The Life-Cycle Cost Method
For Evaluating Alternative Lighting Systems

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Abstract

When evaluating the cost of alternative lighting systems, the smart investment will be the one that costs the least to own *and operate*. Because operating expenses over the life of a lighting system can be more than 10 times greater than the first cost, the prudent financial decision maker will consider all of the costs associated with each alternative—including a projection of future expenses.

This paper presents a widely accepted method for evaluating the true costs of a lighting system—the life-cycle cost method. The life-cycle cost takes into account all costs—the installed cost, the cost of capital (or time-value of money), and the operating and maintenance expenses that are incurred over the life of the equipment. Although a computer is required for calculating the life-cycle cost, the methodology is readily available in standard spreadsheet programs. But beware of the limitations inherent with the more simplistic approaches. For example, the “simple payback” calculation ignores the life-cycle implications of operating and maintenance costs, which can yield very shortsighted financial decisions that fail to maximize profit or minimize costs.

The steps presented below will guide you in understanding the benefits of this least-cost approach. Note that this method can be used for evaluating alternatives being considered for either new construction or retrofit. In either case, simply choose the alternative with the least life-cycle cost—the lowest overall cost.

Follow the example below to see how the life-cycle cost is determined. This example compares the life-cycle cost of an existing T12 lighting system to the life-cycle costs of two alternatives: 1) replacing existing fixtures with half as many Ergolight lighting systems with integrated controls, and 2) replacing existing T12 lamps and ballasts with T8 components.

Step One: Count the Costs

The first step in determining the the life-cycle cost is to quantify the costs associated with all of the alternatives. These costs should be quantified as follows:

- ✓ Installed cost (materials & labor)
- ✓ Energy cost per year
- ✓ Maintenance (relamping) cost per year

A spreadsheet program can be used to calculate these values.

Step Two: Forecast Operating and Maintenance Expenses Over Time

Next, we need to forecast the cost of operating and maintaining the lighting system over the life cycle. But how long is the life cycle? In most cases, owner-occupants will either 1) keep lighting systems in place for at least 20 years, or 2) move out of the facility within 20 years. Well-established businesses and institutions should assume a 20-year life cycle for the analysis; businesses that have uncertain future plans should use a shorter term. *Note, however, that underestimating the life-cycle term can yield decisions that do not maximize profit or minimize cost.*

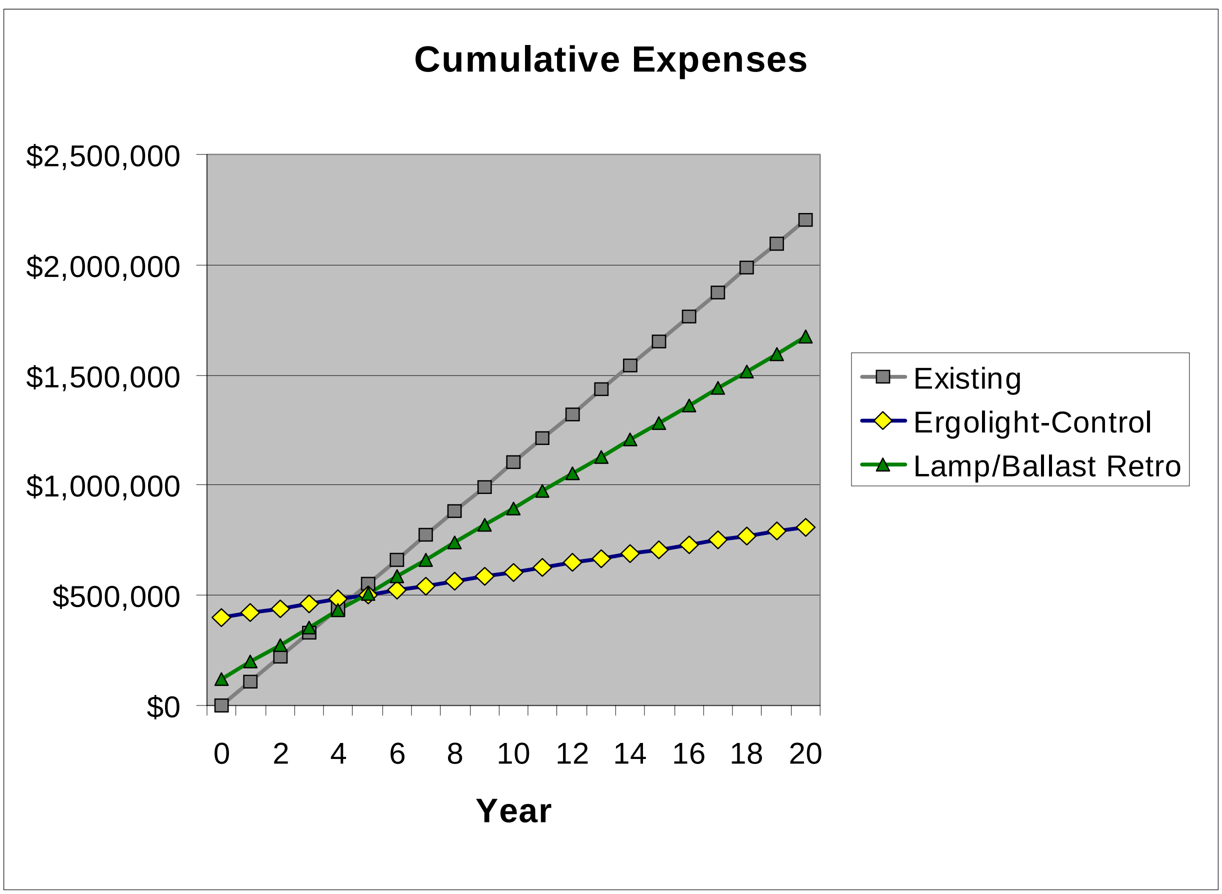
When projecting operating and maintenance costs over time, include an estimate of inflation to reflect expected long-term price increases in materials, labor and energy. With this information, you can now calculate the total cost of purchasing, operating and maintaining the lighting system over the life cycle. So far, we have considered all of the life-cycle costs except for the time-value of money. We will address this cost in step three.

To illustrate the first two steps, consider the example below. In this simple example, the effect of inflation has not been included.

	Existing System	Ergolight-Control	Lamp/Ballast Retro
Installed Cost	$0	$400,000	$120,000
Annual Energy Cost	$101,883/yr	$17,810/yr	$69,189/yr
Annual Maintenance Cost	$8,400/yr	$2,730/yr	$8,400/yr
20-Year Total Cost*	$2,205,660	$810,800	$1,671,780/yr

*First Cost + 20 years x (Annual Energy Cost + Annual Maintenance Cost)

In this example, we see that over the 20 years, we will be paying much more money to keep the existing system in operation, compared to investing in more efficient alternatives. This cash flow example is presented graphically below:



Note that the alternative with the highest installed cost (year 0) required the least amount of money to be spent over the 20-year period. However, in order to achieve the life-cycle cost advantage shown here, you would have to wait 20 years. Therefore, let's proceed to step three, which takes into account the cost of capital and translates this *future* benefit into *today's* equivalent benefit.

Step Three: Determine the Present Value of Future O&M Costs

To take into account the cost of capital (or the time-value of money), future operating and maintenance (O&M) costs must be translated into their "present value". In the same way that *interest rates* translate a present value (today's investment) into a future value (principal plus interest), *discount rates* translate future costs into present value costs. *The present value calculation is simply the interest rate calculation working in reverse.*

Why translate future costs into the present value? By expressing all future costs in their present value, we can express the total life-cycle cost of a lighting system as a single dollar amount, payable *today*. In this way, we can compare vastly different lighting system cash flows with "apples-to-apples" objectivity, while taking into account the time-value of money.

What discount rate should be used? Typically, the value should be related to the financial returns that your organization expects to yield on low-risk capital investments. Most organizations have a specific discount rate that is used for evaluating capital investments. For example, the Federal Government's life-cycle cost analyses currently assume a 5.7% annual discount rate; private-sector discount rates are usually higher—in the 10-14% range.

Using a standard "net present value" (NPV) spreadsheet function, each future cost in our example is discounted to the present value using the following formula:

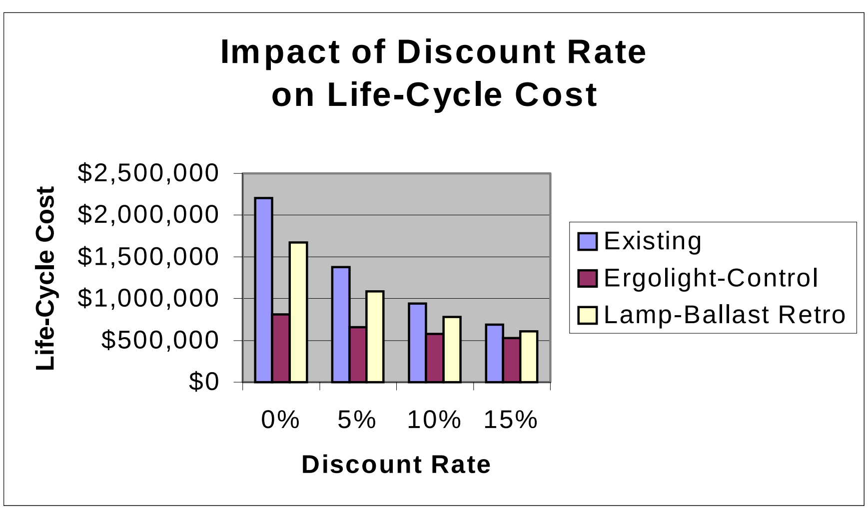
$$\text{Present Value} = \text{Future Cost} \times (1 / (1 + \text{Discount Rate})^n)$$

Where *Discount Rate* is expressed as an annual decimal value and
n is the number of years from today that the future cost occurs in the cash flow

Now, back to our example. The table on the next page shows the effect of discounting future accumulated expenses into a single value expressed in an amount payable today. Note that the effect of discounting becomes more pronounced as the analysis term (in years) is increased. Assuming a 20-year analysis term, the life-cycle cost is the value under the Present Value heading for the 20th year, indicated in **bold**.

In this example, the most expensive option is to do nothing. The LCC of the existing system is $938,900, which if invested today in an account earning an assumed 10% interest rate (discount rate), will be just enough money to pay for the future O&M costs over the next 20 years. The least-cost alternative is the Ergolight lighting system with controls. Here, we only need to invest a total of $574,865 in the 10% interest account today to pay for the installation *and* the future O&M costs over 20 years.

To illustrate the impact of the time-value of money, the graph below shows the life-cycle cost for each alternative, using a variety of discount rates.



Example Cash Flow Analysis

Term	Base Case:	40W T12 System		Option 1:	Ergolight-Control		Option 2:	Lamp/Ballast Retro	
Years	**Cash Flow**	**Total Expense**	**Present Value**	**Cash Flow**	**Total Expense**	**Present Value**	**Cash Flow**	**Total Expense**	**Present Value**
0	$0	$0	$0	$400,000	$400,000	$400,000	$120,000	$120,000	$120,000
1	$110,283	$110,283	$100,257	$20,540	$420,540	$418,672	$77,589	$197,589	$190,536
2	$110,283	$220,566	$191,400	$20,540	$441,079	$435,647	$77,589	$275,178	$254,659
3	$110,283	$330,849	$274,257	$20,540	$461,619	$451,079	$77,589	$352,767	$312,953
4	$110,283	$441,132	$349,582	$20,540	$482,158	$465,108	$77,589	$430,356	$365,947
5	$110,283	$551,414	$418,059	$20,540	$502,698	$477,861	$77,589	$507,946	$414,124
6	$110,283	$661,697	$480,311	$20,540	$523,237	$489,455	$77,589	$585,535	$457,921
7	$110,283	$771,980	$536,903	$20,540	$543,777	$499,995	$77,589	$663,124	$497,736
8	$110,283	$882,263	$588,351	$20,540	$564,316	$509,577	$77,589	$740,713	$533,932
9	$110,283	$992,546	$635,122	$20,540	$584,856	$518,288	$77,589	$818,302	$566,838
10	$110,283	$1,102,829	$677,641	$20,540	$605,395	$526,207	$77,589	$895,891	$596,752
11	$110,283	$1,213,112	$716,294	$20,540	$625,935	$533,406	$77,589	$973,480	$623,946
12	$110,283	$1,323,395	$751,434	$20,540	$646,474	$539,950	$77,589	$1,051,069	$648,668
13	$110,283	$1,433,677	$783,379	$20,540	$667,014	$545,900	$77,589	$1,128,659	$671,143
14	$110,283	$1,543,960	$812,420	$20,540	$687,553	$551,308	$77,589	$1,206,248	$691,575
15	$110,283	$1,654,243	$838,820	$20,540	$708,093	$556,225	$77,589	$1,283,837	$710,149
16	$110,283	$1,764,526	$862,821	$20,540	$728,633	$560,695	$77,589	$1,361,426	$727,035
17	$110,283	$1,874,809	$884,640	$20,540	$749,172	$564,759	$77,589	$1,439,015	$742,385
18	$110,283	$1,985,092	$904,475	$20,540	$769,712	$568,453	$77,589	$1,516,604	$756,340
19	$110,283	$2,095,375	$922,507	$20,540	$790,251	$571,812	$77,589	$1,594,193	$769,027
20	$110,283	$2,205,658	**$938,900**	$20,540	$810,791	**$574,865**	$77,589	$1,671,782	**$780,560**
Year	**Cash Flow**	**Total Expense**	**Present Value**	**Cash Flow**	**Total Expense**	**Present Value**	**Cash Flow**	**Total Expense**	**Present Value**

Conclusion

Once these calculations have been completed, the financial decision is simple: Choose the lowest life-cycle cost—it is in your best financial interest to do so. In general, larger investments that yield greater savings will yield the best overall financial performance—but not necessarily the fastest payback period.

This least-cost approach can be used to evaluate a wide variety of projects and financing mechanisms. If the project is to be funded with a lease or shared savings agreement, the owner's projected payments are added to the O&M expenses over time. In all cases, the calculation of life-cycle cost will yield the most accurate indication of the project's financial performance.