Life Cycle Cost Analysis

Selection of Heating Equipment

By Henry Manczyk, CPE, CEM

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When selecting equipment to renovate or upgrade facilities, replace obsolete or unreliable equipment, etc., one of the factors one must consider is the economics of the alternatives available to accomplish this. A low-priced system or piece of equipment, for example, might appear initially attractive, but might be excessively costly to operate over its lifetime or its useful life might be unusually short, making the item of less economic value than other alternatives in the long term. The technique of "Life Cycle Cost Analysis" allows one to move beyond the simple acquisition cost of a piece of equipment to evaluating its long term economic impact on the facility for which it is proposed.

The factors one considers in "Life Cycle Cost Analysis" include the initial purchase price of the system or piece of equipment; estimated useful life; operating and maintenance costs; energy costs adjusted by energy efficiency factors; and salvage value of the equipment at the end of its useful life. Operating and maintenance costs are typically discounted to obtain the net present value of the cost stream.

The following table compares the life cycle cost analyses of four HVAC systems that might be installed in a residence or a small commercial facility to replace existing equipment. Each has a 15-year estimated useful life. A uniform 3% discount rate is applied to the cost stream of each to calculate the net present value of the annual energy and maintenance costs. The annual energy cost shown, based on natural gas cost of \$6/MMBtu and \$0.075/kwh, has been adjusted for equipment efficiency. The detailed calculations for each system follow the table.

In the examples chosen, it is clear that initial purchase price alone is not a sufficient basis for determining the real cost of the alternatives. The unit that is least expensive to install turns out to be the most costly to own and operate. The unit with the highest installation cost is in fact the most economic system over the 15-year period. Only by performing the life cycle cost analysis of each alternative, however, can one determine this.

While "Life Cycle Cost Analysis" is a valuable tool in assessing the economics of an equipment selection, it is only one of many assessments the energy professional must make. One must also consider the system owner's ability to afford to invest in a particular piece of equipment; the impact of energy program incentives; price fluctuations of different energy sources; etc.

LIFE CYCLE COST OF ALTERNATIVE TYPES OF NEW HEATING SYSTEMS

Case Number	1	2	3	4
Item	New Gas Furnace With an Add-On Air Conditioner	New High Efficiency Gas Furnace With Add-On Air Conditioner	Heat Pump with Auxiliary Gas Backup	Heat Pump with Auxiliary Electric Backup
Life of Equipment	15 Years	15 Years	15 Years	15 Years
Initial Cost of Equipment	$10,733	$11,183	$10,153	$9,983
Annual Energy Cost	$1,191	$928	$1,366	$1,468
Annual Maintenance Cost	$60	$60	$150	$120
Heating Efficiency (AFUE)	68.9%	91.4%	68.9%	100.0%
Discount Rate	3%	3%	3%	3%
Salvage Value	$30	$30	$50	$50
Life Cycle Cost	$25,648	$22,958	$28,219	$28,909
Best Selection	2	1	3	4

LIFE CYCLE COST
PRESENT WORTH

Case Number: 1

1) Present Worth of a Future Amount

$$P = A\left[\frac{1}{(1+i)^n}\right]$$

(SPW: 15, 3%): 0.64186

2) Present Worth of a Uniform Series Compound Amount

$$P = A\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right]$$

(UPW: 15, 3%): 11.9379

Where:

P = Present worth
A = Amount
i = Interest Rate: 3%
n = Number of Interest Periods: 15
SPW = Present Worth Factor
UPW = Uniform Series Compound Amount Factor

Equipment Cost					$10,733
Energy Cost:	$1,191	x	11.9379	:	$14,218
Maintenance Cost:	$60	x	11.9379	:	$716
Salvage Cost:	$30	x	.64186	:	$-19
			Total Life Cycle Cost	:	$25,648

LIFE CYCLE COST
PRESENT WORTH

Case Number: 2

1) Present Worth of a Future Amount

$$P = A\left[\frac{1}{(1+i)^n}\right]$$

(SPW: 15, 3%): 0.64186

2) Present Worth of a Uniform Series Compound Amount

$$P = A\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right]$$

(UPW: 15, 3%): 11.9379

Where:

P = Present worth
A = Amount
i = Interest Rate: 3%
n = Number of Interest Periods: 15
SPW = Present Worth Factor
UPW = Uniform Series Compound Amount Factor

Equipment Cost					$11,183
Energy Cost:	$928	x	11.9379	:	$11,078
Maintenance Cost:	$60	x	11.9379	:	$716
Salvage Cost:	$30	x	.64186	:	$-19
			Total Life Cycle Cost	:	$22,958

LIFE CYCLE COST
PRESENT WORTH

Case Number: 3

1) Present Worth of a Future Amount

$$P = A\left[\frac{1}{(1+i)^n}\right]$$

(SPW: 15, 3%): 0.64186

2) Present Worth of a Uniform Series Compound Amount

$$P = A\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right]$$

(UPW: 15, 3%): 11.9379

Where:

P = Present worth
A = Amount
i = Interest Rate: 3%
n = Number of Interest Periods: 15
SPW = Present Worth Factor
UPW = Uniform Series Compound Amount Factor

Equipment Cost					$10,153
Energy Cost:	$1,366	x	11.9379	:	$16,307
Maintenance Cost:	$150	x	11.9379	:	$1,791
Salvage Cost:	$50	x	.64186	:	$-32
			Total Life Cycle Cost	:	$28,219

LIFE CYCLE COST
PRESENT WORTH

Case Number: 4

1) Present Worth of a Future Amount

$$P = A\left[\frac{1}{(1+i)^n}\right]$$

(SPW: 15, 3%): 0.64186

2) Present Worth of a Uniform Series Compound Amount

$$P = A\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right]$$

(UPW: 15, 3%): 11.9379

Where:

P = Present worth
A = Amount
i = Interest Rate: 3%
n = Number of Interest Periods: 15
SPW = Present Worth Factor
UPW = Uniform Series Compound Amount Factor

Equipment Cost					$9,983
Energy Cost:	$1,468	x	11.9379	:	$17,525
Maintenance Cost:	$120	x	11.9379	:	$1,433
Salvage Cost:	$50	x	.64186	:	$-32
			Total Life Cycle Cost	:	$28,909