Sternberg Lighting

LED retro-fits, *what are you really buying?*

Comparison of "off-the-shelf" units vs. purpose built kits

Cost

When considering an LED retro-fit project one must take into account all facets of the project. To make responsible choices cost, service life, warranty, quality and application all need to be taken into account. This paper will explain facets of LED retro-fit selection criteria from these points of view and will be limited to outdoor lighting products. Tubular fluorescent and recessed down-light retro-fits will not be discussed in this paper.

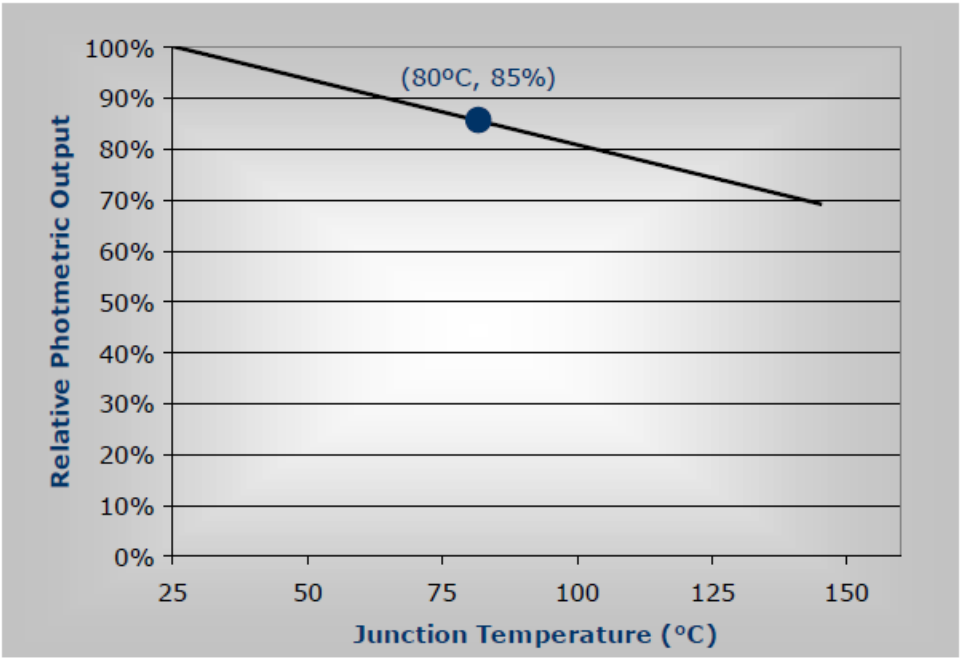
The goal of any LED retro-fit project is to replace old or legacy technologies with current, more energy and cost efficient options. There are many sources for retro-fit products on the market today ranging from the consumer grade products found at DIY stores to kits designed and manufactured by lighting fixture companies specifically for their products. The former ranges from products that take their form factor from traditional lamps to those that will be referred to as "Corn cobs" throughout this document. This paper will focus on the Corn Cob version as that is what most often is selected when Maintenance and service teams choose a retro-fit product.

The primary criteria when selecting a new Corn Cob LED retro-fit solution is price. Corn Cob's are inexpensive, most under one hundred dollars. They are normally built as screw-in styles that allow installers a relatively easy way to get new LED technology into lighting systems. Installers cut supply wires to the ballast and either abandon it or remove it completely. The Corn Cob retro-fit is then screwed into the remaining socket. Since Corn Cob assemblies are self-contained, meaning the driver and LED optic as one assembly, there is no need to make internal connections other than the power supply that was previously severed.

This sounds simple and inexpensive but is it really? In terms of first cost this solution appears to be cheap and simple. But as anyone who has paid for service work knows the real cost is in the labor to install. So let's look at how much a Retro-fit system really costs over its lifetime. We will compare the Corn Cob solution to a purpose built kit from a manufacturer specifically for a reference luminaire.

	Initial cost (lamp)	*Initial cost (labor to install)*	*Life rating*	*Warranty*	*Tested in situ*	*Final Cost*
Corn Cob	< $100	$250-$350	5-10 yr	Limited 1-5 yr	No	$350-$450
Engineered To fit product	$350	$250-$350	> 10 yr	Limited 5 yr	Yes	$600-$700

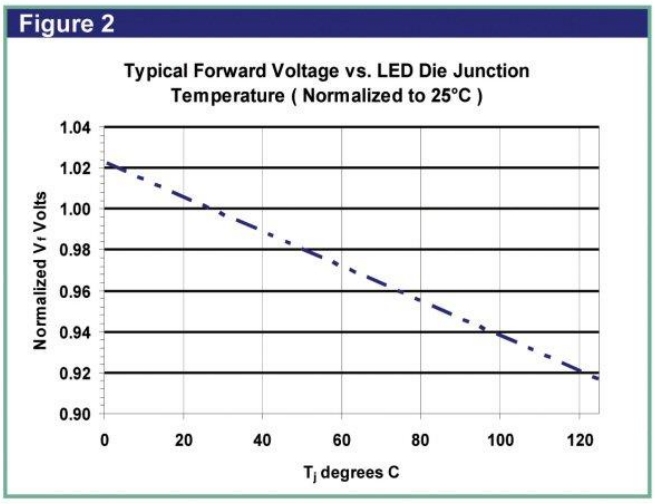
After examining the chart the Corn Cob still looks like an acceptable choice. Let's look closer at the in situ column and what that means. In situ is a term used to describe a product, in this case a retro-fit, tested in its ultimate environment meaning the fixture it will live in. Two very important aspects of in situ are heat dissipation and optical performance. Let's get into thermal management first. Corn Cob apparatus are designed and built as stand-alone items performing and tested in an open socket surrounded by free air. Thermal management is not as important in this case since the moving air around the Corn Cob cools the piece. If, however, the Corn Cob is installed within an enclosure there is no free air movement and heat dissipation is limited by the conductivity of the housing it is installed in. It is a proven fact that the life of any piece of electronics is negatively affected as ambient temperatures rise. The 5-10 year life span will be reduced to 1-3 years. Prior to end of life there will be color shift and lumen output reduction as well as higher power consumption in a fairly linear fashion. Lumen output in relation to junction temperature is shown on the following graph.



*1

Temperatures of 100 degree C are easily realized in an enclosed luminaire and temperatures above that are not uncommon. Keep in mind that the usable life of an LED array of any kind is described as L-70 or 70% of its initial output.

Additionally, consumed power rises as temperature rises making a poor heat management system into a very inefficient power consuming system. See the chart below for data.



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So in review a poorly heat synced luminaire housing with a Corn Cob retro-fit will build up internal heat leading to premature product failure and higher than expected power consumption.

Let's look at our chart of costs now with the new data plugged into it.

	Initial cost	*Initial cost (labor)*	*Life rating*	*Additional lamp changes*	*Cradle to Grave Cost*
Corn Cob	< $100	$250-$350	5-10 yr	2	**$1050-$1250**
Engineered To fit product	$350	$250-$350	> 10 yr	0	$600-$700

You can plainly see that even with one change of the original Corn Cob product the perceived value when only considering first cost is really not there.

Further, there are disposal costs. Responsible disposal of electronics helps our environment but there is a cost to being environmentally responsible. Generally E-Waste costs a city .50c a pound. While not a big deal on a per piece basis it is a large expense to any city.

This paper is addressing outdoor lighting in public spaces and safety is a key element to these types of Municipal and public gathering places. So what is the cost of safety or more importantly what is the cost to having a poor lighting system? It can't be quantified easily but suffice it to say that one law suit due to a lighting outage will make a poor but cheap project too expensive to tolerate for anyone.

One final thought on saving money over buying the right product for the job;

"It's unwise to pay too much, but it's worse to pay too little. When you pay too much, you lose a little money-that is all. When you pay to little, you sometimes lose everything, because the thing you bought was incapable of doing the thing it was bought to do."

John Ruskin, British Social Critic 1819-1900[3]

Engineered Solutions

Purpose Engineered and built retro-fit solutions and Corn Cob products are diametrically opposed in terms of performance and cost. Retro-fit products, as named, imply that a like product in fit and performance has been created to take the place of a legacy technology.

So let's look at what kind of thinking and design concepts go into making a purpose built retro-fit product and how they compare to original design intent and performance.

First, fitment is critical. This means that an ill-fitting retro-fit will not perform as designed since traffic and wind vibration will in all likelihood damage the product over time. So products made as "one size fits all" truly do not work since there are literally thousands of possible luminaire construction combinations. In the end a lighting fixture meant to do a job can be limited in its ability to do so due to poor fitment. Things like attachment points for the retro-fit assembly, electrical feed paths and position of the light source within its housing will determine whether retrofit success is achieved or not.

Loose components will ultimately lead to failures due to vibration from street traffic and wind. Electrical conductors will rub against each other and metal parts causing shorts and outages.

In many "one size fits all" retrofits modifications need to be made to the housing in order to reroute electrical conductors. Drilling holes and bending metal partitions to fit wires will cause abrasions to the cabling and often shorts will occur. In most cases any original UL listing for the luminaire will be void if field modifications are done.

If the installation is incorrect due to fitment flaws the light emitting element of the retro-fit will not be optimized or positioned properly in relation to the lens, roof and housing causing poor optical performance and ultimately less light on the target surface than was planned. Some sockets are too high and some are too low producing light quality issues like shadowing, striations and internal inefficiencies.

Further to the point, retrofit products often use plastic lens covers that yellow over time adding to the degradation of light output as time goes on. Heat and UV accelerate this process shortening the useful life range of the product.

Purpose built retrofit products are designed around a specific product with expected performance results built in to the design process. This allows for predicted results in the field to be much more reliable over time. Retrofits of this type are tested within the housing for which they were designed. Thermal management, fitment, electrical conductor paths and optimized optical performance are all addressed with this type of design ensuring a quality product that performs at or better than the legacy technology it is replacing in all aspects.

An entire series of in situ testing occurs so that performance can be documented and certified while maintaining its UL listing. Other entities within the Lighting profession carefully watch retrofit performance as well including DLC (Design Lights Consortium) and IES (Illuminating Engineering Society). Screw-in type retrofits do not normally do in-situ testing. This can lead to unreliable performance results and possibly premature and catastrophic failures that leave project sites without light and residents without the security provided by good lighting systems.

Another aspect of retrofit design is that of power supply (driver) placement. Screw-in retrofit products have integral drivers usually mounted below the LED arrays while purpose built retrofits generally remote mount the driver in order to isolate heat away from sensitive electronic components. As noted in the section on cost, lumen (light) output of LED's decreases as ambient, and specifically junction temperature, rises beyond 25 degree Celsius. Junction temperature is measured at the point where an LED chip is mounted to its board. The design of an integral driver product that screws into a threaded socket is inherently going to run hotter than a remote mounted driver assembly. When coupled by mounting within an enclosed luminaire that has no or little air exchange with the outside environment dangerous heat buildup can occur further leading to lumen depreciation and shortened life expectancy.

Another point to be made is that of surge protection. Electronic components exposed to high current or high in-rush will be damaged either immediately or over time depending on the severity of the event. The best way to manage electrical over-stress of this type is to design a retrofit with integral surge suppression. Surge suppression when applied properly mitigates over voltage events without damage to sensitive components. Most Corn Cob style products use a minimum amount of protection or none at all. 2kv to 4kv is most common and tend to be "one event" components. In other words one over voltage event will not cause harm but the second time it occurs the Corn Cob product will be destroyed. There is no way to change damaged surge suppression devices in Corn Cob products so once they have been hit they will need to be replaced.

In an Engineered solution the minimum surge protection rating is 10kv and can go as high as 20kv. This assures that the product can take several high current exposures and still keep working as designed with no reduction in light output or loss of life. Quality manufacturers use drivers with built in surge suppression and then add secondary surge protection devices that not only give added protection but cover all three conductors including the ground. In some

cases current can flow back through a grounding system and attack electronic components from the grounding side of a system. Over voltage events don't always occur over incoming power conductors. This is a key point as Corn Cob designs do not account for this type of event.

Lastly, Surge suppression will also help mitigate damage due to Lightning strikes. Systems hit by lightning will often lose several luminaires since the excess power travels in all directions during a strike. With adequate surge protection in a direct strike only the luminaire hit will be lost. Surge protection will save adjacent equipment from damage. Corn Cob devices will be, in all likelihood, destroyed in groups during a lightning event. In an indirect strike a 10kv-20kv surge suppression device would be adequate protection and no equipment damage should occur. Corn Cob devices will have a small chance of survival depending on the amount of current that reaches the equipment. One thing to note however is that since grounding wires are not protected in screw-in Corn Cob products lightning will travel through the ground and have a real possibility of traveling up through the pole grounding system to inflict damage via this unprotected pathway.

Warranty

Warranties are a tricky subject. Some are long with several "gotcha's" so that the company does not have to honor its products quality commitments. Some are of short duration and cover any failure possible. You can tell a lot about a company by its warranty. Are they easy to do business with or are they only interested in taking your money? Are they a reputable company or patently dishonest? Everyone asks these questions but what is a warranty really and what should we expect from one.

Warranties are simply an agreement between a purchaser and a seller of a product or service. Warranties are ***not*** a statement of quality! That being said the industry average for retrofit products of reasonable quality is 5 years. These warranties are normally full of verbiage that disqualifies claims for any number of reasons related to electrical stress put on a product or perceived abuse by the customer. In short, the burden of proof of failure lands on the consumer. Since most of the time customers don't read the fine print and the first cost was under one hundred dollars a replacement is just paid for to be expedient. Using the math from the chart above you can easily see that any savings realized when considering first cost to purchase will be gone with one warranty replacement. Even if the company covers the cost of the retrofit they most often will not cover the cost to install the new product. This is where the majority of the expense lies.

Conclussion

Be very careful when considering an LED retro-fit product. Ask these questions;

- How long has the company been in business
- Does the warranty allow for replacement for "reasonable" issues
- Does the retro-fit product fit the Luminaire by design

- Is the UL listing for the luminaire effected by the installation of a retro-fit (Luminaire manufacturer to answer this question not the retro-fit company)
- What is the life cycle cost including labor to install or replace
- What is the projected life of the retro-fit in the housing it will be mounted in

Here is some advice to help you along the way;

- Be armed with knowledge prior to buying a retro-fit product
- Know all the product facts and the downstream impact of those facts
- Try to buy from the luminaire manufacturer to ensure proper fit and performance
- Make sure the warranty you get is one you can live with.

retro-fit comparison

FEATURES:	 CORN COB	 PURPOSE BUILT RETRO-FIT
INITIAL COST	✓	
SERVICE REPLACEMENT COST		✓
WARRANTY SERVICE COST		✓
OUTAGE COST	✓	✓
DISPOSAL		✓
EASE OF INSTALLATION		✓
CRADLE TO GRAVE COST:	$1050 – $1250	$600 – $700