Streetlight Refurbishment with Energy Performance Contracting

Guide

Street lighting can account for up to 30-50 % of the total electricity consumption of municipalities. The recent market introduction of LED technology for street lighting offers high savings with comparatively short pay-back times.

Municipalities are faced with an urgent need to act: nearly 80 % of all currently used street lighting lamps will be "phased out" by 2017, which means they will no longer be available for purchase. In most cases this will entail substantial investments, thus presenting a major problem for many municipalities.

Here Energy Performance Contracting (EPC) can be a solution: energy efficiency investments are pre-financed and implemented by an energy service company (ESCO). The annual energy and maintenance cost savings then cover the investment and capital costs.

The EU-Project Streetlight-EPC is funded by the Intelligent Energy Europe Programme and was launched in April 2014 with the objective of triggering the market uptake of EPC through street lighting refurbishment projects.

Within this project, guides for municipalities and ESCOs on implementing streetlight EPC projects were prepared. They are available in the respective languages and for the specific contexts of the project regions (Upper Austria, North-West Croatia, South Bohemia/Czech Republic, Pomerania/Poland, Carlow & Kilkenny County/Ireland, South East Sweden, Podravje/Slovenia, Macedonia, North & Central Spain). This document summarises the information from these guides in English.

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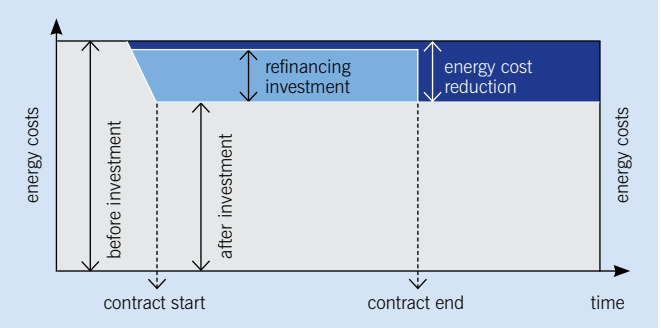
Refurbishment of street lighting with LED and EPC

The recent market introduction of LED technology for street lighting offers high savings with comparatively short pay-back times. LED technology has developed very rapidly over the past years. In many cases it is now an economically very interesting option for street lighting refurbishment. Advantages of LEDs include high energy efficiency, long lifetime (about 50-70,000 hours), low maintenance costs and a high flexibility for dynamic light control systems. They also offer a better choice of light colours and allow for an exact light direction (good for animal night life). However, these benefits can only be reaped if the whole system is well planned.

Why Energy Performance Contracting (EPC)?

Street lighting refurbishment with LEDs requires significant upfront investments. This is a major barrier for most municipalities in Europe. In many cases, Energy Performance Contracting (EPC) can offer a solution to overcome this obstacle.

Energy Performance Contracting is a contractual arrangement between a client (e.g. a municipality) and a provider of an energy efficiency improvement measure, a so-called "Energy Service Company" (ESCO). The ESCO finances and implements energy efficiency investments - for example the refurbishment of a street lighting system to LED technology for a whole city or a selected project. The ESCO guarantees the energy savings. The annual energy savings are used to cover the investment and capital costs. After the end of the contract, the client benefits from the energy and cost savings.



The Streetlight-EPC Project
Triggering the market uptake of Energy Performance Contracting through street lighting refurbishment projects

Despite the great potential, most European regions have not yet seen a significant development of EPC markets. Apart from legal barriers, this can be attributed to the lack of understanding of EPC and the absence of experienced ESCOs and organisations facilitating the EPC market development. Street lighting refurbishment offers a good "learning ground" for the uptake of EPC. Pressure created by the phasing out of street lamps presents a unique opportunity for the development of EPC markets.

The project "Streetlight-EPC" funded by the Intelligent Energy Europe Programme was launched in 2014 with the objective of triggering the market uptake of EPC through street lighting refurbishment projects. It will create demand and supply for EPC projects in 9 regions by setting up regional EPC facilitation services. These services provide comprehensive support to municipalities and ESCOs. The project team includes 9 regional agencies/organisations, which will provide the EPC facilitation services, 9 municipalities and a European network.

Region	Regional partner	City/county partner
Upper Austria	OÖ Energiesparverband (ESV)	City of Wels
North-West Croatia	Regionalna energetska agencija Sjeverozapadne Hrvatske (REGEA)	Zagreb County
South Bohemia/Czech Republic	Energy Centre České Budějovice (ECČB)	City of Trhové Sviny
Pomerania/Poland	Bałtycka Agencja Poszanowania Energii (BAPE)	City of Gdansk
Carlow & Kilkenny County/Ireland	Carlow Kilkenny Energy Agency (CKEA)	Kilkenny County
South East Sweden	Energikontor Sydost (ESS)	City of Kalmar
Podravje/Slovenia	Energetska agencija za Podravje (ENERGAP)	City of Maribor
Macedonia	Centar za energetska efikasnost na Makedonija (MACEF)	City of Skopje
North & Central Spain (regions of Madrid, Castilla y Léon, Cantabria)	ESCAN	City of Santander

Further information and contact details are available on the project website: **www.streetlight-epc.eu**

Frequently asked questions on Streetlight EPC

What is the meaning of...

- ESCO: Energy Service Company, specialised company that offers EPC services
- ESCO client: municipality/public body (or company) on whose installations an ESCO project is carried out
- ESCO contract: basis for the cooperation between ESCO and client, regulates rights and obligations for both parties, most importantly the achieved savings, the contract duration and warranty issues.
- Quality assurance: guarantees the agreed quality level of the ESCO's work (e.g. minimum savings, functionality of the system)

Which measures are typically implemented in a street lighting-EPC project?

Replacement of lamps, new control systems, system optimisation, retrofitting of poles, complete replacement of luminaires. Extending the street lighting system can be incorporated into the project, but can usually not be financed by savings.

What size of investment is typical?

In many cases, an investment of several tens of thousands Euro is the minimum, otherwise the cost of preparing the project (including setting up the contract) represents too large of a proportion of the savings. However, this strongly depends on the specific circumstances.

Which important provisions should the EPC contract contain?

Guaranteed savings and consequences if they are not achieved, respectively allocation of additional savings; contract duration; how the ESCO's fee is calculated; billing schedule; changes in energy prices; split of tasks between the ESCO and the municipality; ownership issues after the end of the contract; bankruptcy of a contracting party.

What impact does the EPC project have on the municipality's staff?

An experienced ESCO will strive to integrate existing staff and service providers (e.g. local electrician) into the project. The EPC project might also result in new tasks for the staff previously in charge of some aspect of the street lighting system such as data collection, quality control, the implementation of the measures and the revision of annual accounts.

How time consuming is an EPC project for the municipality?

Careful preparation and development are crucial for the successful implementation of an EPC project. At the beginning of the project, all concerned staff should be involved in order to ensure transparency and acceptance by all parties. Good planning of the project and clear requirements for the ESCO in terms of quality criteria are required.

How are the reference costs (baseline) determined?

The "baseline" is the basis for calculating the ESCO's fee. To prevent that factors which are out of the ESCO's control (e.g. energy prices, change of operation times) act to its advantage or disadvantage, energy costs and energy consumption levels are compared to those of the reference year.

What happens at the end of the EPC contract period?

At the end of the contract period, the municipality can take back the ESCO's tasks and benefit from the lower energy costs. Of course, the contract may also be extended or amended.

Example: Steps in preparing and implementing a Streetlight-EPC project

The following steps were discussed by the project partners of the Streetlight-EPC project.
Depending on the context, these steps can vary significantly.

Project steps The order of the steps depends on the regional context.	**Support by the Facilitation Service**
Data collection › analysis of the current state of the street lighting system › identification of priority refurbishment areas › data collection (luminaires/lamps, light poles, etc.)	Use the Streetlight-EPC Checklist
Definition of quality and procurement criteria › how much light is required/desired? which colours? › expected service life › which control system (dimming, reduction during night, etc.)? › maintenance costs › other criteria for technology solutions	Information included in this guide (pages 6 and 7)
Detailed analysis of investment costs & savings › development of the baseline › identification of potential public support	Technical and economic advice from the facilitation service
Tendering & selection of ESCO › tendering (based on criteria defined above) › identification of potential ESCOs › development of EPC contract	List of ESCOs from the facilitation website
Implementation › implementation & tracking results › accounting	Communicate results and findings to other cities

Examples of Streetlight-EPC projects in the project regions

Wels/Austria – comprehensive LED project

- Population: 61,000
- total street lighting system: 7,700 lights and 9,100 lamps
- Prior to the retrofitting project, mercury vapour discharge lamps (HQL), sodium lamps, plug-in solutions and fluorescent lamps were in use, of which 4,500 were older than 15 years.
- Between 2011 and 2014, 50 % of the lighting system was converted to LED technology.
- A third of the street lighting is dimmed to 50 % between 21:30 and 5:30, resulting in increased saving without compromising road safety.
- Investment by the ESCO: 1,656,000 Euro
- Contract duration: 7 years
- Achieved annual savings: 36 % (guaranteed)

Trzebielino/Poland – first 100 % LED rural community

- Population: 3,735
- In 2012, the entire street lighting system was refurbised to LED technology.
- By replacing the 218 luminaires and exchanging additional 136 lamps (previously mostly mercury and sodium lamps) with LEDs, the installed capacity was reduced from 54 kW to 26 kW.
- Instead of the previous "switch-off" during the night, a light intensity control system was installed, leading to additional savings of 30 %.
- Investment by the ESCO: 92,500 Euro
- Contract duration: 4 years
- Achieved annual savings: 46 % (actual savings)
  Electricity consumption reduced by approx. 112,400 kWh/year
  Savings: 13,000 Euro/year

Palencia/Spain – a pioneer project

- Population: 81,000
- Urban area with 11,000 lighting points.
- Before renovation, mostly high-pressure sodium lamps and high-pressure mercury lamps were used, frequently with low efficiency and insufficient colour rendition.
- In the context of a streetlight-EPC project, as a first step, 3,139 luminaires were changed to LED.
- An individual luminaire dimming control system was installed.
- Contract duration: 12 years
- Guaranteed energy savings: 75 %
- Total savings: 2,000,000 Euro

LED technology for street lighting

When preparing LED street lighting projects, it is very important to set quality criteria.
These can be used for developing tenders and to compare different offers.

Key criteria (technical specifications) for a street lighting refurbishment project include:

- electrical power (wattage)
- luminous efficacy (light output)
- light colour
- expected service life
- the ability to switch-on/switch-off and control the system (incl. dimming)
- test certificates

Important aspects when planning the conversion to LED technology

Prefer modular construction
Some LED and electronic modules cannot be separated from the light fixture, requiring that the entire luminaire must replaced in case of failure.

Minimise glare
Due to LEDs' small light emitting surface an extremely high luminance (up to about 10,000,000 cd/m^2) arises and can lead to glaring. Precautions should be taken to minimise this.

Avoid stray light
Directed LED lighting usually results in little stray light.

Availability of spare parts
In comparison to conventional discharge lamps, there is no standardisation for LED lamps yet (size, plug, mounting, ballasts, etc.). It is therefore important to ensure the availability of spare parts for the duration of the lamp's planned service life.

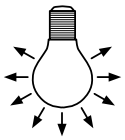
Define warranty
Length and conditions of the warranty should be precisely defined.

Require complete technical specifications
In addition to a lighting calculation, a data sheet with the following points should be requested from the ESCO: electrical power (wattage), luminous efficacy (light output), light colour, expected service life, the ability to switch-on/switch-off and control the system (incl. dimming), assembly instructions, test certificates.

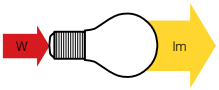
Be careful with retrofit solutions
Replacing conventional lights in conventional luminaires with LEDs is usually problematic in terms of light direction and heat dissipation and may result in loss of system warranty. Also, the advantages of LED (such as targeted light directing, high efficiency, etc.) are usually not exploited in such solutions.

Important units and definitions for LED streetlight

Luminous flux [lumen]:
Indicates the light output - how bright a lamp shines. Attention should be paid to whether the lumen specification refers to the LED chip or the entire LED luminaire.



Luminous efficacy [lm/W]:
Luminous flux (how bright the light shines) in relation to the electricity consumption. This permits to determine how efficient a light is and to compare different products.



Lifetime of LED and lights [hours]:
Manufacturers promise a service life of up to 100,000 hours, although only for individual components rather than for the entire system. Close attention should be paid to the details and guarantees should be requested. Service life significantly influences maintenance costs.

Rate of decline of the luminous flux:
When used correctly, LEDs have an extremely low failure rate. However, as with all lights, the luminous flux will decline over the product's life span (reduction of up to 70 % after 50,000 hours of operation). This means that, in order for a lighting system to fulfill standards, it either needs to be significant over-dimensioned at the time of installation (not recommended) or an electronically controlled luminous flux compensation system needs to be used. This type of system keeps the luminous flux approximately constant over the installation's service life.

To evaluate the lifetime of LEDs, the specifications of failure rate and the luminous flux decline rate should be taken into account separately.

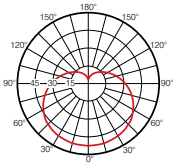
Example "L70/B50": "L70" means that the light will still emit at least 70 % light at the end of the indicated life span. The "B value" indicates how many lights will fail according to statistics: B50 = 50 %.

Gradual decline

Abrupt decline

Light colours [Kelvin]:
"Warm" (less than 3,300 Kelvin) or "cold" (neutral white or cold white 3,300-5,300 Kelvin) light. The higher the colour temperature, the more energy efficient the LED light is. Daylight-white LEDs (approx. 5,300 Kelvin) have a 15 % higher light output (luminous efficacy) than warm white LEDs.

Beam angle:
LEDs often have a smaller beam angle than conventional lights; therefore, more lamps may be necessary.



Effective "thermal management" (heat dissipation):
About 65 – 80 % of the electricity consumed by an LED is converted to heat. Good heat dissipation has a significant impact on the life of the LED and is thus an important quality characteristic. Therefore, high-power LEDs are equipped with appropriate cooling fins or other heat dissipation components.

Light management and controls:
Light controllers allow for more specific switch-on/switch-off times and dimming of the lighting system - an important requirement for demand-driven lighting. However, not all LEDs are dimmable.

Implementing LED Streetlight Refurbishment Projects

Street lighting, altough an important contributor to traffic and public safety, requires a substantial amount of electricity and money. For municipalities with older, inefficient systems, street lighting can account for 30-50 % of their total electricity consumption.

This high efficiency potential was recognised by European policies, leading to phasing out requirements (between 2010 and 2017) for many lamp types. As a result, they will no longer be purchasable. Nearly 80 % of all street light lamps currently in operation will be affected by this. Municipalities are under strong pressure to act.

The recent market introduction of LED technology for street lighting offers high savings with comparatively short pay-back times. LED technology has been developing very rapidly over the past years. With cost reduction potentials of over 50 %, it is already an economically very interesting option for street lighting refurbishment.

Reaping the benefits of efficient street lighting technologies requires substantial upfront investments - the major market barrier for operators of street lighting. A functioning and trust-worthy financing model is needed to help municipalities overcome this barrier and succeed in carrying out refurbishment projects.

Energy Performance Contracting (EPC) is potentially a key instrument for financing and implementing economic energy efficiency investments. In the context of EPC, energy efficiency investments are pre-financed and carried out by an energy service company (ESCO). The annual energy and maintenance cost savings then cover the investment and capital costs. Guaranteed energy services in the form of EPC work best in cases of high energy and cost saving potentials.

This publication was developed in the context of the EU-Project Streetlight-EPC which is supported by the Intelligent Energy Europe Programme. It was launched in April 2014 with the objective of triggering the market uptake of EPC through street lighting refurbishment projects.

www.streetlight-epc.eu

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