

"User Friendly" Building Life-Cycle Costing

a spreadsheet
implementation of
BLCC

"User-Friendly" Life-Cycle Costing: The BLCC Procedure in an Easy-to-Use Spreadsheet

Marlin S. Addison
M.S. Addison and Associates
Tempe, Arizona
marlin.addison@doe2.com

SUMMARY

This paper describes an Excel spreadsheet implementation of *BLCC*, called *User-Friendly Life-Cycle Costing*. Although the life-cycle cost formulas used in *BLCC* are widely published and recognized, some *BLCC* users describe *BLCC*'s conventional procedure of first collecting user input, then "going away" to calculate results, as a familiar but uncomfortable "black box" procedure, i.e., does not display intermediate results. Spreadsheet users express greater confidence using the user-friendly "glass box" spreadsheet implementation of *BLCC* reported here. The *User-Friendly Life-Cycle Costing* spreadsheet is available for free download in Excel Office95 and Office 97 formats at <http://www.doe2.com>.

ABSTRACT

The Life-Cycle Costing (LCC) analysis method is recognized to reliably identify cost optimal building design solutions yet it is not widely used with confidence, even within the federal sector where its use is mandated (10 CFR 436). At the direction of the Federal Energy Management Program (FEMP), and drawing on standards work by the American Society for Testing and Materials (ASTM), the National Institute of Standards and Technology (NIST) has rendered a valuable service to the buildings industry at large by developing a recommended life-cycle costing procedure. NIST's LCC procedures standardize both nomenclature and conventions so that the entire buildings industry can speak one "language" when using LCC analysis. The centerpiece to NIST's LCC contributions is a

computer program called *BLCC*, the *Building Life-Cycle Cost Program*, which automatically applies the FEMP/NIST LCC conventions in LCC analyses. Despite *BLCC*'s contribution to the buildings industry's use of LCC methods, many *BLCC* users report feeling uncomfortable with a "black box" procedure that collects user inputs, then reports LCC results.

This paper describes an alternative: a thorough implementation of *BLCC* in an Excel spreadsheet format, *User-Friendly Life-Cycle Costing*. Users already familiar with spreadsheet programs, e.g., *Excel*, *Lotus*, *QuattroPro*, report greater confidence using this "glass box" spreadsheet implementation of *BLCC*. The *User-Friendly Life-Cycle Costing* spreadsheet is available for free download in Excel Office95 and Office 97 formats at <http://www.doe2.com>.

KEYWORDS

Life-Cycle Costing, BLCC, Simplified Life-Cycle Costing

INTRODUCTION AND BACKGROUND

The Life-Cycle Costing (LCC) analysis method is recognized to reliably identify cost optimal building design solutions. The Federal Energy Management Program (FEMP) of the U.S. Department of Energy (DOE) has codified the rules for performing LCC analysis of investments for energy and water conservation and renewable energy resource projects in the Code of Federal Regulations, 10 CFR 436, Subpart A, "Methodology and Procedures for Life-Cycle Cost Analysis" [1]. These rules apply to both new and existing buildings owned or leased by the

Federal Government. These economic evaluations are required by the Federal Energy Management Improvement Act of 1988 (Public Law 100-6 15) and the National Energy Conservation Policy Act (NECPA) of 1978 (P.L. 95-6 19). More recently, these requirements have been renewed in Executive Order 13123 [2], "Greening the Government through Efficient Energy Management", issued on 3 June 1999 (available online).

At the direction of FEMP, and drawing on standards work by the American Society for Testing and Materials (ASTM) [3], the National Institute of Standards and Technology (NIST) has developed standardized LCC nomenclature and conventions so that the entire buildings industry can speak one "language" when using LCC analysis. These are documented in NIST Handbook 135, *Life-Cycle Costing Manual for the Federal Energy Management Program* [4] (available online). The centerpiece to NIST's LCC procedures is a computer program called *BLCC* [7], the *Building Life-Cycle Cost Program*, which automatically applies the FEMP/NIST LCC conventions in LCC analyses. Despite *BLCC*'s contribution to the buildings industry's use of LCC methods, many *BLCC* users report feeling uncomfortable with a "black box" procedure that collects user inputs, then reports LCC results.

An Excel spreadsheet implementation of *BLCC*, called *User-Friendly Life-Cycle Costing* [8] is now available for free download to Excel users in Office95 and Office 97 formats (<http://www.doe2.com>). Spreadsheet users report greater confidence using this user-friendly "glass box" spreadsheet implementation of *BLCC*.

LIFE-CYCLE COST BASIC CONCEPTS

With regard to energy efficiency and energy conservation projects, there seems to be an unwritten rule of nature which holds that whatever project design options cost less to acquire will tend to cost more to operate and conversely. In other words, more efficient project

alternatives tend to cost more than less efficient alternatives.

For a hypothetical project, if the first costs for all identified project alternatives were plotted against their respective operating costs, a curve somewhat like the one illustrated in Figure 1 would result. Actual first cost vs operating cost data for glass type options for a large institutional new construction project are plotted in Figure 2, which roughly resembles Figure 1. In Figure 2, glass type #1 would be the preferred choice if least operating cost was the principal concern. Conversely, glass type #5 would be the preferred choice if minimum first cost was the principal concern. Glass types #3, #4, and #5 present other options that weigh the relative importance of first vs operating costs differently. Clearly, the best choice lies on the imaginary line connecting glass types #1 through #5. According to multiple criteria decision methods [5], the other glass types (un-numbered in Figure 2) are said to be *dominated* by glass types #1 through #5. Which of the *non-dominated* options (1 through 5) we favor will depend on how we weigh the relative importance of first vs operating costs. The value of life-cycle costing can be understood as a rational means to weigh the value of first costs versus future (e.g., operating) costs. The principle used to do this is the "time value of money".

The Time Value of Money

Everyone intuitively recognizes that a dollar today does not have the same value as a dollar in the distant future. The time value of money results from two considerations: 1) inflation, which is the "erosion" of future purchasing power and 2) opportunity cost, which for existing capital is the cost of forgone investment opportunities and for borrowed capital is the cost of borrowing (i.e., the loan rate). Of the two, most of us have a more intuitive feel for the process of inflation, where future increases in the level of prices for goods and services causes an effective loss in the future purchasing power of our dollars. Opportunity costs recognize that a fair comparison of the

economic benefit of two or more project options must consider what else we might have done with our money (i.e., in the case of existing capital) had we chosen to invest in something other than the available project options or what it would cost us to borrow the capital if necessary. Life-cycle costing considers both effects in weighing the value of present costs against future costs.

Figure 3 illustrates a process in which all costs, both future and present, are expressed in terms of the same time frame, i.e., the present. Owing to the influences of inflation and opportunity cost, the process is referred to as "discounting" future costs to their "present value". The FEMP/NIST method for life-cycle costing have established recommended procedures, resources, and requirements for federal projects. They are well described in NIST Handbook 135, *Life-Cycle Costing Manual for the Federal Energy Management Program* [4].

FEMP/NIST LIFE-CYCLE COST PROCEDURES

A very brief summary of the principal conventions and requirements of the FEMP/NIST LCC method includes:

- use PRESENT VALUE method, i.e., discount all future values to present value
- use "REAL" discount and escalation rates (explained below)
- use the FEMP discount rate, i.e., 3.1% for 1999 (real rate, revised annually, see [6])
- use DOE energy price escalation rates (real rates, revised annually, see [6])
- since all rates are "real", estimate all costs in TODAY'S dollars, i.e., "constant" dollars
- assume end-of-year cash flows
- use site-metered energy (i.e., not source)
- use local energy tariffs (not average costs)
- 25 years maximum study period
- five principal cost components are broken into two main categories (Figure 3 and Equation 1):

- ♦ investment-related
 - initial investment costs (i.e., acquisition or installed costs)
 - capital replacement costs
 - residual value
- ♦ operations-related
 - energy costs
 - operation, maintenance, and repair (OM&R)

The basic life-cycle cost equation (1) sums the present value of all cost components.

$$\begin{aligned} \text{LCC} = & \text{Initial investment costs} & (1) \\ & + \text{PV replacement costs} \\ & - \text{PV Residual Value} \\ & + \text{PV energy costs} \\ & + \text{PV OM\&R} \end{aligned}$$

See NIST Handbook 135 [4] for a complete discussion of these conventions.

"Real" vs "Nominal" discounting rates

Under the influence of inflation, the future value of a present cost can be calculated using equation (2).

$$F_t = P_0 \times (1+i)^t \quad (2)$$

where:

F_t = future value of a present cost, P_0 , in year t

P_0 = present cost of goods or services in year 0

i = the assumed rate of general inflation

t = future year assumed in the calculation

Assuming an expected rate of return, D , on an alternative available investment, a future cost is discounted to its present value using equation (3).

$$PV = F_t \times \frac{1}{(1+D)^t} \quad (3)$$

"User-Friendly" Life-Cycle Costing: The BLCC Procedure in an Easy-to-Use Spreadsheet

where:

- PV = present value of the future cost of goods/services
- F_t = future cost of goods/services in year t
- t = future year assumed in the calculation
- D = the assumed "discount rate",
for existing capital, D is the minimum rate-of-return on an alternative investment
for borrowed capital, D is the cost of borrowed capital, i.e., the loan rate

Of course, any investor would hope for a minimum rate-of-return that would out pace the influence of general inflation, else, the net value of their investment return is negative, i.e., a loss. Hence, they would hope that their realized rate-of-return is greater than the inflation rate, i.e., $D > i$.

The FEMP LCC procedures require a convention that permits the LCC analysis to "factor out" inflation. This is done by using "real" rather than "nominal" rates. For example, equation (4) can be used to determine a "real" discount rate, d , which is exclusive of inflation.

$$d = \frac{1 + D}{1 + i} - 1 \quad (4)$$

where:

- d = the "real" discount rate, exclusive of inflation
- i = the assumed rate of general inflation
- D = the assumed "nominal" discount rate,
for existing capital, D is the minimum rate-of-return on an alternative investment
for borrowed capital, D is the cost of borrowed capital, i.e., the loan rate

Using real discount rates in equation (5), a user need not explicitly adjust future costs, F_t , for inflation.

$$PV = F_t \times \frac{1}{(1+d)^t} \quad (5)$$

where the terms are the same as in equation (2), except:

- d = the assumed discount rate (real)
- $F_t = P_0$ if d is "real"

Rather, future costs (e.g., future repair or replacement costs) can be estimated in today's dollars, which is much more convenient! Real rates are alternately referred to as "net", "differential", or "effective" rates (i.e., they are expressed net of inflation and are the difference between the nominal rate and the real rate... the effective rate).

Inflation vs Escalation

One further distinction in the FEMP/NIST LCC method is important to discuss briefly. While goods and services are assumed to inflate at the same rate (i.e., the general inflation rate), the FEMP/NIST LCC procedures require that inflation of energy prices be treated separately. In other words, this assumes that energy prices will not inflate at the same rate as other goods and services. Accordingly, we distinguish general price inflation from energy price inflation by referring to the latter as energy price "escalation". As with the use of the discount rate, the energy price escalation rates are "real" (i.e., net or differential). DOE publishes official projections for future energy prices annually [6] each April for the residential, commercial and industrial sectors, broken down by region of the country, for six energy types (electricity, natural gas, LPG, distillate fuel oil, residual fuel oil, and coal).

"USER-FRIENDLY" LIFE-CYCLE COSTING SPREADSHEET

M. S. Addison and Associates, Tempe, AZ, has implemented the FEMP/NIST LCC procedures used in *BLCC* into an easy-to-use Excel spreadsheet format [8]. Users already familiar with spreadsheet programs will find the User-Friendly LCC spreadsheet intuitive, flexible, and easy to use. The spreadsheet can be downloaded free from <http://www.doe2.com>. Figures 5 and 6 illustrate main sheets in "User-Friendly" LCC.

"User-Friendly" Life-Cycle Costing: The BLCC Procedure in an Easy-to-Use Spreadsheet

General data applicable to all alternatives are input on the "General Data" tab sheet. This includes (refer to Figure 5):

- the discount rate to be used for the analysis (for federal projects, this should be the current year FEMP discount rate)
- number of years for the analysis (25 max)
- DOE energy price escalation region (1 - 4, 5=U.S. average, see map in Figure 5)
- analysis sector (Residential, Commercial, or Industrial)
- second fuel type (electric is assumed for all, one additional fuel can be specified: none, N.Gas, LPG, Distillate Oil, Residual Oil, Coal)
- uniform energy price escalation rates are optional, i.e., if omitted (the default), all analyses use the DOE energy price escalation rates for the current year
- reference discount rates for the current year are shown (i.e., FEMP, OMB Short- and Long-term)
- a "nominal" discount rate calculator is provided to convert nominal to real rates.
- comments for each of the input cells are provided
- Inputs cells are shown in blue font. Only the input cells are unprotected. The remainder of the General Data tab sheet is protected, but can easily be unprotected if edits to protected cells are desired. To unprotect any sheet, from the menu select "Tools", "Protection", "Unprotect Sheet...").

Data unique to each alternative are input on each of the "LCC" tab sheets. Sheet "LCC0" is assumed to be the base case. Sheets "LCC1", "LCC2", etc., are for project alternatives. Nine alternative sheets are provided on the example available for download. These "LCC" tabs sheets are illustrated in Figure 6. Inputs include:

- name of the project alternative, e.g., "base case", "alternative 1", etc.
- investment-related costs, e.g., first cost,

capital replacement costs, residual values; each estimated in today's dollars, entered in the year in which they are expected to occur.

- operations-related capital costs, e.g., non-annually recurring maintenance such as overhauls; each estimated in today's dollars, entered in the year in which they are expected to occur.
- annual electric costs, estimated in today's dollars (normally first year only, although you can assume any year-to-year variations you wish)
- annual second fuel costs, estimated in today's dollars, e.g., natural gas, LPG, etc. (normally first year only, although you can assume any year-to-year variations you wish)
- annually recurring costs, e.g., ongoing operations, maintenance, and repair (OM&R)

Items of interest that are reported on the "LCC" tab sheets include:

- total life-cycle cost, also reported by year and by cost category (e.g., investment-related, operations-related, utility costs, annually recurring costs)
- general data from the "General Data" tab sheet, e.g., FEMP fiscal year, discount rate, length analysis period, DOE region, and analysis sector
- the year-by-year "real" or differential energy price escalation - normally these are allowed to default to select the DOE energy price escalation rates for the current year, region and sector, however, user input for uniform energy price escalation rates on the General Data tab sheet can over ride these DOE values. Alternately, if a user obtains local energy price projects (e.g., specific to a particular utility) for any of the analysis years, they may be input.
- annually recurring costs, e.g., ongoing operations, maintenance, and repair (OM&R)

Items of interest that are reported on the "LCC" tab sheets but which are normally in hidden or unprinted columns include:

- annual energy costs, adjusted only for energy price escalation (no discount rate effect)
- annual energy costs, adjusted only for the discount rate (no energy price escalation)
- *(the preceding are provided mostly for instructional purposes)*
- discounted cumulative costs (reported year-by-year)
- discounted cumulative savings (year-by-year only for the alternative cases, relative to "LCC0")
- *(the preceding are provided mostly for graphing purposes)*
- discounted simple payback, shown in the year in which discounted payback occurs (includes ALL costs up the year of payback)

EXAMPLE RESULTS

Figure 7 illustrates example results from *User-Friendly LCC*. The data are from the same example plotted in Figure 2, i.e., glass type options for a large institutional new construction project. In Figure 7, the tabular results are divided into an upper and lower half. The upper half reports life-cycle costs. The lower half reports life-cycle savings. Cells in the cost portion of the table (upper portion) are linked directly to the "LCC" tab sheets for the base case and each alternative. Cells in the savings portion of the table (lower portion) are calculated from the upper portion of the table, by subtracting a row for each project alternative from the base case. Thus, two columns, "Total LCC Savings" and "Net Savings" are identical. Using the results in Figure 7, we can answer the question posed previously regarding the "best" glass type illustrated in Figure 2.

Simple Payback Method vs Life-Cycle Cost Method

The measure-of-merit most commonly used

throughout the buildings industry to make project investment decisions is Simple Payback. This is unfortunate because simple payback almost always fails to identify the most economic solution measured over the project life cycle. In part, this is not surprising since simple payback considers only initial costs, i.e., incremental initial investment cost and incremental first year utility savings. Simple payback ignores capital replacement, residual value, life-cycle utility costs, and operations and maintenance costs (OM&R). In summary, decisions made using simple payback are usually inferior because they are short-sighted. Like refusing to invest in preventative maintenance, long-term operating costs are ignored in favor of short-term cost (i.e., investment) savings.

As an example, if we select the glass type based on minimum simple payback, we would select Alt 1, which would yield \$417,795 in 25-year life-cycle utility savings and \$397,215 in net total 25-year life-cycle cost savings. Alt 1 in Figure 7 corresponds to point #4 in Figure 2. Alternatively, if we select based on minimum life-cycle costs (or maximum net savings), we would select Alt 9, which yields \$852,158 in 25-year life-cycle utility savings and \$681,798 in net total 25-year life-cycle cost savings. Alt 9 in Figure 7 corresponds to point #2 in Figure 2. In this example, selecting based on minimum life-cycle costs, rather than minimum simple payback adds \$170,360 in first costs, but also adds \$434,634 in 25-year life-cycle utility savings or \$284,584 in net total 25-year life-cycle cost savings. Figure 4 illustrates cumulative life-cycle savings for both alternatives.

Interestingly, for this glass type selection example, no capital replacement costs or residual values were considered appropriate and OM&R costs were assumed to be identical for all glass types and hence were ignored. Even in the case where these additional life-cycle cost components are eliminated, simple payback failed to select the life-cycle minimum cost alternative.

USER-FRIENDLY LCC STRENGTHS AND LIMITATIONS

A list of limitations of the spreadsheet implementation of *BLCC* include:

- only two energy types are possible, electricity plus any one additional fuel type (e.g., none, N.Gas, LPG, Distillate Oil, Residual Oil, Coal)
- Only end-of-year cash flow convention is possible. *BLCC* permits either end-of-year, or mid-year cash flow convention.
- *BLCC* permits user input describing the number of years and months for length of analysis and occurrence of costs (e.g., capital replacement costs). The spreadsheet assumes whole year time steps.

Based on user comments, a list of advantages of the spreadsheet implementation of *BLCC* include:

- Life-cycle costing done in the spreadsheet form of *BLCC* seems like a "glass box" rather than a "black box" since the intermediate calculations and input assumptions are presented year-by-year for recurring as well as non-recurring costs. Each "LCC" tab sheet is formatted to print out on a single page, self-documenting all of the significant analysis assumptions.
- Any number of project alternatives are easily reviewed and compared side-by-side in one spreadsheet "workbook". Additional project alternatives (i.e., LCC sheets) can be added by simply copying existing LCC sheets (drag and drop using the ctrl key + left mouse button).
- Being in a spreadsheet, comparative and summary results are possible in user-controllable tabular and/or graphic formats, e.g., Figures 4 and 7.
- DOE energy price escalation rates can be easily replaced with uniform user rates or with actual utility-projected rates for any portion of the analysis period.
- energy price escalation rates are shown for

each analysis are shown year-by-year in real (i.e., differential) form, therefore, for years that the net price of energy decrease (as in periods of deregulation), escalation rates are shown as negative values.

- LCC results can also be dynamically linked to other analysis results (e.g., energy and water conservation estimates). Iterative changes in either the conservation estimates or the general LCC parameters (e.g., discount rate), require no rerunning of the LCC calculations — they are recalculated and updated automatically, thus greatly facilitating "what-if" iterations.

CONCLUSIONS

Today's environmental and regulatory context for building design requires, even mandates, more thorough analysis that considers the whole picture, i.e., the whole project life-cycle. Fortunately, recent development in simulation and economic analysis programs make this extra level of design effort more affordable and reliable. Tools and methods that can better weigh the life-cycle cost of short-term budget expediencies will help project decision makers realize "globally optimal" design.

REFERENCES

- [1] Code of Federal Regulations, 10 CFR 436, Subpart A, *Methodology and Procedures for Life Cycle Cost Analysis*, effective November 20, 1990. (for a PDF version, visit <http://www.gpoaccess.gov/cfr/index.html> and search for "10CFR436", then search your results for "Subpart A")
- [2] Executive Order 13123, *Greening the Government through Efficient Energy Management*, 3 June 99 (available at: <http://ceq.eh.doe.gov/nepa/regs/eos/eo13123.html>).
- [3] *ASTM Standards on Building Economics*, American Society for Testing and Materials, Third Edition, Philadelphia, PA, 1994.
- [4] Fuller, S.K. and S.R. Petersen, *Life-Cycle Costing Manual for the Federal Energy Management Program*, NIST Handbook 135, National Institute of Standards and Technology, Gaithersburg, February 1996. For a PDF version, visit <http://www.bfrl.nist.gov/oae/publications/handbooks/135.html>. Order a free printed copy by phone from the DOE Help Desk at (1-800-363-3732).
- [5] Fandel, G. and Spronk, J. Eds., *Multiple Criteria Decision Methods and Applications*, Springer-Verlag, Berlin, 1985
- [6] Fuller, S.K., Annual Supplement to NIST Handbook 135, *Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis 1999*, NISTIR 85-3273-9, National Institute of Standards and Technology, Gaithersburg, October 1994 (revised annually, available each April). For a PDF version, visit: http://www.eere.energy.gov/femp/information/download_blcc.cfm#annual_supplement.

LCC SOFTWARE

- [7] *BLCC, The NIST "Building Life-Cycle Cost" Program*, NISTIR 5185-2, National Institute of Standards and Technology, Gaithersburg, MD, April 1999. To download a free copy and manual, visit: http://www.eere.energy.gov/femp/information/download_blcc.cfm
- [8] *User-Friendly Life-Cycle Costing*, M. S. Addison and Associates, Tempe, AZ, 2002. Available in Excel Office95, Office97 and Office2000 formats. To download a free copy, visit: <http://www.doe2.com>.

BLCC SUPPORTING SOFTWARE

The following programs are often used in support of BLCC. To download a free copy and manual for any of the programs listed below, visit the FEMP information resources web site:

http://www.eere.energy.gov/femp/information/download_blcc.cfm

EMISS: A Program for Estimating Local Air Pollution Emission Factors Related to Energy Use in Buildings, User's Guide and Reference Manual, NISTIR 5704, National Institute of Standards and Technology, Gaithersburg, MD, October 1995.

ERATES: A Computer Program for Calculating Time-of-Use, Block, and Demand Charges for Electricity Usage, User's Guide and Reference Manual, NISTIR 5186-2, National Institute of Standards and Technology, Gaithersburg, MD, October 1996.

DISCOUNT--A Program for Discounting Computations in Life-Cycle Cost Analyses, User's Guide and Reference Manual, NISTIR 4513, National Institute of Standards and Technology, Gaithersburg, MD, January 1991.

"User-Friendly" Life-Cycle Costing: The BLCC Procedure in an Easy-to-Use Spreadsheet

Figure 1: First vs Operating Costs (hypothetical)

What's good for first costs tends to be bad for operating costs (i.e., efficiency usually costs more)

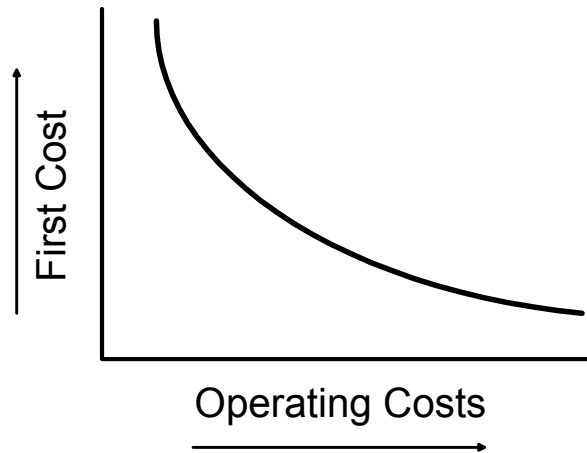


Figure 2: First vs Operating Costs (actual data)

The data below represent glass type alternatives for a building project. Which one is "best"?

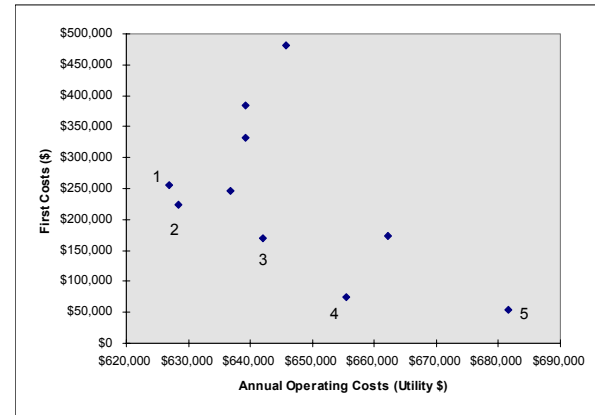


Figure 3: "Discounting" Future Cash Flows
In LCC, future costs are expressed in their equivalent "present value" by being discounted

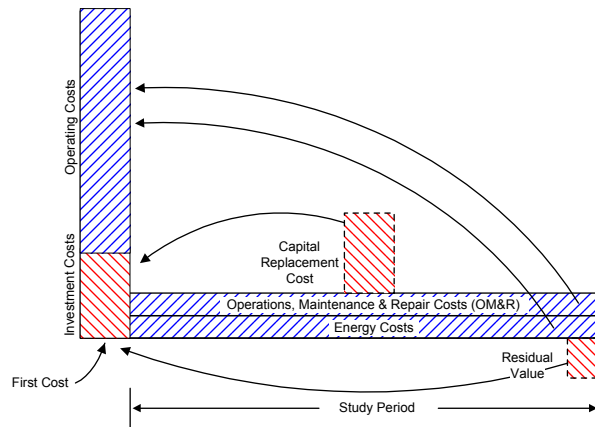
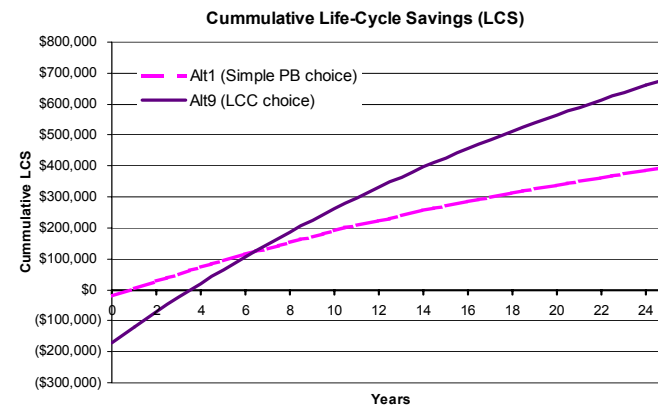


Figure 4: Cummulative Life-Cycle Savings
Cummulative life-cycle savings for glass types selcted via Simple Payback and LCC



"User-Friendly" Life-Cycle Costing: The BLCC Procedure in an Easy-to-Use Spreadsheet

Figure 5: User-Friendly LCC "General Data" tab sheet

USER-FRIENDLY BUILDING LIFE-CYCLE COST ANALYSIS
 by M.S. Addison and Associates, Tempe, AZ marlin.addison@doe2.com
 User input fields are indicated in blue.

*IMPORTANT NOTE: This spreadsheet should be updated (replaced) every April, after DOE releases updated energy price escalation factors.
 Visit <http://www.doe2.com> to download the most current copy.*

Basic Data, this analysis	FY 1999 Federal Discount Rates:
DOE/FEMP Fiscal Year 1999	DOE/FEMP 3.1%
Discount Rate for this Analysis 3.1%	OMB Short Term 2.7%
Number of Analysis Years 25	OMB Long Term 2.9%
DOE Fuel Price Escalation Region 4 (West) (1 through 4, see map below, 5=U.S. average)	Reference Rates: 5.7% Nominal Discount Rate
Analysis Sector 2 (Commercial) (1=Residential; 2=Commercial; 3=Industrial)	2.5% General Inflation Rate
Second Fuel Type 1 (Natural Gas) (0=None, 1=N.Gas; 2=LPG; 3=Dist Oil; 4=Resid Oil; 5=Coal)	3.1% Real Discount Rate
Uniform Electric Price Escalation Rate _____ (to use DOE escalation rates, which vary by year, leave this entry empty)	
Uniform Natural Gas Price Escalation Rate _____ (to use DOE escalation rates, which vary by year, leave this entry empty)	

Source: U.S. Bureau of the Census

"User-Friendly" Life-Cycle Costing: The BLCC Procedure in an Easy-to-Use Spreadsheet

Figure 6: User-Friendly LCC Example "LCC" tab sheet
(user input cells are show shaded below)

Base Case Rooftop Package HVAC						FEMP Fiscal Year: 1999			Disc. Rate: 3.1%			DOE Region: West				
									Years of Analysis: 25			Analysis Sector: Commercial				
Year	NON-ANNUAL RECURRING COSTS						ELECTRIC COSTS			NATURAL GAS COSTS			ANNUAL RECURRING COSTS		TOTAL COSTS	
	Investment-Related Costs <i>(e.g., 1st cost, replacement, residual)</i>			Operations-Related Costs <i>(e.g., non-annual maintenance)</i>			Annual Recurring Electric Constant \$	Electric Differential Escalation %	Discounted Electric w/Fuel Esc. PV \$	Annual Recurring Nat Gas Constant \$	Nat Gas Differential Escalation %	Discounted Nat Gas w/Fuel Esc. PV \$	Annual Recurring Constant \$	Discounted Recurring PV \$	Year	Discounted Total Costs PV \$
	Descript of Cost	Constant \$	Discounted PV \$	Descript of Cost	Constant \$	Discounted PV \$										
0	First Cost	\$75,000	\$75,000	n/a	n/a	n/a	\$62,500			\$3,650			\$1,000	0	\$75,000	
1		\$0	\$0				\$62,500	-1.30%	\$59,834	\$3,650	1.09%	\$3,579	\$1,000	\$970	1	\$64,383
2		\$0	\$0				\$62,500	-1.46%	\$57,190	\$3,650	0.36%	\$3,484	\$1,000	\$941	2	\$61,614
3		\$0	\$0				\$62,500	-2.29%	\$54,201	\$3,650	0.18%	\$3,385	\$1,000	\$912	3	\$58,498
4		\$0	\$0				\$62,500	-0.44%	\$52,341	\$3,650	0.71%	\$3,306	\$1,000	\$885	4	\$56,532
5		\$0	\$0				\$62,500	-0.10%	\$50,717	\$3,650	0.18%	\$3,213	\$1,000	\$858	5	\$54,788
6		\$0	\$0				\$62,500	-0.10%	\$49,144	\$3,650	0.35%	\$3,127	\$1,000	\$833	6	\$53,104
7		\$0	\$0				\$62,500	0.34%	\$47,830	\$3,650	0.53%	\$3,049	\$1,000	\$808	7	\$51,687
8		\$0	\$0				\$62,500	-0.59%	\$46,119	\$3,650	-0.35%	\$2,947	\$1,000	\$783	8	\$49,850
9		\$0	\$0				\$62,500	-0.49%	\$44,513	\$3,650	-0.88%	\$2,833	\$1,000	\$760	9	\$48,106
10		\$0	\$0				\$62,500	-0.45%	\$42,982	\$3,650	-1.06%	\$2,719	\$1,000	\$737	10	\$46,438
11		\$0	\$0				\$62,500	-0.65%	\$41,420	\$3,650	-1.08%	\$2,609	\$1,000	\$715	11	\$44,744
12		\$0	\$0				\$62,500	-1.30%	\$39,653	\$3,650	-1.45%	\$2,494	\$1,000	\$693	12	\$42,840
13		\$0	\$0				\$62,500	-0.61%	\$38,227	\$3,650	-1.29%	\$2,388	\$1,000	\$672	13	\$41,287
14		\$0	\$0				\$62,500	-0.36%	\$36,945	\$3,650	-1.30%	\$2,286	\$1,000	\$652	14	\$39,883
15	Replace	\$65,000	\$41,118				\$62,500	0.15%	\$35,889	\$3,650	-1.13%	\$2,192	\$1,000	\$633	15	\$79,832
16		\$0	\$0				\$62,500	-0.36%	\$34,686	\$3,650	-0.57%	\$2,114	\$1,000	\$614	16	\$37,413
17		\$0	\$0				\$62,500	-0.51%	\$33,470	\$3,650	-0.38%	\$2,042	\$1,000	\$595	17	\$36,108
18		\$0	\$0				\$62,500	-0.62%	\$32,263	\$3,650	0.00%	\$1,981	\$1,000	\$577	18	\$34,821
19		\$0	\$0				\$62,500	0.21%	\$31,358	\$3,650	0.00%	\$1,921	\$1,000	\$560	19	\$33,839
20		\$0	\$0				\$62,500	-0.98%	\$30,116	\$3,650	0.19%	\$1,867	\$1,000	\$543	20	\$32,526
21		\$0	\$0				\$62,500	-0.94%	\$28,936	\$3,650	0.19%	\$1,815	\$1,000	\$527	21	\$31,277
22		\$0	\$0				\$62,500	-0.21%	\$28,007	\$3,650	0.38%	\$1,767	\$1,000	\$511	22	\$30,284
23		\$0	\$0				\$62,500	0.00%	\$27,164	\$3,650	0.38%	\$1,720	\$1,000	\$496	23	\$29,380
24		\$0	\$0				\$62,500	0.00%	\$26,348	\$3,650	0.38%	\$1,675	\$1,000	\$481	24	\$28,503
25	Residual	(\$21,646)	(\$10,090)				\$62,500	0.00%	\$25,555	\$3,650	0.38%	\$1,631	\$1,000	\$466	25	\$17,562
		\$118,355	\$106,028	\$0	\$0		\$1,562,500		\$994,907	\$91,250		\$62,142	\$25,000	\$17,221		\$1,180,298

"User-Friendly" Life-Cycle Costing: The BLCC Procedure in an Easy-to-Use Spreadsheet

Figure 7: User-Friendly LCC Example "Results Summary" Sheet

Using minimum simple payback or discounted payback, Alt 1 is the best choice. Minimum LCC would select Alt 9.

Case	Description	One-Time Costs		Total Utility Costs		Maintenance		Total LCC PV \$	Net Savings NS	Simple Payback yrs	Discnt'd Payback yrs	Saving -to- Invest Ratio SIR	Adjusted Internal Rate-of-Return AIRR
		1st year \$	LCC PV \$	1st year \$	LCC PV \$	1st year \$	LCC PV \$						
Life-Cycle COSTS													
Base	Single Clear	\$54,300	\$54,300	\$681,630	\$10,878,556	\$0	\$0	\$10,932,856	n/a	n/a	n/a	n/a	n/a
Alt 1	Single Pane Azurlite	\$74,880	\$74,880	\$655,380	\$10,460,762	\$0	\$0	\$10,535,642	n/a	n/a	n/a	n/a	n/a
Alt 2	Calif Series - Water White Crystal	\$482,040	\$482,040	\$645,720	\$10,307,255	\$0	\$0	\$10,789,295	n/a	n/a	n/a	n/a	n/a
Alt 3	Calif Series - Sea Foam Low-E Clear	\$383,760	\$383,760	\$639,220	\$10,201,814	\$0	\$0	\$10,585,574	n/a	n/a	n/a	n/a	n/a
Alt 4	Calif Series - Tahoe Blue	\$332,280	\$332,280	\$639,140	\$10,203,131	\$0	\$0	\$10,535,411	n/a	n/a	n/a	n/a	n/a
Alt 5	Viracon - VE1-55 - Low-E Clear	\$169,650	\$169,650	\$642,060	\$10,243,006	\$0	\$0	\$10,412,656	n/a	n/a	n/a	n/a	n/a
Alt 6	Viracon - VE1-85 - Low-E Clear	\$174,330	\$174,330	\$662,150	\$10,563,041	\$0	\$0	\$10,737,371	n/a	n/a	n/a	n/a	n/a
Alt 7	Viracon - VE7-55 - Low-E Azurlite	\$256,470	\$256,470	\$626,930	\$10,002,944	\$0	\$0	\$10,259,414	n/a	n/a	n/a	n/a	n/a
Alt 8	Viracon - VE7-85 - Low-E Azurlite	\$245,540	\$245,540	\$636,780	\$10,159,188	\$0	\$0	\$10,404,728	n/a	n/a	n/a	n/a	n/a
Alt 9	Viracon - SolarBan 2000	\$224,660	\$224,660	\$628,370	\$10,026,398	\$0	\$0	\$10,251,058	n/a	n/a	n/a	n/a	n/a
Life-Cycle SAVINGS (negative entries indicate increased costs)													
Alt 1	Single Pane Azurlite	(\$20,580)	(\$20,580)	\$26,250	\$417,795	\$0	\$0	\$397,215	\$397,215	0.8	0.8	20.3	16.3%
Alt 2	Calif Series - Water White Crystal	(\$427,740)	(\$427,740)	\$35,910	\$571,302	\$0	\$0	\$143,562	\$143,562	11.9	16.4	1.3	4.3%
Alt 3	Calif Series - Sea Foam Low-E Clear	(\$329,460)	(\$329,460)	\$42,410	\$676,742	\$0	\$0	\$347,282	\$347,282	7.8	9.5	2.1	6.1%
Alt 4	Calif Series - Tahoe Blue	(\$277,980)	(\$277,980)	\$42,490	\$675,426	\$0	\$0	\$397,446	\$397,446	6.5	7.8	2.4	6.8%
Alt 5	Viracon - VE1-55 - Low-E Clear	(\$115,350)	(\$115,350)	\$39,570	\$635,551	\$0	\$0	\$520,201	\$520,201	2.9	3.2	5.5	10.4%
Alt 6	Viracon - VE1-85 - Low-E Clear	(\$120,030)	(\$120,030)	\$19,480	\$315,515	\$0	\$0	\$195,485	\$195,485	6.2	7.2	2.6	7.2%
Alt 7	Viracon - VE7-55 - Low-E Azurlite	(\$202,170)	(\$202,170)	\$54,700	\$875,612	\$0	\$0	\$673,442	\$673,442	3.7	4.1	4.3	9.3%
Alt 8	Viracon - VE7-85 - Low-E Azurlite	(\$191,240)	(\$191,240)	\$44,850	\$719,368	\$0	\$0	\$528,128	\$528,128	4.3	4.8	3.8	8.7%
Alt 9	Viracon - SolarBan 2000	(\$170,360)	(\$170,360)	\$53,260	\$852,158	\$0	\$0	\$681,798	\$681,798	3.2	3.5	5.0	10.0%
Analysis Conditions:		DOE/FEMP Fiscal Year		1999		Discount Rate for this Analysis		3.1%		Number of Analysis Years		25	
		DOE Fuel Price Escalation Region		4		(West)				Analysis Sector		2 (Commercial)	