The Myth of Large Energy Savings of LED Tubes

One popular retrofit option for T8 fluorescent fixture is to use electronic ballast compatible, tubular LED tubes (also known as **Type A TLED**). Type A TLED manufacturers often claim that it is the simplest and cheapest solution for fluorescent light upgrade – just pop out the fluorescent tubes and put in a TLED tube and save 40% energy(?) Sounds easy, right?

Not so fast. In this article we will examine the energy saving claims for TLED and some issues that you should be aware of when considering the LED tubes for your lighting upgrade.

We will analyze the energy savings using a popular retrofit option, which is to replace 32W T8 fluorescent tubes with 17W LED. We present our findings for 1-tube, 2-tube and 4-tube fluorescent fixtures. You will be surprised to learn that the energy saving math is a lot more complex than what the rated power ratings suggest.

If you are in a hurry, we have summarized our analysis in the following table for your quick reference. We will then explain in details how we arrived at these numbers in the rest of this article.

	Singe Tube Fixture	Two-tube Fixture	Four-tube Fixture
Input power: 32WT8 FL	28W	56W	112W
Input power: 17W TLED	22W	39W	75W
% Energy Saving	21%	30%	33%

Note: There are also installers who might propose using 12W TLED to replace 32W fluorescent in order to increase the energy saving percentage. We believe this could lead to underlighting which is something you need to check. While underlighting may be acceptable in some applications, you do risk serious complaints if the users feel that they are getting less light than previously after they have spent the money on a "new" light.

Theory And Calculation Details

T8, T12, magnetic ballast and e-ballast

A quick primer for those who are not familiar with fluorescent lighting: A fluorescent light requires a "ballast" to operate properly. Older T12 (1.5-inch diameter) fluorescent lights use "magnetic ballast". Modern T8 (1-inch diameter) fluorescent fixtures mostly deploy electronic ballast (e-ballast) and you must know what type of fluorescent tubes and ballasts you have before you rush out to buy TLED to replace your fluorescent lamps.

The reason is that the magnetic ballasts used on T12 fixtures do not work with most Type A TLED. Few manufacturers today want to invest in making magnetic ballast compatible TLED because these ballasts are energy hog themselves and a magnetic ballast alone consumes between 14W to 25W during

operation before it gives out any light. It is also an obsolete 20th century technology that is no longer used in any new fluorescent fixtures manufactured in the past two decades.

So if your current fixture is T12 you are out of luck with Type A TLED, unless you want to spend the money to replace the fossilized magnetic ballast with the soon-to-be obsolete e-ballast, which doesn't make sense.

However, if your fixture is T8 with magnetic ballast, then TLED "may" be a workable option. Among e-ballasts, there are also many "species" – "Instant Start", "Rapid Start", "Program Start" and "Dimming" ballasts. Many TLED tubes will work with "Instant Start" ballast only but will not work with the other e-ballast types. Some new TLED tubes do work with more e-ballast types but not all of them. Even tier-one manufacturers such as Philips only claim that their TLED tubes work with 80% of ballast on the market. This also means that there is a 1 in 5 chance that your TLED tube may not work with your e-ballast. So you have to check your ballast type against the TLED spec sheet to ensure that your e-ballast is compatible to the TLED you have in mind.

TLED Saves 40% Energy - Really?

A popular suggestion is to replace a 32W T8 fluorescent lamp with a 17W Type A TLED. One may rush to do a quick calculation and conclude that the energy savings = (32-17)/32 = 46% right? **WRONG**! This is because of another two other terms that most people aren't familiar with: the "ballast factor" and the ballast loss.

The electronic ballast itself consumes between 5 to 8W of power when there is no fluorescent tube. This is known as "ballast loss" Ballast loss increases when a fluorescent tube is installed and can increase to 13W in a four-tube fluorescent. However, our tests showed that when a TLED is installed the ballast loss seems to remain the same as the no-tube reading.

What about ballast factor? What you should know is that for fluorescent light, the actual T8 fixture input power = lamp rated power x ballast factor. The fixture input power already takes into account the ballast loss when applying the ballast factor in the calculation. It seems like the industry has defined a "normal" ballast factor to be 0.88 and which is applicable to most indoor fluorescent fixtures.

On the other hand, the TLED rated power of 17W DOES NOT include the ballast loss. For one and two-tube fluorescent ballasts we tested, the ballast loss = 5W and for a four-tube fluorescent ballast the ballast loss = 7W. The ballast loss is to be added to the rated power of TLED.

Armed with the above information, we now compute the potential energy savings of TLED:

Single-Lamp Fluorescent Fixture

32W T8 Fluorescent input power = 32W x 0.88 = 28W

17W TLED input power = 17W + 5W = 22W

% Energy savings = (28-22)/28 = 21%

Two-lamp Fluorescent Fixture

2 x 32W T8 Fluorescent input power = 2 x 32W x 0.88 = 56W

2 x 17W TLED input power = 2 x 17W + 5W = 39W

% Energy savings = (56 – 39)/56 = 30%

Four-lamp Fluorescent Fixture

4 x 32W T8 fluorescent input power = 4 x 32 x 0.88 = 112W

4 x 17W TLED input power = 4 x 17 + 7 = 75W

% Energy savings = (112 – 75)/112 = 33%

Why Use Alec SLC?

The ALEC Smart LED retrofit kit (SLC) does not use the ballast or the lamp holders at all and therefore can be used to retrofit T8 or T12 fluorescent light. The LED light in SLC is dimmable from 5 to 100% and the controller in SLC automatically dims the light when it is not needed, such as when nobody is around or when there are sufficient daylight. As a result ALEC SLC energy savings is largely dependent on the what you set for the working brightness, dimming brightness and the percentage of time the space is being utilized.

For example, a two-strip SLC can be used to retrofit a 2-tube or 4-tube LED light. At 100% brightness a 40W SLC is brighter than 4 tubes of 32W T8 LED in a fixture with normal ballast factor. Since the working brightness is adjustable you can dim the light to match the original fluorescent brightness, or make it brighter or dimmer than the original fluorescent fixture. For spaces such as stairwell and carpark, you can set the vacancy brightness to just 10%, using only 4W per fixture. The space utilization (percentage of time the space is occupied, which require full working brightness) is key to the energy savings.

Assuming SLC is used to retrofit fixtures in a space that is occupied 20% of the time, and that the working brightness = 50% (20W) and vacancy brightness = 5% for 1 and 2-tube fixture. Also assuming that we set working brightness to 100% (40W) and vacancy brightness to 10% (4W) for a 4-tube fixture:

	Singe Tube Fixture	Two-tube Fixture	Four-tube Fixture
Input power: 32WT8 FL	28W	56W	112W
Input power: Smart LED (SLC)	5.6W	5.6W	11.2W
% Energy Saving	80%	90%	90%

The following page shows the calculation of the energy consumption of SLC vs T8 LED with respect to the space utilization and minimum brightness settings.

Alec Smart LED Retrofit Kit vs 2xT8 LED Tubes

SLC1 24FxxK				
Maximum power (W)	40	40	40	40
Minimum %	5%	10%	15%	25%
Minimum power (W)	2	4	6	10
Space Utilization	Average Power			
1%	2.38	4.36	6.34	10.3
5%	3.9	5.8	7.7	11.5
10%	5.8	7.6	9.4	13
20%	9.6	11.2	12.8	16
30%	13.4	14.8	16.2	19

T8 LED tubes 17W x 2 + 4W e-ballast loss				
Maximum power 100%	39	39	39	39
Minimum power (W)	39	39	39	39
Space Utilization	Average Power			
1%	39	39	39	39
5%	39	39	39	39
10%	39	39	39	39
20%	39	39	39	39
30%	39	39	39	39

Operating hours / year	8760	
Electricity rate (BC) $/kwh	0.15	/kWh
Set Minimum brightness =	10%	

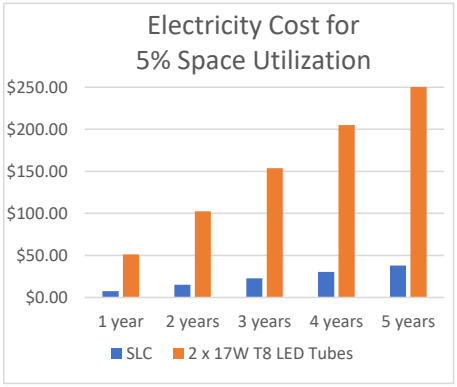
Electricity Bill per year SLC

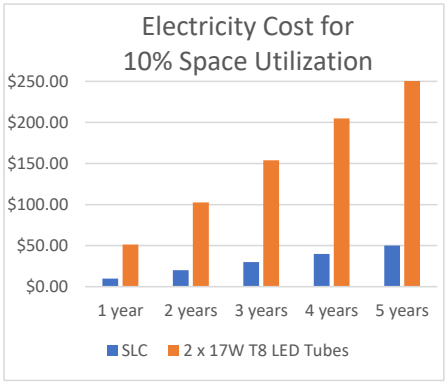
5% Space Utilization	1 year	2 years	3 years	4 years	5 years
SLC	$7.62	$15.24	$22.86	$30.48	$38.11
2 x 17W T8 LED Tubes	$51.25	$102.49	$153.74	$204.98	$256.23
Extra Savings Using SLC	$43.62	$87.25	$130.87	$174.50	$218.12

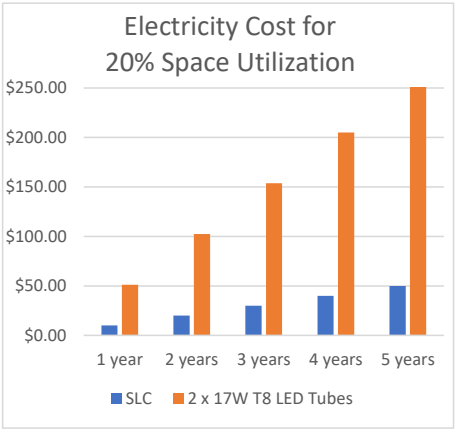
10% Space Utilization	1 year	2 years	3 years	4 years	5 years
SLC	$9.99	$19.97	$29.96	$39.95	$49.93
2 x 17W T8 LED Tubes	$51.25	$102.49	$153.74	$204.98	$256.23
Extra Savings Using SLC	$41.26	$82.52	$123.78	$165.04	$206.30

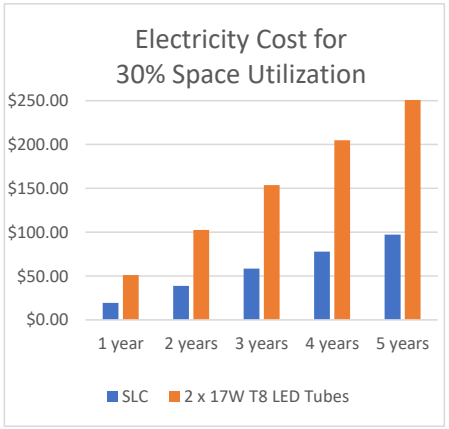
20% Space Utilization	1 year	2 years	3 years	4 years	5 years
20%	$14.72	$29.43	$44.15	$58.87	$73.58
2 x 17W T8 LED Tubes	$51.25	$102.49	$153.74	$204.98	$256.23
Extra Savings Using SLC	$36.53	$73.06	$109.59	$146.12	$182.65

30% Space Utilization	1 year	2 years	3 years	4 years	5 years
30%	$19.45	$38.89	$58.34	$77.79	$97.24
2 x 17W T8 LED Tubes	$51.25	$102.49	$153.74	$204.98	$256.23
Extra Savings Using SLC	$31.80	$63.60	$95.40	$127.20	$158.99









Note: ALEC SLC1-24FxxK at full brightness will be 50% to 100% brighter than 2 x T8 LED tubes (ground Lux readings)