Why You May Not Get the Savings You Expect from Your Electricity Saving Project

By Paul Grover, MS

"We have all seen bad assumptions generate calculated savings exceeding what could possibly be saved. Sometimes I purchase more efficient equipment based on the importance of it 'being more efficient' as the 'right thing to do over a pure ROI decision."

This is a candid comment from Frank Joy, P.E., director of plant operations & maintenance at Santa Fe Community College, on how his school measures energy savings and calculate dollar savings for energy projects.

There are a variety of methods used to calculate savings. This article will explore two generic ways to calculate savings from energy projects and to examine and illustrate some of the pitfalls that occur when savings are calculated using commonly-used "average cost per kWh" approach.

More than one million pounds of steam are used each year to help heat Love Library, which has 416,649 sq. ft. of floor space on the campus of the University of Nebraska-Lincoln.

Kirk Conger, P.E., mechanical engineer in the facilities management and planning department at the University of Nebraska-Lincoln, uses a common method.

"Normally I use power *hours/year* current energy price," Conger said. "The only time I calculate energy separately from demand is for actual equipment replacement, like to replace ballasts."

Carol Dollard, P.E., LEED AP, utility engineer at Colorado State University approaches the task of quantifying energy savings in a similar fashion.

"We estimate savings based on energy saved and then multiply by current rates to get dollar savings," said Dollard. "We use a blended cost per kWh when appropriate, but use separate demand and energy costs when we have to—for example, when a measure will save energy primarily off-peak demand times."

Conger adds that it can also be challenging to present savings figures to non-technical administrative staff. "I correct everything to current fuel prices," he said. "That way, you don't have to specify the baseline prices—it's one less thing for decision makers to wonder about."

TWO METHODS OF CALCULATING ELECTRICITY PROJECT SAVINGS

When replacing individual pieces of equipment, such as ballasts and lights, it is relatively straightforward to measure the power used by the new equipment and subtract it from the power used by the old equipment (this approach assumes that the new equipment will be used the same number of hours). So you can calculate the kWh and/or KW savings and multiply them by the hours of operation and the cost of power. Your understanding of the electricity tariff (rates) will have a profound effect on your calculated savings.

When replacing more complex building energy systems or measuring the effects of operational efficiency changes, you must use a "baseline" (expected future costs based on past meter and energy data) to calculate energy unit and cost reductions. Baselines can be created from utility meter data or private sub meter data. This creates some challenges since you can have many buildings on one meter or one building with several meters. But the smallest increment of measurement is a meter. There can be challenges in developing baselines and adjusting them for changes, but they can be an absolute measure of unit energy savings and, in some case, the only measurement approach.

Regardless of which approach you use, the question remains: "How do I convert the energy unit savings into accurate and defensible dollar savings when energy rates and prices are changing rapidly?"

Table 1: Savings Calculations Using Different Average Costs per kWh

Source	Exelon HT Rate	EIA for PA	Total Bill Divided by Total kWh
Avg. Cost	$0.0505/kWh	$0.089/kWh	$0.0944/kWh
Savings	**$3,346**	**$5,896**	**$6,253**

For actual monthly bill of 265,000 kWh costing $25,012
Savings for a 25% kWh reduction (66,250 kWh)

Table 2: Savings Calculations Using Different Average Costs per kWh and Using Rate Tariff

Source	Exelon (PECO) HT Rate	EIA for PA	Total Bill Divided by Total kWh	Actual Savings by Rate Tariff
Avg. Cost	$0.0505/kWh	$0.089/kWh	$0.0944/kWh	
Savings	**$3,346**	**$5,896**	**$6,253**	**$1,949**

For actual monthly bill of 265,000 kWh costing $25,012
Savings for a 25% kWh reduction (66,250 kWh)

Chart 1

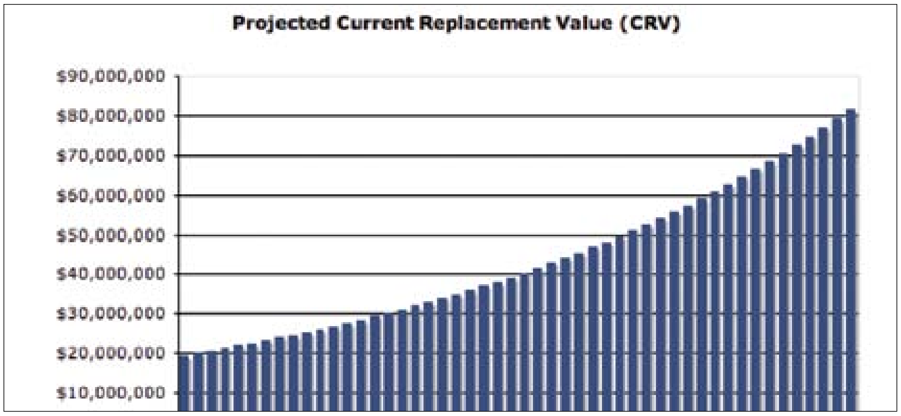
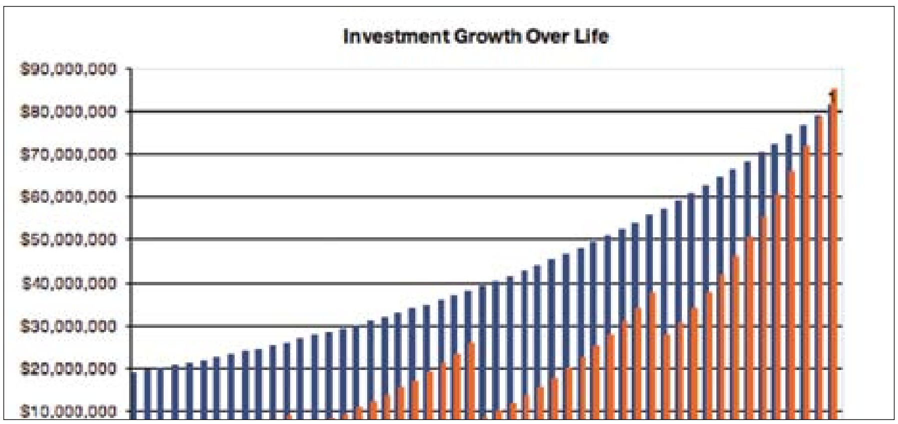


Chart 2



standable. Understanding electricity tariffs and calculating electricity savings is another story.

Reducing energy use is an important decision that should be based on sound financial data, measurements and calculations. However, most educational institutions are making economic decisions based on inaccurate (inflated) dollar savings projections so the period needed to recoup their investment is much longer than they are told. Let's look at how this happens.

WHAT CAN HAPPEN WHEN YOU USE AN AVERAGE COST PER KWH APPROACH

Most energy saving companies, consultants and government entities use an average cost per kilowatt-hour (kWh) to calculate dollar savings for their energy projects. The building owner is told that the average cost per kWh times the number of kWh saved is your projected dollar savings. On its face, this is a reasonable and traceable method. In reality, however, it often grossly overstates the savings.

There are a variety of ways to derive an average cost per kWh. Such numbers can come from utilities, government statistics or from dividing the cost, or some portion of the cost, of a bill(s) by the number of kWh used.

As an example, we'll take a monthly bill from one of our clients, a university campus in Pennsylvania, which is on the PECO Energy Company (Exelon) High Tension (HT) electricity rate.

- The Exelon website gives the average price for the PECO HT rate: $0.0505/kWh in 2007. *http://www.exeloncorp.com/ourcompanies/peco/pecobiz/energy_rates/energy_choice/pricetocompare.htm*
- The U.S. Energy Information Agency website provides the average price of electricity to commercial customers in Pennsylvania is about $0.089/kWh in September 2006. *http://www.eia.doe.gov/cneaf/electricity/epm/table5_6_a.html*
- If we divide the total cost of the school's September 2006 electricity bill of $25,012 by the number of kWh used that month (265,000), we come up with a cost of $0.0944/kWh.

If we reduce the kWh use of this building in this month by 25 percent—or 66,250 kWh—Table 1 (on page 53) shows the dollar savings calculations using the three "average costs per kWh" numbers listed above:

Any of these three numbers is commonly used to calculate savings. The problem is that they don't correspond to the actual savings the building will realize.

The amount of money your energy reduction project will save depends primarily on the number of kilowatt-hours of use (kWh) *and the kilowatts of demand (KW)* reduced each month and throughout the year, not just the kWh reduced. Your actual dollar savings depends on how these two are linked through winter, summer, heating, demand ratchets and rate blocks, just to name a few of the variables. Some commercial electricity tariffs are mind-boggling, containing 30 or 40 or more independent and linked variables. But it is these complex rate structures that determine your bills and savings.

If you want accurate financial savings, you must first research, model and verify the formulae for the rate structures that comprise the applicable tariff. So when you plug in the kWh and kW numbers for the month, along with others numbers such as power factor, sales tax, energy efficiency surcharges and so forth, you will come up with the same cost as the utility for that month and tariff.

In our school building example, we already know the kWh, KW and cost (and other variables) of the monthly bill. To get the real savings from your energy reduction effort, enter the reduced kWh values into our algorithm of the tariff and calculate the actual bill. The difference between the bill without the kWh reduction and the bill that reflects the kWh reduction is your actual savings. In real life, we would set a baseline cost for that month and subtract the current month bill from the baseline cost to calculate the real savings.

We can now compare the "savings" from the three average costs per kWh to the actual reduction calculated from the model of the tariff (Table 2, on page 53).

WHY AVERAGE COST PER KWH USUALLY OVERESTIMATES SAVINGS

If we chart the algorithms for this tariff, we can see how all the interlocked variables and rate block costs actually contribute to the bill. Chart 1 (page 54) shows the different cost blocks produced by this particular building with its unique kWh use and KW demand relative to the PECO HT tariff (every building uses different amounts of electricity and its interactions with the rate will be different).

Because of the complexity of the interactions between kWh and KW, we can see that there are three different pricing blocks for kWh use. The first block of use is charged at about $0.18/kwh while additional blocks cost much less. Note that this first block accounts for $17,219 of the $25,012 bill.

Here's the million-dollar question. If we reduce kWh use by 25percent, from which blocks did the dollar reductions come? The answer is in Chart 2 (page 54).

In this example, and in many cases, reductions are weighted toward the least expensive kWh blocks. So if most of your kWh reductions came from the block priced at $0.03/kWh, your actual savings will be much less than if you used an average cost per kWh of $0.089/kWh.

Educational institutions need and deserve accurate data and numbers to make sound financial decisions. Your actual dollar savings depends on the structure of the tariff and the electricity consumption of the particular building. The only way to accurately quantify savings and paybacks for energy reduction projects is to enter actual kWh, KW, and other pertinent values into the algorithm of the tariff and calculate dollar savings. Otherwise, your savings may be inflated, in some cases by a factor or two or three, and the paybacks on your investments much longer than promised or expected.

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