Can Simple Payback Justify Building Energy Improvements?

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When deciding whether or not to implement Energy Improvement Opportunities (EIOs), key decision makers may require that some type of economic review be performed to justify any financial investment required. With the decision to select one (or more) EIO based on this review, it is critical that all benefits be properly represented so that the project can be weighed on its true cost effectiveness.

Performing the analysis necessary to help drive an informed decision can be both complex and time consuming. It may fall into the hands of personnel who have had little training in performing calculations of this type. This can result in using the quickest and simplest analysis method that "spits out" a result, and may be one reason why the *Simple Payback Period (SPP)* is so often used. The simple payback period is the easiest method of economic analysis as shown here:

SPP= Project Cost ($) / Annual Savings ($/year)

To determine the SPP for a project you add up all the individual costs and savings for the project each year and then divide the total cost by the total savings. This can show how quickly an opportunity will "pay-back" on the initial investment however it does not consider the time value of money nor the benefits from the investment following the payback period. This limitation means the SPP tends to favor shorter-lived projects, a bias that is often economically unjustified. Consider the two projects detailed below:

		Savings by Year				
Project	**Cost**					
		1	**2**	**3**	**4**	**5**
A	**$5000**	$2500	$2500	$2500		
B	**$5000**	$2500	$2500	$2500	$2500	$2500

SPP = $5,000/$2,500 = 2 years

Each project has a simple payback period of two years, but project “B” continues to provide savings of $2,500/year for three years beyond the SPP of two years, while project “A” only provides savings for one year past the two year SPP period. The SPP method ignores critical information, such as the expected life of the project and the value to any savings after the end of the simple payback period. (1)

When the SPP for an energy improvement project is calculated to be between 2-3 years most companies will consider implementing it. A review of the various energy conservation measures shown in Table 1 include several which would deserve consideration based on this requirement, but by applying a strict payback criterion (e.g., all projects must have a payback of 2 years or less) are opportunities overlooked that could easily generate an attractive financial return?

Energy-Conservation Measures Available for Retrofit	
Controls	**Estimated Payback (years)**
Control retrofits and control strategies	3-4
Demand control ventilation	2-5
Mechanical	
Variable flow primary/secondary systems with controls, VFD's	2-4
HVAC	
Change constant-speed air handles to variable air volume	2-4
VAV boxes, control set points, box flow minimums	5 or more
Convert boilers from steam to hot water	5-8
High-efficiency fully condensing boilers	6-8
High-efficiency VFD chiller system	8-12
Lighting	
Install controls to schedule interior systems	2-4
Convert incandescent lighting to CFL	1-3
Replace exit signs with LED kits	<2
Convert T-12s to high-efficiency T8s with electronic ballasts	2-5

Table 1: United States Building Energy Efficiency Retrofits: Market Sizing and Financial Models 2012

SPP ignores cash flows that occur past the point of capital recovery therefore should not be used on projects with extended life expectancies (greater than 2 years).Today’s building automation technology evolves quickly, but it still may take from ten to twelve years after installation before an upgrade or replacement may be warranted.

ASHRAE has published information which lists the life expectancy for various types of HVAC equipment, ranging from between fifteen and thirty years. This helps validate the concept that HVAC “systems” are not short-term investments and consequently the financial benefits derived from these EIOs can be better judged using a metric other than SPP.

ASHRAE Life Expectancy Table	
Equipment Item	**Medium Years**
Packaged Roof Unit	15
Reciprocating Chiller	20
Centrifugal Chiller	23
Galvanized Cooling Tower	20
Cast Iron Boilers	30
Electronic Controls	15

Table 2: Excerpts from ASHRAE Service Life Expectancy Table

An analysis method that is used to base a project decision on the ***(IRR) Internal Rate of Return**** can define the interest rate or discount rate that makes the present value of the implementation costs equal to the present value of any project benefits. If the project earns more than it costs to finance, it creates economic value. The internal rate of return measures the result in percentage terms (in the form of an interest rate) (2). The table below shows what occurs when we take a simple payback period and calculate the projects IRR to include its lifespan.

SPP in Years	15	20	25
4	24.01%	24.69%	24.90%
5	18.42%	19.43%	19.78%
6	14.47%	15.77%	16.28%
7	11.49%	13.06%	13.71%
8	9.12%	10.93%	11.71%
9	7.19%	9.19%	10.11%
10	5.56%	7.75%	8.78%
11	4.15%	6.52	7.65%
12	2.92%	5.45%	6.67%
13	1.84%	4.51%	5.82%
14		3.67%	5.07%
15		2.91%	4.39%
16		2.23%	3.78%
17		1.59%	3.21%

Table 3: Internal Rate of Return for Project Life of 15-20-25 yrs.

For example, a 7-year simple payback translates to an approximate 13% internal rate of return (for a project with a 20-year life) if cash flow is relatively consistent throughout the project.

The ***(MARR) Minimum Attractive Rate of Return*** (aka ”Hurdle Rate”) is the term used which defines the “interest rate” that a company considers acceptable, typically used to evaluate investments in new product lines or new facilities. MARR can be company specific, often supplied by the accounting department or from the corporate management level.

An attractive EIO could be one which provides an owner with a rate of return equal to (or better) than that available through “other” investment options. This makes it important to have knowledge of what these other options are (and what they are capable of returning) in order to compare them to any EIO’s being considered. If MARR has been established based on exceeding net profit margins, knowledge of the company’s profitability will help determine if the EIO will be considered attractive or not. To give a broad view of the spectrum of profit margins for U.S. manufacturing sectors, Table 4 lists after-tax profit margins (net margins) on sales as reported for various industries.

Industry	Net Margin	Industry	Net Margin
Aircraft and aerospace equipment	5.6%	Lumber and wood products	3.3%
Apparel	5.4%	Machinery	5.3%
Chemicals	9.6%	Motor vehicles and equipment	2.1%
Drugs	15.5%	Nonferrous metals	5.2%
Electrical machinery	7.0%	Paper	3.4%
Fabricated metals	5.7%	Petroleum	7.4%
Food and tobacco	7.7%	Primary metals	5.0%
Furniture and fixtures	4.9%	Printing	8.5%
Industrial chemicals and synthetics	3.8%	Rubber	3.6%
Instruments	4.9%	Textiles	4.2%
Iron and steel	4.8%	Transportation equipment	3.4%

Table 4: U.S. Bureau of the Census, 1998.

By calculating the IRRs that result through long-term EIO investments, it can be noted there are many which provide returns exceeding the net profit margin for many U.S. industry sectors (Table 4). For example, if a textiles business has determined they will consider investments which return 2% above their after-tax net profit margin (4.2%) they

may be willing to accept an EIO with a lifespan of 20 years and an IRR of 6.52% (Table 3). In this case, the projects eleven year simple payback has no real relevance in the company's desire to return an established MARR. Had the company instead insisted on a 2-3 year SPP they would have overlooked an opportunity which could have met their financial expectations.

Most companies have established the return they expect from their financial investments. Armed with an understanding of these expectations, along with the ability to analyze the economics of various opportunities, a platform can be created from where EIOs can be viewed by a company right alongside other investment options. Being able to effectively communicate with key decision makers the benefits an EIO offers when compared to a traditional investment can make the difference between a project being shelved verses one which is slated for implementation.

Can Simple Payback justify building energy improvement opportunities? It may provide some insight into a short-term project's viability, but when used to analyze a long-term project it will most likely lead to overlooked opportunity which would have resulted in reduced utility costs and an attractive return on investment.

** Internal Rate of Return is only one of many analysis alternatives used to determine the feasibility of various investment opportunities. While not perfect, many financial decision makers use IRR when evaluating capital projects, therefore it is a metric they may find easy to understand. When faced with mutually exclusive projects (projects in which multiple options exist, but only one can be chosen) the* ***Net Present Value*** *method may be preferable (2). Future articles will cover this subject in more detail.*

References:

(1) The Association of Energy Engineers, CEM Course Materials.
(2) Economic Analysis in Individual Project Selection, Steve Kihm, CFA, and Scott Hackel, PE, CSE Online Magazine (June, 2012)