



Maximize your lighting investment while improving overall performance

Dimitri Dini

Eaton's Crouse-Hinds series lighting product line manager

Challenge:

The use of LED technology in hazardous (Ex) environment is steadily increasing, but the initial investment is typically higher than conventional technology.

Solution:

Conventional lighting may seem like a cheaper option. However, when you compare the advantages over the life of the product, LED technology has a significant impact to the overall performance and return on the investment.

Advantages of LED technology in harsh and hazardous areas

When it comes to LED, there are several advantages over conventional technology when lighting an Ex areas.

- Low energy consumption
- Higher efficiency
- Instant light
- Helps decrease impact of vibration
- Lower heat generation
- Optical control on the beam pattern
- Helps reduce maintenance (varies by design of LED fitting)

Additionally, LED technology has a significant impact on return on investment (ROI). Initial investment of an LED installation is usually higher than conventional technology.

Therefore, it is important to estimate the cost savings generated by using LED technology to understand the true investment cost.

The end user should keep in mind other aspects that may impact the investment. This decision may include carbon footprint reduction, possible rebates for using LED technology, future availability of spare parts and marketing related aspect due to the reduction of energy consumption.

Calculating LED Fitting Return of Investment

Return on investment (ROI) should be estimated before starting a project or to evaluate selecting LED over your current conventional technology.

Calculating ROI requires the initial investment (CapEx) and operation cost (OpEx) of a lighting installation and application.

Estimating CapEx requires the following considerations.

- Costs for replacing the conventional product
- Time to install and/or replace the current installed base
- Cost for the new LED fitting
- Time to replace the current conventional product with LED
- Number of people required for the work (for Ex areas usually two people are required)
- Cost per hour of the installer



Powering Business Worldwide

- Other cost related to renting scaffolding or elevators, if needed
- Other cost related to shut down, if needed
- Tax refunding or rebates

When estimating CapEx, it is important to compare the use of LED technology with the best current conventional alternative. In the case of an installed base, this means the replacement of a lamp to get the installation running without the need of replacing with a completely new fitting.

Estimating OpEx requires additional following considerations.

- Power of the conventional product (light source and ballast)
- Power of the LED product (light source and control gear)
- Cost for the conventional light source to be replaced
- Time to replace the conventional light source
- Other cost related to renting scaffolding or elevators, if needed
- Other cost related to shut down, if needed
- Energy cost per kWh
- Number of hours per year the fitting is on

Understanding ROI calculations

Typically, when comparing conventional technology and LED fitting, only the lifetime of the light source is considered. In this case, the LED light source shows a longer lifetime than a conventional lamp.

The underlying question for the ROI then becomes: **How many times does the conventional light source need to be exchanged before the LED light source reaches its end of life?**

Lighting installation cost can be calculated as a function of the operation time (t).

The formula for this estimation can be described as:

Cost (t) = number fitting * (Capex + Energy (t) + maintenance (t))

Where: Capex considers the initial invest and is calculated as:

Capex = quantity * (product cost + installation cost) + others - rebates

- Installation cost = time for installation * cost per hour of installer * number of installers
- Others = other cost related to renting scaffolding or elevators, shut down
- Rebates = possible tax refunding

Where: Energy(t) considers the energy consumption over time and is calculated as:

Energy(t) = power * time(t) * energy cost /1000

- power = fitting power consumption
- time = total usage of the fitting in hours
- energy cost = energy cost in kWh

Where: Maintenance(t) consider the cost for replacing the conventional light source and is calculated as:

Maintenance(t) = if (t) > n * lifetime Maintenance(t) = n * (cost spare + time for installation * cost per hour of installer * number of installers)

- Where: Lifetime = lifetime of conventional light source

Debunking LED lighting myths

Myth 1: The ballast / control gear of the conventional fitting and LED have the same lifetime and needs to be replaced the same number of times. This is not always the case.

How it really works

With the rapid adaption of LED fitting in the Ex market and with

more and more suppliers in the market, it is now possible to get different performances of the control gear.

In fact, Lighting Europe, the Association of Lighting Manufacturer (refer to LightingEurope.org), as well as ZVEI (German Electrical Association, Lighting Division, refer to ZVEI.org), recommend presenting the lifetime of control gear for LED fitting in datasheet or free available documents as described in the IEC62722.

Myth 2: The lifetime of the light source is the same.

How it really works

A definition of lifetime for LED luminaire is presented in IEC62722. While the lifetime value for conventional light sources is based on the same assumption between different manufacturers, this is not the case for LED.

It is possible to find several descriptions, starting from "system life" to "rated life" or value claiming L70, L70B10, L80 and others (often with value exceeding 20 or 30 years continuous operation).

With Lighting Europe recommendations for lifetime, a comparison is possible. It also mentions, fixing the statistical assumption behind a lifetime and the maximum number of hours to 100,000h. (Refer to [Guidance Paper](#))

Note: Our examples are based on the use of two IECex LED fittings: ExLin, LED linear fixtures for hazardous areas and PXLED, Power Floodlight Series for Hazardous areas. We have implemented the Lighting Europe guideline in the ExLin and PXLED datasheet.

Myth 3: The lifetime is constant over the full temperature range.

How it really works

With LED, the used value should be based on the ambient temperature of the application.

Return on investment (ROI) calculation methods, examples and recommendations

In this section, we review three typical methods for estimating ROI. In these examples, we explain the process and the best option to calculate your total return on investment.

First example

1:1 replacement ROI calculation example

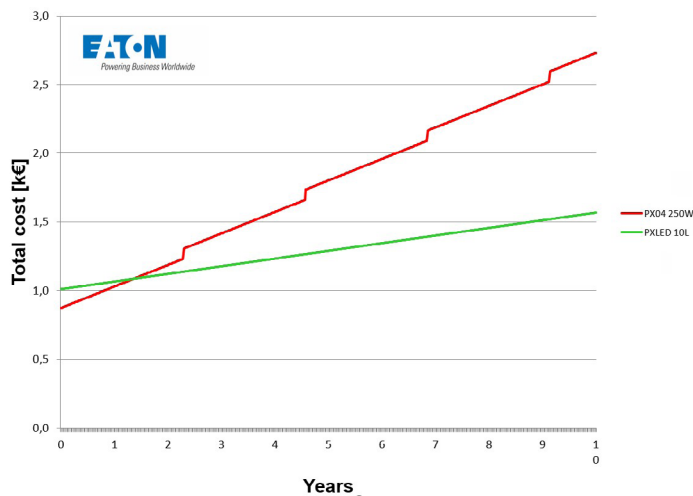
Performing a 1:1 replacement is the fastest method to estimate ROI.

In this case, compare the CapEx and OpEx running cost for a conventional product and the LED option for replacement.

For example, the following features a comparison between a conventional floodlight, such as the PX04 with a 250W HID lamp, against a PXLED 10L LED light. *Note: Unit prices are indicative only.*

		
Model	PX04 250W	PXLED 10L
Number of fitting	1	1
Power	275W	98W
Lifetime*	L70: 10,000h	L90: 100,000h
Unit price	800€	900€
Operation hours	12h/day, 365days/year	
Installation time	30min	
Cost of installer	60€/h	
Energy cost	0.13€/kWh	

With this data, we can estimate the running cost over 10 years. (Demonstrated in the graph below)



A few key conclusions can be concluded from the graph.

- The initial invest on LED fitting is higher than with conventional ones.
- The lower energy consumption of the PXLED is reflected in reduced operational cost over time (see lower slope in the curve).
- The lower lifetime of the HID source requires a replacement every ~2.5 years, resulting in a drastic increase in the cost (see zigzag curve of conventional fitting).

* Lifetime of light source defined as Lx is the time before 50% of the population has a lumen output that is x% of the initial value. Refer to www.lightingeurope.org.

Taking this into consideration, the ROI shows that the initial additional CapEx on PXLED is recovered due to lower OpEx after ~2 years. The point at which the crossing occurs is called payback.

For this example, the payback is estimated as ~1.8 years.

Therefore, choosing an LED fitting would result in a cost saving of ~1,500€ after 10 years.

The calculation is easy to scale to a higher number of fittings with a constant payback and only net savings changing.

A simplified tool to calculate as shown above can be found on our website. ([ROI link](#))

The calculation considers the same number of fittings for conventional and LED, and it focuses only on efficiency and unit cost.

When performing an evaluation of lighting products for the Ex environment, there are other parameters that are also important, such as:

- The use of [Daylight sensors](#) or [Motion sensors](#) can reduce further the operational usage of an LED fitting, considering the robustness of the light source to frequent switching.
- Due to the different electrical characteristic of an LED fitting compared to conventional technology, further modification of the system (breaker characteristic, EMC protection, etc.) can be necessary for a safe use of the new LED fitting, which can generate additional cost.

The 1:1 replacement calculation approach considers LED as a “better light source” compared to traditional fittings. LEDs are a different technology and should be looked in a different way.

Considering LED, a fitting in only a 1:1 replacement for a conventional luminaire is a limited approach and does not allow a full implementation of the advantages of this new technology.

Note: The 1:1 comparison calculation does not consider a superior lighting design, meaning there are no indication on the luminous intensity by using conventional or LED fitting.

Second example

Effective replacement ROI calculation

The effective replacement for existing and new projects ROI calculation is an improvement compared to the 1:1 ROI calculation.

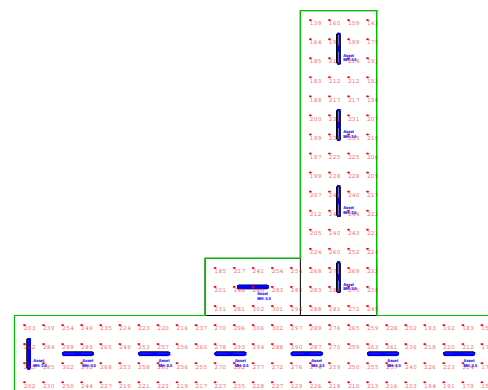
With this calculation, the focus is on the main task of a lighting design, which is providing illumination where required with the lowest effort for the customer.

The first step of this approach is selecting the right LED product and the right quantity to fulfill the lighting task. This means selecting a product with the right quality of light (color temperature, color rendering index) with an optimized optic design.

The easy control of the light source optical beam is one of the main advantages of LED for general lighting applications.

Therefore, a lighting design can help in selecting the correct fitting and the correct quantity. The following is an example to help explain.

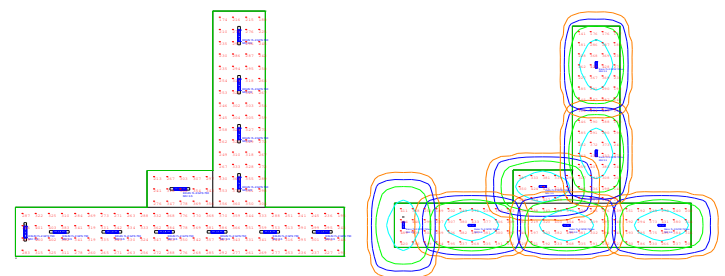
Imagine a room which require 12 total light fittings with 2 x 58 watt fluorescent tubes to reach an illumination level >200 lux on average as shown below.



The same area can be illuminated by replacing the fluorescent fitting with our ExLin 7L LED fitting with standard optic, in which the beam pattern is like the one of the fluorescent lights.

It can make a difference if you are replacing the fluorescent fitting one for one (refer to Alternative A below) or if you decide to utilize the advantage of the different optics and select the ExLin 7L with wide beam optic (refer to Alternative B below).

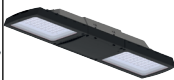
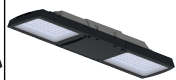
In the graphic below, the difference in lighting design is clear.



Alternative A

Alternative B

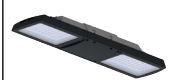
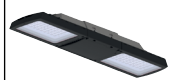
The results are summarized in the table below.

			
Design	Baseline	Alternative A	Alternative B
Fitting used	Fluorescent 2x58W	ExLin 7L standard optic	ExLin 7L wide beam
Number of fittings	12	12	7
Avg. lux	236	304	234
Install. power	1.4kW	0.8kW	0.47kW

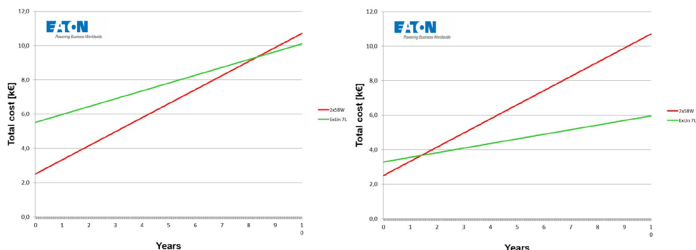
Alternative B requires only 5 LED fixtures in comparison to baseline and Alternative A.

Once the better fitting is selected for this application, a return on investment calculation can be done.

The parameters used are listed below. *Note: unit prices are indicative only.*

			
Model	eLLK 58/58	Exlin 7L standard optic	ExLin 7L wide beam
Power	120W	67W	67W
Lifetime	L70:60kh	L90:100kh	L90:100kh
Unit price	160€	400€	410€
Operation hours	12h/day 365days/year		
Installation time	20min	30min	30min
Cost of installer	60€/h		
Energy cost	0.13kW/h		

The results are shown in the graph below.



Alternative A

Alternative B

The use of lighting design and the choice of the correct fitting can reduce the payback up to 7 years for a payback of ~1.5 years for Alternative B.

While the effective replacement for existing and new projects ROI calculation makes the choice conventional or LED much easier, there are still some aspects not fully covered by this calculation method.

It is important to understand the full system. We explain this in our system consideration ROI calculation on the next page.

Third and recommended example

System consideration for new projects and EPC ROI calculation example

Until now, the calculations focused mainly on the operational savings that can be achieved by using LED fittings. It is also important to consider the complete system to understand the full possible ROI.

By reducing the number of total fittings results in the reduction of the number of cable glands, panels, feeders and breakers required.

The use of fewer luminaires helps reduce the total weight, a very important aspect in offshore construction.

The total lower load of the circuit also reduces the cable dimension and the quantity of copper required.

Other parameters, such as inrush current, should be checked and evaluated. A closer discussion with the end user is required to understand the design guideline to offer a complete cost savings breakdown. For example, plastic panel or stainless steel, B-type breaker characteristic and other design guidelines, may impact the complete cost savings.

A system ROI calculation can be a time consuming and complex effort, but it can really impact your overall return on investment.

We are available to assist you with selecting the most appropriate fitting to achieve optimal cost savings and help improve weight.

Summary

The use of LED fittings can help reduce total cost compared to conventional technology by considering the complete operational lifetime of the product.

The full advantage of LED technology can only be used by validating the application with a lighting design to optimize the general lighting task.

For new project considering the complete system savings including cable glands, panels, breaker, feeder, cables can make an LED solution more convenient by reducing the CapEx cost. The additional savings in weight and total power can optimize the system further and reduce hardware and infrastructure costs.

For more information about Eaton's Crouse-Hinds series harsh and hazardous lighting solutions, visit Eaton.com/lighting.

Additional resources for reference

- www.lightingeurope.org
- www.zvei.org
- [Guidance Paper](#)
- Crouse-Hinds Lighting tool - [ROI link](#)
- [Daylight sensor](#)
- [Motion sensor](#)

For more information about Eaton's Crouse-Hinds series harsh and hazardous lighting solutions, visit Eaton.com/lighting.