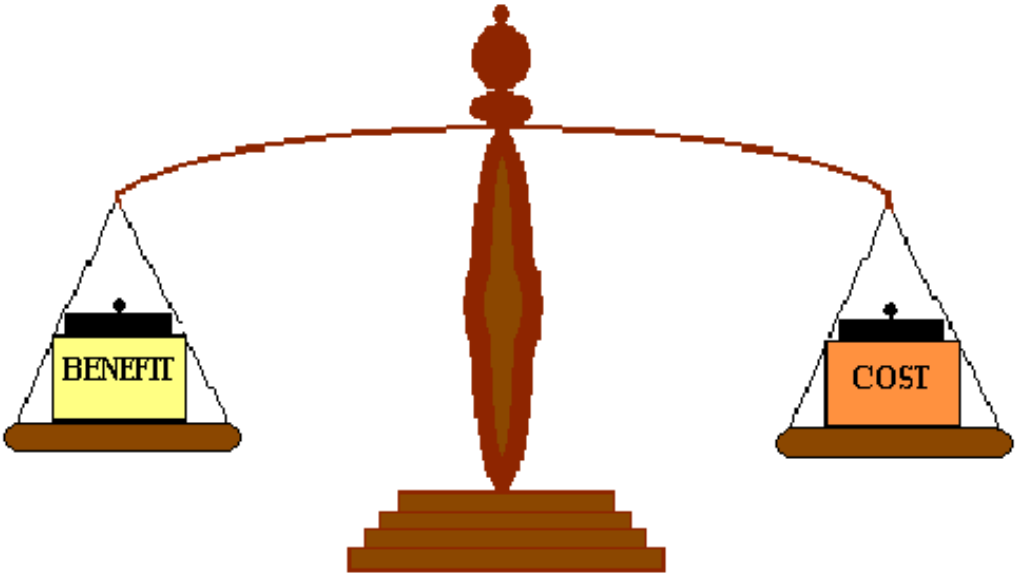
Economic Analysis for an Energy Management System in a Commercial Type Office Building



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Introduction

A facility owner may have opportunities for several types of worthwhile investments that might be made in a facility, but only funds available for one of two of them. While each might produce cost savings or favorable life cycle costs, the owner must also examine which investment will pay for itself most quickly or at the highest rate of return. This article will show how to calculate the "net present value" of the savings realized by an improvement, and the payback period and "internal rate of return" of the investment made in it.

This article will examine the example of purchasing an energy management system for a commercial office building as a case study. Assume that the owner has already determined that it meets the company's performance objectives and that the life cycle cost analysis of this versus comparable systems is the most favorable.

The proposed energy management system in the Commercial Type Office Building will perform three (3) basic functions:

a) Monitor and record data;

b) Control HVAC and electrical operations within the building; and,

c) Provide preventive maintenance scheduling.

The estimated installation cost for the system is $160,600. As a result of this energy management system, the building management should realize annual savings of $30,000 on labor costs and $20,000 on energy cost, overall a good return investment.

We will project a ten-year cumulative savings, based on the estimated ten-year service life of the system, accruing from the estimated annual energy savings and the savings in labor. The value of annual cost savings for labor and energy is assumed to increase by 5% annually (conservative). The cost for computer maintenance is also assumed to increase at a rate of 5%. The difference between the savings and the cost is the Net Annual Savings (NAS).

Because the flow of net annual savings from different investments vary from each other over a period of years, one can adjust the value of each future year's NAS to its value in current year dollars to make the cumulative value of the cash flows comparable. This is called the "Net Present Value" (NPV) of those savings. The NAS multiplied by the

present value factor (PVF 5%) results in the present value of net annual savings (PVNAS).

The simple payback is the time required to return your investment in accumulated savings. One can also calculate a "discounted payback" period to account for the time value of money.

The internal rate of return (IRR) expresses the time value of the Net Annual Savings of the equipment investment in a measurement that is comparable to the interest rate one might earn by investing cash in a bank account or in securities. It is a discount rate, the one that makes the present value of the future cash flows equal to the cost of the investment.

Illustrations of the calculation of these measures follow.

Equations and Definitions

$$\text{Simple Payback} = \frac{D}{(A + B)}$$

$$\text{Internal Rate of Return} = R_E + (R_F - R_E) \times \frac{(E - D)}{(E - F)}$$

$$\text{Present Value Factor} = \frac{1}{(1+5\%)^n}.$$

Present Value Net Annual Savings = (A+B-C)*PVF

A = Fuel Energy Savings
B = Labor Savings
C = Computer Maintenance Costs
D = Initial Investment
R_E = First Internal Rate of Return Estimate
R_F = Second Internal Rate of Return Estimate
E = Total Return at First IRR
F = Total Return at Second IRR
PVF = Present Value Factor
n = Year number in the series of years analyzed (year 1 to year x)
PVNAS = Present Value of Net Annual Savings

Building Analysis

Cost and Benefit Summary

	A+	B-	C=	NAS*	PVF=	PVNAS
Year	Energy Savings 5% Inflated	Labor Savings 5% Inflated	Maintence Computer Cost 5% Inflated	Net Annual Savings A+B-C	PVF Factor 5%	Present Value of Net Annual Savings
1	$20,000.00	$30,000.00	$3,000.00	$47,000.00	0.952	$44,761.90
2	$21,000.00	$31,500.00	$3,150.00	$49,350.00	0.907	$44,761.90
3	$22,050.00	$33,075.00	$3,307.50	$51,817.50	0.864	$44,761.90
4	$23,152.50	$34,728.75	$3,472.88	$54,408.38	0.823	$44,761.90
5	$24,310.13	$36,465.19	$3,646.52	$57,128.79	0.784	$44,761.90
6	$25,525.63	$38,288.45	$3,828.84	$59,985.23	0.746	$44,761.90
7	$26,801.91	$40,202.87	$4,020.29	$62,984.50	0.711	$44,761.90
8	$28,142.01	$42,213.01	$4,221.30	$66,133.72	0.677	$44,761.90
9	$29,549.11	$44,323.66	$4,432.37	$69,440.41	0.645	$44,761.90
10	$31,026.56	$46,539.85	$4,653.98	$72,912.43	0.614	$44,761.90
					Total Discounted Savings	$447,619.00

Net Present Value and Discounted Payback Analysis

Net Present Value = Discounted Savings - Investment

Net Present Value = $447,619.05 – $160,600 = $287,019.05 NPV

$$\text{Simple Payback} = \frac{\text{Initial Cost}}{\text{Fuel Energy Savings + Labor Savings}}.$$

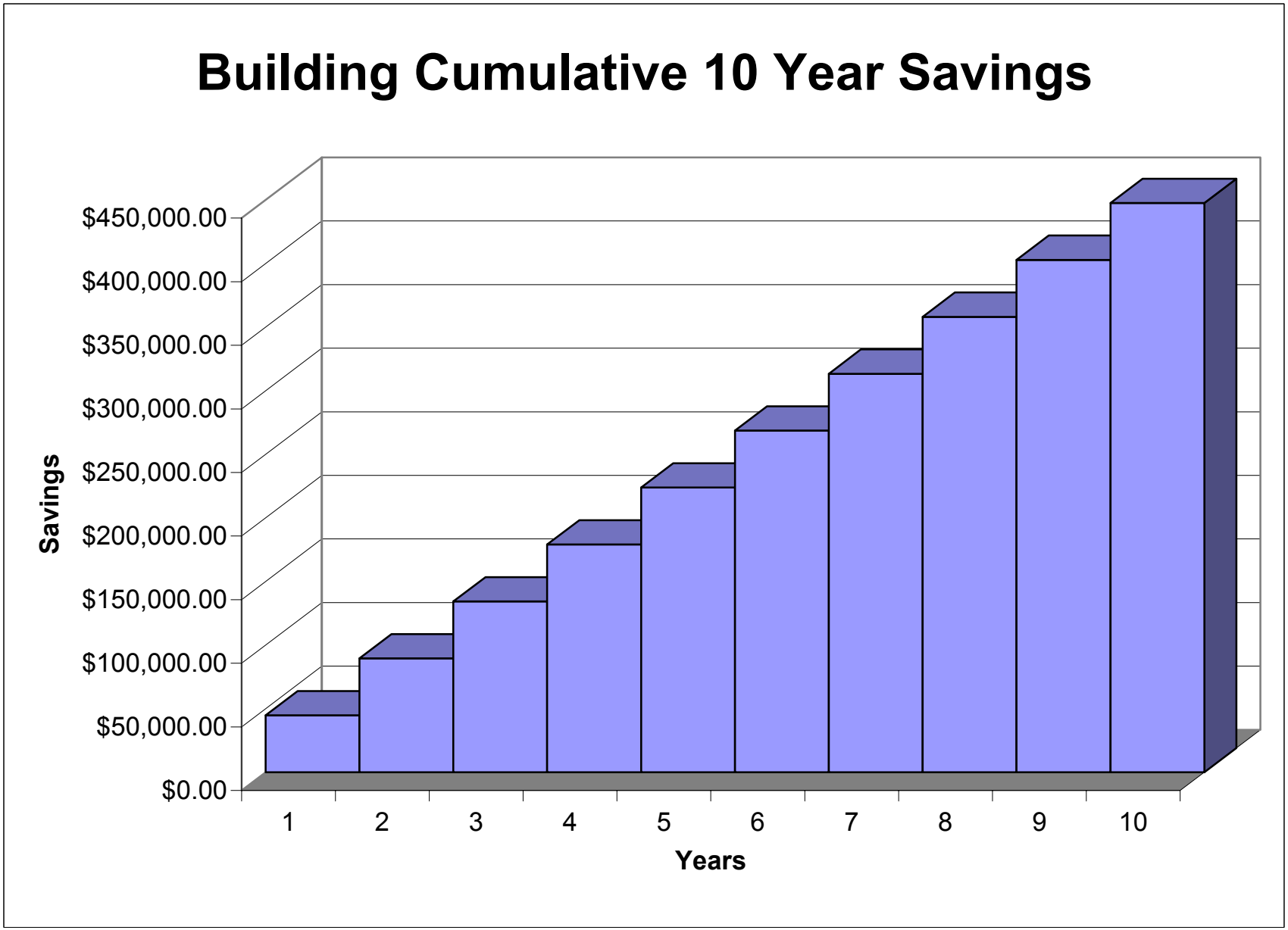
$$\textbf{Discounted Payback} = \frac{\$160{,}600}{\text{Discounted Savings}}.$$

First Year = $ 44,761.91
Second Year = $ 44,761.91
Third Year = $ 44,761.91
$134,285.73 (maximum savings not greater than investment)

Initial Investment – Three Year Savings = $160,600 - $134,285.73 = $26,314.27
(residual savings to equal investment)

$$\frac{\text{Difference between 3 Year Savings \& Initial Investment}}{\text{Fourth Year Savings}} = \frac{\$26{,}314.27}{\$44{,}761.91} = 0.588$$

Total Payback = **3.588 Years**


Building Cumulative 10 Year Savings
$450,000.00
$400,000.00
$350,000.00
$300,000.00
$250,000.00
$200,000.00
$150,000.00
$100,000.00
$50,000.00
$0.00
Savings
1
2
3
4
5
6
7
8
9
10
Years

Building Analysis

Internal Rate of Return

$$PVF = \frac{1}{(1 + i\%)n}$$

Year	Investment	Net Annual Savings	30%	Discount	35%	Discount
1	$160,600.00	$47,000.00	0.769	$36,153.85	0.741	$34,814.81
2		$49,350.00	0.592	$29,201.18	0.549	$27,078.19
3		$51,817.50	0.455	$23,585.57	0.406	$21,060.81
4		$54,408.38	0.350	$19,049.89	0.301	$16,380.63
5		$57,128.79	0.269	$15,386.44	0.223	$12,740.49
6		$59,985.23	0.207	$12,427.51	0.165	$9,909.27
7		$62,984.50	0.159	$10,037.61	0.122	$7,707.21
8		$66,133.72	0.123	$8,107.30	0.091	$5,994.50
9		$69,440.41	0.094	$6,548.20	0.067	$4,662.39
10		$72,912.43	0.073	$5,288.93	0.050	$3,626.30
			PW(30)=	$165,786.48	PW(35)=	$143,974.61

IRR = 30% + (30% - 35%) * ((PW(30) - Investment)/(PW(30) - PW(35))=

30% + (35% - 30%) * (($165,786 - $160,600)/($165,786 - $143,975))=

30% + (5% * ($5,186/$21,811)) = 30% + (5% * 0.24) = 30% + 1.2% =

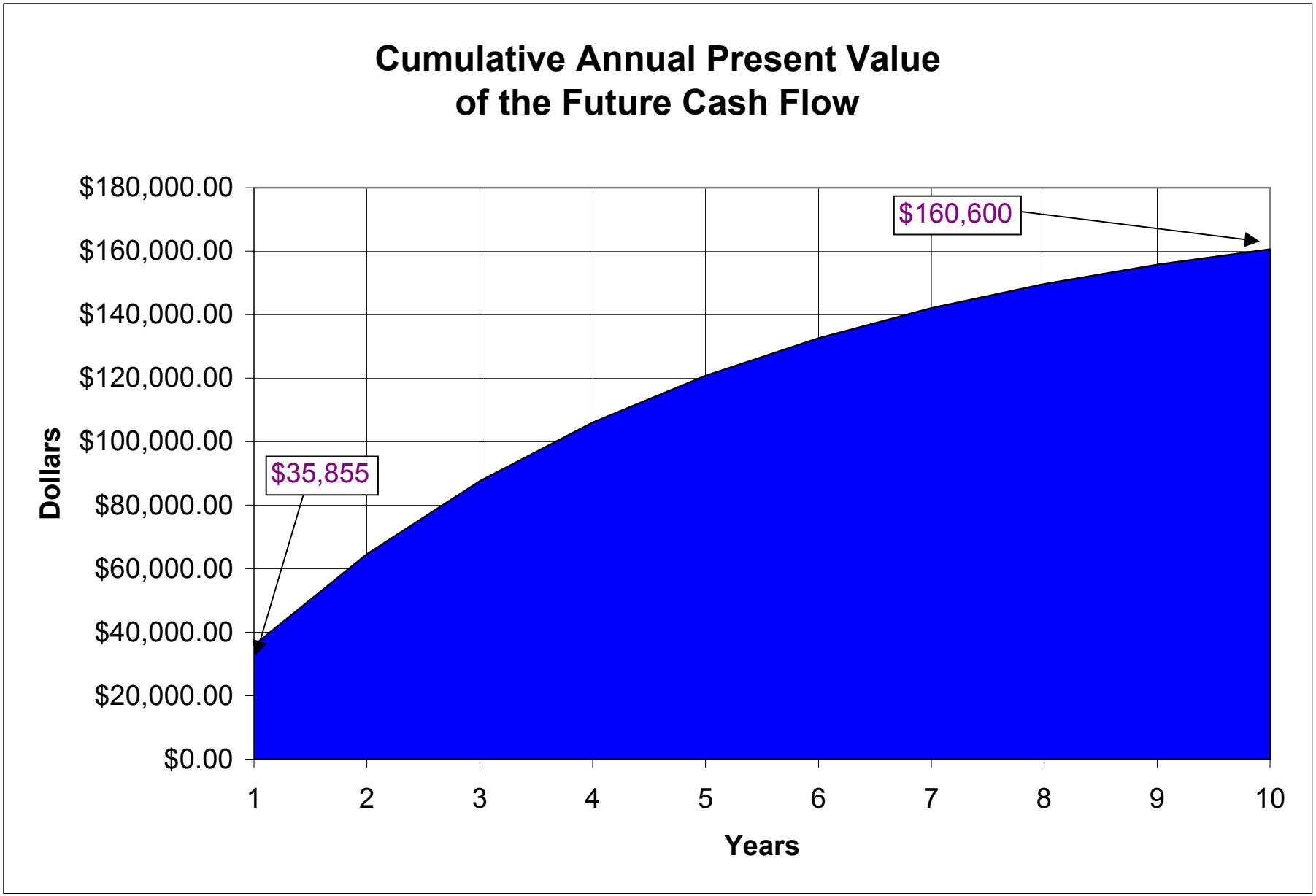
IRR = 31%

Building Analysis

Internal Rate of Return

$$PVF = \frac{1}{(1 + i\%)n}$$

Year	Investment	Net Annual Savings	31.08%	Discount
1	$160,600.00	$47,000.00	0.763	$35,855.27
2		$49,350.00	0.582	$28,720.86
3		$51,817.50	0.444	$23,006.04
4		$54,408.38	0.339	$18,428.34
5		$57,128.79	0.258	$14,761.50
6		$59,985.23	0.197	$11,824.29
7		$62,984.50	0.150	$9,471.52
8		$66,133.72	0.115	$7,586.89
9		$69,440.41	0.088	$6,077.27
10		$72,912.43	0.067	$4,868.02
			PW(31.08)=	$160,600.00


Cumulative Annual Present Value
of the Future Cash Flow
$180,000.00
$160,000.00
$140,000.00
$120,000.00
$100,000.00
$80,000.00
$60,000.00
$40,000.00
$20,000.00
$0.00
Dollars
$35,855
$160,600
1
2
3
4
5
6
7
8
9
10
Years