can deliver all this without adding to the energy bill.

Whereas many regions will be characterized by population growth, others will face challenges from the demographic change towards an ageing population. Older people need adequate light to be able to remain in their surroundings. Research on the impact of light to the circadian rhythm is at the beginning and needs to be intensified to provide to an ageing population the schools, workplaces, home lighting solutions, hospitals and nursing homes they need and deserve. SSL is the technology that can meet these challenges.

Beside these facts, the following two trends may also accelerate the SSL uptake:

1. On the consumer side, the trend towards using sustainable and “green” products: there is an avant-garde especially of domestic users who switch already today to SSL despite a still high price entrance barrier. The expected decrease of prices especially for LED lamps will further accelerate this trend.
2. On the professional side, the trend towards more individualization and design. Especially in shop and hospitality applications, sophisticated lighting design gains ground as a pattern to emphasize uniqueness and style. The unprecedented design possibilities of SSL are a natural reply to meet these demands of artistic expression, especially as SSL is the only technology that can be used as an artistic feature already in the architectural planning of the built environment.

All the above are driving factors that have the potential to shape the uptake of SSL from various angles. Preconditions for success, however, are to have quality products, systems and solutions in the market that meet consumers’ demands, the establishment of a level playing field in Europe and globally and the raising of quality awareness.

## Building the Business Case

### The Deployment of Outdoor and Indoor Lighting Applications

When taking a general look at deployment of SSL applications in outdoor and indoor lighting, it is noticeable that the expected SSL penetration rates vary significantly depending on the applications. Whereas in outdoor applications a high growth rate is to be expected during the next decade[2], any prediction concerning growth rates for indoor applications will require a differentiated approach for each application. Whereas those applications that have a high design component or where lighting is part of a sales strategy (e.g. hotel or shop lighting) already today show a significant penetration rate, other applications stay behind. The proliferation of cost-competitive linear-fluorescent lamps in office and industrial lighting will mean that penetration of LEDs will be slower in these applications environments.

[2] http://ledsmagazine.com/features/8/9/13 (12 June 2012)

These observations may be translated into the following two challenges:

- How can the deployment of SSL in outdoor applications and installations be accelerated?
- How can SSL be made a feasible and cost saving alternative for indoor applications and installations?

Both questions should be addressed from a point of view of relevance for cities and municipalities. However, such relevance should not exclusively be judged related to cost savings for public budgets. If the definition is used that "business case captures the reasoning for initiating a project or task[3], it appears to be necessary to develop business cases that go beyond a mere cost-benefit analysis and will accommodate non-economic benefits such as improved safety and well-being of citizens.

As for the need to prioritize applications to switch to SSL, the concept of building on existing strengths may be applicable and be pursued in order to achieve tangible results within a reasonable timeframe. Given this, initiating projects in outdoor applications is likely to meet lower barriers for implementation than indoor applications.

## *The Concept of Total Cost of Ownership*

**Total cost of ownership** (TCO) is essentially the total cost to the owner of buying, installing, maintaining and operating a lighting system over the total useful life of the product. LED based lighting systems can offer a significant reduction in TCO compared to traditional technologies by offering a reduced "cost of light". This is primarily driven by the decreased cost of energy consumed by LED lighting, along with decreased maintenance expenses through useful life. Maintenance expenses include both the cost of lamps and the labour required to replace them. In addition, decreased heat generation means less heat load and lower air conditioning costs.

**Payback** is essentially how long it would take to recoup the incremental investment made for higher-cost, energy-efficient technology solutions. Payback is typically calculated in years, and is determined by estimating the incremental project costs and dividing by annualized savings due to decreased energy consumption and reduced maintenance.

**Return on investment** (ROI) measures investment performance. Essentially, ROI is a measurement of the increased profit (or decreased expense) realized by an investment, divided by the incremental cost of making that investment. In the case of an energy efficiency project, ROI would be annualized energy and maintenance savings, divided by the incremental project investment.

These definitions of terminology need to be translated into making them digestible in concrete applications. Such translation is the indispensable step in order to make the TCO concept attractive and understandable for decision makers that actually take purchasing decisions.

Today in a municipality, the guiding principle for taking a decision on renovation of lighting installations is still to go for the cheapest purchasing price of the product or the installation. Moreover, purchasing decisions are taken in the context of annual budgets and therefore, the long term benefit usually has not been part of the municipalities' purchasing model.

This constraint appears to lose its importance in the context of price decreases for LED based products and installations and the increased penetration of models of service contracts (cf. Annex 3). The main obstacle in bringing the benefits of TCO concepts to decision makers is their focus on

[3] http://en.wikipedia.org/wiki/Business_case

purchasing costs. A SWOT analysis of switching outdoor applications and installations to SSL leads to the following results:

| Strengths | Weaknesses |
|---|---|
| 1. Reference projects, benchmark cases and best practices are available<br>2. Energy savings are proven, comparable framework conditions in cities[4]<br>3. Cost-benefit analysis can easily be effected and actual budgetary savings calculated | 1. Purchasing costs of installations |
| **Opportunities** | **Threats** |
| 1. Clear net benefits for municipal budgets<br>2. Benefits can go much beyond energy savings | 1. Identify street lighting as a single source for energy efficiency in lighting<br>2. Limit business case to energy savings<br>3. Political decisions not to take into account total-cost-of-ownership, but to focus on up-front costs<br>4. Compromise on quality of product and systems in order to keep costs low |

It appears possible to address the identified weaknesses and threats to TCO concepts predominantly by improved communication to the right target groups. Moreover, the TCO concept must be developed to become an integral and directly applicable part of purchasing decisions, so that long term benefits are calculated against initial front-up costs.

TCO calculations should be made easily, correctly, transparently and in an unbiased way. Web-based calculation tools that allow for a neutral comparability of total costs of different installations compared to up-front investments need to be promoted and made available widely. One point of reference could be the "Rekenhulp" model hosted by the Dutch national *Rijkswaterstraat* Agency for the Environment[5] (see Annex 4). This calculation tool is based on the inclusion of the following:

- How to make a calculation, which parameters are relevant
- Calculation is tailor-made for each product in order to ensure comparability
- Basic calculation as starting point: energy efficiency cost-benefit analysis, ROI
- Savings are expressed in a clear percentage of energy and money saved

Analysis of the value of the switch to SSL should not be limited to a mere cost-benefit analysis by relating (higher) purchasing costs to (significant) savings on energy. Despite the fact that a positive result of such a calculation remains rightfully at the core of each decision to switch to SSL applications and installations it does not cover all dimensions of benefits. There are benefits from SSL installations that cannot be calculated even in a well-established TCO model, as they go beyond

4 In classes above M4 it is not yet the case in comparison to gas discharge lamps.

5 http://www.rwsleefomgeving.nl/onderwerpen/ovl/publicaties/ovldownloads/rekenhulp-energie

economic benefits: Freedom of design, techno-aesthetics, safety and wellbeing of citizens are arguments that also need to be taken into account when taking purchasing decisions.

A more complicated picture has to be drawn when addressing the switch to SSL in indoor applications. This exercise will focus exclusively on applications and installations in publicly owned buildings, e.g. administration offices, schools, hospitals, etc. The main challenge in such installations consists in replacing fluorescent applications and installations, which are already highly energy efficient. Moreover, business cases on indoor applications are not as frequent as for outdoor applications, which can negatively impact on the readiness of a municipality to switch to SSL applications and installations also for their indoor lighting. This is underlined by the fact that in order to exploit the full potential of indoor efficient lighting, the whole system would need to be made “intelligent”, which can result in a more complex decision than replacing outdoor installations.

In order to remedy this, a checklist could help municipalities evaluate their indoor lighting installations and enable them to make an informed and holistic choice if switching installations to SSL is a feasible and value adding option. Such checklist needs to contain the following minimum content:

- Identification tool for installations to be switched to SSL
- Overview of best available technology at system level
- Tool to calculate energy savings
- Tool to calculate total cost of ownership

Such a checklist is also recommended for outdoor applications and installations.

### *Calculations for Different Business Cases*

**Making the Business Case**[6]

In order to successfully sell energy-efficient products, specifiers and designers must learn how to make the business case to justify upgrading to these products. At the bare minimum, they must be able to speak the language of lighting economics. The basic metrics are total cost of ownership, payback and return on investment as defined under 2) above and illustrated in the following cost comparison example for an under-cabinet installation.

[6] LED Lighting Explained, Understanding LED Sources, Fixtures, Applications, and Opportunities, PHILIPS Solid State Lighting Solutions Inc, 2010, ISBN 978-0-615-36061-4

| Cost Comparison for a 10-Foot Under-Cabinet Installation | | | |
|---|---|---|---|
| **Installation** | **eW Profile Powercore**[7] | **Halogen**[8] | **Xenon**[9] |
| Number of fixtures | 6 | 7 | 6 |
| Fixture Costs ($) | 780 | 394 | 510 |
| Number of lamps | 0 | 21 | 18 |
| Lamp Cost ($) | 0 | 84 | 126 |
| Control Cost ($) | 20 | 20 | 20 |
| Installation ($47/hr)[10] | 42 | 263 | 226 |
| TOTAL INSTALLATION COST ($) | 842 | 761 | 882 |
| **Maintenance** | | | |
| Relamps per 50.000 hours | 0 | 25 | 5 |
| Lamp Cost per Change ($) | 0 | 2.100 | 630 |
| Relamp Charge[11] ($) | 0 | 419 | 72 |
| TOTAL MAINTENANCE COST ($) | 0 | 2.519 | 702 |
| **Power** | | | |
| Power Consumed per 10 ft (W) | 60 | 500 | 330 |
| TOTAL POWER COST ($)[12] | 330 | 2.750 | 1.815 |
| **TOTAL COST OF OWNERSHIP** ($) | 1.172 | 6.030 | 3.399 |
| Cost Savings [%] | | 81% | 66% |
| Installation Premium ($) | | 81 | -39 |
| Annual Operating Cost ($)[13] | 19 | 308 | 147 |
| Annual Savings ($) | | 288 | 128 |
| Simple Payback | | 0,28 | -0,31 |
| ROI | | 355% | -325% |

7 Philips eW Profile Powercore 523-000027-01 LED fixture

8 WAC BA-LIV-3 fixture, 25W halogen lamps

9 Juno UPX322 fixture, 20W Xenon lamps

10 Estimated 9 minutes per foot for LED, 0,8 hours per fixture for incandescent

11 One minute per lamp, $47 / hr labour rate

12 $0,11 / kWh, www.eia.doe.gov

13 Based on 8 hours per day usage, 365 days per year

**Basic Lighting Economics Example**

$$\text{Simple Payback} = \frac{\text{Incremental Investment}}{\text{Annual Savings}} = \frac{\text{LED Installation - Halogen Installation}}{\text{Annual Maintenance Savings + Annual Energy Savings}}$$

$$= \frac{\$842 - \$761}{\left(\frac{\$2.519-\$0}{50.000} + \frac{\$2.750 - \$330}{50.000}\right)(12 \text{ hours x } 365 \text{ days})} = 0{,}67 \text{ year}$$

$$\text{Simple ROI} = \frac{\text{Annual Savings}}{\text{Incremental Investment}} = \frac{1}{\text{Simple Payback}} = 150\%$$

To truly sell the value of energy-efficient lighting, you must look beyond the basic economics of lighting. Green and energy efficiency upgrades provide customers with marketing and PR opportunities in addition to reduced TCO and favourable ROI. LEED and ENERGY STAR, for example, afford strong market attraction in North America. Recent studies show a direct link between improvements in lighting quality and improvements in employee productivity, performance and health. A Carnegie Mellon research study demonstrated a median increase in productivity of 3.2% as the result of lighting improvements. The study estimates that a 1% increase in productivity is equivalent to a 100% reduction in energy costs[14].

Another factor to consider is employee recruitment and retention value. A monster.com survey result found that 92% of respondents desire "sustainability" in a potential employer[15]. 80% desire an employer that is making a positive impact on the environment[16].

In addition to employee productivity and marketing opportunities, studies have found an increase in building value. A CoStar market study[17] found that on average building values increased 10 to 15 times the annual energy savings resulting from energy efficiency upgrades. For example, a $100.000 annual savings on a $300.000 energy efficiency investment would result in a three-year payback. However, it would also result in a $1.0 to $1.5 million increase in building value. That is essentially a 333% to 500% immediate return on investment.

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[14] Yudelson, Jerry and Galayda, Jaimie. *Green Goes Mainstream: How to Profit from Green Market Opportunities.* National Association of Electrical Dealers 2008 Whitepaper. NAED Education & Research Foundation Inc, 2009.

[15] Strandberg Consulting, *The Business Case for Sustainability.* December 2009, p.6.

[16] Mattioli, Dana. "How Going Green Draws Talent, Cut Costs." The Wall-Street Journal Digital Network website, http://online.wsj.com/article/SB119492843191791132.html

[17] Burr, Andrew C. *CoStar Study Finds Energy Star, LEED Bldgs. Outperform Peers.* CoStar Reality Information Inc. press release, March 26, 2008.

**Standardised Economic Calculation for Public Lighting**

A more accurate method is described in the technical report CIE 115 Annex A: economic calculations which is based on the Net Present Value (NPV). It gives insight into whether a certain investment is profitable.

Evaluation of many large road construction projects is based on the ***life cycle costs method*** (LCC). This method is also useful for road lighting installations. Life cycle consists of consecutive and interlinked stages of a product system, from raw material acquisition or generation of natural resources to the final disposal. Life cycle costs include construction, maintenance, energy, demolition, recycling and final disposal costs. It is important to include the whole life cycle costs in the calculation. Considerable costs during operation result from energy consumption and maintenance. Greater initial investment may result in lower energy and maintenance costs and lead to lower life cycle costs. For example long lasting good quality lighting equipment is usually more expensive but the maintenance costs are smaller. Thus life cycle costs will decrease compared to the poor quality lighting equipment. All necessary costs can be calculated from the following formulae:

Construction costs

$$K_r = \frac{m \cdot H_p + n \cdot H_v + S \cdot H_{sv}}{S}$$

| | |
|---|---|
| $K_r$ | construction costs |
| m | number of columns on the cross-section ( e.g. 2 for opposite array, 1 for centre median array) |
| $H_p$ | cost of the column and the foundation (€/piece) |
| n | number of luminaires on the cross-section |
| $H_v$ | cost of the luminaire and the first lamp/lamps (€/piece) |
| S | spacing of the columns (m) |
| $H_{sv}$ | cost of the power supply mains (€/road metre) |

Operating costs

$$K_{kk} = \frac{t_1 \cdot n \cdot P_i \cdot H_e + \dfrac{n \cdot H_l}{t_2} + q \cdot n \cdot H_{ly} + m \cdot C}{S}$$

| | |
|---|---|
| $K_{kk}$ | operating costs of the first year |
| $t_1$ | annual burning time (h) |
| $t_2$ | life time of the lamp (a) |
| n | number of luminaires on the cross-section |
| $P_i$ | power of the luminaire (kW) |
| $H_e$ | cost of the energy (€/kWh) |
| $H_l$ | cost of the group replacement of the lamps (€/piece) |
| $H_{ly}$ | cost of the individual replacement of the lamp (€/piece) |
| q | relative number of individual replacement of lamps per year |
| m | number of columns on the cross-section |
| C | fixed costs (€/column) |
| S | spacing of the columns (m) |

Life cycle costs

*Present value method*

$$E_k = K_r + \frac{1-(1+p)^{-t}}{p} \cdot K_{kk} + \frac{1}{(1+p)^t} \cdot J$$

| | |
|---|---|
| $E_k$ | present value of life cycle costs |
| $K_r$ | construction costs |
| p | interest |
| t | length of the examination period (years) |
| $K_{kk}$ | operating costs of the first year |
| J | residual value |

*Method of average annual costs*

$K_v^{(t/2)} = \alpha_t \cdot K_r + \beta_t \cdot K_{kk}$

| | |
|---|---|
| $K_v$ | average annual costs (€/m/annum) |
| $\alpha_t$ | capital recovery factor |
| $\beta_t$ | growth factor of operating and maintenance costs |
| $K_r$ | construction costs |
| $K_{kk}$ | operating costs of the first year |

### *Collection & Dissemination of Best Practices*

A pilot project of switching to SSL road lighting is the stretch of A 44 between Burgerveen and Kaagbrug in The Netherlands. Intelligent dimming technology can adapt the light output from 100% during rush hours to 20% during low peak times. This results in energy savings of 180.000 kWh. Further to that, the flexible dimming system contributes significantly to road safety. The system can immediately adapt the light intensity in case of rain or when accidents happen on the equipped stretch. This example makes it very clear that when establishing business cases to prepare a decision to switch to SSL lighting in road applications, the energy dimension is of significant importance but should not be the deliberation exclusively guiding the process.

As for the energy dimension a number of case studies that are capable to be used as business cases are available for illustrative calculations, benchmarks and best practices, among others:

- Public lighting reconstruction in Hódmezővásárhely involving more than 6000 LED street lighting luminaires[18]
- Tilburg Project – Lighting on Demand[19]
- LEDsGO Tilburg[20]

Cities needs to engage themselves to develop appropriate communication channels in order to enable spatial planners as well as regional and municipal administration to make better use of this tool, which is likely to result in enhanced possibilities to calculate the financial benefits arising from the switch to SSL.

In this context also an interesting reference is a report of The Climate Group[21] published in 2012. The report explores the global market status and potential for LED technology and provides guidelines for policymakers and city light managers who want to scale-up and finance large LED retrofits. The report was launched as part of the Clean Revolution campaign at the Rio+20 UN Global Compact Corporate Sustainability Forum. Its main findings related to financial implications arising from the switch to SSL are the following:

- The lifespan of LED lighting trialled ranges from 50,000 to 100,000 hours indicating a high return on investment.
- LED lighting was found to be a durable technology with the need for minimal repairs; the failure rate of LED products over 6,000 hours is around 1%, compared, for example, to around 10% for conventional lighting over a similar time period.
- The LED market is at a tipping point, with white light LEDs (used in outdoor lighting) at the early stage of the technology curve. Market penetration is accelerating as the market is expected to expand by 60% by 2020. A recent ILO report[22] concluded that the green

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18 http://www.schreder.com/en-aes/News/Pages/Hodmezovasarhely-leading-example-reducing-energy-costs-CO2-emissions.aspx, http://esholding.hu/pdf/EOS_public_lighting.pdf

19 http://www.tilburg.nl/bpmapp-upload/download/fstore/9107105412011d1c_86c347_12eb2ef86c6_-4074/philips-casestudy-lumimotion.pdf

20 http://www.tilburg.nl/stad/ep/channelView.do?channelId=-14881&displayPage=%2Fep%2Fchannel%2Ftl_channel_related_content.jsp&relCntPage=%2Fep%2Fcontent%2Ftl_ed_ar_content.jsp&programId=17388&contentId=32597&contentTypeId=1001&pageTypeId=8540

21 *Lighting the Clean Revolution*, June 2012, http://thecleanrevolution.org/_assets/files/LED_report_web1.pdf

22 *Working towards sustainable development: Opportunities for decent work and social inclusion in a green economy*, International Labor Organization, May 2012.

economy could yield up to 60 million jobs.

When embarking on an exercise of benchmarking and dissemination the following currently visible issues of concern need to be addressed:

- How to move into “another type of thinking” towards this disruptive technology
- Municipalities and end users to be at the front of realizing their vision
- Social construction, hotspots in hospitals and schools
- Concentration on hotspots in cities, reference objects
- “Illuminating project”
- Include future aspects of control systems, how can they develop (e.g. smart sensors)
- Business case: environment, safety, limitation of maintenance – all part of TCO
- Municipalities to shape their expectation, energy – design – price etc.
- Concentration on benchmarking, not necessarily developing business cases
- Add one page on general impact by switch to LED, highlight different dimensions.

# ANNEX 2

## Procurement Specifications, Innovation and Procurer Skills

### *Introduction*

European Cities can become frontrunners and create an intelligent, competent and efficient demand side for Solid State Lighting (SSL) technologies. Today the demand side for SSL concepts and products is still weak, that is why there is a clear outspoken need for a fast dress-up of the demand side in Cities with regards to: sufficient knowledge; procurer skills; procurement procedures and requirements; consumer comfort about reliable testing results; and, proper standards and best practise examples for outdoor lighting concepts and designs.

This Annex provides concrete guidelines for municipalities on the following subjects:

- Technical specifications to include in public procurement of outdoor LED lighting applications
- Testing facilities of SSL products
- Selection criteria, Award Criteria and Exclusion Criteria that can be included in a public tender to promote innovative LED based lighting solutions
- Training the procurers
- Sharing good practice and practical applicable knowledge among decision makers and practitioners

### *Procurement and Specifications*

The actual ownership and thereby responsibility for installation and maintenance of outdoor lighting equipment varies a lot. It ranges from private land plot associations responsible for local private roads and paths, municipalities responsible for public roads, paths and outdoor spaces, and regions, state or private investors who may own and operate public main roads and motorways. In many cases ownership and maintenance of outdoor lighting installations are outsourced to private companies based on a service contract typical with local power distribution networks, or private contractors. In some larger cities, the municipalities may have in house lighting service department.

According to national spatial planning and road legislation, the planning and approval of outdoor lighting installations are normally under the responsibility of the park and road authorities within the municipalities. General requirements for outdoor lighting concepts can be defined and demanded by the municipalities and laid down in various planning documents.

Experience so far shows that the procurement for LED lighting is found quite difficult by most procurers. LED is a new technology with different characteristics than traditional lighting. From the procurer's point of view it is not clear what specifications to ask for. From the market point of view, research shows a great spread in product quality and reliability of provided information. The number of good quality products is definitely rising, but still there are many low-quality products which often result in bad case stories which harm the good reputation of the technology. **The combination of a lack of knowledge combined with the current market situation puts the procurers on hold and prevents market penetration of good products.** By setting up good procurement specifications, the procurers' confidence in LEDs will grow, good products will get a fair chance and bad products will be banned because they do not meet the requirements.

After research and several test sites in Europe, it was concluded that for a higher acceptance and improvement of SSL luminaires, minimum performance requirements in specifications of public tender documents need to be defined.

Such performance requirements should be laid down through the standards of the lighting equipment already in place, developed by CEN and CENELEC or if not available by IEC and CIE. However the product standard needs some extra feasible constraints to ensure the procurers' comfort.

Correct product information:

- Technical parameters such as light output, light distribution and efficiency should be measured under ISO17025 accreditation following the appropriate standards.

Ask for luminary quality aspects such as:

- Certain inspections by an independent institution (ENEC, VDE, KEMA, CEBEC etc.)
- The materials used should be adapted to the conditions (weather, vandalism etc.) of the environment of the application (corrosion protection, strength, water tightness etc.)
- Adapted construction of the luminaire to avoid thermal problems in time (dirt etc.)
- The components in the luminaire may not shift or deform due to normal expected vibrations
- Shift of colour of the light source has to be between certain tolerances in time
- The depreciation of the light source has to be between certain tolerances in time
- The failure rate should have a maximum value
- A minimum lifetime should be demanded based on correct ageing tests
- A warranty plan regarding lifetime should be included.

### *Light Source Requirements*

- *Shift of colour of the light source has to be between certain tolerances in time*

  The initial (0h) chromaticity co-ordinates of the luminary are measured respecting an ambient temperature of 25$^{o}$C +/- 1$^{o}$C for the test set-up. The chromaticity co-ordinates should be within the CIE diagram (u’v’) with a maximum allowed deviation between measured value and the value supplied by the luminary manufacturer of 0,005.

  The chromaticity co-ordinates of the luminary after 25% of specified maximum lifetime, with a maximum of 6000h, should be within the CIE diagram (u’v’) with a maximum allowed deviation between measured value and the value supplied by the luminary manufacturer of 0,010.

  The initial Correlated Colour Temperature (CCT) is measured respecting an ambient temperature of 25$^{o}$C +/- 1$^{o}$C for the test set-up. The maximum allowed deviation between measured value and the value supplied by the luminary manufacturer is 10%.

  The Correlated Colour Temperature (CCT) after 25% of specified maximum lifetime, with a maximum of 6000h, has maximum allowed deviation between measured value and the value supplied by the luminary manufacturer of 10%.

The initial Colour Rendering Index (CRI) is measured respecting an ambient temperature of 25°C +/- 1°C for the test set-up. The maximum allowed deviation between measured value and the value supplied by the luminary manufacturer is 5 points.

The Colour Rendering Index (CRI) after 25% of specified maximum lifetime, with a maximum of 6000h, has maximum allowed deviation between measured value and the value supplied by the luminary manufacturer of 5 points.

- *The depreciation of the light source has to be between certain tolerances in time*

  Lamp Lumen Maintenance Factor (LLMF) / Life (Lx)

  The luminous flux of the luminary after 25% of specified maximum lifetime, with a maximum of 6000h, should be at least 90% of the initial luminous flux (Lumen Maintenance code 9 of IEC/PAS 62717 and 62722 2-1).

  The luminous flux of the luminary after 60.000 operating hours should be at least 70% of the initial luminous flux ($L_{70}$ value at 60.000h)

  All values should be measured at an ambient temperature of 25°C +/- 1°C for the test set-up.

- *The failure rate should have a maximum value*

  Lamp Survival Factor (LSF) / Failure fraction (Fy)

  After 60.000 operating hours a maximum of 10% defects is allowed. (F10 value at 60.000h)

### *Energy-Efficiency Requirements*

- Energy and optical parameters should be based on the correct testing methods.

  The initial luminous flux (lm) and the system efficiency (lm/W) should be measured in a laboratory under ISO17025 accreditation respecting an ambient temperature of 25°C +/- 1°C for the test set-up.
- The optical components have to be protected to avoid depreciation due to dirt deposit
- Possibility to adjust light output (dimming etc.)
- Use of the future EN 13201-5 to declare the energy efficiency for a certain application (former SLEEC)
- Luminaires shall have an optical system that has an ingress protection rating as follows (EU GPP Criteria for Street Lighting & Traffic Signals):
  - IP65 for road classes ME1 to ME6 and MEW1 to MEW6
  - IP54 for road classes CE0 to CE5, S1 to S6, ES, EV and A

### *Safety Requirements*

- The standards for photo biological safety have to be respected even for the passer-by or for the people in charge of the maintenance.
- The measured value of the light source should not exceed the limits as imposed for Risk group RG1 according to standard EN 62471

***Maintenance Requirements***

- The LED light source and driver must be clearly identifiable so as to guarantee any replacement
- Correct positioning of the light source in the optical compartment must be guaranteed in all cases
- A replacement or upgrade of the light source and driver can be effected easily

## *SSL Testing Facilities*

When testing SSL equipment, tests should be scientific based and performed under specific conditions following the applicable standards. All test facilities should conduct tests under the same conditions so that test results are interchangeable between laboratories.

**The major part of these issues can be covered by demanding that tests should be carried out by ISO 17025 Lighting laboratories**. By doing so, quality is guaranteed and we make use of the existing network of accreditation laboratories. These laboratories already exist in almost each European country. The European Cooperation for Accreditation is the right body to watch over the accreditation.

Nevertheless the following recommendations apply:

- A database or list of accredited laboratories should be set up to make access to such a facility easy. Existing databases are incomplete and hard to access.
- For each laboratory it should be clearly mentioned which tests can be performed under accreditation.
- There should be a list of applicable standards for each test.
- Laboratories should be encouraged to cooperate, improve existing methods and develop new testing methods (for example on aging of an SSL product).

## *Urban Lighting Testing Facilities*

National or regional public controlled or owned testing and standardisation laboratory facilities and organisations focus on the technologies, the single physical products and their performance.

A very limited number of private European companies have established larger scale testing and demonstration facilities, enabling the testing of lighting designs in an urban environment at natural scale. The OLAC laboratory of Philips in Lyon is the most prominent of such facilities.

This leaves the municipalities and companies (SME's) with a gap of the option to test innovative lighting design *solutions* for the urban space in neutral, publicly accessible testing facilities. The facilities should ideally be in scale 1:1 and also contain virtual testing facilities, allowing municipalities to bring in decision makers, politicians & citizens groups as well as SME's not having their own facility at disposal.

In order to ensure sufficient testing facilities, it is necessary to:

- Provide independent test facilities related to scientific institutions
- Provide internationally recognized standardization on measuring, testing and certification of SSL-technology

- Open up for demand side (municipalities) in order to provide better solutions and at the same time promote innovation and product development among SME's.

A chain of European testing facilities needs to be established. This should be done in coordination with national and/or regional scientifically based laboratories, adding the offering of user- and demand side oriented facilities, enabling municipalities (as well as other public operated facilities, e.g. healthcare and hospitals) to test new LED solutions based on best accessible technologies. The initiative should secure that common standards of measurements and testing are adopted throughout the European Union, a systematic documentation practice and the sharing of tests results as well as the follow up on good practice projects in networks.

The targeted impact of a network of New Lighting testing facilities would be:

- Faster uptake of new energy efficient LED technologies in public sectors
- Better quality in public lighting for the benefit of the citizens
- Increased knowledge based and user oriented innovation in the European SMEs.
- The creation of new work places in the European Union

## *Procurement and Innovation*

Due to lack of knowledge and experience in SSL, most architects and technical consultants are not very advanced specialists in modern lighting concepts and design possibilities. That is why they often propose to clients that tenders should be based on simple functionality leaving it all up to the contractors or suppliers to do the detailed design and technical specification of their deliveries. The result is often that the economic offer for the client is evaluated only based on the contracting sum without proper accounting of other relevant aspects such as quality and environmental aspects.

SSL technologies have a great potential for further development and possibilities for add-on solutions and products such as advanced communication and information features based on digital technologies.

**The government procurement regulation in the European Union allows putting Selection criteria, Award Criteria and Exclusion Criteria in a public tender. These can be used to prevent procurement solely based on pricing and give room for innovative design of lighting installations.**

***Examples of Exclusion Criteria***

- Luminaries in the offer do not meet the minimum performance requirements
- Suppliers company does not meet required legal issues

***Examples of Selection Criteria***

- Energy efficiency of the lighting design. Set minimum level for system energy efficiency. Not only the luminary efficiency but the system efficiency including the application.

***Examples of Award Criteria***

- Energy Efficiency is higher than minimum requirement
- Product lifetime & warranty plan is higher or higher than the minimum requirements
- Sustainable design of the public lighting system (Intelligent Street Lighting, cradle to cradle design etc.)

- Future-proof design:
  - Foresee place for extra components for future applications (sensors, communication etc.)
  - To be able to use LED-modules with separated electronic gear to have the ability to upgrade (lower energy, maintenance, etc.) on an easy way
- Inclusion of and contribution to regional (European) knowledge and innovation system, e.g
  - R&D on universities & university colleges to increase uptake of newest knowledge on high level in decision and development process
  - Other organizations active within research, systematized test and demonstration and good practice dissemination
- Contribution to local (European) growth and workplace creation in terms of SME-driven innovation, encouraging
  - Inclusion of end users in development and prioritizing
  - Prototyping and product development (technologies, design, integration a.o.)
  - Local manufacturing or servicing parameters

The procurers should be able to award points for those aspects that are important for the procurer. If for example sustainable design is very important from the procurer's point of view, the procurer should be able to award more points for sustainable design.

Lighting is a significant functional service in the local society, which should engage the citizens in the process of the solution priorities in order to secure acceptance and thus increase uptake and implementation. Award points connected to the process design can be an option.

Another possibility is Public Private Innovation based on *contracts, which contain innovation*. These contracts can be exempted from tender procedures and thus offer an opportunity to develop new solutions on a specific field.

## *Training the Procurers*

*The human resources* are a key to change patterns of investments and consumption in the lighting sectors of the municipalities. Without having solid evidence-based knowledge of the functioning conditions and position of lighting planning in the European municipalities, the area is under-prioritized and lack specialization in terms of knowing, educated and capable key persons, able to handle lighting issues in all its aspects.

The procurer and planner will need knowledge and skills within the following areas:

- Basic lighting source technologies
- Lighting control and management systems
- The options of combining renewable energy sources into grids with lighting
- Future trends and emerging technologies
- Urban lighting planning, theory and praxis
- Lighting economics in different time and sustainability perspectives
- Financial options and models

- Investment, construction and operating models (traditional, ESCO, OPP, OPI)

The fastest way to achieve desired targets will be to invest in a comprehensive educational program, offering specialized courses in those disciplines.

The courses and educational offerings could be seen as a 3 step process and structure

1. Short courses in various disciplines, orientation, inspiration
2. Short courses on vocational level
3. Courses integrated in technical, vocational and academic educations

*Skills and praxis oriented*

At the same time the municipalities will need motivation to accelerate specialisation and upgrading of lighting in the municipal processes of investment, construction and procurement, securing that decisions concerning lighting will not be dominated by only short-perspective economic factors.

A survey investigating the factual level of specialisation and educational background as well as lighting procurement praxis among municipalities in Europe could form a good background for a more detailed planning and execution of a European lighting procurement education program.

The roll-out of an education program for municipal procurers and lighting planners in Europe should be on a regional level, engaging the regions and regional organizations in financial support, communication and execution.

## *Dissemination of Knowledge and Good Practice*

An important part of influencing decisions concerning lighting is to share good practice and practical applicable knowledge among decision makers and practitioners.

Only by showing the good and <u>proven example</u>, based on solid documentation and analysis of good practice lighting solutions in all their aspects (investment, maintenance, energy costs, life-cycle calculations, etc.) will it be possible to improve decision quality for addressing the targets and strategies both at EU level and at the level of national governments.

This recognizes the fact that the public sectors are under pressure in many countries and will tend to choose economically viable solutions prior to more long-term, sustainable, environmental friendly and well-designed solutions.

The current situation in Europe emphasises even more the need for a coordinated approach at EU level in order to provide a range of actions, supporting joint activities across borders, while at the same time securing efficient dissemination of results and experiences made.

Target groups for knowledge and good practice dissemination activities would need to include:

- Decision makers, the political system on local (regional and national) level
- Lighting planners and staff in municipal technical and environmental departments
- Lighting professionals, advisory engineering, lighting designers and architects
- Organisations, NGO's and industry

The dissemination task should be solved in a collaborative action between regionally or nationally based networks or cluster organizations.

## *Reference Documents*


- Green paper on SSL: COM(2011) 889 final of 15 December 2011
- Synergrid specification: C4/11-3 SPECIFICATIONS FOR LIGHTING EQUIPMENT WITH LED TECHNOLOGY: http://www.synergrid.be/download.cfm?fileId=C4_11_3_Specifications_for_lighting_equipment_with_LED_technology_v032012.pdf

# ANNEX 3

## Financing models and best practices

### *Introduction*

One challenge in the market uptake of SSL in Cities is the high investment costs for such applications if compared to conventional technology. Although prices have come down, the initial costs are about two times higher for SSL. Even if these projects pay back due to the energy savings, the high initial investment cost may be a barrier to implementation.

Therefore financing models are of high interest if the market penetration should be accelerated.

The main objectives of this Annex are:

- to give an overview of existing financial schemes and support programs for SSL in the Member States
- to provide concrete information on energy service models, and in particular on the energy performance contracting model

The report is mainly based on information gathered in the framework of the ESOLi project[23].

### *Financing*

The majority of public funding sources available for lighting projects are managed at national level (although some come from EU and other foreign donors) and funding conditions differ in each Member State. In general, the funds are not for (solid state) lighting only, but they are in relation with environmental and energy saving issues.

On European level there is e.g. the European Energy Efficiency Fund (EEEF)[24], targeting energy efficiency and renewable energy investments in the EU Member States. The final beneficiaries of EEEF are local and regional authorities, as well as public and private entities acting on behalf of those authorities, such as utilities, public transportation providers, social housing associations, energy service companies, etc. EEEF can pursue two types of investments:

- Direct Investments in energy efficiency and renewable energy projects in the range of €5million to €25million. Investment instruments include senior debt, mezzanine instruments, leasing structures, forfeiting loans, and others.
- Investments into Financial Institutions, including investments in local commercial banks, leasing companies and others. The financial institutions lend to the beneficiaries of the Fund meeting the eligibility criteria to finance energy efficiency and/or renewable energy projects.

Another European source of funding is the ELENA program installed by the European Investment Bank.

Within the present inquiry, information of funding sources from the following countries was available: Bulgaria, Czech Republic, Germany, Hungary, Ireland, Italy, Latvia, the Netherlands,

[23] http://www.esoli.org

[24] European Energy Efficiency Fund. Available online: http://eeef.eu

Norway, Poland, Slovenia, Spain, and Sweden. An overview of the situation in these countries was accomplished based on questionnaire responses in the framework of the ESOLi project (in 2010) with some additional information based on the knowledge of from the Task force members.

### ***Funding Sources in European Countries***

Bulgaria

In Bulgaria, there are no funds provided by the national/regional/local government that can be used for investments in intelligent street lighting. Such investments in the country are supported by the EU Structural and Cohesion funds (*SCF)*. In Bulgaria, funding for energy efficient street lighting is provided within Operational programme "Regional Development" and particularly Operation 1.4. Improvement of Physical Environment and Risk Prevention, where one of the indicative activities is: Rehabilitation, reconstruction of street networks and introduction of energy efficient street lighting and other measures for increasing security and preventing criminality. The beneficiaries can be municipalities or NGOs in collaboration with municipalities. The particular eligible investments, funding %, and other details are announced in the relevant calls. However, no calls covering lighting have been published yet.

Another funding possibility is the Bulgarian Energy Efficiency Fund (BgEEF). It was established through the Energy Efficiency Act in 2004. The initial capitalisation of the Fund is with grant funds and the main donor is the Global Environment Facility through the World Bank. The Fund has the combined capacity of a lending institution, a credit guarantee facility and a consulting company. It provides technical assistance to Bulgarian enterprises, municipalities and private individuals in developing energy efficiency investment projects and then assists their financing, co-financing or plays the role of guarantor in front of other financing institutions. An interesting form of a guarantee is the ESCO Portfolio Guarantee, covering up to 5% of the receivables of ESCOs. Eligible projects are ones costing from 30 thousand to 3 million BGN (1 € = 1.9558 BGN) and payback period of less than 5 years. Street lighting is among the eligible activities and the Fund has supported street lighting projects in 5 municipalities by 2010. All projects include replacement of inefficient luminaries with efficient ones, but additionally some projects include introduction of a system for better management of the street lighting. BgEEF can be considered successful in view of its efficiency. Although it is a self-sustaining revolving fund, it provides noticeable support to investors. More information is available at: www.bgeef.com.

Czech Republic

In the Czech Republic, there is a national fund supporting investments in intelligent outdoor lighting. The fund is under a wider energy efficiency government programme EFEKT of the Ministry of Industry and Trade. The maximum subsidy is about €125.000, maximum 40% of the project cost. The programme is intended to support only the luminaires and control systems, not constructional elements of public lighting. Eligible beneficiaries are municipalities. The municipality should have information about the input power and other technical details, so an energy audit should have been done before that. The fund cannot be considered as a successful one for lighting projects, because: 1) there is small amount of money in the government programme; and 2) most municipalities do not have sufficient information and knowledge about public lighting and as a result its priority is low. In the country, there are no other funds available to support investments in intelligent street lighting. SCF does not finance such investments.

Germany

In Germany, a soft loan scheme is available for energy efficient city lighting: KfW - Promotional Program "Energy-efficient Urban Lighting" (KfW–Investitionskredit Kommunen Premium – Energieeffiziente Stadtbeleuchtung).

Investments (incl. SSL) to improve the energy efficiency of public outdoor lighting must be in compliance with minimum technical requirements of the EU Ecodesign Directive for the year 2015 certified by technical experts. The cost of planning and reviewing existing infrastructure, incl. concepts for improving energy efficiency, and of technical experts may be co-financed.

Details are given in the following table:

| | |
|---|---|
| Creditor | KfW |
| Program | Energy-efficient Urban Lighting |
| Type | soft loan |
| Amount | 100 % of eligible costs |
| Applicants | Municipalities |
| Type of projects | street lighting, parking lighting, lighting of public areas, traffic lights in SSL-technology |
| Valid from | 01/04/2011 |
| Website | http://www.kfw.de/215 |

Another support is provided by the German Government, by the Federal Ministry for Environment. Within that programme LED outdoor and street lighting has been funded by a grant of 40 % of the eligible costs in 2011 which was reduced to 25 % in 2012 and a further reduction to 20 % for the last funding period in 2013. Projects have received the support if the prove to reduce energy consumption by 60% and if they include control systems.

Hungary

In Hungary there is no funding programme from local/regional/national government, but EU structural and cohesion funds (SCF). In this context, an Environment (Környezet) and Energy Operative Programme (KEOP) is available (see http://www.nfu.hu/?lang=en).

In this programme, one of the biggest LED public lighting projectswas realised in Europe: Hódmezővásárhely (2010-2011). The call for the KEOP tender dated in 2009.Investment costs: €2.7 million, 50 % paid by the EU and 50% by the local government; Payback time: 10-11 years; Energy saving: 565 MWh / year, 33%$CO_2$ reduction (352t) (project details: www.schreder.hu/news.php?id=57)

Another source of funding is EBRD, in Hungary through the Erste Bank. With EBRD funding a successful public lighting project in Komlówas realised in 2011. Brutto investment cost was €310.000 financed by the investor company. The city municipality paid back the money by simple terms (the same sum in every month) through 5 years from the savings. Cost savings/year: €80.000. Energy saving: 273 MWh/ year, 69% reduction of $CO_2$: 150 t; Changed 1048 pcs old mercury and sodium luminaries, replaced 836 pcs LED luminaries and 212 pcs metal halide luminaries. There was an achieved energy saving of 69%. The municipality has got a new, energy-efficient public lighting, without own investment (project details: www.schreder.hu/news.php?id=64).

Ireland

In Ireland, there is no possibility to obtain public financial support for investments in energy efficient outdoor lighting. None of the following funding sources is available: Government; SCF; international funding institutions.

Italy

In Italy, the Government does not provide any funding for energy efficient street lighting, except for the national co-financing of the Structural and Cohesion funds (SCF) of the EU. The Regional Operative Programs (POR) is financed by a mix of European Structural Funds and regional funds. Between 2008 and 2010 there have been funds (available through calls for proposals) for interventions in public lighting in several regional operative programs in Italy. For example in Lombardy there was a call in 2008 in the framework of POR-Competitiveness–Axis 2 Energy- Measure 2.1.2.2: “Interventions for ameliorating the energy efficiency of public illumination”. The call budget of 10 million EUR was available both for refurbishment and new installation projects. The grant covers 80% of eligible project costs, for eligible costs between €50.000 and €500.000. The eligible beneficiaries are local authorities and their associations.

The evaluation criteria applicable to the abovementioned call favour intelligent lighting systems. In particular these criteria are:

a) Energy efficiency (inter-distance and height of light points, number of light points and extension of involved territory, energy savings)
b) Project quality (economic efficiency, luminance, flux reducers, quality of application)
c) Dimension of local authority (number of inhabitants)
d) Synergy with urban recovery actions
e) Individual proposer or aggregation of local authorities
f) Protected area or of astronomical importance
g) Synergy with other actions of other programs

The call was very successful. Unfortunately due to the limited funds a lot of eligible projects were not financed.

Latvia

In Latvia, in the first half of 2011, there was no Government funding for energy efficient public lighting, while in the second half of 2011 it has been expected that a $CO_2$ trade programme will co-finance energy efficiency programme that will finance (among the others) energy efficiency in municipal street lighting systems. SCF in Latvia do not provide financing for lighting projects. Priorities of EBRD foresee financing of modernization of municipal and environmental infrastructures.

Netherlands

In the Netherlands, at all levels (National, Province, City) there are budgets for street lighting, allocated to investments in intelligent street lighting and LED projects. Organisations use their own budgets normally to maintain and extend their street light systems. Apart from this there have been several subsidies from the National Government to stimulate additional investigations, pilots and tests. There has been a 2-year project of the Ministry of Economics to stimulate Durable Purchasing of Outdoor Lighting. http://www.pianoo.nl/duurzaaminkopen.In the country, there are neither SCF nor funds from international organizations that can be used for intelligent outdoor lighting.

Poland

An improvement or building of new intelligent street lighting systems supported by SCF is possible only when constructing a new road or fully renovating a road. There is no possibility to use these funds directly only for street lighting. The subsidy for the programming period 2007-2013 is 100%, of which 85% are EU and 15% national funds. See:

www.funduszeeuropejskie.gov.pl/English/Introduction/Strony/Introduction_to_European_Funds.aspx

In Poland there are neither Government funds nor international funds that can be used to support investments in intelligent outdoor lighting.

Slovenia

In Slovenia, there is no possibility to obtain public financial support for investments in energy efficient outdoor lighting.

Spain

The following Government support is available in Spain:

- Subsidy: 40% for investments done by municipalities and 15% - by ESCOs.
- Soft loan scheme: €12 million. The interest rate is EURIBOR+2 for loans for less than 6 years, EURIBOR + 2.25 for loans between 6 and 8 years, and EURIBOR+2.5 for loans between 8 and 10 years. The maximum loan amount is 500 thousand EUR. See: www.gencat.cat/icaen
- Technical assistance: €2 million is provided by ELENA Project through Barcelona province government. See: www.diba.cat.

The above-mentioned support scheme is considered successful, because it helps municipalities decide to invest in new intelligent lighting installations. Increasingly ESCOs finance the investments, due to the lack of financial sources of municipalities, so the option to support ESCOs is important.

Sweden

In Sweden, SCF provide support to intelligent public lighting, but it is up to each municipality to make a request to these funds.

In Sweden, when there is money for EU projects, usually they concern a whole urban estate where the lighting is one part of the project and then there is a possibility to introduce intelligent efficient street lighting to get a more energy efficient solution.

The Swedish Environmental Protection Agency and the Swedish Energy Agency support research and development in new technology for municipalities, so it can be carried out in various tests on a smaller scale.

Norway

In Norway, at all levels (Counties with the Directorate of Public Roads, Municipalities, and City) there are budgets for street lighting, allocated to investments in intelligent street lighting and LED projects. Organizations use their own budgets normally to maintain and extend their street light systems. Apart from this there have been several subsidies from the National Government to stimulate additional investigations, pilots, and tests. Today there is a long term on-going test for almost 20 000 luminaries.

The Norwegian Parliament has set up an Energy Fund and indicated grants, coming from a levy on the electricity distribution tariffs. The Fund is managed by Enova - a public enterprise owned by the

Royal Norwegian Ministry of Petroleum and Energy. Enova provides grants to energy savings measures in road and street lighting. The grant size is fixed per kWh saved. This contribution from the authorities has contributed to an increased number of energy savings measures.

Summary

The availability of funding for intelligent public lighting in all reviewed countries is summarized in Table 1 that shows a quite different situation in different countries. While in some countries (Ireland and Slovenia) no financial support for intelligent public lighting including LED is available, in other countries (Spain) all 3 types of support are offered.

**Table 1**: Availability of funding for intelligent public lighting

| | Funding from national / regional / local government | EU Structural and Cohesion funds | International funding institutions |
|---|---|---|---|
| Bulgaria | No | Yes - OP "Regional Development" | Yes – Energy Efficiency Fund, funded by GEF |
| Czech R. | Yes - programme EFEKT by Ministry of Industry and Trade | No | No |
| Germany | Yes – KfW Bank – Investitions-kredit Kommunen Premium – Energieeffiziente Stadtbeleuchtung | No | No |
| Hungary | No | Yes – OP "KEOP" | Yes – EBRD |
| Latvia | No, but expected in 2nd half of 2011 | No | Yes – EBRD |
| Ireland | No | No | No |
| Italy | No (only SCF co-finance) | Yes | No |
| NL | Yes | No | No |
| Poland | No | Yes – as part of road (re-)construction | |
| Slovenia | No | No | No |
| Spain | Yes | No | Yes – ELENA facility |
| Sweden | No | Yes | No |
| Norway | Yes | No | No |

## *Energy Services*

### *Introduction*

Directive 2006/32/EC on energy end-use efficiency and energy services (ESD) promotes the development of the market of energy services as a measure to realize the economically viable energy end-use efficiency potential.

The public owners of street lighting systems have to keep the systems in good shape to ensure road safety, prevention of crime, well-being during night time, and others. In the last years of financial crisis, the limited public budget has often led to a stagnation of investments in increased energy efficiency of public street lighting, so private funding sources need to be sought.

***Private-public partnership models*** in relation to energy services may be a viable option to save energy and maintenance costs and at the same time to guarantee high quality of the lighting systems. In general, energy services in street lighting means financing and operating procedures for the provision of specific energy services for owners of street lighting systems. This may also include cost effective delivery of electricity for the owner of the system. There are also energy service models including provisions for utilization of renewable energy, replacement of existing components/systems, energy metering and billing, Life Cycle Cost Assessment, and interfaces with other customer services.

The main distinguishing feature in energy services is, that the service company bears the risk (wholly or partly) of the lighting and installation management with regard to energy and thus, of course, at the same time is given the chance to gain profit if the intended improvement in efficiency is actually achieved.

The following definitions have been applied:

- **Energy Service Company (ESCO)** is a natural or legal person that delivers energy services and/or other EE improvement measures in a user's facility or premises, and accepts some degree of financial risk in so doing. The payment for the services delivered is based (either wholly or in part) on the achievement of EE improvements and on the meeting of the other agreed performance criteria.
- **Energy Performance Contracting (EPC)** is a contractual arrangement between the beneficiary and the provider (normally an ESCO) of an energy efficiency improvement measure, where investments in that measure are paid for in relation to a contractually agreed level of energy efficiency improvement.

### *Energy Service Models*

From the point of view of the customer (i.e. owner of the street lighting system), an energy service project can be funded by three types of sources.

- self-financing - the customer provides the financing from own funds
- debt financing – the customer takes a loan from a financial institution
- Energy service provider financing (third party financing) - the funding comes from the energy service provider (e.g. ESCO).

Additionally, a combination of the above options is possible, for example a part of the financing may come from the ESCO and another part from the municipality owning the street lighting.

There are many models and various classifications are used, but according to a widely recognized classification, depending on the system approach or the aim of energy service, the following basic models can be distinguished:

- **Technical Plant Management** (also Operation Management Contracting or Technical Building Management)
- **Energy Supply Contracting** (also Facility Contracting or Energy Delivery Contracting/delivery of useful energy)
- **Energy Performance Contracting** (EPC) (also Saving Contracting or Energy Saving Contracting).

In the street lighting sector, these three basic models are equivalent respectively to:

- **Lighting Contracting** – a pure service model, where the lighting system ownership remains at the public authority. It is the simplest and the most widely used model.
- **Light Supply Contracting** – a complete transfer of the system to a private company. The contracting providers take over the planning and construction of lighting system, the financing and operation of system, and invoicing of the finished end product, namely lighting.
- **Energy Performance Contracting (EPC)** – a combination of elements from the two above models. The ESCO is responsible for the implementation of the energy saving measures and the operation and maintenance of the lighting system. The payment to the ESCO is based on the actual energy savings.

Some of the key features of the three models are shown at Table 2.

**Table 2:** Different models of contracting in the lighting sector

| | Lighting Contracting | Light Supply Contracting | Performance Contracting (EPC) |
|---|---|---|---|
| Application | Optimizing operations and if applicable refurbishment measures of the lighting devices | Optimizing operations and if applicable refurbishment measures of the lighting devices | Measures to achieve energy and maintenance costs savings |
| Services | Operational management and if applicable financing, planning of the refurbishment, installation and maintenance | Operational management and if applicable financing, refurbishment planning, installation & maintenance. Additionally: energy purchasing and supply | Financing, Planning, Installation, maintenance and implementation of saving measures |
| Financing | Contracting rate as remuneration for the services | Contracting rate as remuneration for the services and energy costs | Remuneration for the operating cost savings achieved |
| Remarks | For single refurbishment measures including maintenance | For complex solutions including operation | For complex solutions with high saving potential |

Each of the above models has advantages and disadvantages and could be the most appropriate one in some cases. Apparently, not only the choice of a model but also the concrete contract details plays a major role.

Lighting contracting is highly common and well-known in many EU countries, so it is not necessary to describe it here.

Light supply contracts have one special difference from lighting contracts - the contractor takes over the whole responsibility over the lighting system, including the purchase of electricity. This might be of interest, if the contractor is a utility and therefore has access to good electricity purchasing conditions. However, this contract could be a disadvantage for the municipality, as they are bound to the contractor over the whole contract period.

Energy performance contracting (EPC), has high potential to finance modern and energy efficient street lighting solutions, especially in municipalities with limited budget for investments and staff with limited know-how in street lighting. As the development of an EPC project needs some effort in the initial phase and a lack of information exists in some EU Member States, the remaining part of this chapter focuses on EPC.

### *Energy Performance Contracting (EPC)*

#### *Benefits for the public owner of the lighting system*

There are several benefits of EPC for the owner of the public lighting (i.e. municipality). With EPC the owner is relieved from both organizational implementation and (in most cases) the financial burden of new investments. Additionally, due to the specific knowledge, financial incentives and the legal commitment of the ESCO, economical saving potentials are efficiently used and saving measures are implemented much faster than by the owner himself. Besides significant reductions of operating costs implemented measures can lead to better light quality, fewer failures, upgrading of value and attractiveness, and reduction of greenhouse gases.

#### *Savings sharing*

In EPC, it is possible that the payment to the contractor is equal to the total amount of operational cost savings (energy costs, maintenance costs, etc.) for the entire contract duration. Therefore, in this case the owner will benefit from the savings after the end of the contract.

Another possibility is that a part of the savings (e.g., 15% – 25 %) goes to the owner of the lighting system. In that way the owner profits from the savings not only after the contract end, but also during the contract time-frame. This option would normally require longer contract duration.

#### *Inherited owner-operator relations*

When the municipality owning the lighting system is also responsible (either directly or through a municipal utility) for all services, this establishes favourable frame conditions for implementation of EPC.

When a private company is operator, based on concession contract, the introduction of EPC is more difficult. As operation and maintenance would be a part of the tender, a solution has to be found about how to deal with existing concession contracts. A solution might be an early cut of the contract (if contract penalty is not too high), or new negotiation of the contract with the concessionaire. Another problem to be solved would be regulations of interfaces between equipment provided by the ESCO and the concessionary company.

#### *Barriers and possible solutions*

Experience has shown some general barriers for the use of contracting models (and particularly EPC) in the municipal sector, which also apply to the street lighting sector. The main barriers and possible solutions are reviewed below:

**Technical and organizational barriers** are data collection, baseline calculation, lack of appropriate cost benefit analysis and planning instruments, difficulty to prove energy savings and subsequently cost reductions, increased organizational efforts. The effort in compiling data depends on the complexity of the project, the background knowledge of the personnel and the level of detail of the records. Available tools like data entry forms, model contracts or calculation tools for the economics of the project can assist to enhance and simplify the project. Furthermore energy agencies or consulting companies can be contracted for assistance.

**Legal barriers** are the provision of a secure and fair contract, uncertainties in e.g. public budget, municipal law, and procurement. Legal barriers can be solved by standardized and legally examined model contracts. The provision of such contracts guarantees fair and secure project procedures. Usually minor adaptation is needed for the concrete project.

**Human barriers** are the lack of confidence in the unknown model and fear of staff reduction. Sometimes the municipality staff believes that they can realize refurbishments the same way but even cheaper. There is a possibility for the solution in own-direction, but these projects are commonly only realized successfully if staff is very engaged and competent in street lighting topics. Therefore the following questions should be considered before deciding for a solution in own-direction:

- Can the amount of investment be provided?
- Is the necessary know-how available?
- Can the desired savings be guaranteed for several years?
- Are there sufficient economic incentives to achieve these savings?

The fear of staff reduction is usually not justified. Generally EPC does not lead to staff reduction but rather leads to a shift in duties. Normally the ESCO works in the field of energy saving and energy management and therefore takes over responsibilities which have been sparsely, if at all, focused on before.

**Information barriers**: lack of promotion of best practice examples. This barrier can be addressed by the relevant State authorities and energy agencies.

## *Development of an Energy Performance Project for Street Lighting*

This section summarizes the main steps of the development of EPC in the street lighting sector.

EPC could be profitable for both parties, but a good preparation and partnership collaboration on the basis of adequate and proven contract models is required. The success of an EPC project depends mainly on the tendering procedure.

After the decision to implement EPC, the lighting data is listed in the course of project development. With its help the operating (energy and maintenance) costs baseline is determined to serve as the reference value for the operating costs in the contractual period. Furthermore, the standards or system requirements should be defined at this stage. This requires clarification of the interfaces with regard to maintenance, definition of the minimum savings to be achieved and if a share in the savings is desired.

Hereupon the tender documents are compiled. The EPC is already a main component. The next step is publication in the official gazette, other official publications for public contracts and above all in special databases. Prospective bidders may then express their interest. After evaluation of the interests the best bidders are invited to submit offers in a functional invitation to tender.

The bidders are given the opportunity to inspect all installations and devices and validate the technical data. The most important characteristics of the tenders to be submitted are the guaranteed cost savings, data on investment volume and structure, and on the required extent of maintenance. The best offers should be substantiated as the negotiation process progresses; only after this step the best bidder is finally selected.

Following the conclusion of the contract, the ESCO implements the saving measures during the preparatory phase. Only on completion of the preparatory phase the period of main obligation to perform will commence in which the savings achieved are determined and the ESCO receives a performance-related remuneration.

The following figure shows the steps and responsibilities for the project preparation, development, and implementation of EPC:

| Responsible | Project phases | |
|---|---|---|
| Client | **Project preparation**<br>• Inspection of data availability<br>• Selection of lighting systems<br>↓ | |
| Client | **Project Development**<br>• Constitution of a steering committee<br>• Evaluation of data / Analysis of saving potential<br>• Determination of operating costs baseline<br>• Stipulation of system requirements<br>↓ | |
| Client | **Tender**<br>• Compilation of tender documents<br>• Statement of interest<br>• Call for tender<br>↓ | |
| Client / Contracting provider | **First Validation Phase**<br>• Validation of data sheets<br>• Preparation of draft analysis<br>• Submittal of offer<br>• Determination of best offer<br>↓ | |
| Client / Contracting provider | **Contract Negotiation** → | If necessary: end of procedure; no competitive offer |
| Client / Contracting provider | ↓<br>**Saving Guarantee Contract**<br>↓ | |
| Contracting provider | **Second Validation Phase** → | Preparatory phase |
| Contracting provider | ↓<br>**Savings and Services** → | Obligation to perform |

# ANNEX 4

## The “Rekenhulp” model by the Dutch Agency for Spatial Planning and Environment

Agentschap NL
*Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer*

**Doel van de rekenhulp:**
Deze rekenhulp is geschikt om verschillende OVL systemen met elkaar te kunnen vergelijken op het gebied van energie-, installatie- en beheerkosten.

**Werkwijze:**
Het rekenblad is bedoeld om de berekening te maken. Dit blad kan desgewenst meerdere malen gekopieerd worden.
Op het rekenblad dienen de wit gekleurde cellen ingevoeld te worden. Zie ook de onderstaande tabel.
Per rekenblad kunnen er maximaal 4 verschillende OVL systemen met elkaar vergelegen worden.
Aan de rechter zijde is aanvullende informatie weergeven over de in te voeren gegevens.

**Verklaring van de kleuren op het Rekenblad:**

- [wit] = invullen
- [grijs] = niet invullen, wordt automatisch berekend (let op: cellen zijn niet beveiligd)
- [geel] = aanvullende informatie t.b.v. het invullen van gegevens

**Aanduidingen voor lampen en armaturen in de voorbeelden:**
In de voorbeelden zijn enkele veel gebruikte lamptypen/armaturen met alternatieven genoemd. De conventionele compactfluorescentielamp is aangeduid met PL-L/PLL echter deze is ook verkrijgaar onder benamingen zoals Dulux, Lynx e.d. Naast de SON(-T) zijn (tubulaire) hogedruk natriumlampen ook verkrijgbaar onder benamingen zoals NAV(-T) en SHP(-T). (Keramische) metaalhalogeendamplampen zijn verkrijgbaar onder benamingen zoals CPO, CDM, HCI, HCI-Powerball, CMI e.d. Bij Leds zijn er grote verschillen tussen die concepten die de diverse leveranciers aanbieden. De Fortimo van Philips in combinatie met de Residium en Koffer2 zijn slechts voorbeelden.
Hoewel er ook andere geschikte armatuurtypen voor conventionele oplossingen werden en worden toegepast is in deze voorbeelden uitgegaan van de volgende typen:

- voor bestaande compactfluorescentiearmaturen is uitgegaan van de FGS104-105, IND 2500 en Schreder VN
- voor nieuwe compactfluorescentie-EVSAarmaturen is uitgegaan van de Residium, Libra en Altra II-III
- voor bestaande hogedruk natriumarmaturen is uitgegaan van de JVC70 en SGS203
- voor nieuwe hogedruk natrium EVSA- en de CPOarmaturen is uitgegaan van de Aurora en Irdium

**Disclaimer:**
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