[Published in *Energy Engineering*, Vol. 109 (5), 2012]

Energy Conservation Also Yields: Capital, Operations, Recognition and Environmental Benefits

"CORE" Benefits are Highly Probable and Worth a Double-Digit Improvement to Energy Savings

Eric A. Woodroof, Ph.D, CEM
Wayne C. Turner, Ph.D., PE, CEM
Warren Heffington, Ph.D., PE, CEM
Barney Capehart, Ph.D., CEM

A Peer Reviewed Publication

ABSTRACT

Previous research indicates there are additional (often unreported) benefits from saving energy.[1,2] This paper identifies these "additional benefits" and describes how to calculate their value.[3,4] In addition, we found a high percentage of facility managers experienced some of these benefits. For example, in a recent survey, 92% of facility managers experienced reduced maintenance material costs as a result of energy conservation (primarily because lights, filters and other equipment lasted longer when operated less hours per year). Due to site-specific factors, not all facility managers will experience every benefit, however a high percentage of respondents (92%, 71% and 63%) did experience three of the six "additional benefits" surveyed. Because facility managers do receive some of these "additional benefits", we developed two approaches to quantify their value. When applicable, these benefits should yield a direct and verifiable dollar savings a majority of the time. Via a simple example, we calculated these benefits to be worth approximately 31% of additional value beyond the direct energy dollar savings (and that was only applying half of the possible benefits). There are other benefits that defy quantification, some of which we list at the end of the paper for use in future research and when evaluating energy conservation projects and programs.

OUTLINE

---

1 Woodroof, E., Turner, W. and Heinz, S. (2008), "The Secret Benefits from Energy Conservation Contribute Value Worth An 18% Improvement To Energy Savings", *Strategic Planning for Energy and the Environment, Vol 28(1).*

2 Komor, P., (1999), "Selling Energy Efficiency: Multiple Benefits, Multiple Messages", *E Source: The Large Commercial Series LC-1 Report- April 1999.*

3 This paper is focused on "additional benefits" that occur as a result of classic energy conservation techniques- primarily turning off equipment when not needed or by optimizing equipment to reduce wasteful losses. These are actions that usually do not require a capital investment. *Additional research would be required to include energy efficiency measures that require capital investments, which do save energy, but may require the systems to be "on" to save energy. Additional examples of such projects include: installing more efficient equipment such as new chillers, different light sources, or any measure that saves energy not through demand-side reductions.*

4 These "CORE Benefits" have also been labeled as "Secret Benefits" as well as other acronyms such as "MAC", which means "Maintenance, Administrative and Capital" Benefits.

Approach #2
Supplementary Benefits
Conclusion

INTRODUCTION

During a diet, when a person does not "over eat", they are likely to receive benefits that extend beyond weight loss. The person may be happier, live longer, have increased stamina and avoid other disease as well as medications. Similarly, the benefits of putting a building on an "energy diet" extend beyond the reduction of energy expenses. Such benefits can include very tangible and measurable values such as reduced material and labor costs, as well as other "soft" benefits such as increased productivity and morale, although "soft" benefits are not calculated within this article.[5]

This article quantifies the additional tangible benefits from demand side energy conservation activities (reduced operational hours).[6] If a benefit was difficult to quantify, we still identified it, but did not estimate savings. *Note to readers: if you see additional ways to quantify benefits, or if there are other benefits we did not include, please contact the primary author (Dr. Woodroof) who will continue this research.*

EXAMPLES OF "ADDITIONAL BENEFITS" FROM ENERGY CONSERVATION

The "Additional Benefits" are explained with examples to illustrate the value that they represent. The benefits we identify below usually apply to a facility's capital, operations, maintenance, administrative, marketing, environmental and/or other budgets.

1. Reduced Maintenance Material Costs[7]
Example: If lights are not "on" as many hours, they may not burn out as often... meaning you will not have to buy as many replacement lamps in a year. Another example is reduced Heating, Ventilating and Air Conditioning (HVAC) filter replacement costs as a result of operating such systems fewer hours per year.[8]

2. Reduced Maintenance Labor Costs[9]
Example: If an HVAC system is not "on" as many hours, the filters can be changed less often, resulting in labor savings. Similarly, if lighting is used fewer hours, then lamp lives are longer and annual relamping labor costs decline. Finally, if an energy conservation program results in a labor savings

---

[5] "Soft" benefits can include items like improved morale. *For Example: some clients that have implemented energy conservation programs have experienced a definite increase in morale when employees feel they are doing their part to help the environment and are empowered to make decisions to conserve energy. Not every employee is motivated by these factors, but for those that are, a strong energy conservation program adds a global aspect to every position that can lead to improved job satisfaction and increased productivity.*
[6] Installation of better equipment (supply side) activities will be covered in future research.
[7] If replacement occurs at failure or based on run time, these savings automatically occur. If replacements are planned in advance, planners should adjust their schedules to ensure savings are captured from extended equipment lives (not replacing assets pre-maturely).
[8] Note that a facility may still need to meet minimum ventilation requirements.
[9] Labor savings are direct savings when using "external" personnel. When man-hour savings exist using "in-house" salaried personnel, the personnel must be re-allocated to other useful purposes, otherwise there are no direct dollar savings (you still are paying the personnel-even if they aren't working as hard).

worth 10% of a maintenance person's time, that is a real savings as that 10% is available for other activities.[10]

3. Avoided Capital Investment

Example: You reduce energy consumption so much that you don't need to purchase equipment you thought you needed (an additional chiller, boiler, lights, etc.) This would be a "one-time" savings and its amount can be huge (new chillers are expensive for example).[11]

4. Avoided Procurement Costs

Example: You operate the equipment less hours per year and it lasts longer. Then you don't need to replace it as often, which represents deferred planning, legal, administrative, procurement and other costs. The savings would depend on the amount deferred and other factors, such as your interest rate, opportunity cost, staff time, or new positions avoided, etc..

5. Avoided Purchases of Carbon Offsets[12]

Example: If your facility is buying carbon offsets, then they will need to purchase fewer carbon offsets as a result of energy savings. This is only a direct, measurable savings if your organization is purchasing offsets as an objective to be more sustainable.[13]

6. Enhanced Image, Public Relations or Recognition[14]

Example: If your facility pays for public relations, or "green marketing", your success at energy conservation may provide some benefits such as free press in newspaper, awards, etc..

7. Reduced Sales Taxes/Environmental Penalties

Example: A company will not pay taxes or environmental surcharges on energy that it does not use. This avoided cost represents an additional 8% to 15% of the energy savings usually estimated by engineers.[15,16] *Note that if a facility calculates savings using an "average cost per kWh" (when the total electric bill is divided by total kWh), these savings are automatically recognized (and the value from Benefit #7 would be zero).*

8. Improved Building Value

Example: From a property management standpoint, when comparing two identical buildings- if one has reduced operational costs, then that building is worth more. You can estimate the increased value by applying a Capitalization Rate Factor, which = [Yearly Income/Total Value]. Consider a business that earns $100,000 per year and it is valued at $1,000,000 then the Capitalization Rate is 10%. Thus, if

---

[10] Alternatively viewed, the company can grow a little without additional personnel.

[11] If the purchase is delayed, then the value equals the interest expense or opportunity cost on the avoided capital investment.

[12] It is also interesting to note that even the voluntary carbon markets for carbon offset projects have grown substantially during 2008-2012, even during a stagnant global economy. Thus, more organizations (public and private) are committing to reducing carbon or improving their sustainability programs.

[13] Some day, avoided carbon emissions may have direct sellable value. In today's conditions, the tangible value exists if you are trying to be "carbon neutral" and these are offsets you don't have to buy.

[14] Saving energy reduces pollution (mercury, SO_x, NO_x, greenhouse gases, etc.) from fossil-fueled power sources. Therefore, energy conservation is an effective sustainability strategy. *For Example, Frito Lay's Sun Chips brand has received significant sales increases due to recognition of energy projects completed at its manufacturing facility in Modesto, CA.*

[15] You should investigate whether your existing calculations of energy savings include taxes and environmental penalties to avoid "double counting". However, many facility managers and energy engineers do not include the additional taxes and environmental penalties that are assessed on a unit energy basis, as these penalties/fees can be hidden within the bills, or rate structure's fine print.

[16] Woodroof, E., (2011) "Sales Taxes and Utility Rebates can Yield Massive Savings", *Buildings.com Magazine*, October 2011 Issue.

that business reduces its operating cost (via energy conservation) by $20,000/year (thereby improving income by $20,000/year), then the Total Value becomes:
= [Yearly Income/Cap Factor]
=[$120,000/0.1]
=$1,200,000

Within this article's context, the increased value of a building = [(Energy Savings $) / (Capitalization Rate)].[17] *If a facility's capitalization rate is 10%, it is reasonable to say a building value is increased by 10 times the operating cost savings (from energy savings).*[18]

Although not included in this paper, it is noted that stock prices of corporations have been proven to improve dramatically when energy management programs are announced, or when an organization publishes its corporate sustainability report.[19,20] It is also worth mentioning that avoided energy expenses go "directly to the bottom line" and result in a very efficient use of money, sometimes even greater than the host company's profit margin.[21]

METHODS TO FIND THE PROBABILITY THAT SPECIFIC "ADDITIONAL BENEFITS" ARE RECEIVED BY FACILITIES[22]

A survey of 182 energy managers from 182 different organizations was conducted during a 10 day period from late February to early March 2012. To be eligible to participate and receive the survey questionnaire, all participants had to have achieved at least a 20% savings from their energy consumption baseline. Of the 182 energy managers that were sent the survey, 63 facility managers were able to respond to the web-based questionnaire. The 63 respondents were primarily from educational facilities across the USA. These 63 facility managers provided the results relating to probabilities that are presented in Table 1.

Because this survey's participants operated non-profit or government buildings, our questionnaire did not inquire about Benefits #7 and #8 because they would not apply to these types of facilities. However, such benefits can be substantial and would be highly probable in private companies, which are more likely to sell buildings as well as pay taxes.

For all organizations (public and private), even more "additional benefits" from energy conservation practices are listed near the end of this paper.[23]

---

[17] When evaluating businesses and buildings, one technique is to estimate value as a multiple (7 to 12) of the annual profit. Because energy savings ultimately reduce costs and therefore improve profits, they raise the value of a building at the time of sale.

[18] Alternatively, several studies (research from real estate managers and coordinated by the Institute for Market Transformation between 2009-2011) show that the sale price of a building can increase by 2% to 25% after a commercial building has attained the Energy Star label. Occupancy and Rental rates also experienced a premium price after being labeled Energy Star.

[19] Wingender, J. and Woodroof, E., (1997) "When Firms Publicize Energy Management Projects: Their Stock Prices Go Up"- How much- 21.33% on Average! *Strategic Planning for Energy and the Environment*, Summer Issue 1997.

[20] Griffin, P. and Sun, Y., (2012) "Going Green: Market Reaction to CSR Newswire Releases", University of California. Griffin, Paul A. and Sun, Yuan, Going Green: Market Reaction to CSR Newswire Releases (January 29, 2012). Available at SSRN: http://ssrn.com/abstract=1995132 or http://dx.doi.org/10.2139/ssrn.1995132

[21] *For Example: an energy conservation program that saves $100,000 in operating costs is equivalent to generating $1,000,000 in new revenue (assuming the organization has a 10% profit margin). It is more difficult to generate $1,000,000 in new revenue, and would require more marketing, infrastructure, etc.. Thus, the energy conservation/efficiency program is an investment with less risk and quickly improves cash flow.*

[22] The majority of survey respondents were in educational environments, however the results can apply in most facilities that are saving energy.

SURVEY RESULTS

As Table 1 illustrates, it is probable that facilities will experience some "additional benefits" from energy conservation.[24]

Table 1 – Percentage of Facility Managers that Experienced each "Additional Benefit"

Additional Benefits of Energy Conservation	% of Facility Managers that Experienced this Benefit
1. Reduced Maintenance Material Costs	**92%**
2. Reduced Maintenance Labor Costs	**71%**
3. Permanently Avoided Capital Investment	**33%**
4. Avoided Procurement Costs	**63%**
5. Avoided Purchases of Carbon Offsets	**10%**
6. Enhanced Image, Public Relations or Recognition	**44%**
7. Reduced Sales Taxes/Environmental Penalties	**Not Surveyed**
8. Improved Building Value	**Not Surveyed**

PROCEDURES TO CALCULATE ADDITIONAL BENEFITS

Quantifying the value of "additional benefits" can be accomplished a number of ways, depending on site-specific factors. If it is possible to collect actual savings data, that is the best choice. However, as these benefits occur outside of the utility budgets, such data might not be currently tracked within your facility. Therefore, below are two independent calculation approaches, which can be used depending what information is available within your organization.

APPROACH #1: Calculating Benefits Related to a Specific Energy Conservation Measure; or
APPROACH #2: Calculating Benefits using Organization-Wide Budget Data.

Although both approaches can be applied, in the absence of site-specific budget data, Approach #1 may be able to accurately predict savings using a logical approach and standard industry cost estimates. Approach #2 is more likely to be useful when the facility manager has access to (or can validate) site-specific budget data. Approach #2 also involves far less calculations than Approach #1, but it recommended only when a facility manager has access to budget data.

Within each of the approaches, sample calculations are provided for the "Additional Benefits". *Although not all of the benefits will apply to every facility, the calculations below will guide the reader to estimate the value of each benefit and determine if it should be applied.*

---

[23] We labeled these as "Supplementary Benefits" as we did not include calculations for them in this paper.

[24] The data could be further stratified to further evaluate the responses by facility size, location or other parameters. This information may be used during future research in an attempt to determine the average value of each "additional benefit".

APPROACH #1: How to Calculate Benefits Related to a Specific Energy Conservation Measure

This approach involves calculating each benefit associated with an Energy Conservation Measure ("ECM"), and then adding the benefit values together to determine the "total additional value" per ECM. *For Example: If you optimized a building system and it lasted longer, you could use the sample calculations below to estimate the values of avoided material, labor, etc.. Then you would add these values together to determine the ECM's "total additional value". If you had implemented multiple ECMs, you would repeat this approach for each ECM and then use the sum to estimate the total additional value to the facility.* ***Note that all cost estimates can be adjusted to reflect your local conditions.***

To illustrate the "total additional value" from an ECM, we will apply this approach to a simple example and show calculations for each individual benefit.

The Sample Energy Conservation Measure:
Consider a lighting system that has 10,000 fluorescent lighting fixtures, each with two lamps and one ballast. Each fixture consumes 60 watts. The baseline operational hours are 5,000 per year and energy costs are $0.10/kWh. Thus, our baseline energy consumption is:

= (10,000 fixtures)(5,000 hrs/year)(0.06 kW/fixture)
= 3,000,000 kWh/year,
Thus, at $0.10/kWh the annual energy cost to operate the lighting system = $300,000/year.

If we implement an ECM that turns the lights "off" 25% of the time, then we would save 750,000 kWh/year and $75,000 per year in direct energy savings. Using the calculations below, we can calculate the "additional benefits" that extend beyond the energy savings. Although not all "additional benefits" will apply to this particular ECM, we will show calculations as examples. At the end of Approach #1, we will tally the value of the applicable "additional benefits" for this ECM.

Benefit #1: Sample Calculation for Reduced Maintenance Material Costs:
Assume you turn off a lighting system 25% of the time (due to vacancy). If lights are used 25% less, the lighting ballasts (and lamps) should last about 25% longer. Let's calculate the impact on the ballast material first:

A ballast life is rated for 60,000 hours of operation. If your building operates the lights 5,000 hours per year, they would need to replace the ballasts at the 12th year. If there are 5,000 ballasts, each costing about $20 in material (includes shipping and taxes), then at the 12th year, the material replacement cost would be:

= ($20/ballast)(5,000 ballasts)
= $100,000

Annualized ballast material replacement cost would be:
= ($100,000)(1/12 years)
= $8,333/year

If the lights are only "on" 3,750 hours/year (a 25% reduction), the ballasts should last 16 years. This would reduce the annualized ballast material replacement cost to:
= ($100,000)(1/16 years)
= $6,250/year

Thus, the Annualized Material Savings for ballasts are:
= $8,333/year - $6,250/year
= $2,083/year in ballasts

Now, we can use similar calculations to quantify the reduced maintenance material costs for the lamps:

> If there are 10,000 lamps, each costing $2.50 (includes shipping and taxes), and they last 20,000 hours. If lamps are on 5,000 hours per year, then after 4 years they would need to be replaced and this would cost:
> = ($2.5/lamp)(10,000 lamps)
> = $25,000
>
> The annualized lamp material replacement cost would be:
> = ($25,000)(1/4 years)
> = $6,250/year
>
> Again, if the lights are only "on" 3,750 hours/year (a 25% reduction), the lamps should last 5.3 years.[25] This would reduce the annualized lamp material replacement cost to:
> = ($25,000)(1/5.3 years)
> = $4,717/year
>
> Thus, the Annualized Material Savings for lamps are:
> = $6,250/year - $4,717/year
> = $1,533/year in lamps

Therefore the total annual avoided maintenance material costs (lamps and ballasts) are:
= $2,083/year + $1,533/year
= $3,616/year

This same approach could be used to calculate maintenance material savings values for other ECMs that extend the lives of motors, filters, etc..

Benefit #2: Sample Calculation for Reduced Maintenance Labor Costs:
Continuing with the Lighting ECM from above, if the lights are used 25% less, the ballasts and lamps should last longer and won't need to be replaced as often, resulting in a labor savings. Let's calculate the impact on the ballasts first.

> A ballast life is 60,000 hours of operation. If your building operates the lights 5,000 hours per year, they would need to replace the ballasts at the 12^{th} year. Assume it requires maintenance about 30 minutes to replace a ballast, including set-up, re-wiring and disposing of the ballast. Assume the labor and disposal costs would be: $15/ballast. If there are 5,000 ballasts, then at the 12^{th} year, the labor cost to replace the ballasts would be:
>
> = ($15 in labor and disposal costs/ballast)(5,000 ballasts)
> = $75,000
>
> Annualized ballast replacement labor cost would be:
> = ($75,000)(1/12 years)
> = $6,250/year
>
> If the lights are only "on" 3,750 hours/year (a 25% reduction), the ballasts should last 16 years. This would reduce the annualized ballast replacement labor cost to:
> = ($75,000)(1/16 years)

[25] If replacement occurs at failure or based on run time, these savings automatically occur. If replacements are planned in advance, planners should adjust their schedules to insure savings are captured from extended equipment lives (not replacing assets pre-maturely).

= $4,688/year

Thus, the Annualized Ballast Replacement Labor Savings are:
= $6,250/year - $4,688/year
= $1,562/year in labor to replace ballasts

Now, we can use similar calculations to quantify the reduced maintenance labor costs for the lamps:

A typical fluorescent lamp life is 20,000 hours.[26] If lights are "on" 5,000 hours per year, the building would need to replace lamps at the 4th year. If there are 10,000 lamps, each costing about $5 in labor to re-lamp (including disposal expenses), the replacement expense at the 4th year would be:
= ($5 in labor/lamp)(10,000 lamps)
= $50,000 in labor

Annualized re-lamping labor cost would be:
= $50,000/4 = $12,500.

If the lights are only "on" 3,750 hours/year, the lamps should last longer (5.3 years), thereby reducing the annualized labor re-laming cost to:
= $50,000/5.3 years
= $9,434/year

Thus, Annualized Labor Savings are:
= $12,500 - $9,434/year
= $3,066 per year

Therefore the total annual avoided maintenance labor costs (ballasts and lamps) are:
= $1,562/year + $3,066/year
=$4,628/year

This same approach could be used to calculate maintenance labor savings values for other ECMs that involve motors, filters, etc..

Benefit #3: Sample Calculation for Avoided Capital Investment:
Although this "additional benefit" might not apply within our Lighting ECM example, the value can be large when it occurs, so we include another example that demonstrates the calculations below.

Assume that a large capital investment is being planned to meet increasing demand with a budgeted cost of $500,000. Assume that via energy conservation (minimizing leaking HVAC ducts or compressed air systems, reduced operating hours, altered thermostat set points, etc.) you reduce demand such that you can avoid this planned capital investment (additional chiller or compressor to satisfy artificial demand). If a chiller would have cost $500,000 to purchase and install, the annual savings would be the interest on that amount until the chiller is actually purchased. Thus, if the cost of capital (interest rate) is 5%, the saving would be (.05) X ($500,000) or $25,000 per year. Note that if the chiller is permanently avoided, the avoided capital is $500,000.

[26] Lamp life is rated at the factory by turning lamps on and off every three hours until they burn out. If the frequency of on/off cycling is less than 3 hours, lamp lives will decline by 25% on average. Therefore, turning a lamp off for longer periods is better than shorter periods. *For example, it is better to find locations where you can turn off lamps for 5 hours out of 15 hours, instead of 1 minute out of every 3 minutes, although the % time off is the same.*

It is worth mentioning that 33% of the energy managers surveyed say this benefit occurred, so it can be very real, especially for HVAC and compressed air systems. Also, if the facility "grows" but the demand drops, the need for additional capital equipment never arises. We think these savings occur often but are seldom expressed.

Benefit #4: Sample Calculation for Avoided Procurement Costs:
Although this "additional benefit" might not apply within our Lighting ECM example, we include an example below.

Continuing with the previous example from above that dealt with avoiding a capital investment, if your organization would have spent additional internal/external costs (legal, engineering, permitting, delays, purchasing, administration, etc.) to procure the chiller, then those avoided costs should also be included if applicable. The authors leave it to the reader to estimate the value of this benefit (if at all), because the value is highly dependent on organization-specific characteristics.

Benefit #5: Sample Calculation for Avoided Purchases of Carbon Offsets:
If your organization has committed to being "carbon-neutral", or has some sustainability goal that requires the purchase of carbon offsets when energy is consumed, then there will be tangible savings from energy conservation. When we reduce the amount of energy consumed, we would avoid purchasing a certain amount of carbon offsets. Alternatively, this benefit could also be expressed in avoided purchases of Renewable Energy Credits (RECs).[27]

Using the lighting ECM, which reduced energy consumption by 750,000 kWh/year or 750 MWh/year. This allows our organization to avoid purchasing 750 RECs/year. If RECs cost $10/MWh, the avoided purchases would be:
= $7,500/year.

Benefit #6: Sample Calculation for Enhanced Image, Public Relations or Recognition:
Although this "additional benefit" might not apply within our Lighting ECM example, we include an example that demonstrates the calculations below.

Assume that your organization has received front-page exposure from an article that was written about your success in energy conservation. If this type of regional advertising normally costs $15,000 then you may be able to consider that as a quantifiable benefit.[28] Alternatively, if your organization has won an award and perhaps that award has allowed your organization to attract better employees, or have increased sales of a product, etc., those are tangible benefits that could be quantified.[29] Many of those surveyed are recognized through EPA with an Energy Star designation. This usually is recognized by the press, and facilities that earn this designation often display their Energy Star Plaque at the entrance to a building. This has direct value but is difficult to quantify as the range of values can be large. *For Example- A small survey of press releases (non-front page exposure) revealed a value of $1,800 per press release/article in local papers*

Benefit #7: Sample Calculation for Reduced Sales Taxes/Environmental Penalties:

[27] Additional information on emissions, offsets and reporting can be found in this article: Woodroof, E. (2011), "GHG Emissions Management for Dummies", *Strategic Planning for Energy and the Environment*, Vol 31(2)
[28] $15,000 is a sample price based on real costs of "cover" advertising in newspapers in the US and Asia, however it is just a sample- thus the reader should apply an estimated price based on appropriate/available advertising within the local geographic area.
[29] Wall Street Journal, November 13th, 2007- "How Going Green Draws Talent, Cuts Costs".

Many utilities apply a sales tax as well as an environmental tax/fee on the total energy cost. Together, these extra costs can represent an additional 8% to 15%.[30] Continuing with the lighting ECM from before where we saved $75,000/year, the avoided sales and environmental taxes (lets assume 10%) could have a value worth:
= ($75,000/year)(0.10)
= $7,500/year

As mentioned before, if (total energy bill $)/ (total kWh) is used to evaluate average cost per kWh, the value of this benefit is automatically incorporated into the direct energy dollar savings (in this case $75,000). Thus if you are using an average cost per kWh, Benefit #7 should not apply. For some readers, using an "average or blended cost" is simpler than segregating the kW and kWh savings. However, blended rates assume impact on demand is equal across the board of ECMs and that may not be accurate. In another survey, we found that most energy conservation projects impact demand but perhaps not equally.

Benefit #8: Sample Calculation for Improved Building Value:
Although this "additional benefit" might not apply within our Lighting ECM example, we include an example that demonstrates the calculations below.

This "additional benefit" is only recognized if the building is sold. Similar to any piece of equipment: its value is partially dependent on the O&M expenses (Ex- a hybrid car has less annual gas expenses, thus it has additional market value). Thus, if a building is showing less O&M expenses it will be worth more when it is sold. If an ECM saves $150,000/year, those savings go directly to the bottom line. The building value would increase by a factor of 10 (capitalization factor is 10%) or

Increased Building Value = ($150,000)(10) = $1,500,000 (a one-time benefit when the building is sold)

Table 2 summarizes the total dollar values of the "additional benefits" estimated from one sample ECM, using Approach #1. It is noted that it would be rare to have an ECMs produce tangible value from all "additional benefits", so in this example, we only included values from half of the listed "additional benefits". The approach and calculations for these benefits could be used as a guide to identify the "additional benefits" of other ECMs that involve HVAC, motors, etc.

Table 2 – Summary of "Additional Benefits" from a Lighting Energy Conservation Measure

Additional Benefits (most are Annual)	**Value Estimates**	***% Improvement to Energy Savings***
1. Reduced Maintenance Material Costs	**$3,616**	***4.8%***
2. Reduced Maintenance Labor Costs	**$4,628**	***6.2%***
3. Permanently Avoided Capital Investment	**Not Applied to this ECM**	
4. Avoided Procurement Costs	**Not Applied to this ECM**	
5. Avoided Purchases of Carbon Offsets	**$7,500**	***10%***
6. Enhanced Image, Public Relations or Recognition	**Not Applied to this ECM**	
7. Reduced Sales Taxes/Environmental Penalties	**$7,500**	***10%***
8. Improved Building Value	**Not Applied to this ECM**	
Total Additional Value from this ECM	**$23,244**	
% Additional Value Improvement Beyond Energy Savings of $75,000/year		***31%***

[30] Samples from several energy audits completed by Profitable Green Solutions, LLC.

Thus, as we have done above, one method for estimating these additional benefits would be to take case specific numbers for all ECMs and quantify the values using actual local ballast, bulb, labor, costs, etc. This would take time but would yield very accurate numbers. You could also select which of the Benefits apply to your organization and add up those values (the relevant Benefits to your facility may be different than Benefits #1, #2, #5 and #7 that were applied in the Lighting ECM Example).

Another method would be to use the 31% number we generate above and simply say, "our experience shows that additional benefits are worth 31% or more of the energy savings". Thus, if we save $100,000 in energy expenses, we recognize additional benefits worth $31,000.

Alternatively, you could also apply a portion of the 31% if that was a more conservative approach based on your facility's conditions, or based on the specific benefits that your facility receives. *For Example, if your facility does not purchase carbon offsets and also uses an "average kWh cost" then you might not receive value from Benefits #5 and #7, yet you would still receive additional benefits worth an 11% improvement to energy savings.* Conversely, your facility may experience more benefits than the example used in Approach #1. *To illustrate this point, avoiding a capital purchase or improving a building's value would provide benefits that would be substantial and could be much higher.*

APPROACH #2: How to Calculate Benefits Given Organization-Wide Budget Data

Below is an approach that could be used for individual cases where more detail is desired. Getting this data would not be elementary but the approach would be more tailored for individual cases and would establish procedures useful for future documentation.

Budget Based Calculation Procedure:

Additional Value of a Benefit = (Budget) X [(Reduction in operating hours)/(Original or old operating hours)]

where:

- *(Budget) is a figure reflecting how much annually is presently spent for a function (budget line item). By working with accounting personnel you obtain a total cost for that function last year or an average of the previous 3 years.*
- *(Reduction in operating hours) is the number of reduced operating hours per week or month.*
- *(Original or old operating hours) is the number of original operating hours for that period*
- *(Reduction in operating hours)/ (Original or old operating hours) is a fraction between 0 and 1 that reflects the % savings.*

Below we show sample calculations for only two budget line items, as the remainder of Benefit calculations would follow a similar format:

Benefit 1: Sample Calculation for Reduced Maintenance Material Costs using Budget-Based Data
By working closely with accounting personnel, you obtain an average annual cost for labor replacing ballast and bulbs, probably by reviewing all maintenance purchase orders. You find that over the last three years, you spent an

average of $19,500 per year on lamps and ballasts. Once you begin turning the lights off 25% of the time, the Additional Value is:

= (Budget)[(Reduction in operating hours)/ (Original or old operating hours)]
= (Budget)[(% Savings)]
= ($19,500)(.25)
= $4,875 per year in material savings

This approach is tedious in that it requires careful perusal of three years accounting data. However, it should be easy to codify the data for future years so this number can be electronically retrieved at the end of each year.

Benefit 2: Sample Calculation for Reduced Maintenance Labor Costs using Budget-Based Data
By carefully examining work order records for the last three years, you find you are spending an average of $23,000 per year on labor to replace lamps and ballasts.[31] Since you are group relamping, this figure is relatively easy to obtain. Once you begin turning the lights off 25% of the time, the Additional Value is:

= (Budget)[(Reduction in operating hours)/ (Original or old operating hours)]
= (Budget)[(% Savings)]
= ($23,000)(.25)
= $5,750 per year in labor savings

Again, the work orders could be codified so that this figure can be easily retrieved electronically each year.

Following similar processes as above, you could develop estimates for all the applicable benefits for which you have budget-based data and compile the values to determine the total value of Additional Benefits. In all cases, we recommend a monitoring procedure be designed to validate your savings (going forward). This can be done but it will require some effort and training at the start.

SUPPLEMENTARY BENEFITS

Beyond the benefits estimated in this research, there are many more which may be applicable to facility managers.

Table 3 – Additional Benefits from a Focused Effort on Energy Conservation

Additional Benefit	*Examples*
Utility Rate Reduction	*By focusing on energy conservation and learning alternative rate schedules, your organization was able to switch to a lower energy rate structure.*
Identification and Capture of all Utility and/or Government Rebates	*By focusing on energy conservation, your organization was able to acquire rebates.*
Recovered Billing Errors	*By focusing on energy conservation, your organization received billing credits from the utility. History shows that energy managers often uncover billing errors when schedules and bills are reviewed carefully.*
Reduced Risk to Environmental and/or Legal Costs	*Since they last longer, there is less cost for disposal/recycling of bulbs, ballasts, motors, etc. and less environmental risk.*
Increased Training and	*As your energy saving program matures, so does the staff running the*

[31] To get this figure, you must peruse work orders to determine the total man-hour dollars spent for replacing lamps and ballasts as before.

Performance of Facility Staff	*buildings and equipment. Better understanding of the functions yields reduced operating costs in ancillary areas.*
Improved Ability to Manage Energy and Assign 3rd Party Costs to the 3rd Party	*As a focus of energy is deployed across the organization, management can be more astute in dealing with external contractors, as well as the parasitic energy consumption they create during construction of new facilities.*
Improved Compliance with Building Standards	*As more attention is paid to comfort and ventilation requirements, there is better compliance with ASHRAE 62, 55, and other standards*
Utility Savings Applied to Staff Positions	*Utility savings can be used to fund new positions or avoid staff layoffs*
Improved Staff Comfort and Productivity	*Through optimization, productivity can improve (comfort, outside air, personnel etc)*
Water and Sewer Savings	*Through optimization, water consumption and sewerage costs are reduced.*

CONCLUSION

This article has presented additional benefits from energy conservation. From the survey, it is clear that there is a high probability that facility managers will experience at least some "additional benefits" from energy conservation. To calculate the value of these benefits, two Approaches are provided. One calculates the "additional benefits" as they relate to a specific energy conservation measure. Another alternative is to collect "tailored" budget data from the whole organization and estimate values.

Within an example application, we found that the Additional Benefits contributed an additional value worth 31% beyond the energy savings per year. **Perhaps you will estimate more (or less) value at your facility… but it is clear that <u>these Additional "CORE" Benefits exist and are highly probable</u>.**

<u>You may also choose to only apply a portion of the 31%; if that is a more conservative approach based on your facility's conditions, or based on the specific benefits that your facility receives</u>. Conversely, your facility may receive a greater number of benefits than we showed in the example. *For Example, avoiding a capital purchase or improving a building's value would provide benefits that would be substantial.*

We hope that this article motivates additional action for energy conservation, dollar savings and environmental benefits. *Please give these Approaches a try, and let us know about your results*.

ABOUT THE AUTHORS

ERIC A. WOODROOF, PH.D., CEM

is completely committed to helping businesses and organizations "go green", while improving profits. For more than 20 years, he has helped over 400 organizations and governments improve profits with energy-environmental solutions, generating over $100 million in savings. Beyond his contributions as a consultant/project developer, he has taught over 100 seminars to help educate thousands of engineers worldwide on the best practices of energy and carbon management. His work has appeared in hundreds of articles and he has also delivered keynote speeches for his clients on 6 Continents.

Dr. Woodroof served as the 2011 President of the Association of Energy Engineers, which is present in over 80 countries. He is the Chairman of the Board for the Certified Carbon Reduction Manager (CRM) program and he has been a Board Member of the Certified Energy Manager (CEM) Program since 1999. Dr. Woodroof has advised clients such as ESCOs, Airports, Utilities, Cities, Universities, the US and Foreign Governments. He is the founder of ProfitableGreenSolutions.com and he can be reached at eric@ProfitableGreenSolutions.com

WAYNE C. TURNER, PH.D., PE, CEM

is a Regents Professor Emeritus of Industrial Engineering and Management at Oklahoma State University. He is founder and Director of OSU’s Industrial Assessment Center and has conducted or supervised well over 1000 energy audits for industrial and commercial facilities. Dr. Turner has broad experience in energy management and has authored five textbooks and numerous articles in professional magazines and Journals. He has won many teaching and professional awards and is listed in numerous Who’s who. He has served as past president of the Association of Energy Engineers (AEE) and is in AEE’s Hall of Fame. He is Editor-In-Chief of AEE’s journals ENERGY ENGINEERING and STRATEGIC PLANNING FOR ENERGY AND THE ENVIRONMENT. He is an avid fly fisherman and is willing to fly fish anywhere anytime. His email address is wayne.turner@okstate.edu

WARREN M. HEFFINGTON, PH.D., P.E., C.E.M. is an associate professor emeritus of mechanical engineering at Texas A&M University and directed an Industrial Assessment Center for 25 years. He personally has directed 250 industrial assessments and has supervised the review of over 300 energy audit reports for commercial and institutional buildings. He has been active in research on industrial energy use and on the energy audit process. He teaches seminars on engineering ethics and professionalism, and co-teaches the five-day Energy Management Fundamentals course offered by the Association of Energy Engineers.

BARNEY CAPEHART, Ph.D., C.E.M., is a professor emeritus of industrial and systems engineering at the University of Florida, Gainesville. He has broad experience in the commercial/industrial sector, having served as Director of the University of Florida Industrial Assessment Center from 1990 to 1999. He has personally conducted over 100 audits of industrial facilities and has assisted students in conducting audits of hundreds of office buildings, small businesses, government facilities, and other commercial facilities. He is the lead author for the *Guide to Energy Management* textbook, founding editor of the *Encyclopedia of Energy Engineering and Technology*, and co-author or editor of five other energy books. Dr Capehart is the creator of AEE's Five Day Training Program for Energy Managers, and has trained over 10,000 energy managers in that program.