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LEAST-COST ENERGY DECISIONS

Rosalie T. Ruegg
Stephen R. Petersen

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Comprehensive Guide for Least-Cost Energy Decisions

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PREFACE

More than a decade after the first shock from escalating energy prices, millions of buildings in the United States still reflect the days when oil cost 18¢ per gallon. Buildings continue to be built without adequate regard for energy conservation. The resulting cost to building owners is enormous, and the waste of national resources is serious. It is important to continue the effort to adjust buildings and equipment to reflect the higher cost of energy today.

Reflecting governmental concern over the inefficient use of energy in buildings, the U.S. Department of Energy was required by legislation and by Presidential Executive Order* to develop methods and procedures to be used in evaluating the long-run cost consequences of alternative designs and systems for Federal buildings, taking into account the cost of energy. The Department was also directed to make available to the building industry the methods, procedures, and related aids developed for Federal use. This book was sponsored by the Department of Energy and prepared by the National Bureau of Standards in response to this directive.

ACKNOWLEDGMENTS

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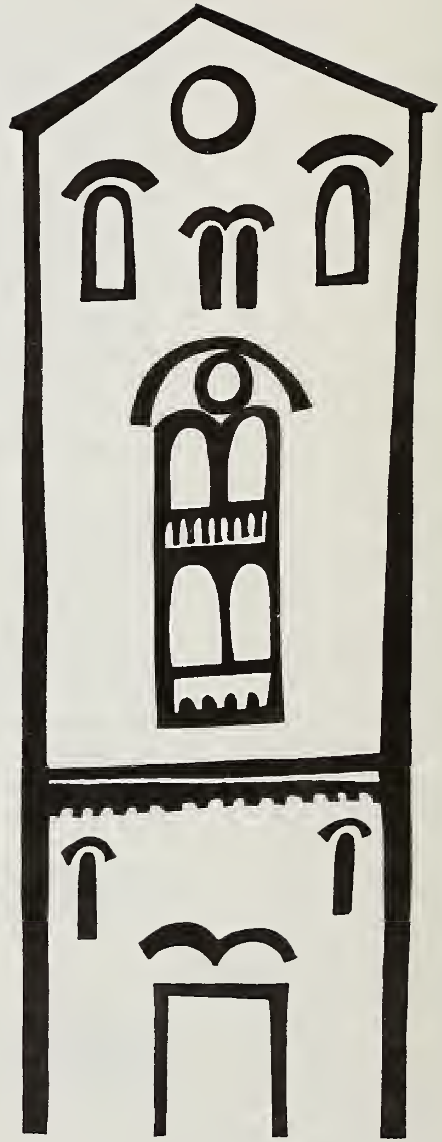
Credit is due to Dr. Harold Marshall, Head of the Applied Economics Group, Dr. Stephen Weber and Mr. Matthew Wiener, also of the Applied Economics Group, and Mr. Joseph Greenberg, of the Center for Building Technology, for their valuable technical and editorial comments. Appreciation is extended to Ms. Sieglinde Fuller and Ms. Bobbie Lippiatt, both of the Applied Economics Group, for their assistance in preparing the tables in Appendix B, Part I. Appreciation is also extended to Ms. Laurene Linsenmayer for supervising the typing of the manuscript, and to Ms. Amy House and Ms. Margaret Robinson for their assistance with the typing.

The authors also wish to thank Nancy Gogniat and Ilse Putman of the Electronic Typesetting Group for typesetting the final draft.

* Energy Policy and Conservation Act, as amended (42 U.S.C. 6361); Executive Order 11912, as amended by Executive Order 12003, 42FR 37523 (July 20, 1977); National Energy Conservation Policy Act, Title V, Part 3 (42 U.S.C. 8255), as amended by Energy Security Act (P.L. 96-294).

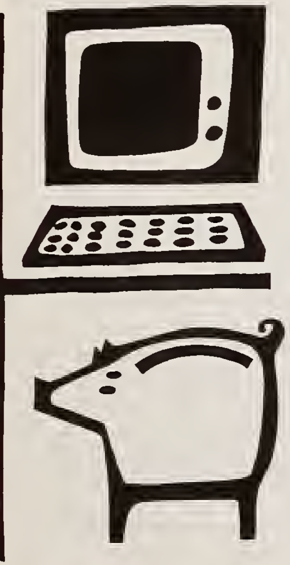
CONTENTS

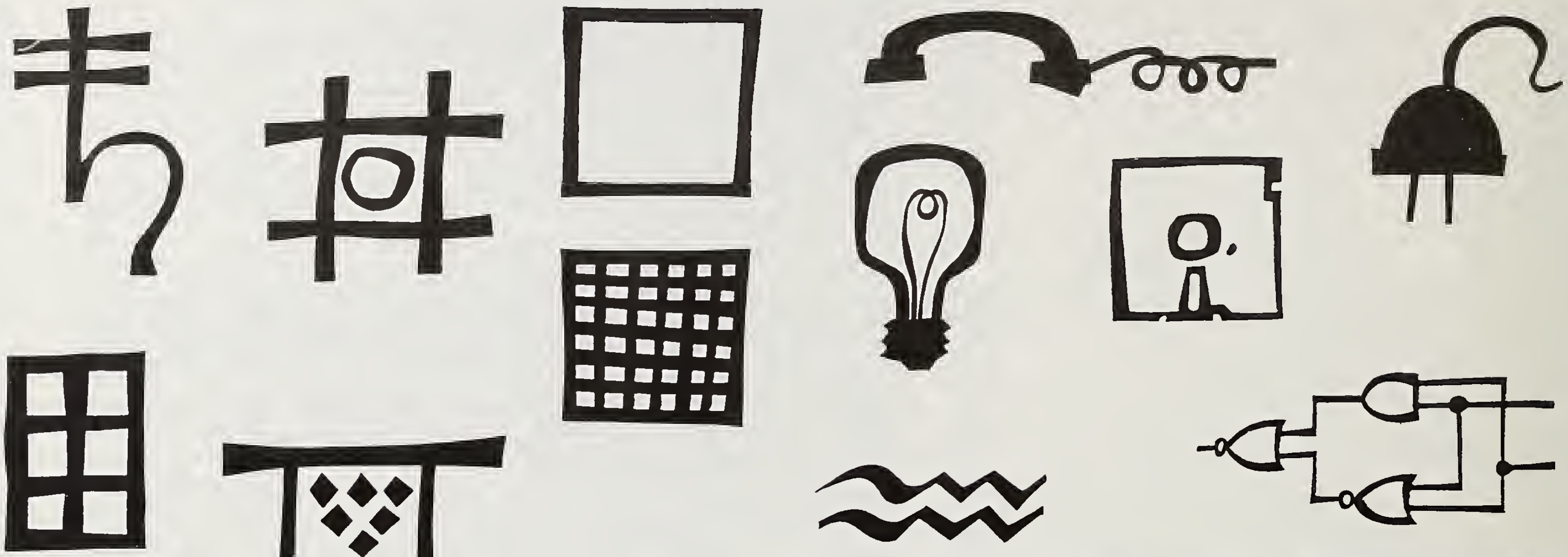


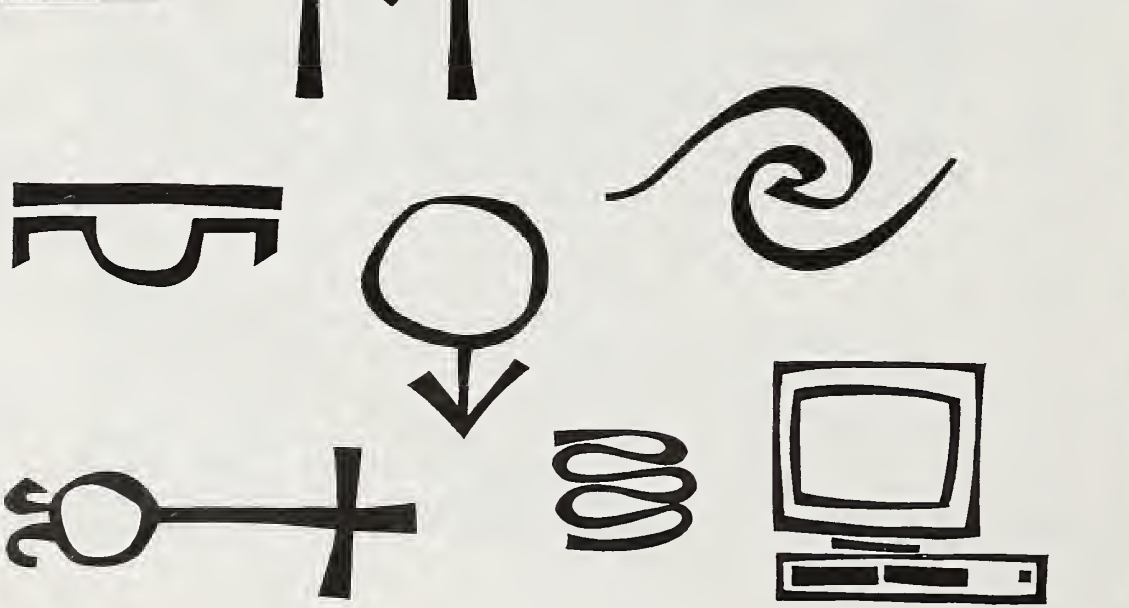
LIST OF FIGURES

LIST OF WORKSHEETS

LIST OF TABLES







The drawings of this book were inspired by the signs and symbols collected by the celebrated German typographer professor Rudolf Koch as a graphic history of the development of written communication. Koch gathered his collection from early Christian signs, monograms of the medieval church, stone masons' signs, the four elements, astronomical signs, botanical signs, house and holding marks, and the runes.

In this book, Koch's symbols are gradually supplanted by the communication symbols of our time such as the diagrams used by mechanical and electrical engineers and the notations of computer logic. There are also figures and symbols of houses, buildings, and the tools of our daily life expressed in the graphic style of Koch's earlier signs and symbols.

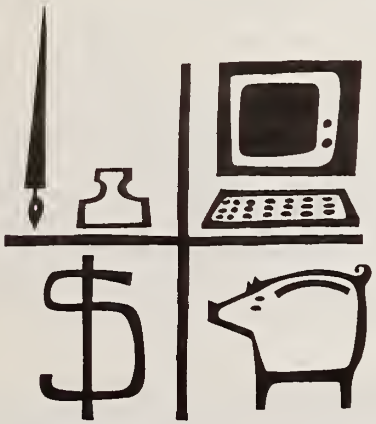
The drawings can be divided into three categories: iconographic, ideagraphic, and mystical. The iconographic drawings are abstract symbols of recognizable objects such as houses, buildings, and computers. The ideagraphic drawings are recognizable signs and symbols combined to express ideas or comments. The mystical drawings are signs and symbols whose meanings have been lost, yet retain an appealing decorative quality and are included for this reason.

We have labeled some drawings after Koch, others we feel will be apparent to you, and others are left for you to puzzle over as we have done.

1. INTRODUCTION

ADJUSTING TO HIGHER ENERGY COSTS

The attention of building owners and operators was riveted on energy costs following OPEC's four-fold price increase in late 1973–74 and the subsequent doubling of OPEC prices in 1979. The rise in energy prices has since abated and even reversed to a considerable extent, but world oil prices, measured in dollars of constant purchasing power, remain substantially more than they were in the early 1970's. As shown by Figure 1-1, average annual world oil prices were projected by the U.S. Department of Energy at the time of this report to fall within a range of about $20 (low) to $40 (high) per barrel (1985 dollars) through the rest of this decade, given no major oil disruptions.



The building industry is still in the process of adjusting to the past shocks of high energy costs and uncertain fossil fuel supplies. This adjustment entails designing, building, equipping, and operating buildings for greater energy efficiency, as well as in some cases incorporating the use of renewable energy sources. But in the face of a short-term easing of prices there are the twin dangers that existing buildings will not be retrofitted for energy conservation to the degree warranted by long-run costs and that new buildings will be designed and constructed to reflect temporarily lower energy prices. The possible failure to upgrade the thermal performance of existing buildings is particularly troubling given that about 75 percent of the approximately 85 million U.S. residential buildings existing in 1984, as well as a high percentage of commercial buildings, were constructed before 1970—prior to those dramatic rises in energy prices.[1]

ABOUT THE BOOK

The purpose of this book is to assist builders, building designers, owners, and operators to find a balance between energy consumption and energy conservation which will result in more cost-effective buildings. It assists in four ways: by guiding the decision maker to ask the right economic questions, by showing how to evaluate the cost effectiveness of energy conservation and renewable energy investments, by providing two computational aids—worksheets and a computer program, and by supplying some of the data that are needed to make the evaluations.

The focus of the book is on estimating the long-run economic performance of energy-related building components. To do this will require engineering information as well as economic data. Chapter 2 discusses briefly how to get started on this task. References are given which the reader may find useful in identifying potential investments in energy conservation or alternative energy sources. Those who have experience in energy conservation may wish to proceed directly to Chapter 3.

Chapters 3 through 7 comprise the heart of the book. Chapter 3, "Evaluation Methods, Data, and Assumptions," guides the reader in asking questions and answering them so as to increase the return on investment from conservation expenditures. A framework for economic evaluation is presented, and guidance in selecting a method of evaluation, estimating costs and savings, and making assumptions is provided. Chapter 4, "Making Decisions," demonstrates how to use the economic evaluation methods to make different kinds of decisions. Chapters 5 and 6 present computational tools for calculating life-cycle costs and benefits of alternative conservation investments. Chapter 5 presents a set of worksheets for manual calculations of LCC, and Chapter 6 describes a computer program for the same purpose. Chapter 7 provides sample problems with solutions to guide the reader in using the computational tools and interpreting the results. Chapter 8 concludes the Guide. Ten appendices provide supporting economic data, evaluation tools, and additional information about the computer program.

Theoretical discussions have been kept to a minimum; the emphasis is on application of the economic evaluation methods. References are provided for the reader who wants more information about the methods.

[1] U.S. Energy Information Administration, *1982 Annual Energy Outlook*, Washington, DC, DoE/EIA-0383(82), April 1983, pp. 33 and 38; and *Annual Report of Energy Conservation Indicators for 1982*, Washington, DC, DoE/EIA-0441(82), January 1984, p. 13.

2. GETTING STARTED

IDENTIFYING ENERGY USAGE

A first step in reducing energy costs is to identify those elements of the building which account for most of the energy use—that is, conduct an energy audit—so that conservation efforts can be focused where they will do the most good.

Physical components which generally should be assessed in an energy audit are the building envelope and its site, including the overall design, shape, orientation, and envelope characteristics; mechanical systems, including heating, ventilating, air conditioning, plumbing, and process facilities; and electrical systems, including lighting, power, communications, and appliances.

Although the specific amount of energy consumed depends on many things, such as type, size, age, use, and location of the building, some general tendencies can be noted. For residential buildings in all but very mild climates, the primary energy use is for climate control. Therefore, the thermal quality of the building's exterior and the efficiency of the heating and cooling equipment are of primary concern. Figure 1-2 shows the average annual household consumption of energy and related expenditures, by region, in 1981. Expenditures are highest in the Middle Atlantic States, New England, and the North Central region, due to the combination of climate effects and above average energy prices.

For commercial buildings, the factors determining energy usage are more complex. The main determinant of the rate of energy consumption in many commercial buildings tends to be not climate, but function, because the rate of energy consumption depends on the energy-consuming equipment within a building, and the energy-consuming equipment is determined by building function. For example, a dry cleaning store or a data processing facility typically has high energy use rates, whereas a retail store or a bookstore usually has low rates. The effect of building function on energy use is demonstrated by Figure 1-3, which shows the average consumption per square foot by building type in 1979. Health care buildings were on the average the largest energy users per unit of space at 262 Btu's per ft^2, offices were in the middle range at 124 Btu's per ft^2, and retail stores were among the lowest users at 87 Btu's per ft^2. In terms of *total* energy consumed nationally by the various categories of nonresidential buildings, Figure 1-4 shows that office buildings were the major users at 33.1 percent of the total, followed by retail/wholesale buildings at 26.8 percent.

Another important determinant of a commercial building's energy consumption is the type of control for heating, cooling, and process systems. Poorly designed controls may result in a wasteful disparity between energy delivered and energy needed at the end-use point. A third major determinant of a commercial building's energy use is the amount of energy required to distribute the heating and cooling energy throughout the building and to provide proper ventilation. A fourth major determinant is the number of hours during which the heating and cooling systems operate. Often in commercial buildings that are not used around the clock, there are opportunities for large savings through scaled back operations during "off" hours.

Computerized controls and sensors can be used to take advantage of these opportunities while maintaining proper comfort levels during hours of occupancy. In addition, the thermal quality of the building envelope affects its energy efficiency, though generally much less in larger buildings than in houses and smaller commercial buildings. For instance, cooling costs of large office buildings often have little relationship to climate, but instead arise primarily from the need to offset heat gains from people, lights, and equipment.[2]

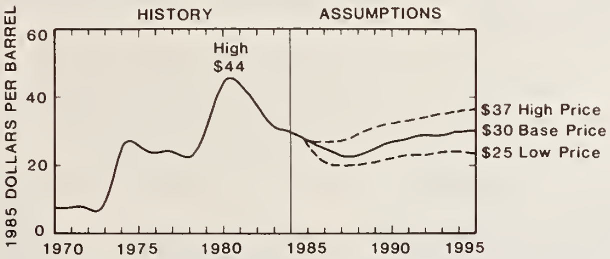
Figure 1-5 indicates an inverse relationship between nonresidential building size and energy consumption per square foot. It shows 1979 consumption per square foot to range from an average of 303,000 Btu's in buildings with 1,000 or less square feet to an average of 108,000 Btu's in buildings with more than 50,000 square feet. However, the figure also shows, not surprisingly, that large buildings use much more energy on the average than small buildings.

IDENTIFYING POTENTIAL ACTIONS

There will likely be a number of energy conserving actions which will cost little or nothing, and which can be implemented without further analysis, such as turning off lights in unoccupied spaces, using existing window shades and coverings more effectively, reducing hot water consumption, weatherstripping windows and doors, and setting back the thermostat at night. There will probably also be actions which save energy but whose costs make the economic merit of the action unclear. In other words, not all opportunities to reduce energy use are necessarily cost effective.

[2] For further general discussion of the factors accounting for energy consumption, see Lawrence G. Spielvogel, "How and Why Buildings Use Energy," *Energy Conservation through Building Design,* ed. Donald Watson (New York, NY: McGraw Hill Book Company, 1979).

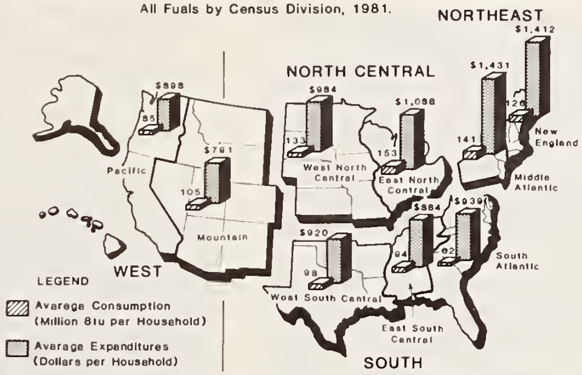
Figure 1-1. World Oil Price Projections, 1970 to 1995
(In constant 1985 dollars)



Note: All prices reflect the average landed price of crude oil in the United States.

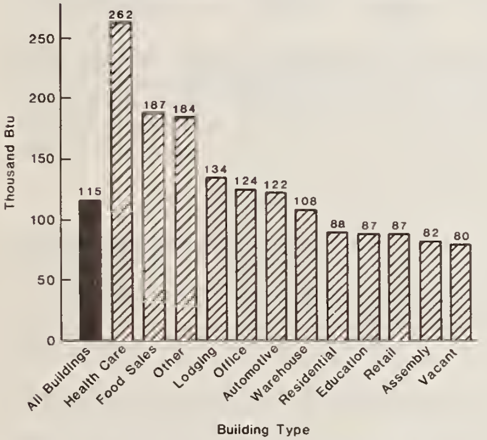
Source: U.S. Energy Information Administration, Annual Energy Outlook 1985, Washington, D.C. DoE/EIA-0383(85), p. 3.

FIGURE 1-2. Average Household Energy Consumption and Expenditures for All Fuels by Census Division, 1981.



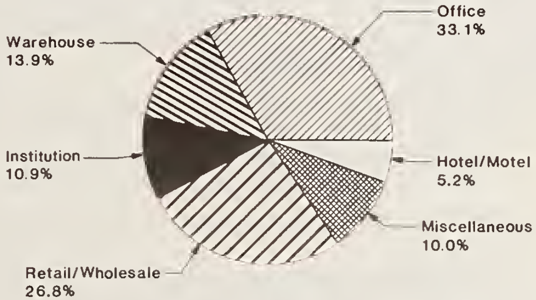
SOURCE: U.S. Energy Information Administration, Residential Energy Consumption Survey: Consumption and Expenditures, April 1981 through March 1982, Part 2: Regional Data, U.S. Energy Information Administration, DoE/EIA-0321/2(81), November 1983, p.3.

FIGURE 1-3. Average Consumption per Square Foot for Major Fuels By Building Type, 1979 (Thousand Btu).



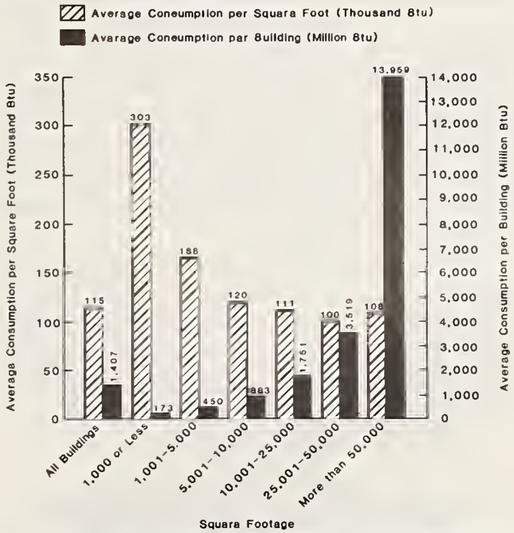
SOURCE: U.S. Energy Information Administration, Nonresidential Buildings Energy Consumption Survey: 1979 Consumption and Expenditures, Part 2: Steam, Fuel Oil, LPG, and All Fuels, DoE/EIA-0318(79)/2, December 1983, p. 10.

FIGURE 1-4. Percentage of Total Energy Consumed by Nonresidential Building Category in 1979 (Percent).



SOURCE: U.S. Energy Information Administration, 1982 Annual Energy Outlook, DoE/EIA-0383(82), April 1983, p. 42. (Estimated by EIA from a computer tape of disaggregated data underlying its publication Nonresidential Buildings Energy Consumption Survey: Fuel Characteristics and Conservation Practices, DoE/EIA-0278, 1981.)

FIGURE 1-5. Relationship Between Building Size and Energy Consumption per Square Foot.



SOURCE: U.S. Energy Information Administration, Nonresidential Buildings Energy Consumption Survey: 1979 Consumption and Expenditures, Part 2: Steam, Fuel Oil, LPG, and All Fuels, DoE/EIA-0318(79), December 1983, p. 13.

For example, in houses, the following actions are often, but not always, cost effective: (1) adding wall, ceiling, and floor insulation; (2) installing storm windows or double-glazed windows (or both); (3) replacing electric resistance heating with heat pumps, and older oil and natural gas furnaces and air conditioners with updated systems; (4) insulating the hot water tank and piping; (5) replacing incandescent lamps with fluorescent or other energy conserving lamps; (6) purchasing energy-efficient appliances; and (7) installing solar energy systems for heating domestic hot water.

Similarly, in commercial buildings, there are a number of actions, in addition to those mentioned for houses, which are energy efficient and may be cost effective. Examples are energy management systems which automatically direct energy to the various energy-using systems within a building in controlled patterns, cogeneration as an energy alternative for buildings that use steam for space heating, and use of process waste heat.

In cases such as these, when energy savings are obtained at the expense of other resources, it is advisable to assess the overall effect in deciding whether to take the action. When the cost tradeoffs occur over time, a life-cycle evaluation approach is recommended.

A brief, annotated listing of selected guides to conducting energy audits and to identifying and implementing strategies for saving energy is provided in Table 2-1 for the convenience of the reader, since these topics are not treated in this book.

Table 2-1. Selected references: Identifying energy conservation and renewable energy strategies.

The Consumer's Energy Handbook, by Peter Norback and Craig Norback (New York, NY: Van Nostrand Reinhold Company, 1981).

This paperback book is an easy-to-read guide to energy-saving tips, weatherizing a house, and buying energy conservation and solar energy equipment. It provides a listing of additional sources of information.

Energy Conservation in Commercial and Residential Buildings, ed. by Melvin H. Chiogiogi and Eleanor N. Oura (New York, NY: Marcel Dekker, Inc., 1982).

This book surveys architectural/engineering techniques for combating energy waste in residential and commercial buildings. Energy conservation possibilities are discussed in the use of lighting and appliances; solar heating and cooling; new building design techniques; computer analysis methodologies; and specific techniques for energy conservation in residential and commercial buildings.

Manual of Energy Savings in Existing Buildings and Plants Vols. 1&2, ed. by Stephen L. Baron (Englewood Cliffs, NJ: Prentice-Hall, Inc., 1978).

Volume 1 presents a range of opportunities and options to save energy and reduce operating costs through proper operation and maintenance. Included are suggestions for minor modifications to the structure and the mechanical and electrical systems which can be implemented promptly with little, if any, investment cost. Volume 2 includes more comprehensive options, some of which involve considerable investment.

Architects and Engineers Guide to Energy Conservation in Existing Buildings, U.S. Department of Energy, Federal Energy Management Program DoE/CS-0132 (In revision 1985), available from the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161 and the U.S. Government Printing Office, Washington, DC 20402, stock no. 061-000-00394-1.

This manual offers a field-tested approach to identifying, analyzing, and recommending a wide range of energy conservation options for existing buildings.

Energy Strategy Selector for Small Office Building Design, by S. H. Pansky and J. R. Holton, Burt-Hill-Kosar-Rittleman Associates, for Pacific Northwest Lab., Richland, WA, available through the National Technical Information Service, Springfield, VA, NTIS, PCA02/MFA01; 1. Report No.: PNL-SA-11509, August 1983.

This report guides the selection of energy conservation strategies for the design of small office buildings.

Handbook of Industrial Energy Conservation, by S. David Hu (New York, New York: Van Nostrand Reinhold Company, 1983).

This book focuses on energy management and planning for industry. It treats waste heat recovery and utilization, as well as cogeneration. An appendix summarizes major industrial energy conservation technologies.

Directory of Energy Software for Microcomputers, Government Institutes, Inc., 966 Hungerford Drive, #4, Rockville, MD 20850; Tel. (301) 251-9250 (Directory available for $68).

This directory provides four indexes which cross-reference entries by (1) subject, (2) hardware compatibility, (3) vendor, and (4) title.

Optimizing Performance of Energy Systems, by Paul Strickler (New York, NY: Macmillan Publishing Company, Scientific & Technical Books, 1985).

This book provides monitoring techniques and simulation methods for field performance, designed to reduce the cost and time required for evaluating competing energy systems.

3. EVALUATION METHODS, DATA, AND ASSUMPTIONS

THE RIGHT QUESTIONS

Table 3-1 summarizes some of the key questions you need to ask in order to make economically sound energy-related investments. For one thing, you need to ask if a given project will save more through energy conservation than it will cost. You also need to ask what is the best design or size of that project, how it might fit in with related projects, and how the project compares with alternative investments. Chapter 4 illustrates how answers are found to each of these questions.

Answering these questions is straightforward for simple problems. As might be expected, the solution becomes more complex as the number of alternatives and their interactions increases, and as financing and tax effects are added to the problem. For complex problems, the use of a computer program such as that described in Chapter 6 makes solving the problem easier.

Table 3-1. Ask the right questions

(1)	Will project savings exceed costs?
(2)	Which design solution will be most cost effective?
(3)	What project size will minimize overall building costs?
(4)	Which combination of interrelated projects will maximize net savings?
(5)	What priority should projects be given?

STEPS IN AN ECONOMIC EVALUATION

Table 3-2 lists 10 principal steps in performing an economic evaluation of a project. The first two steps are to define the objective and identify any technical, physical, functional, economic, or other constraints which will limit potential solutions. The third step, identify technically sound conservation strategies, is non-economic in nature. It is usually the most important part of the evaluation, and sometimes the most difficult. This step is discussed in Chapter 2. The fourth step, choosing a method, or methods, of evaluation is the topic of the next section. The fifth step, compile data and establish assumptions, may also present challenges, particularly if several of the strategies interact significantly. The following sections of Chapter 3 provide guidance in compiling data and making assumptions: "Selecting a Discount Rate or Minimum Acceptable Rate of Return," "Estimating Costs," "Setting the Study Period," "Adjusting Values for Time-Equivalency," and "Financing and Taxes." After you have obtained estimates of the before-and-after energy performance of the investment, and other data, step 6, calculate measures of economic performance, follows. Chapters 5 and 6 provide tools to assist with the calculations.

The seventh recommended step, evaluate and compare alternatives, does not complete the procedure. If there are uncertainties about any of the data or assumptions—and there usually are—it is strongly advised that the uncertainties be taken into account. One approach is to perform sensitivity analysis, which is listed as step 8. This entails repeating the calculations in step 6, using values of selected parameters other than those used initially. By changing the values of each parameter by a given percent and assessing the associated percentage change in outcome, sensitivity analysis can be used to identify the most important elements in an analysis and to guide the gathering of additional information. By testing the outcome to changed values of selected parameters, the analyst can address "what-if" questions. By performing the analysis with pessimistic values, lower-bound estimates of economic performance can be estimated. The computer program of Chapter 6 is particularly useful in performing sensitivity analysis.

Another question to ask before making a decision is if all the important effects of the project have been adequately captured in the numerical evaluation; that is, are there unquantified effects? If there are, step 9, take into account unquantified effects, is crucial. At a minimum, unquantified effects should be called to the attention of the decision maker in descriptive terms. Additionally, it is often useful to impute the maximum or minimum value which the decision maker must attribute to the unquantified effect in order to accept the project. For example, if an energy conserving project has a detrimental effect on a building's appearance, but is estimated to be cost effective in other ways, the project's estimated net dollar savings is the maximum cost which the decision maker can impute to the detrimental unquantified effect and still accept the project.

Table 3-2. Steps in the economic evaluation process

(1)	Define the problem and state the objective
(2)	Identify constraints
(3)	Identify technically sound strategies
(4)	Choose method(s) of evaluation
(5)	Compile data and establish assumptions
(6)	Calculate measures of economic performance
(7)	Evaluate and compare alternatives
(8)	Perform sensitivity analysis
(9)	Take into account unquantified effects
(10)	Make recommendations

Table 3-3. Methods of economic evaluation and recommended applications

METHOD	APPLICATIONS: Measuring Cost Effectiveness	Sizing and Designing Projects	Combining Projects	Ranking Projects	Recovering Investment Funds
LIFE-CYCLE COST	●	●	●		
NET SAVINGS	●	●	●		
INTERNAL RATE OF RETURN	●	○ (See Table 3-7 "Approach for Application (3)")		●	
SAVINGS-TO-INVESTMENT RATIO	●	○ (See Table 3-8 "Approach for Application (3)")		●	
PAYBACK	○ (See Table 3-9 "Special Considerations")				○

● Recommended

○ Caution is advised to ensure correct use

Step 10 of the evaluation procedure is to recommend what to do. The results of the economic analysis provide information for decision making, but are not a substitute for judgment. In reporting findings, it is important to reveal key values and assumptions to aid understanding of the basis for the recommendation. The printed reports of data files and analyses which are provided by the computer program of Chapter 6 are useful in presenting evaluation results and supporting recommendations.

CHOOSING A METHOD[3]

There are a variety of related methods that are used to evaluate and compare the economic merits of alternative investment decisions. Table 3-3 lists some of the more common methods and indicates their most appropriate uses. More detailed descriptions of each method are provided below in the text and summarized in a series of tables, 3-4 through 3-9. The tables give a brief description of each method, a condensed algebraic formula, a list of applications, a general approach to each application, and special factors to consider in using each method. Textual footnotes provide references from which further information and guidance can be obtained.

[3] The economic evaluation methods presented in this chapter are consistent with the series of Standard Practices for Economic Evaluation of Buildings and Building Systems published by the American Society for Testing and Materials (ASTM).

Life-Cycle Cost Method. The life-cycle cost (LCC) method measures the total long-run dollar costs of a given course of action. A project is cost effective if its life-cycle costs are lower than those of alternative courses of action for achieving the same objective. Table 3-4 summarizes key information about the LCC method for easy reference.[4]

Table 3-5 gives an overview of the typical components of a life-cycle cost analysis. The first column of the tables lists the principal cost elements that usually go into the analysis: initial investment costs (which might include renovation and/or modification costs of an existing building or system, or the costs of design, site preparation, purchase and installation or construction of a new building or system), future energy costs, non-fuel operation and maintenance costs, repair and replacement costs, and resale or scrap value.

The remainder of the table is divided vertically into two main parts. The first part, denoted by the bars over the symbol, contains expected costs if the given project is not undertaken; that is, the base case. The second part, denoted by the absence of the bars over the symbols, contains expected costs if the given project *is* undertaken. Each of the two main parts is in turn subdivided vertically to denote time differences: the first column represents the present. The remaining columns represent the future, where 1, 2, 3, ..., N indicate the number of elapsed years from the present, N being the total number of years over

[4] For an in-depth review of the LCC method, see Rosalie T. Ruegg, Stephen R. Petersen, and Harold E. Marshall, *Recommended Practice for Measuring Life-Cycle Costs of Buildings and Building Systems*, Washington, DC, National Bureau of Standards, NBSIR 80-2040, June 1980.

Table 3-4. Life-Cycle Cost method[a]

Abbreviation	LCC
Unit of Measure	$
Description	Sums all relevant past, present and future costs of a project, in present or annual value dollars, over study period.
Formula (See Symbology, p. 16)	$LCC_{A1} = \sum_{j=0}^{N} (C_{A1} - B_{A1})_j/(1+d)^j$
Applications	Approach
(1) Project cost effectiveness	Compare the LCC of a project against the LCC of the base case and find the project cost effective if its LCC is lower than that of the base case.
(2) Project design and sizing	Compare a project of one size or design against the same project of an alternative size or design and choose the project size/design that meets the objective at the lowest LCC.
(3) Project mix for a given building	Find the combination of projects which minimizes the overall LCC of a building, while meeting the building's performance requirements.
Special Considerations	• Most suitable when the focus is on costs rather than benefits. When comparing alternatives based on their LCC's, benefits must be held constant among alternatives or subtracted from their costs. • Effects not measured in dollars must be uniform across alternatives or should be weighted subjectively by the decision maker. • To be useful for decisions, LCC's must be computed for 2 or more mutually exclusive project alternatives over the same study period and compared. • LCC is not recommended as a direct ranking criterion for assigning priority among independent projects. • If the budget is limited, it may be necessary to forego cost-effective projects or increments to projects in order to realize a greater savings from investing in competing projects or project increments. A condition for minimizing LCC of a building or facility, holding the level of performance constant, is that the cost reductions from the last dollar spent on each project be equal.

[a] This method may be carried out by using NBSLCC Computer Program, Chapter 6.

Table 3-5. Anatomy of a Life-Cycle Cost analysis

	COMPUTE $\overline{LCC}$ WITHOUT THE PROJECT						COMPUTE LCC WITH THE PROJECT					
		Future Years						Future Years				
Cost Elements	Present Time	1	2	3	....	N	Present Time	1	2	3	....	N
Investment (Renovation/ Modification) (I)	$\bar{I}_p$						I_p					
Energy (E)	$\bar{E}_p=\sum_{j=1}^{N}\frac{(\bar{E}_j)}{(1+d)^j}$	$\bar{E}_1$	$\bar{E}_2$	$\bar{E}_3$	....	$\bar{E}_N$	$E_p=\sum_{j=1}^{N}\frac{(E_j)}{(1+d)^j}$	E_1	E_2	E_3	....	E_N
Nonfuel Operation & Maintenance (O&M)	$\bar{M}_p=\sum_{j=1}^{N}\frac{(\bar{M}_j)}{(1+d)^j}$	$\bar{M}_1$	$\bar{M}_2$	$\bar{M}_3$	....	$\bar{M}_N$	$M_p=\sum_{j=1}^{N}\frac{(M_j)}{(1+d)^j}$	M_1	M_2	M_3	....	M_N
Repairs & Replacements (R)	$\bar{R}_p=\sum_{j=1}^{N}\frac{(\bar{R}_j)}{(1+d)^j}$	$\bar{R}_1$	$\bar{R}_2$	$\bar{R}_3$	....	$\bar{R}_N$	$R_p=\sum_{j=1}^{N}\frac{(R_j)}{(1+d)^j}$	R_1	R_2	R_3	....	R_N
Resale/Scrap[a] (S)	$(\bar{S}_p)=\frac{\bar{S}_N}{(1+d)^N}$					$\bar{S}_N$	$(S_p)=\frac{S_N}{(1+d)^N}$					S_N
Total Present Value Life Cycle Cost (LCC)	$\overline{LCC}=\bar{I}_p+\bar{E}_p+\bar{M}_p+\bar{R}_p-\bar{S}_p$						$LCC=I_p+E_p+M_p+R_p-S_p$					

COMPARE LCC with $\overline{LCC}$ and accept Project if LCC is lower

[a] Usually a positive amount that is subtracted from the costs.

Nomenclature: d = discount rate

$1/(1+d)^j$ = single present worth discount formula for discount rate, d, and year, j.

which the building owner or operator is concerned about the costs associated with the investment in question.

Investment costs are usually the only sizable costs that occur at the present time. Since they occur in the present, they are already expressed in "present value dollars," as signified in Table 3-5 by the subscript p. All of the other amounts usually occur in future years, and therefore are in "future dollars," as signified by the subscripts 1...N, until they are adjusted to present dollar equivalents.

To enable valid economic comparisons to be made among alternatives, all dollar values must be expressed in dollars with identical purchasing power (see "Changes in the General Price Level") and reflecting the opportunity cost associated with delayed payment or receipt. The latter adjustment is indicated by the equations in the "present time" columns, whereby the future amounts are adjusted to present value amounts. This adjustment process, usually referred to as "discounting," is explained in more detail in "Adjusting Values for Time-Equivalency ("Discounting")." Guidance in the mechanics of the discounting operation is provided in the worksheets of Chapter 5, and discounting is performed by the computer program in Chapter 6.

The present values for each cost element are then combined to find the life-cycle costs without the project and with the project, as shown in the lower section of Table 3-5. The life-cycle cost estimates are then compared to see which is lower. The alternative with the lower life-cycle cost is the cost-effective choice, other things being equal. Thus, if LCC is less than $\overline{\text{LCC}}$, the project is cost effective, but if LCC exceeds $\overline{\text{LCC}}$, the project is *not* cost effective.

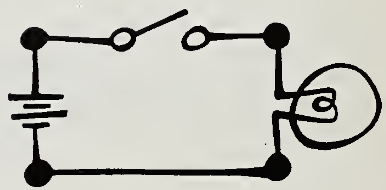


Table 3-6. Net Savings (Net Benefits) method[a]

Abbreviation	NS, NB
Unit of Measure	$
Description	Finds net difference in present or annual value dollars between two mutually exclusive project alternatives.
Formula (See Symbology, p. 16)	$NS_{A1:A2} = LCC_{A2} - LCC_{A1}$ or $NB_{A1:A2} = \sum_{j=0}^{N} \frac{[(B_{A1}-B_{A2})_j - (C_{A1}-C_{A2})_j]}{(1+d)^j}$
Applications	Approach
(1) Project cost effectiveness	Compute NS (NB) for a project as compared with the base case alternative and find the project cost effective if its NS (NB) are positive.
(2) Project design and sizing	Compute total NS (NB) for each project design/size by comparing each with the base case. Choose the project size/design that results in the highest NS (NB) for the building.
(3) Project Mix	Find the combination of cost-reducing projects for a building which maximizes NS for a given level of benefits, or the combination of benefit-producing projects which maximizes NB.
Special Considerations	• Benefits must be held constant when comparing alternatives on the basis of their NS. • Effects not measured in dollars must be uniform across alternatives or should be weighted subjectively by the decision maker. • NS (NB) is not recommended as a direct ranking criterion for assigning priority among independent projects. • If there is no budget constraint, NS (NB) will be maximized by accepting all independent projects, and all increments to those projects, having a positive NS (NB). • If the budget is limited, it may be necessary to forego cost-effective project or increments to projects in order to realize a higher return from investing in competing projects or project increments. A condition for maximizing NS (NB) is that the return on the last dollar spent on each project be equal.

[a] This method may be carried out by using either Worksheet Series A, Chapter 5, or NBSLCC Computer Program, Chapter 6.

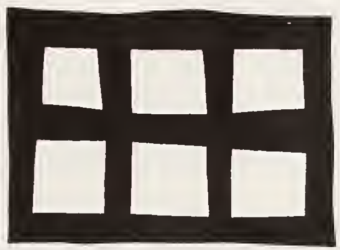
Net Savings (Net Present Value or Net Benefits) Method. The net savings (NS) method measures the long-run dollar difference between two alternative courses of action. A project is cost-effective if it results in positive net savings. Thus, in Table 3-5, if $\overline{LCC}$ minus LCC exceeds zero, the investment yields positive net savings and is cost effective; if net savings are negative, the project is not cost effective. Table 3-6 summarizes key information about the NS method.[5]

The essential features of both the LCC and NS methods are as follows:

(1) the methods look beyond first costs to include projections of significant future values over the investor's study period;

(2) they adjust dollar values occurring at different times to time-equivalent values to enable valid comparisons; and

(3) they are particularly useful for comparing mutually exclusive alternatives, such as different designs or different sizes of a given project.



[5] For an in-depth review of the NS (NB, NPV) method, see Harold E. Marshall, *Recommended Practice for Measuring Net Benefits and Internal Rates of Return for Investments in Buildings and Building Systems,* Gaithersburg, MD, National Bureau of Standards, NBSIR 83-2657, October 1983.

Internal Rate of Return Method (Adjusted and Unadjusted). The internal rate of return (IRR) method measures the percentage yield on investment. It uses the same cost elements as the LCC and NS methods but differs from them in two ways: (1) in its unit of measure—percentage rather than dollars—and (2) in the way discounting is performed. While the former methods use a specified rate of interest to discount cash flows from future values to present values, the internal rate of return method solves for the value of the interest rate which will cause discounted total benefits to equal discounted costs. The solution rate is the investment's internal rate of return. This rate is compared against the investor's minimum acceptable rate of return (MARR), or hurdle rate, and if it is greater than the MARR, the project is economically attractive.

The IRR method tends to be favored by businesses which frequently change their MARR. Changing the MARR does not necessitate recalculating the IRR, but changing the discount rate does require recalculating the life-cycle cost, net savings, savings-to-investment ratio and discounted payback measures.

The IRR method is often used to evaluate and establish priority among non-mutually exclusive projects when there is a budget constraint. This is done by ranking projects in descending order of their IRR's. (See discussion of limitations which follows.)

The unadjusted version of this method (UIRR) does not specify the rate at which returns from the project in each time period are reinvested, and the calculation procedure implicitly assumes reinvestment at a rate equal to the rate earned on the unrecovered investment. The adjusted version (AIRR) specifies the rate at which returns from the project are reinvested. Table 3-7 summarizes key information about this method.[6]

The UIRR has two major shortcomings: (1) computational difficulties under certain circumstances; (2) the likelihood that proceeds from the project will not be reinvested at the same rate as that earned on the unrecovered investment, resulting in erroneous rate-of-return estimates. This could cause errors in project acceptance or rejection and in setting priorities among projects. The AIRR avoids both these problems and, therefore, is recommended over the UIRR.

Both the adjusted and unadjusted versions are often misused in determining project design and sizing. The proper way to use the IRR method when choosing among mutually exclusive project alternatives, such as project designs and sizes, is to compute the IRR (AIRR preferred) on incremental changes in costs and benefits, rather than on totals. If the incremental IRR exceeds the MARR, that increment to the project is cost effective.

Although the IRR method is useful for ranking non-mutually exclusive projects when there is a budget contraint, both the UIRR and AIRR have the shortcomings of not providing a reliable ranking when the available budget cannot be totally expended by taking projects exactly in descending order of their IRR's. This may happen if project costs are "lumpy." In this case, it may be necessary to calculate the net benefits for trial groups of projects that fit within the budget to see which has the highest net benefits, using the IRR ranking only as an indicator of project groups to test. The UIRR has the further limitation of not providing a completely reliable indicator of which project group will yield the highest net benefits even if the budget *can* be totally expended while strictly adhering to the UIRR rankings. In contrast, the AIRR can be relied on for project ranking if the budget can be totally expended.

[6] For an in-depth review of the IRR method (adjusted and unadjusted versions), see Harold E. Marshall, *Recommended Practice for Measuring Net Benefits and Internal Rates of Return for Investments in Buildings and Building Systems,* Gaithersburg, MD, National Bureau of Standards, NBSIR 83-2657, October 1983.

Table 3-7. Internal Rate of Return method (unadjusted and adjusted)[a]

Abbreviation	IRR (general) UIRR (unadjusted) AIRR (adjusted)
Unit of Measure	%
Description	Finds the compound rate of interest which will equate a project's benefits to its costs, such that net benefits are zero. – Unadjusted version is based on the assumption that returns from the project are reinvested at a rate of return equal to the rate of return on the unrecovered investment. – Adjusted version is based on the assumption that returns from the project are reinvested at a specified rate which may differ from the rate on the unrecovered investment.
Formula (See Symbology, p. 16)	*Unadjusted*: Find i for which $\sum_{j=1}^{N} \frac{(B_{A1}-B_{A2})_j-(C_{A1}-C_{A2})_j}{(1+i)^j} - (C_{A1_o}-C_{A2_o})=0$ *Adjusted*: Find i for which $\sum_{j=1}^{N} \frac{[(B_{A1}-B_{A2})_j-(C_{A1}-C_{A2})_j](1+r_j)^{N-j}}{(1+i)^N} - (C_{A1_o}-C_{A2_o})=0$
Applications	Approach
(1) Project cost effectiveness	Compute a project's IRR by comparing the project with the base case; compare the IRR with the investor's minimum acceptable rate of return (MARR), and find the project cost effective if the IRR is greater than the MARR.
(2) Assigning priority to independent projects under a budget constraint	Give priority to independent projects in descending order of their IRR's.
(3) Project design and sizing	Compute IRR's on the basis of incremental benefits and costs by comparing each design/size of a project with the design/size of the same project just below it in cost, and accept (reject) the more costly design/size if its incremental IRR is greater than (less than) the MARR.
Special Considerations	• There may be multiple solutions or no solution for the UIRR. • Setting priority among independent projects according to the descending order of their UIRR's usually leads to a *reasonably satisfactory* group of projects within a budget constraint, but may not maximize net benefits for the budget even if the budget can be totally expended. • Setting priority among independent projects according to the descending order of their AIRR's will maximize net benefits provided the budget can be totally expended. If project costs are "lumpy," so that the budget cannot be used up exactly, it may be necessary to depart from the AIRR ranking in order to maximize net benefits from the budgeted expenditure.

[a] This method may be carried out by using NBSLCC Computer Program, Chapter 6.

Savings-to-Investment (Benefit/Cost) Ratio Method. The savings-to-investment ratio (SIR) method evaluates economic performance in terms of the ratio of savings to investment costs. If a project has an SIR greater than 1, it is cost effective.

Like the internal rate of return method, the SIR method is particularly useful for comparing non-mutually exclusive projects and establishing priority among them when the budget is limited. Priority is established by ranking projects in descending order of their SIR's. The SIR can be relied upon to rank projects to maximize net benefits from the available budget provided that the budget can be totally expended while taking projects exactly in descending order of their SIR's. But if the budget cannot be totally expended while adhering to the SIR project rankings (due to "lumpiness" in project costs), the SIR, like the IRR, may not identify the set of projects which will maximize net benefits. In this case, it is advisable to test different groups of projects that fit within the budget to see which has the highest net benefits, using the SIR rankings as an indicator of project groups to test.

Like the internal rate of return method, the SIR method is prone to misuse in making choices among mutually exclusive project alternatives, such as designs and sizes. This problem can be avoided by computing the ratio on incremental changes in costs and benefits, rather than on totals, when choosing among mutually exclusive project alternatives. Each increment in size or change in design is cost effective if its SIR is greater than 1.0. Table 3-8 summarizes key information about this method.[7]

[7] For an in-depth review of the SIR method, see Harold E. Marshall and Rosalie T. Ruegg, *Recommended Practice for Measuring Benefit/Cost and Savings-to-Investment Ratios for Buildings and Building Systems*, Gaithersburg, MD, National Bureau of Standards, NBSIR 81-2397, November 1983.

Table 3-8. Savings-to-Investment Ratio (Benefit/Cost Ratio) method[a]

Abbreviation	SIR, BCR, B/C
Unit of Measure	Pure Number
Description	Finds the ratio of present or annual value benefits or savings to initial investment costs.
Formula (See Symbology, p. 16)	$BCR_{A1:A2} = \sum_{j=1}^{N} \frac{[(B_{A1}-B_{A2})_j-(C_{A1}-C_{A2})_j]/(1+d)^j}{(C_{A1_o}-C_{A2_o})}$ $SIR_{A1:A2} = \sum_{j=1}^{N} \frac{(C_{A2}-C_{A1})_j/(1+d)^j}{(C_{A1_o}-C_{A2_o})}$
Applications	**Approach**
(1) Project cost effectiveness	Compute a project's SIR or BCR by comparing the project's benefits and costs with those of the base case, and find the project cost effective if the ratio is >1.
(2) Assigning priority to independent projects under a budget constraint	Give priority to independent projects in descending order of their SIR's or BCR's.
(3) Project design and sizing	Compute SIR's or BCR's on the basis of incremental, rather than total, benefits and costs by comparing each design/size of a project with the design/size of the same project just below it in cost. Accept (reject) each more costly design/size if its incremental ratio is greater than (less than) 1.0 and there is no budget constraint or if it is greater than (less than) the cut-off ratio and there is a budget constraint.
Special Considerations	• Setting priority among independent projects according to the descending order of their SIR's will maximize net benefits provided the budget can be used up exactly. If project costs are "lumpy," so that the budget cannot be used up exactly by adhering strictly to SIR rankings, it may be necessary to depart from the SIR ranking in order to maximize net benefits from the budgeted expenditure.

[a] This method may be carried out by using either Worksheet Series C, Chapter 5, or NBSLCC Computer Program, Chapter 6.

Table 3-9. Payback method (simple and discounted)[a]

Abbreviation	PB (general), SPB (simple), DPB (discounted)
Unit of Measure	Time (usually years)
Description	Finds the time required for a project's cumulative future benefits net of cumulative future costs to just pay back the investment cost.
Formula (See Symbology, p. 16)	Find the minimum solution value of PB, Payback Year, for which $\sum_{j=1}^{PB} \frac{(B_{A1}-B_{A2})_j-(C_{A1}-C_{A2})}{(1+d)^j}=(C_{A1_0}-C_{A2_0})$ For simple payback, d=0. Approximate DPB: Compute SPB; go to UPW or appropriate UPW* table for desired d; find factor closest to solution value of SPB; read off corresponding years (using interpolation to obtain a closer approximation). Also see graphical approach to DPB in Appendix D.
Applications	Approach
(1) Rough guide to project cost effectiveness	Solve for the time to payback; if this time is significantly less than the expected project life, the project is likely to be cost effective.
(2) Break-even analysis of project life	Solve for the time to payback; evaluate the likelihood of the project's actual life exceeding the solution value which is the break-even life.
(3) Protecting initial investment in face of uncertainty	If risk is considered an increasing function of time, the Maximum Acceptable Payback Period (MAPP) may be constrained to eliminate projects which require a relatively long time to recover their costs.
Special Considerations	• Simple payback ignores the time value of money, and, hence, mistates the true time to payback. • Payback does not provide a comprehensive economic assessment. • The investment with the shortest payback may not be the best investment. • Even if the payback measure shows the number of years to payback to be less than the project's life or the investor's MAPP, the investment may not provide the return expected by the investor.

[a] This method may be carried out by using Worksheet Series B, Chapter 5.

Payback Method. The payback (PB) method measures how long it takes one to just break even from a project, in the sense of recovering investment costs. The PB method does not account for costs and savings that occur after payback is achieved, and the project with the shortest payback is not necessarily the project with the highest return. This shortcoming is reflected in a nickname that is sometimes used for payback: the "fish bait" technique, so called because it focuses on recovering the bait (the initial investment) rather than on the size of the fish (the profitability of the investment). Table 3-9 summarizes key information about this method.[8]

On the positive side, the PB method is easy to compute and to understand, and it can provide useful information if properly interpreted and used in conjunction with other economic evaluation measures. If a project is expected to "pay back" its costs well before the end of its life and there are no sizable costs expected after payback is achieved which might reverse payback, it is generally safe to consider the project to be cost effective.

In addition to requiring a project to pay back before its estimated end-of-life, investors often impose as a further condition for project acceptance that the project pay back in a shorter time than a designated "maximum acceptable payback period" (MAPP). A MAPP is sometimes set to reflect the investor's knowledge about specific future events that are expected to jeopardize the investor's ability to realize potential savings or benefits past some point. Sometimes it is set arbitrarily to reflect the investor's strategy to pre-

[8] For an in-depth review of the PB method, see Harold E. Marshall, *Recommended Practice for Measuring Simple and Discounted Payback for Investments in Buildings and Building Systems,* Gaithersburg, MD, National Bureau of Standards, NBSIR 84-2850, March 1984.

serve investment capital in the face of risks which are perceived to increase with time. Unfortunately, very short MAPP's are often set with the misconception that this approach will result in selecting more profitable projects regardless of the circumstances.

If, in computing the payback period, the discount rate is set equal to zero, a rough version of payback results. This rough version, "simple payback" (SPB), does *not* adjust cash amounts to time-equivalent values in computing years to payback, and, therefore, tends to understate the true time to payback. If the yearly net cash amount is uniform, simple payback can be found simply by dividing project investment cost by yearly savings net of yearly costs. If the yearly net cash amount is not uniform, years to simple payback can be calculated by using the formula in Table 3-9; setting the discount rate (d) to zero.

A more accurate calculation of payback, "discounted payback" (DPB), takes into account variation in yearly cash flows and adjusts the cash amounts to time-equivalent values. Discounted payback can be calculated by using the formula in Table 3-9; or, if annual savings are uniform or increase at a relatively constant rate, discounted payback can be approximated from simple payback by the procedure given in Table 3-9 (using the UPW tables) or the nomograms provided in Appendix D.

HOUSE

Symbology used in formulas of Tables 3-4 through 3-9.

Σ	summation
N	study period
d	discount rate
i	interest rate
r	reinvestment rate
A1	subscript denoting project being evaluated
A2	subscript denoting a mutually exclusive alternative project[a] against which project A1 is evaluated
C_{A1_j}	costs in year j for the project (A1) being evaluated; C_{A1_0} denotes costs at the beginning of the period
C_{A2_j}	costs in year j for the alternative (A2) against which project A1 is compared; C_{A2_0} denotes costs at the beginning of the period
B_{A1_j}	benefits (positive cash flows) in year j for the project (A1) being evaluated
B_{A2_j}	benefits in year j for the alternative (A2) against which project A1 is compared
A1:A2	subscript denoting the evaluation of project A1 relative to alternative A2

[a] Mutually exclusive project alternatives are those for which accepting one automatically means not accepting the others. These kinds of projects are denoted above by use of the subscript A followed by a number to distinguish among alternatives. For a given investment, one mutually exclusive alternative is not to undertake the investment, and it is against this alternative that potential investments are at a minimum compared. Not to undertake the investment is referred to as the "base case." Alternative designs and sizes of a project for a given application are also mutually exclusive.

SELECTING A DISCOUNT RATE OR MINIMUM ACCEPTABLE RATE OF RETURN

With the exception of simple payback, each of the economic evaluation methods presented in the preceding section enables the analyst to impose a minimum profitability condition on a project which it must meet in order to qualify for acceptance. For the LCC, NS, SIR, and DPB methods, this is done by specifying a discount rate, which must be compensated for before a project will appear cost effective. The discount rate should reflect the rate of return which will be foregone if the project in question is undertaken instead of the next best investment opportunity of similar risk; that is, it should reflect the "opportunity cost" of the project.

For the IRR method, the minimum profitability condition is imposed by setting a "minimum acceptable rate of return" (MARR) or "hurdle rate." The calculated IRR for a project must exceed the MARR in order for the project to be found cost effective. The MARR is based on the same concept of opportunity cost as the discount rate, and the two rates would generally be expected to be identical under the same conditions.

Since it affects whether a project will be accepted, the choice of the discount rate or MARR is a key ingredient in an economic analysis. This section discusses briefly some of the considerations in selecting the discount rate or MARR.

One consideration is whether the rate should be on a before-tax or after-tax basis. If the project evaluation is performed on a before-tax basis, the discount rate or MARR should be on a before-tax basis; if the evaluation is on an after-tax basis—which is the proper approach—the discount rate or MARR should be on an after-tax basis. Even though there may be few, if any, explicit tax effects in evaluating most homeowner energy conservation investments, it is generally appropriate to use an after-tax discount rate or MARR in the evaluation because energy savings for the homeowner are like tax-free income, in that no taxes are owed on them.

Another consideration is whether the discount rate or MARR should be a *real* rate, that is, excluding purely inflationary or deflationary changes in the general price level, or a *nominal* rate, that is including changes in the general price level. To illustrate the difference, if the projected inflation rate were 5 percent, market interest rates (which are nominal rates) could be expected to be approximately 5 percent higher than they would be if the projected inflation rate were zero. If the projected inflation rate were zero, there would be no difference between nominal and real discount rates. A guideline for choosing between real and nominal rates is if project cash flows are stated in *constant* dollars, the discount rate should be a *real* rate; if project cash flows are stated in *current* dollars, the discount rate should be a *nominal* rate. (The concept of constant and current dollars is covered in more detail in a later section "Changes in the General Price Level.")

HOUSES

A nominal discount rate (D) can be converted to a real discount rate (d) by removing the inflation rate (I) component as follows: $d=[(1+D)/(1+I)]-1$. Conversely, a nominal discount rate can be derived from a real discount rate by including the projected inflation rate as follows: $D=(1+d)(1+I)-1$.

The following examples illustrate how one might select a real or nominal discount rate under differing conditions: Suppose a homeowner is considering the withdrawal of funds from a tax-exempt mutual bond fund, yielding, say, 8.75 percent interest, to make his or her house more energy efficient. The homeowner should use a discount rate no lower than 8.75 percent (nominal) for evaluating an energy investment with the same degree of risk. The rate could be higher if there is another opportunity of equal risk with a yield higher than 8.75 percent.

Suppose a business has the opportunity to realize an after-tax return of 15 percent by using available funds to expand. Then it could use a discount rate of 15 percent (nominal) to evaluate the after-tax performance of energy conservation investments if risk levels were commensurate.

Firms sometimes base the discount rate or MARR on their weighted cost of capital, calculated as a weighted average cost of the next dollar of capital apportioned between new equity and new debt. (See Chapter 5, Worksheet 2.) The rationale for using the weighted cost of capital as the discount rate is that the firm must obtain an overall yield on its investments at least sufficient to cover its cost of capital to prevent the market price of its outstanding securities from falling.

To reflect different levels of risk among potential investments, discount rates or MARR's are sometimes adjusted for risk. They are raised as the level of risk increases. This means that more benefits are required to compensate for extra risk.

Agencies of the Federal government use a discount rate of 7 percent (real) to evaluate the cost effectiveness of energy conserving projects, as required by the Energy Security Act of 1980. Federal agencies use a discount rate of 10 percent (real) to evaluate the cost effectiveness of most non-energy conserving projects, as required by the U.S. Office of Management and Budget in Circular A-94.[9]

[How to perform discounting is explained in a later section "Adjusting Values to Time Equivalency".]

ESTIMATING COSTS

A bit of dry humor has it that forecasting is difficult at best, but especially when it concerns the future. Some people feel so insecure in an approach that requires forecasting that they base decisions solely on first costs despite the severe shortcomings of that approach—particularly as it is applied to energy-related decisions. A first-cost approach makes the implicit assumption that future costs are zero or the same regardless of the decision. This is generally worse than an approach which uses forecasts, even though the forecasts may fall off the mark in future years. No doubt there is uncertainty in forecasting, but forecasting, either explicit or implicit, structured or unstructured, is unavoidable to improve upon a first cost approach. Explicit, structured LCC analysis offers opportunities for improvement over decision making by raw intuition; it provides valuable insights into the components comprising the total effect of a design or engineering decision.

Changes in the General Price Level (Constant Dollars/Current Dollars). For a valid economic analysis, all dollars of costs and savings must have the same unit of purchasing power. That is, purely inflationary or deflationary effects must be eliminated from projected cash flows. There are two valid methods of accomplishing this:

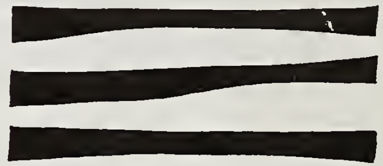
(1) State all cash flows in constant dollars at the outset taking into account only differential price changes (i.e., changes different from the projected rate of general price inflation). Constant dollar cash flows must then be discounted with a real discount rate.

(2) State all cash flows in current dollars at the outset, including the effects of both general price changes and any differential price changes. Current dollar cash flows must then be discounted with a nominal discount rate. The results are in constant dollars.

Stating future amounts in constant dollars means stating them in dollars of uniform purchasing power, exclusive of general inflation or deflation. This is also sometimes called "stating amounts in *real* terms." Stating future amounts in current dollars means stating them in terms of the actual number of dollars that will be paid or received at a future time. This is also sometimes called "stating amounts in *nominal* terms." Current dollars are needed for budgeting purposes. Constant dollars (derived by either of the two methods given above) are needed to evaluate and compare the economic performance of investments. A clear distinction should be made between these two needs for projecting future costs: budgetary needs versus economic evaluation needs.

One way to state cash flows in constant dollars at the outset of the evaluation is to base the future amount on today's amount, adjusting only for projected price changes different from projected changes in the general level of prices. If the future price of a good or service is expected to change at approximately the same rate as prices in general, the "real" price can be said to remain unchanged in constant dollar terms.

Using this approach, for example, the cost in 10 years of replacing a heating system, which would cost $1,000 if replaced today, would be estimated at $1,000 in constant dollars, provided the price of the heating system is not expected to change at a rate substantially different from prices in general.



PASSIVE INTELLECT

ACTIVE
INTELLECT

[9] OMB Circular A-94, "Discount Rates To Be Used in Evaluating Time-Distributed Costs and Benefits," Executive Office of the President, March 27, 1972, recommends that a real discount rate of 10 percent be used to evaluate most Federal projects. The Energy Security Act of 1980, Public Law 96-294, set the discount rate at the real rate of 7 percent for Federal energy conservation and renewable energy projects.

If the replacement system were expected to change at a rate different from general price inflation, only the differential amount would be included in the constant dollar estimate of the future cost. For instance, suppose prices in general were projected to increase at a compound annual rate of 5 percent, but the future cost of the replacement system were fixed by contract at today's prices. The future replacement cost would decline 5 percent per year in constant dollars, although in current dollars the cost would remain unchanged. Hence, in the 10th year, the current dollar cost would remain at $1,000 because it is set by a contract at that amount, while the constant dollar cost would have declined to $599 (i.e., $\$1{,}000 \times (1-.05)^{10}$).

THE INTELLECT IN ACTION

CREATIVE INTELLECT

Now suppose that, instead of being fixed by contract, the price of the replacement heating system were expected to increase at a rate, say, about 10 percent per annum faster than general price inflation (again assumed to be 5 percent). This might result, for example, from shortages of specific materials. In this case, the projected current dollar cost in 10 years would reflect both general price inflation and the differential rate of price change, and hence would be $4,225 (i.e., $\$1{,}000 \times [(1+.10)(1+.05)]^{10}$, while the constant dollar amount would reflect only the differential rate of price change, and hence would be $1,629 (i.e., $\$1{,}000 \times (1+.05)^{10}$).

If all values are initially stated in constant dollars so that all dollars have identical purchasing power, it remains necessary to adjust the constant dollar cash flows for the opportunity cost associated with delayed payment or receipt. This is done by discounting the future constant dollar values with an after-tax discount rate that also *excludes* projected changes in the general price level, that is, with a real discount rate. (How to make this adjustment is explained in the later section "Adjusting Values for Time Equivalency.")

If all cash flows are stated in current dollars, discounting them to present value using a nominal discount rate will simultaneously adjust them to constant dollars. This is because both the current dollar cash flows and the nominal discount rate include the projected change in the general price level, such that the purely inflationary change in the cash flows is canceled out in the discounting operation.

DISORDERED INTELLECT

Provided the analyst is consistent in the approach taken, either of these two approaches, i.e., the constant dollar/real discount rate approach or the current dollar/nominal discount rate approach, will yield the same result. The important thing is to avoid the common mistake of mixing current dollar estimates of costs and benefits with real discount rates or constant dollar estimates with nominal rates.

The current dollar/nominal discount rate approach is usually the easier to use for analysis of investments subject to tax effects or of investments entailing contractual amounts. Also some analysts prefer the current dollar/nominal discount rate approach because it does not confuse clients with the concepts of constant dollars and real discount rates.

An advantage of the constant dollar/real discount rate approach is that it is streamlined and does not require first adding in, then taking out purely inflationary or deflationary changes. The Federal government usually performs its in-house investment analyses using the constant dollar/real discount rate approach, as recommended by the Office of Management and Budget, in order to avoid projecting price inflation/deflation. This reflects concern over the possibility of "self-fulfilling prophecy" effects.

The worksheets in Chapter 5 are geared towards the current dollar/nominal discount rate approach; the computer program in Chapter 6 is equally compatible with either approach, except that if tax effects are computed, the current dollar/nominal discount rate approach must be used.

Energy Costs. For energy conservation and renewable energy projects, forecasts are needed for prices and quantities of energy expected to be consumed. In many cases, the forecasts of future quantities of energy use can be assumed to match closely the current quantity estimates. If there are reasons to expect a decline in energy saved as the project ages, this assumption often can be reflected by applying a percent reduction factor to the initial estimated quantity. The reduction factor might be based on past evidence from similar projects, engineering test data, or informed judgment.

Forecasts are available for future energy prices from a number of different sources. For example, the U.S. Department of Energy (DoE) provides detailed energy price forecasts extending out 25 years for different regions of the country, fuel types, and categories of buyers.[10] Forecasts are also provided by private organizations such as Data Resources, Inc.,[11] and by some utilities. Some individuals and firms may prefer to make their own forecasts.

Energy price data based on the 1985 DoE regional price forecasts are provided in appendices to this report. Appendix E provides average regional prices for mid-1985. Appendix B contains energy price multipliers, based on DoE projected average fuel prices and selected annual rates of general price inflation (ranging from 0 to 15%). These can be used to derive future constant (0% general price inflation) or current (>0% general price inflation) dollar estimates of energy costs. Appendices B and E are for use with the worksheets in Chapter 5. These data can also be automatically accessed from a data file when using the NBSLCC computer program in Chapter 6. The computer program allows the user to adjust the DoE-energy prices for estimated general price inflation or to leave them in constant dollars.

It is important to note that there are no guarantees that the forecasted price data provided by DoE or by other organizations or individuals will be accurate. Moreover, it should be noted that forecasts are subject to change as new information is obtained. It should also be noted that inclusion of the annual DoE forecasts for 1985 in this report does not mean that they are more reliable than those from other sources. They are, however, nonproprietary, and they embody a level of information gathering and econometric modeling which is beyond the resources of most individuals.

Other Costs. Annually recurring operation and maintenance (non-energy) costs are often assumed to remain stable when measured in *constant* dollars, that is, without inclusion of purely inflationary changes. If they are assumed to remain stable in constant dollars, their initial value can be used for each year's cash flow in the life-cycle cost analysis. If the analysis is performed in *current* dollars, however, the initial value must be adjusted each year to reflect the rate of forecasted inflation.

Nonannually-recurring repair and replacement costs may be more difficult to predict than routine annual costs, because there may be no initial cost on which to base the future estimates. Manufacturers' recommended parts replacement and service schedules can sometimes be used to estimate these costs. (Taking this approach, it may be assumed that by performing recommended parts replacement and service, unscheduled breakdown is either avoided or made infrequent.) If no service guide is provided, estimates must be based on past evidence, engineering test data, or informed judgment. Constant dollar estimates can be made by calculating the expected costs of repair and replacement in dollars as of the beginning of the study period. If the analysis is to be performed in current dollars, these estimates must be adjusted for the projected rate of inflation.

[10] The DoE forecasts are updated in the fall of each year. Tables of energy price data and discount factors for economic evaluations are prepared from DoE forecasts and reported by the National Bureau of Standards in Barbara Lippiatt, Stephen Weber, and Rosalie Ruegg, *Energy Prices and Discount Factors for Life-Cycle Cost Analysis: Annual Supplement to NBS Handbook 135 and NBS Special Publication 709,* Gaithersburg, MD, National Bureau of Standards, NBSIR (last 2 digits of year of publication) -3273.

[11] Data Resources, Inc., *The Energy Review,* published Quarterly, Lexington, MA.

Resale or scrap value is generally estimated in constant dollars as a percentage of the initial project cost. The difference between the initial cost and the constant dollar resale value may reflect deterioration or obsolescence, or both. The equivalent current dollar amount can be obtained by adjusting the constant dollar amount for the expected rate of inflation.

Long-term price forecasts for specific industrial products and construction materials are seldom available. Statistical analyses of historical price trends is one approach which is sometimes taken to generate these forecasts. However, predicting anticipated rates of price change by extending trend lines offers questionable results. For this reason, the assumption is often made—as was suggested for routine maintenance costs—that future prices of individual inputs will change at about the same rate as prices in general.

SUMMER SUN

An exception is when there is a good basis for forecasting differential price changes, such as a contractual agreement for future prices or a prediction model which allows substantial analysis of market forces.

SETTING THE STUDY PERIOD

It is often a good idea to set the study period equal to the period the building owner intends to hold the property, "the holding period." If this is done the assumption can be made in performing the economic evaluation that components lasting less than the study period are replaced and any residual values past the study period are captured as resale or scrap values (less disposal costs). Some project components may last less than the holding period and some longer.

When the holding period is expected to be very long, the study period is sometimes set equal to project life or to some other specified period. This has the advantage of reducing the number of project replications that must be evaluated, but requires care in specifying the period.

If comparisons of net present value savings or present value life-cycle costs are made among project alternatives, it is essential that the alternatives be evaluated for the same period of time; otherwise, differences will result simply from the use of different study periods. (Present values are explained in the next section.) That is, when project alternatives with unequal lives are compared using present values, they must be compared using a common termination date. One approach is to set the study period equal to the lowest common multiple of the lives of the alternatives being compared and assume replacements. When replacement at the end of the life of the shorter-lived alternative is not expected, the study period can be set equal to the life of the longest-lived alternative (even if it is not a common multiple of the shorter-lived alternative), and the funds accruing at the end of the life of the shorter-lived alternative can be assumed to be reinvested elsewhere at a specified reinvestment rate until the study period's termination date. This approach entails computing a future terminal value based on the reinvestment rate. Or, the study period can be set equal to the life of the shortest-lived alternative, and residual values can be taken for the longer-lived alternative which is truncated.

If cash flows are expected to be identical for each repetition of a project alternative, and if the holding period is long-to-indefinite or assumed to be a common multiple of the lives of the alternatives, unequal lives can be used for comparing the alternatives in terms of their annual values. If the actual time horizon is less than a common multiple of the lives of the alternatives, using annual values based on unequal lives for comparing the alternatives implies the assumption that residual values for unused portions of asset life will be such that the annual values would not be changed by taking the alternatives over a shorter time. (Annual values are explained in the next section.)

Under the above conditions of replicating cash flows and either a long-to-indefinite time horizon or one which is a common multiple of project lives, independent projects with unequal lives can be ranked in order of their SIR's or IRR's computed on the basis of project lives. However, most forecasts of energy prices indicate changes in energy prices over time that will alter a project's cash flow as it is replicated. Significant changes in cash flows as projects are replicated argue for the use of a common study period when ranking projects on the basis of their SIR's or IRR's.

ADJUSTING VALUES TO TIME-EQUIVALENCY ("DISCOUNTING")

The term discounting has been previously introduced, but it has not yet been explained how discounting is performed. The purpose of this section is to briefly explain and illustrate the process of discounting and what the results mean.

The value today of a specified sum of money to an individual or organization depends on when it is to be received or paid. This is true even if there is no inflation or deflation to change the buying power of the dollar. Cash in hand affords reinvestment opportunities; hence, cash receipts are generally preferable sooner rather than later (ignoring possible income tax considerations). Deferring payments affords opportunities for interim uses of funds for other purposes, or, at a minimum, the avoidance of borrowing costs; hence, it is generally preferable to delay costs. The "opportunity cost" associated with the timing of cash flows can be taken into account by expressing the opportunity cost as a rate of interest, or "discount rate," and applying compound interest formulas, or factors computed from the formulas, to cash flows. (See Chapter 3, "Selecting the Discount Rate or Minimum Acceptable Rate of Return.") The discounting process produces time-adjusted amounts which can be combined to compute measures of economic performance such as life-cycle costs, net savings, savings-to-investment ratio, and discounted payback. (See Chapter 3, "Choosing a Method.")

By applying the appropriate formula or factor, it is possible to express project cash flows as a lump-sum occurring at the present, i.e., a "present value;" as a lump-sum occurring in the future, i.e., a "future value;" or as a uniform amount recur-

Table 3-10. How to find the future equivalent when the present amount is known

Formula Name:		Single Compound Amount (SCA)
Equation	:	$F=P\,(1+i)^N$ or $F=P \cdot \text{SCA Factor}$
SCA Factors	:	See Appendix A, Table A.2.
Example	:	What is the estimated cost (current dollars) in 10 years of a building component replacement that would cost \$1,000 if replaced today if it is expected to increase in price at a 5% rate compounded annually?
Solution[a]	:	$F=\$1{,}000 \cdot (1+.05)^{10}=\$1{,}000 \cdot 1.63=\$1{,}630.$ ↑ (SCA factor for 10 years and 5% found in Appendix Table A.2)
Interpretation	:	The amount of money to be budgeted in the 10th year for this replacement is \$1,630.

Notation:
- F = Future value, a sum of money at the end of a future period.
- P = Present value, a sum of money at time zero in the study period.
- i = Interest rate per period.
- N = Number of periods.

[a] This can also be solved using the DISCOUNT Computer Program described in Chapter 6.

Table 3-11. How to find the present value equivalent when the future amount is known

Formula Name:		Single Present Worth (SPW) or Single Present Value (SPV)
Equation	:	$P = F \cdot \frac{1}{(1+d)^N}$ or $P = F \cdot \text{SPW Factor}$
SPW Factors	:	See Appendix A, Table A.1.
Example	:	What is the present value of a \$1,630 replacement cost (current dollars) for a building component to be incurred in 10 years if the opportunity cost (including inflation) is 10%?
Solution[a]	:	$P = \$1{,}630 \cdot \frac{1}{(1+.10)^{10}} = \$1{,}630 \cdot \underbrace{0.39}_{\text{(SPW factor for 10 years and 10\% found in Appendix Table A.1)}} = \$638.$
Interpretation	:	Paying \$1,630 (current dollars) at the end of 10 years is equivalent to paying \$638 today. Therefore, it would be worthwhile to pay up to \$638 now in order to avoid the \$1,630 replacement cost in 10 years.
Notation:		F = Present value, a sum of money at time zero in the study period. F = Future value, a sum of money at the end of a future period. d = Discount rate per period. N = Number of periods.

[a] This can also be solved using the DISCOUNT Computer Program described in Chapter 6.

ring annually over the study period, i.e., an "annual value." To evaluate energy projects, taking into account projected changes in energy prices, it is usually convenient to express all project cash flows as present values. The worksheets in Chapter 5 are designed to find present values. The computer program of Chapter 6 finds present values and also gives annual value equivalents by amortizing the present value amounts over the study period.

Tables 3-10 through 3-15 show how to adjust different kinds of cash flows to time-equivalent values. The tables give the name and equation for the compound interest formula used to handle each kind of time adjustment.[12] The tables provide references to discount factors, corresponding to each formula, which can be found in the appendices. The factors are useful because they simplify the calculations. Each cash amount associated with a project is simply multiplied by the appropriate factor to adjust the cash amount to a designated common time. The tables also illustrate each kind of time adjustment with a simple example and interpret the results.[13] [A separate program on the computer program disk (see Chapter

[12] There are additional compound interest formulas and factors not included in this guide; those most frequently used in economic evaluation of energy projects and those needed to complete the Worksheets in Chapter 4 are included.

[13] The user who desires further explanation of discounting operations may consult an engineering economics or capital budgeting textbook, such as Tung Au and Thomas P. Au, *Engineering Economics for Capital Investment Analysis* (Boston, MA: Allyn and Bacon, Inc., 1983); or John J. Clark, *et al., Capital Budgeting,* 2nd Edition (Englewood Cliffs, NJ: Prentice-Hall, Inc., 1984). For a simplified treatment of the procedure as applied to energy-related projects, see Harold E. Marshall and Rosalie T. Ruegg, *Simplified Energy Design Economics,* National Bureau of Standards, Special Publication 544 (Washington, DC: U.S. Government Printing Office: Stock No. 003-003-02156-3, January 1980).

6 and order instructions in the back of this Guide) called "Discount" allows one to perform the discounting operations described in the tables, apart from the overall building analysis.]

Referring back to Tables 3-4 through 3-9, it may be noted that discounting is incorporated in the equations for calculating the economic evaluation measures. Tables 3-10 through 3-15, however, focus on how the discounting part is performed. The information in the two sets of tables is brought together in practice: The analyst typically chooses a method of economic evaluation (Tables 3-4 through 3-9); chooses a common time framework for stating all costs and benefits, such as present or annual values; sorts through the various cash flows of the project, grouping those which are estimated to occur with the same timing; applies the appropriate formula (Tables 3-10 through 3-15) to each group; and calculates the measure of economic performance (Tables 3-4 through 3-9).

Table 3-12. How to find the present value equivalent when the amount of a uniformly recurring future amount is known

Formula Name:	Uniform Present Worth (UPW) or Uniform Present Value (UPV)
Equation :	$P=A\cdot\frac{(1+d)^N-1}{d\,(1+d)^N}$ or $P=A\cdot$ UPW Factor
UPW Factors :	See Appendix A, Table A.4.
Example :	What is the present value of a routine maintenance cost of $1,000 (constant dollars) recurring annually over 10 years if the opportunity cost (excluding inflation) is 6%.
Solution[a] :	$P=\$1{,}000\cdot\frac{(1+.06)^{10}-1}{.06\,(1+.06)^{10}}=\$1{,}000\cdot 7.36=\$7{,}360.$ (UPW factor for 10 years and 6% found in Appendix Table A.4)
Interpretation :	Paying $1,000 (constant dollars) at the end of each of the next 10 years is equivalent to paying $7,360 today. Therefore, it would be cost effective to pay up to $7,360 now to avoid the future costs.

Notation:

P = Present value, a sum of money at time zero in the study period.

A = Annual value, an end-of-period amount in a uniform series over N periods.

d = Discount rate per period.

N = Number of periods.

[a] This can also be solved using the DISCOUNT Computer Program described in Chapter 6.

Table 3-13. How to find the annual value equivalent when the present amount is known

Formula Name:	Uniform Capital Recovery (UCR)
Equation :	$A = P \cdot \frac{d(1+d)^N}{(1+d)^N - 1}$ or $A = P \cdot \text{UCR Factor}$
UCR Factors :	See Appendix A, Table A.3.
Example :	What is the annual value equivalent over 10 years of paying a lump sum of \$10,000 today if the opportunity cost (excluding inflation) is 10%?
Solution[a] :	$A = \$10{,}000 \cdot \frac{.10(1+.10)^{10}}{(1+.10)^{10} - 1} = \$10{,}000 \cdot 0.16 = \$1{,}600.$ ↑ (UCR factor for 10 years and 10% found in Appendix Table A.3)
Interpretation :	Paying \$10,000 today is equivalent to paying\$1,600 at the end of each of the next 10 years. A loan of \$10,000 at an interest rate of 10% per annum could be paid off in 10 end-of-year payments of \$1,600.
Notation:	P = Present value, a sum of money at time zero in the study period. A = Annual value, an end-of-period amount in a uniform series over N periods. d = Discount rate per period. N = Number of periods.

[a] This can also be solved using the DISCOUNT Computer Program described in Chapter 6.

TREE

Table 3-14. How to find the present value of a single future amount (F) when the amount, if it were to occur today (F_o), is known and F is based on F_o adjusted for a constant annual rate of change (e)[a]

Formula Name[b]:	Single Present Worth (or Value) Modified for a Constant Rate of Change (SPW† or SPV†)
Equation :	$P=F_o \cdot \left(\frac{1+e}{1+d}\right)^N$ or $P=F_o \cdot SPW†$
SPW† Factors :	See Appendix C, Table C.1.
Example :	What is the present value of resale proceeds from a building component expected to be sold at the end of 10 years if the future amount is estimated at half the initial component cost of \$1,000, adjusted for a projected 4% per annum rate of price increase over the 10 years, and the opportunity cost (including inflation) is 10%?
Solution[c] :	$P=\$500 \cdot \left(\frac{1+.04}{1+.10}\right)^{10} = \$500 \cdot 0.57 = \$285.$ ↑ (SPW† factor for 10 years, d−e=6, rounded to 0.6 in Appendix C, Table C.1)
Interpretation :	Recovering in resale at the end of 10 years half the original \$1,000 cost of the component adjusted for projected price change is equivalent to receiving \$285 today.

Notation:

P = Present value, a sum of money at time zero in the study period.

F = Future value, a sum of money at the end of a future period.

F_o = Future sum of money stated in prices as of the beginning of the study period.

e = Rate of change per period.

d = Discount rate per period.

N = Number of periods.

[a] This formula is an integrated version of the formulas given in Tables 3-10 and 3-11. The formula and factors are provided to accommodate the Worksheet approach in Chapter 5.
[b] If a variable annual rate of change is assumed, the symbol "SPW*" or "SPV*" is used in this report.
[c] This can also be solved using the DISCOUNT Computer Program described in Chapter 6.

Table 3-15. How to find the present value of an annually recurring amount when its starting value (A_o) is known and it is projected to change at a constant annual rate (e)[a]

Formula Name[b]:	Uniform Present Worth (or Value) Modified for a Constant Rate of Price Change (UPW† or UPV†)
Equation :	$P = A_o \cdot \left(\frac{1+e}{d-e}\right) \cdot \left[1 - \left(\frac{1+e}{1+d}\right)^N\right]$ or $P = A_o \cdot \text{UPW†}$
UPW† Factors :	See Appendix B, Table BII.
Example :	What is the present value of energy costs over 10 years if the opportunity cost is 10% (including inflation), the yearly energy cost priced at the beginning of the study period is $1,000, and the price is expected to increase at a constant annual compound rate of 6% (including inflation)?
Solution[c] :	$P = \$1000 \cdot \left(\frac{1+.06}{.10-.06}\right) \cdot \left[1 - \left(\frac{1+.06}{1+.10}\right)^{10}\right] = \$1{,}000 \cdot 8.20 = \$8{,}200.$ ↑ (UPW† for 10 years, d−e=4, rounded to 8% in Appendix B, Table BII)
Interpretation :	Total energy costs over 10 years are estimated to be equivalent to a lump-sum payment of $8,200 today. Hence, it would be cost effective to pay up to $8,200 now to avoid incurring the future energy costs.

Notation:

P =Present value, a sum of money at time zero in the study period.

A_o =Initial value of a periodic payment (receipt) which changes each period, stated in prices as of the beginning of the study period.

e =Rate of change per period.

d =Discount rate per period.

N =Number of periods.

[a] This formula is a modified version of the formula given in Table 3-12. The formula and factors are provided to accommodate the Worksheet approach in Chapter 5.
[b] If a variable annual rate of change is assumed, the symbol "UPW*" or "UPV*" is used in this report.
[c] This can also be solved using the DISCOUNT Computer Program described in Chapter 6.

FINANCING AND TAXES

Financing. Capital investment analysis usually separates financing considerations (sources of funds) from project evaluations (uses of funds). The entire acquisition cost is generally treated as an initial cash outlay, regardless of whether the acquisition is financed or paid for in cash when evaluating the economic merits of a project. This approach of treating total acquisition costs as an initial outlay is recommended for most project evaluations. An exception may be called for when financing terms are unique to a given investment opportunity and differ from the terms available to the investor on other investments. In this latter case, explicit evaluation of financing effects may be necessary to determine the economic merits of a project. But in most cases, determining the best means of funding a project is a separate step which usually follows the economic evaluation. Although project financing is not the focus of this guide, the computer program in Chapter 6 provides the capability for assessing limited financing options.

Tax Effects. Tax effects change project cash flows and can dramatically alter the economic outcome of a project. Certain costs, such as operating costs (including energy), maintenance costs, repair costs, and capital depreciation costs may be deductible expenses for businesses. Other costs, such as property taxes, sales taxes, and interest on real estate and construction loans may be deductible from the taxable income of both businesses and individuals. Investment tax credits may be available to businesses, and energy tax credits may be available to either businesses or individuals.

An analysis which includes tax effects can be laborious when done by hand. The worksheet approach provided in Chapter 5 allows for a partial tax analysis. A more comprehensive tax analysis is facilitated by the use of a computer program, such as that provided in Chapter 6.

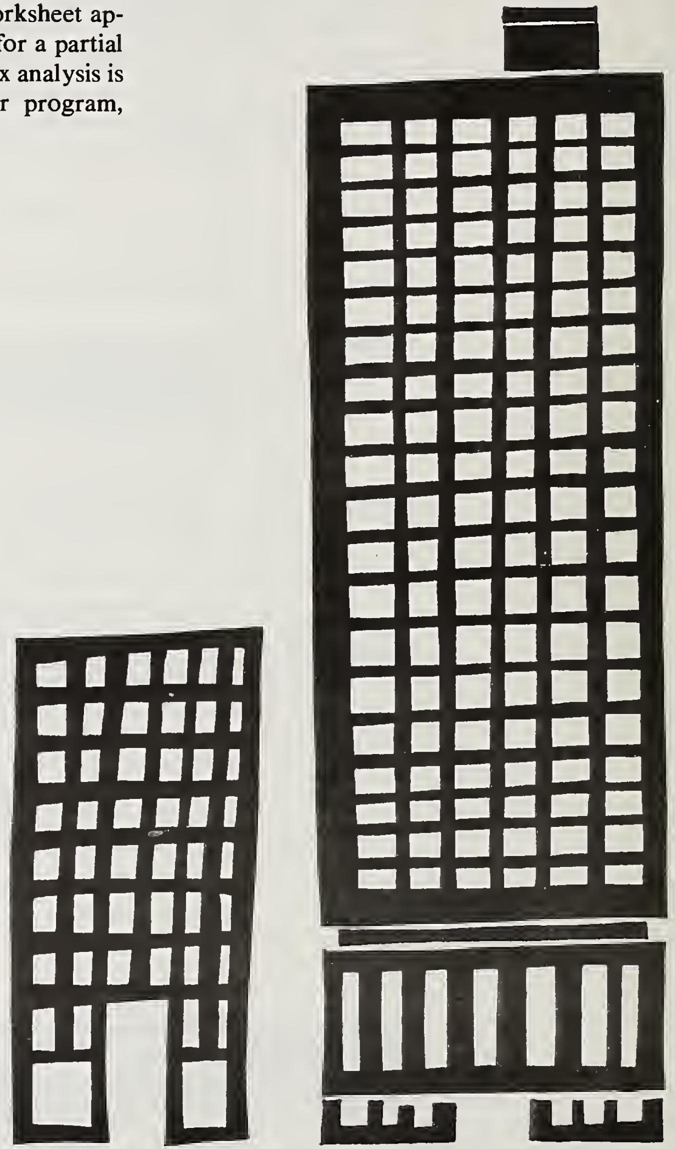


Table 4-1. Choosing among alternative approaches, designs, and sizes for a given purpose

Alternative Actions	Component Costs[a] (In Present Value Dollars) Purchase & Installation	Energy	Non-Energy O&M	Repairs & Replacement	Life-Cycle Costs[a] (In Present Value Dollars)
A Keep Existing Oil Furnace	—	15,500	500	3,000	19,000
B Replace with High Efficiency Oil Furnace	5,500	12,800	500	—	18,800
C Replace with Electric Heat Pump					
C1 Conventional Design	6,000	13,000	500	500	20,000
C2 Advanced Design	7,000	10,000	500	500	18,000*
D Supplement with Solar Energy System					
D1 Size 1	12,500	4,500	1,000	2,000	20,000
D2 Size 2	13,000	3,800	1,000	2,100	19,900
D3 Size 3	13,500	3,500	1,000	2,200	20,200

[a] Data are completely hypothetical, absolutely and comparatively, and are provided only to illustrate the evaluation method.
* Alternative C2 is the least-cost choice in this example.

4. MAKING DECISIONS

Decisions often are not simple yes or no, go or no-go choices. Frequently, decisions must be made among alternative approaches, designs, and sizes of projects to accomplish a given purpose; decisions must be made about projects that are interrelated; and limited budgets must be allocated among competing projects. How to make each of these decisions is illustrated below. Note that the illustrations are based purely on hypothetical data, and the least-cost choices in reality will depend on the specific circumstances and cost data.

CHOOSING AMONG ALTERNATIVE APPROACHES, DESIGNS, AND SIZES

An example of choice among alternative approaches to accomplish a given purpose is whether to provide space heating to an existing building by continuing to operate the existing oil furnace, by replacing the existing furnace with a high performance oil furnace, by replacing it with an electric heat pump, or by supplementing the existing oil furnace with an active solar energy system. An example of a design choice is whether the electric heat pump to be considered should be a conventional heat pump or an advanced design heat pump. An example of a sizing decision is how large the collector array and storage system of the proposed solar energy system should be.

These examples share a common characteristic: each of them involves mutually exclusive alternatives.

The most cost-effective selection can be made by choosing the alternative with the lowest estimated life-cycle cost, assuming they all meet the space heating requirements and that it is unnecessary to forego cost-effective increments to projects due to budget constraints. This procedure is illustrated in Table 4-1, a summary sheet for a hypothetical life-cycle cost analysis. The design and size choices for the heat pump and the solar energy system are made first (i.e., C2 has a lower life-cycle cost than C1; D2 has a lower life-cycle cost than D1 or D3), and then the C and D selections are compared with the A and B alternatives. Table 4-1 shows Alternative C2, the advanced design heat pump, to be the least-cost approach to providing space heating, based on the alternatives considered and the hypothetical cost data.

As can be seen by inspecting the table, the life-cycle cost estimate for each alternative action is calculated from its component costs, in present value dollars, just as was illustrated for a single project earlier in Table 3-5. The estimating procedure must be repeated for each alternative.

FINDING THE COST-EFFECTIVE COMBINATION OF INTERDEPENDENT PROJECTS

Rather than evaluating the life-cycle cost of each project independently, you may need to consider a group of projects in combination. This need arises when projects are interrelated, so that undertaking one will change the cost effectiveness of the others.

For example, you may wish to consider adding insulation to the walls of the building, as well as increasing the efficiency of the heating system.

Table 4-2. Choosing among interrelated projects[a]

	A. Keep Existing Oil Furnace		C2. Change to Advanced Design Heat Pump	
Alternative Actions	Energy Costs (Present Value Dollars)	Total LCC Costs (Present Value Dollars)	Energy Costs (Present Value Dollars)	Total LCC Costs (Present Value Dollars)
1 Keep Existing Insulation at R10 (Purchase & Installation Cost of $0)	15,500[b]	19,000[b]	10,000[b]	18,000[b]
2 Add Insulation to R19 (Purchase & Installation Cost of $500)	12,000[b]	16,000[c]	8,000	16,500[d]
3 Add Insulation to R30 (Purchase & Installation Cost of $800)	10,500	14,800	7,000	15,800
4 Add Insulation to R38 (Purchase & Installation Cost of $1,000)	9,500	14,000*	6,500	15,500

[a] Note that these data are completely hypothetical and are provided only to illustrate the decision process.
[b] These numbers are taken from the example in Table 4-1.
[c] $16,000 is derived by adding the assumed insulation cost of $500 to $12,000 energy cost, plus (from Table 4-1) the $500 for non-energy O&M costs and the $3,000 for repairs and replacement associated with keeping the existing oil burner.
[d] $16,500 is derived by adding the assumed insulation cost of $500 to the $8,000 for energy costs, plus (from Table 4-1) the $7,000 for purchasing and installing the heat pump, the $500 for its non-energy operation and maintenance costs, and the $500 for its repairs and replacement.

* Alternatives A and 4 are the cost-effective choices in combination in this example.

The problem is to determine how much to invest in each. Increasing the insulation will decrease the requirements for heating and, therefore, reduce the benefits of increasing the efficiency of the heating system. By like token, increasing the efficiency of the heating system will decrease the cost of heating and, therefore, reduce the benefit of increasing the insulation.

Table 4-2 illustrates this type of decision, drawing from the previous illustration of Table 4-1. Here a life-cycle cost comparison is made among investments in various levels of ceiling insulation, with and without the advanced design heat pump. It is assumed that any of the alternative combinations would meet the level of required thermal performance.

The first column indicates possible alternatives for ceiling insulation: (1) keeping the existing resistance (R) level, which is assumed to be R-10, (2) raising the existing level to R-19, (3) raising the existing level to R-30, and (4) raising the existing level to R-38. The headings across the top indicate the heating system alternatives. These are taken from the analysis of Table 4-1 which found the advanced design heat pump to be the cost-effective alternative to the existing furnace, based on the existing level of insulation. But, since we now propose to change the level of insulation, we need to reconsider the furnace decision.

The procedure is to estimate life-cycle costs for each of the combinations indicated, and select the least-cost combination. The illustration, which again is based solely on hypothetical data, shows that the least-cost combination is keeping the existing oil burner and increasing the insulation level to R-38. (This outcome was also checked against the other heating system alternatives in combination with insulation.)

This more comprehensive evaluation, which takes into account multiple projects and their interdependencies, supports a different decision from that supported by Table 4-1. The advanced design heat pump, which is estimated to be cost effective without the addition of insulation—in the general sense of saving more than it costs—is estimated to be a *less* cost-effective choice than keeping the existing system and adding insulation to level R-38.

Again note that the actual least-cost choice depends on the specific circumstances and cost data. Also, in an actual case, there may be constraints which limit available options, such as not having enough space to install insulation to the desired level. There may also be many other related investment alternatives which should be taken into account such as wall and under-floor insulation and storm or replacement windows.

SETTING PROJECT PRIORITIES

Another situation in which you will need to consider a combination of projects is allocating limited funds among competing, non-mutually exclusive uses. This occurs when you have identified a number of potentially cost-effective projects and, not having enough money to afford them all, you wish to set priorities among them.

Table 4-3 illustrates this case by comparing the lowest life-cycle cost project from Table 4-2 with other potential projects, some of which are for the same building and some for different buildings. For the purpose of illustration, it is assumed that the life-cycle costs of these other projects have already been evaluated, and they have been found to be cost effective. (Our focus in Table 4-3 is on column 2 and columns 13 through 16. The rest of the information is provided only so that one can see how columns 13-15 are derived.)

Say you have no more than $1,500 to invest and you wish to get the largest return possible from that investment. What should you do now and what should you defer until later?

Column 1 of Table 4-3 lists five independent projects. Column 2 gives the hypothetical investment cost of each. You need to look at these numbers in order to stay within budget.

What are the possible investments for $1,500? Project X is not possible because it exceeds the budget. That leaves two possibilities: undertake either projects 4 and Z, or projects 4, W, and Y.

Now look at column 13 which gives the life-cycle costs associated with each project. Notice that this information alone is insufficient to guide the decision, because the life-cycle costs are not computed for a total building in which all of the projects occur. Look next at column 14 which gives net savings of the project (obtained by subtracting column 13 from column 12). This column gives us the basic information needed to make the decision, because it allows us to calculate which combination of projects will yield the largest total net savings for the available budget. This can be done simply by adding up the net savings for the different possible combinations. That is, projects 4 and Z will save a total of $5,300 more than they cost (in present value dollars). Projects 4, W, and Y will save a total of $7,100 more than they cost. Therefore, to get the highest dollar return, you would give the latter set of projects priority and defer projects X and Z until additional funds are available. (At a later time it would be advisable to reassess these projects before doing them.)

Before leaving this example, look at columns 15 and 16 which illustrate a useful aid for determining project priority. This is the savings-to-investment ratio (SIR) which allows us to rank projects in descending order of their economic priority. The SIR is useful when the number of projects is so large that computing the net savings for all of the different project combinations would be cumbersome.

As described in Table 3-8, the SIR is calculated by dividing the dollar savings by the investment cost. That is, columns 5, 8, and 11 are summed and divided by column 2. Then the project with the highest ratio is assigned priority 1, and so forth, as shown in column 16. Setting project priority according to the SIR rankings leads us to the highest net savings for our $1,500 budget: W, the first ranked project; 4, second ranked; and Y, third ranked.[14]

An issue which arises when designing, sizing, and assigning priority to projects is whether to pre-design/size individual projects before comparing them with competing, independent projects, or whether to let incremental designs/sizes of each project compete for available funding. The preferred approach depends in most cases on future prospects for additional funding. If, for example, no further funding is to be received for a building retrofit, net benefits from the budget in hand can be maximized by letting project design/size increments compete for available funds, on the basis of incremental SIR's. But care should be taken to avoid overly short-run prospectives which may result in the selection of under-designed/under-sized projects and potential net benefits foregone.

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[14] The condition under which ranking projects in order of their SIR's may not maximize net savings is explained in Chapter 3, "Savings-to-Investment (Benefit/Cost Ratio) Method."

Table 4-3. Setting project priorities[a]

Potential Projects (1)	Investment Costs (2)	*Energy Cost* Without Project (3)	With Project (4)	Energy Savings (5) =(3)-(4)	*Non-Energy O&M Cost* With out Project (6)	With Project (7)	Non-Energy O&M Savings (8) =(6)-(7)	*Repairs & Replacement* Without Project (9)	With Project (10)	R&R Savings (11) =(9)−(10)	Life-Cycle Cost Without Project (12) =(3)+(6)+(9)	Life-Cycle Cost With Project (13) =(2)+(4)+(7)+(10)	Net Savings of the Project (14) =(12)−(13)	Project SIR[b] (15) =[(5)+(8)+(11)]/(2)	Project Ranking (16)
4 Add Insulation to level R38 (Keep existing furnace)	1,000	15,500	9,500	6,000	500	500	0	3,000	3,000	0	19,000[c]	14,000[c]	5,000	6.0	2
W Replace incandescent lamps with fluorescent lamps	250	4,000	2,500	1,500	--	--	--	1,000	500	500	5,000	3,250	1,750	8.0	1
X Add solar water heater	2,000	5,000	1,750	3,250	--	200	−200	100	300	−200	5,100	4,250	850	1.4	5
Y Add a whole house fan	250	2,200	1,500	700	--	50	−50	--	50	−50	2,200	1,850	350	2.4	3
Z Replace appliances that need replacing with energy efficient models instead of regular models	500[d]	2,000[d]	1,200	800	--	--	--	--	--	--	2,000[d]	1,700	300	1.6	4

[a] Note that the data are completely hypothetical and are provided only to illustrate the evaluation method.
[b] SIR = Savings-to-Investment Ratio.
[c] These costs are taken from the examples in Table 4-2.
[d] Only the costs that are relevant to the decision need to be considered.

5. EVALUATING PROJECTS USING THE WORKSHEETS[15]

The following worksheets provide step-by-step instructions to assist you in making economic evaluations. For simple problems, the worksheets may be a convenient approach. Note, however, that the worksheet approach provides only partial treatment of tax adjustments and does not accommodate analysis of alternative financing arrangements. The worksheets accommodate estimation of income tax credits. For residential rental and business property, they accommodate approximations of deductions from taxable income of depreciation expenses (Accelerated Cost Recovery and Straight-line methods applied to the initial investment). Deductions from taxable income of energy and non-energy operating, maintenance, repair and replacement expenses are also taken into account.[16]

Not treated are changes in property taxes attributable to projects, deductions from taxable income of sales taxes, and changes in capital gains and depreciation recapture taxes that might be attributable to the project evaluated. For comprehensive tax evaluations, the computer program presented in Chapter 6 is recommended.

To proceed with either the worksheets or the computer program, you will need estimates of the project's energy effects and cost data. A review of the worksheets in this chapter or of the computer program's "Building Characteristics File" in Chapter 6 will indicate the data requirements. Note that the worksheets are designed to accommodate a wide variety of problems and, consequently, allow for many more entries than most project evaluations typically require.

If you elect the worksheet evaluation approach, you will need to select the worksheets to be completed. Three series of worksheets (A, B, and C) are provided, as described below:

Series A worksheets are for calculating present value net savings of a project relative to the base case. To evaluate the cost effectiveness of a project, complete the Series A worksheets for the base case and for the project. If there are positive net savings, the project is estimated to be cost effective.

To compare alternative designs or sizes of an investment, complete the Series A worksheets for each alternative design or size relative to the base case. The alternative which has the highest net savings, other things being equal, is the economical choice.

(See Chapter 3, "Net Savings (Net Present Value or Net Benefits) Method," for general guidelines, and Chapter 4, "Making Decisions," for illustrative applications of this method to different kinds of decisions.)

Series B worksheets are for calculating payback. There are three different worksheets in the Payback Series:

Worksheet 1—for calculating simple and discounted payback when future cash flows are constant;

Worksheet 2—for calculating discounted payback when future cash flows are constant or change at a constant rate, using the graphs of Appendix D; and

Worksheet 3—for calculating discounted payback when future cash flows are not uniform or do not change at a constant rate.

(See Chapter 3, "Payback Method," for guidelines on applying applying this method.)

Series C worksheet is for calculating savings-to-investment ratios. The user's attention is called to two points: (1) Series C worksheets are completed using estimates from Series A. (2) The ratios calculated according to the Series C worksheet procedure are based on *total* project savings and costs and are appropriate for assigning priority among non-mutually exclusive projects. They are *not incremental* ratios and, therefore, are *not* reliable for guiding mutually exclusive investment decisions such as project design and sizing. Use Series A worksheets for that type of decision.

(See Chapter 3, "Savings-to-Investment (Benefit/Cost) Ratio Method," for guidelines on applying this method.)

As a result of changes in the Federal tax law, some of the steps in the worksheets may not be required, such as the computation of tax credits on pages 40–43.

[15] Worksheets for evaluating Federal energy conservation projects are provided in Rosalie T. Ruegg, *Life-Cycle Costing Manual for the Federal Energy Management Programs,* National Bureau of Standards, Handbook 135, Revised 1986.

[16] To supply the necessary data for tax-related computations, the user must be familiar with IRS rules; furthermore, IRS tax provisions are subject to change. The worksheet computations are meant only to provide rough approximations of income tax and other effects.

Neither the National Bureau of Standards nor the U.S. Department of Energy assumes any liability resulting from errors or omissions in the calculations of tax and other effects provided by the Worksheets.

SERIES A—NET SAVINGS EVALUATION[a]

Worksheet 1. Project identification and basic assumptions

A Description: ____

B Objective: To determine ☐ If a Project is Cost Effective

☐ The Cost-Effective Design or Size of a Project

C Building Type: ☐ Owner-occupied Residence ☐ Rental Residence ☐ Commercial

D Study Period[b]: ______ Years.

Planned Holding Period of the Building: ______ Years.

Expected Life of the Project: ______ Years.

E Nominal Discount Rate[c]: 0.___

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[a] These worksheets are intended for developing "ballpark" estimates of economic performance, not precise answers. Neither the National Bureau of Standards nor the U.S. Department of Energy assumes any liability resulting from decisions based on the use of any of the Worksheets in Series A, B, and C.

[b] For assistance, see Chapter 3, "Setting the Study Period." Note that the worksheet approach requires the assumptions that investment costs occur as a lump sum at the beginning of the study period and energy and other costs occur as end-of-year cash flows.

[c] For assistance, see Chapter 3, "Selecting a Discount Rate or Minimum Acceptable Rate of Return," and Worksheet 2.

Worksheet 2. Guidance in estimating the discount rate

Part I. *Homeowner's Discount Rate*

A (1) If the project is to be financed, what is the interest rate at which the money can be borrowed? ___ %.
(2) The interest rate (highest) on debt outstanding is _____ %.
(3) The highest rate of taxable return, before taxes, available from other investments of comparable risk is ______________ %.
(4) Enter here the highest rate from A(1), A(2), and A(3): ______ %.

B (1) Find in the Federal income tax schedule the maximum rate at which your income is taxed and write this as a decimal fraction: 0.____ .
(2) Find in your State income tax form (if applicable) the maximum tax rate at which your income is taxed and write this as a decimal fraction: 0.____ .
(3) Compute a "composite marginal income tax rate." Under tax laws in effect in 1986 this can be done by multiplying the State tax (from B(2)) times the remainder of one minus the Federal tax rate (from B(1)), and adding the product to the Federal tax rate:

0.____	×	(1.00 − 0.____)	+	0.____	=	0.____
marginal State tax rate		marginal Federal tax rate		marginal Federal tax rate		composite marginal income tax rate

C Multiply the rate from A(4) times the remainder of one minus the composite marginal income tax rate (from B(3)):

____ %	×	(1 − 0.____)	=	_____ %.
Before tax rate from A(4)		Composite marginal tax rate from B(3)		After-tax rate

D Enter the result of C expressed as a decimal fraction: 0.____.

E Enter here the highest rate of *tax-exempt* return available from other investments of comparable risk, expressed as a decimal fraction: 0.____.

F Enter here the higher of the rates in D and E. 0.____.
(Enter this rate on Worksheet 1, line E. This is an estimate of your after-tax, nominal discount rate.)

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[a] The concept is explained and illustrated in Chapter 3, "Selecting a Discount Rate or Minimum Acceptable Rate of Return."

Worksheet 2. (Continued) Guidance in estimating the discount rate

Part II. *Firm's Discount Rate*

A traditional approach to determining a proxy for the firm's appropriate discount rate is to compute it as a weighted average of the marginal costs associated with each source of funds to the firm.

A Complete the table below for the Applicable Sources of Funds:

Components of Capital for Investment (1)	Market Values ($ Amounts to be Raised) (2)	Market Weights (Market Values ÷ Total New Capital) (3)	After-Tax Cost of Capital (As Computed in Sec. B next page) (4)	Weighted After-Tax Cost of Capital (5)=(3)×(4)
(a) New Current Liabilities	______	(a)(2)÷(f)(2)	B(1)	______
(b) New Long-Term Debt	______	(b)(2)÷(f)(2)	B(2)	______
(c) New Preferred Stock	______	(c)(2)÷(f)(2)	B(3)	______
(d) New Common Stock	______	(d)(2)÷(f)(2)	B(4)	______
(e) Other Sources	______	(e)(2)÷(f)(2)	B(5)	______
(f) Total New Capital	______			
(g) Marginal Cost of Capital, Sum col. (5) (This is a proxy for your after-tax, nominal discount rate. Enter it in Worksheet 1, line E)				______

Worksheet 2. (Continued) Guidance in estimating the discount rate

Part II. *Firm's Discount Rate* (Continued)

B Compute After-Tax Cost of Capital and enter results in Section A, Column (4), of preceding page[a]:

(1) Cost of New Current Liabilities[b] (Enter in A(a)(4))

$$= \underset{\substack{\text{interest}\\ \text{rate to be}\\ \text{paid}}}{0.\_\_\_} \times \underset{\substack{\text{composite}\\ \text{marginal}\\ \text{income tax}\\ \text{rate}^{c}}}{(1-0.\_\_\_)} = 0.\_\_\_$$

(2) Cost of New Long-Term Debt (Enter in A(b)(4))

$$= \left[\underset{\substack{\text{yearly}\\ \text{interest}\\ \text{to be paid}}}{\$\_\_\_\_} \times \underset{\substack{\text{composite}\\ \text{marginal}\\ \text{income tax}\\ \text{rate}^{c}}}{(1-0.\_\_\_)}\right] \div \left[\underset{\substack{\text{sale}\\ \text{price}\\ \text{of debt}}}{\$\_\_\_\_} \times \underset{\substack{\text{flotation}\\ \text{cost as a}\\ \text{fraction of}\\ \text{sales price}}}{(1-0.\_\_\_)}\right] = 0.\_\_\_$$

(3) Cost of New Preferred Stock Equity (Enter in A(c)(4))

$$= \left[\underset{\substack{\text{stated dividend}\\ \text{on new issue}}}{\$\_\_\_\_}\right] \div \left[\underset{\substack{\text{sale price}\\ \text{of new pre-}\\ \text{ferred}\\ \text{issue}}}{\$\_\_\_\_} \times \underset{\substack{\text{flotation cost}\\ \text{as a fraction}\\ \text{of sales price}}}{(1-0.\_\_\_)}\right] = 0.\_\_\_$$

(4) Cost of New Common Stock Equity[d] (Enter in A(d)(4))

$$= \left[\underset{\substack{\text{expected}\\ \text{dividend}\\ \text{in the}\\ \text{next period}}}{\$\_\_\_\_} \div \left[\underset{\substack{\text{current}\\ \text{market}\\ \text{price of}\\ \text{stock}}}{\$\_\_\_\_} \times \underset{\substack{\text{flotation cost}\\ \text{as a fraction}\\ \text{of market}\\ \text{price}}}{(1-0.\_\_\_)}\right]\right] + \underset{\substack{\text{annual}\\ \text{growth}\\ \text{rate of}\\ \text{dividend}}}{0.\_\_\_} = 0.\_\_\_$$

[a] Depreciation is often omitted from the cost of capital calculation on grounds that the calculated cost of capital *is* the cost of depreciation; hence separate treatment adds nothing.
[b] Assumes no flotation or service charge.
[c] Computed by multiplying the State tax rate times the remainder of one minus the Federal tax rate, and adding the product to the Federal tax rate, as shown on Worksheet 2, Part I "Homeowner's Discount Rate," B(3).
[d] Note that the value of common stock is assumed to reflect retained earnings and a separate calculation for retained earnings is not made. As an alternative to the estimation approach shown here, the cost of common stock equity capital is sometimes estimated according to the Capital Asset Pricing Model. (See John J. Clark, et al., *Capital Budgeting*, 2nd ed., pp. 267-273.)

Worksheet 3. Initial costs

	With the Project (1)	Without the Project[a] (Base Case) (2)	Differential Costs Attributable to the Project (3)=(1)−(2)
A Land	$______	$______	
B Structure	$______	$______	
C Equipment	$______	$______	
D Other	$______	$______	
E Initial Costs[b] ($E=A+B+C+D$) [Proceed to Worksheet 4 if there are *no* tax credits or depreciation writeoffs to consider. If there *are* credits and/or depreciation writeoffs, proceed with E^1, E^2, or E^3, whichever is applicable.]	$______	$______	$______
E^1 Initial Costs Adjusted for Tax Credits—*Owner-Occupied Residential* ($E^1=E-F_j$) [First complete Section F, then E^1]	$______	$______	$______
E^2 Initial Costs Adjusted for Tax Credits and Depreciation—*Rental Residential* ($E^2=E-(F_j+Hd)$) [First complete Sections F&H, then E^2]	$______	$______	$______
E^3 Initial Costs Adjusted for Tax Credits and Depreciation—*Nonresidential* ($E^3=E-(G_j+Hd+Id)$) [First complete Sections G, H, & I, then E^3]	$______	$______	$______

[a] This col. is for evaluating a base line against which to compare the project. For example, to evaluate the cost effectiveness of a new energy system to be retrofitted into an existing building, any initial capital costs associated with keeping the existing system would be needed for comparison with the new system. These might include current resale, reuse, or scrap value, net of disposal costs, plus any up-front renovation or repair costs necessary to keep the existing system in operation. To evaluate the cost effectiveness of an energy conserving design for a new building, the initial costs of a conventional design would be needed for comparison.

[b] No construction scheduling is allowed in the Worksheet Approach; all acquisition costs are lumped together as of the beginning of the first year.

Worksheet 3. (Continued) Adjustment of initial costs

F Residential Tax Credits[a]

	With the Project (1)	Without the Project (Base Case) (2)
Energy Conservation Tax Credit		
a Eligible Conservation Expenditure (a=Worksheet 3, eligible portion of B, C, and D)	$________	$________
b Percentage Credit Stated as a Decimal Fraction	$________	$________
c Amount of Energy Conservation Credit (c=a×b, not to exceed maximum allowable amount)	$________	$________
d SPW Factor for year 1[b] ________ [Go to Appendix A, Table A.1 and find the SPW factor for year 1 in the column for the discount rate closest to the rate specified in Worksheet 1, E.]		
e Present Value of Tax Savings from Energy Conservation Credit (e=c×d)	$________	$________
Renewable Energy Tax Credit		
f Eligible Renewable Energy Expenditure (f=Worksheet 3, eligible portion of B, C, and D)	$________	$________
g Percentage Credit Stated as a Decimal Fraction	$________	$________
h Amount of Renewable Energy Credit	$________	$________

[a] To supply the necessary data for tax-related calculations, the user requires familiarity with IRS rules.
[b] For an explanation of SPW factors, see Chapter 3, "Adjusting Values for Time-Equivalency ('Discounting')."

Worksheet 3. (Continued) Adjustment of initial costs for tax credits, Sec. F. *Residential Tax Credits*

		With the Project (1)	Without the Project (Base Case) (2)
i	Present Value of Tax Savings from Renewable Energy Credit ($i=h \times d$)	$______	$______
j	Present Value of Total Tax Savings from Residential Tax Credit ($j=e+i$)	$______	$______

[*If the building is owner-occupied residential,* subtract the amounts in j, cols. (1) and (2), from the amounts in Worksheet 3, E, cols. (1) and (2), and enter the results in Worksheet 3, E^1, cols. (1) and (2).

If the building is rental residential and

- if there are *no* depreciation expenses to be taken, subtract the amounts in j, cols. (1) and (2), from the amounts in Worksheet 3, E, cols. (1) and (2), and enter the results in Worksheet 3, E^2, cols. (1) and (2); or
- if there *are* depreciation expenses, do not yet subtract j from Worksheet 3, E; instead proceed to Section H.]

Worksheet 3. (Continued) Adjustment of initial costs for tax credits

G Business Tax Credits

	With the Project (1)	Without the Project (Base Case) (2)
Investment Tax Credit		
a Qualifying Investment Expenditures (a=Worksheet 3, qualifying part of B, C, and D, less any deductions for old property traded in, adjusted for 1st year expensing if applicable, and taking into account the used property limitation and the "safe-harbor," at-risk rule (if applicable))	$________	$________
b Present Credit Stated as a Decimal Fraction	$________	$________
c Amount of Investment Credit ($c=a \times b$, not to exceed maximum allowable amount in a given year)	$________	$________
d SPW Factor for year 1[a] ________ [Go to Appendix A, Table A.1 and find the SPW factor for year 1 in the column for discount rate closest to the rate you specified in Worksheet 1, E.]		
e Present Value of Tax Savings from Investment Tax Credit[b] ($e=c \times d$)	$________	$________
Energy Tax Credit		
f Qualifying Energy Expenditures (f=Worksheet 3, qualifying part of B, C, and D)		
g Percentage Credit Stated as a Decimal Fraction	$________	$________
h Amount of Energy Credit ($h=f \times g$)	$________	$________

[a] For explanation of SPW factor, see Chapter 3, "Adjusting Values for Time-Equivalency ('Discounting')."
[b] If tax credits are carried back or forward, those amounts should be multiplied by the SPW for each year in which they are to be applied to tax liability.

Worksheet 3. (Continued) Adjustment of initial costs for tax credits, Sec. G. *Business Tax Credits*

		With the Project (1)	Without the Project (Base Case) (2)
i	Present Value of Tax Savings from Energy Tax Credit ($i=h \times d$)	$________	$________
j	Present Value of Total Savings from Tax Credits ($j=e+i$) [*If the building is nonresidential* and • If there are *no* depreciation expenses to be taken, subtract the amounts in j, cols. (1) and (2), from the amounts in Worksheet 3, E, cols. (1) and (2), and enter the results in Worksheet 3, E^3, cols. (1) and (2); • if there *are* depreciation expenses, do not yet subtract j from Worksheet 3, E; instead proceed to Section H.]	$________	$________

Worksheet 3. (Continued) Adjustment of initial costs for depreciation

H Depreciation of Buildings and Building Components—Applies Only to Residential Rental and Nonresidential Buildings Used for Business
[Estimate depreciation using either of the two methods[a] provided below: 15-Year ACRS Method; S-L Method]

	With the Project (1)	Without the Project (Base Case) (2)
Accelerated Cost Recovery System (ACRS) Method		
a Depreciable Cost (a=Worksheet 3, eligible portion of B, C, and D)	$______	$______
b Multiplier for Computing Building Depreciation [Go to Appendix F and follow instructions for locating the appropriate multiplier in Table F.1.]	$______	$______
c Present Value of Accumulated Building Depreciation ($c=a \times b$)	$______	$______
d Skip lines e–k and go to line 1, next page		
Straight-Line (S-L Method)		
e Depreciable Costs (e=Worksheet 3, eligible portion of B, C, and D)	$______	$______
f Estimated Salvage Value for Computing Depreciation	$______	$______
g Net Depreciable Value ($g=e-f$)	$______	$______

[a] Depreciation regulations are part of the Federal income tax laws which are revised periodically. There are various methods of computing depreciation. Two methods are accommodated here for the purpose of estimating an approximate measure of the effect of depreciation on taxes paid; in practice you may find it advantageous to choose another method, or you may be required by law to choose another method. Use of the Accelerated Cost Recovery System (ACRS) method will provide a faster writeoff than use of the straight-line (S-L) method.

Worksheet 3. (Continued) Adjustment of initial costs for depreciation, Sec. H. *Buildings and Building Components*

		With the Project (1)	Without the Project (Base Case) (2)
h	Depreciable Life (Estimated useful life for computing depreciation; may be specified in tax regulations)	$________	$________
i	Annual Depreciation Allowance ($i=g \div h$)	$________	$________
j	UPW Multiplier for Computing Present Value [Go to Appendix A, Table A.4 and find the UPW factor for the discount rate (as given in Worksheet 1, E) and for the period corresponding to either the depreciable life or the study period, depending on whether (1) or (2) below is applicable: (1) Use the depreciable life (h above) if depreciable life < study period (as given in Worksheet 1, D); or (2) Use the study period if depreciable life > study period.]	$________	$________
k	Present Value of Accumulated Building Depreciation ($k=i \times j$)	$________	$________
l	Income Tax Savings from Building Depreciation	$________	$________

If ACRS Method used,

$l=c \times$ composite tax rate (as computed in Worksheet 2, Part I, B(3))

If S-L Method used,

$l=k \times$ composite tax rate (as computed in Worksheet 2, Part I, B(3))

[*If the building is residential rental property*, and

- if there are *no* tax credits (section F), subtract the amounts in *l*, cols. (1) and (2), from the amounts in Worksheet 3, E, cols. (1) and (2), and enter the results in Worksheet 3, E^2, cols. (1) and (2);
- if there *are* tax credits (section F), add the amounts in *l*, cols. (1) and (2), to the amounts in Fj, cols. (1) and (2); subtract the totals from Worksheet 3, E, cols. (1) and (2), and enter the results in Worksheet 3, E^2, cols. (1) and (2).

If the building is nonresidential business property, and

- if there are *no* tax credits (section G) or *no* separate depreciation of equipment (section I), subtract the above amounts in *l*, cols. (1) and (2), from the amounts in Worksheet 3, E, cols. (1) and (2), and enter the results in Worksheet 3, E^3, cols. (1) and (2);
- if there *are* tax credits (section G) and/or separate depreciation of equipment (section I), add the above amounts in *l*, cols. (1) and (2), to the amounts in Gj and Id, cols. (1) and (2), subtract the totals from Worksheet 3, E, cols. (1) and (2); and enter the results in Worksheet 3, E^3, cols. (1) and (2).]

Worksheet 3. (Continued) Adjustment of initial costs for depreciation

I Depreciation of Business Equipment—Applies Only to Residential Rental and Nonresidential Buildings Used for Business [Estimate depreciation using either of the two methods provided below: 5-Year ACRS Method; S-L Method]

	With the Project (1)	Without the Project (Base Case) (2)
Accelerated Cost Recovery System (ACRS) Method		
a Depreciation Costs (a=Worksheet 3, eligible portion of C and D)	$________	$________
b Multiplier for Computing Equipment Depreciation [Go to Appendix F, and follow instructions for locating the appropriate multiplier in Table F.2.]	$________	$________
c Present Value of Accumulated Equipment Depreciation (c=a×b)	$________	$________
d Skip lines e–k and go to line *l*, next page		
Straight-Line (S-L) Method		
e Depreciable Costs (e=Worksheet 3, eligible portion of C and D)	$________	$________
f Estimated Salvage Value for Computing Depreciation	$________	$________
g Net Depreciable Value (g=e−f)	$________	$________
h Depreciable Life (Estimated useful life for computing depreciation; may be specified in tax regulations)	$________	$________
i Annual Depreciation Allowance (i=g÷h)	$________	$________

Worksheet 3. (Continued) Adjustment of initial costs for depreciation, Sec. I. *Business Equipment*

	With the Project (1)	Without the Project (Base Case) (2)
j UPW Multiplier for Computing Present Value [Go to Appendix A, Table A.4 and find the UPW factor for the discount rate (as given in Worksheet 1, E) and for the period corresponding to either the depreciable life or the study period depending on whether (1) or (2) below is applicable: (1) Use the depreciation life (h above) if depreciation life < study period (as given in Worksheet 1, D); or (2) Use the study period if depreciable life > study period.]	$________	$________
k Present Value of Accumulated Equipment Depreciation ($k=i\times j$)	$________	$________
l Income Tax Savings from Equipment Depreciation *If ACRS Method used,* $l=c \times$ composite tax rate (as compared in Worksheet 2, B(3)) *If S-L Method used,* $l=k \times$ composite tax rate (as computed in Worksheet 2, B(3))	$________	$________

[*If the building is nonresidential*, and
- if there are *no* tax credits (section G), or depreciation of real property (section H), subtract the above amounts in *l*, cols. (1) and (2), from the amounts in Worksheet 3, E, cols. (1) and (2), and enter the results in Worksheet 3, E^3, cols. (1) and (2);
- if there *are* tax credits (section G) and/or depreciation of real property (section H), add the above amounts in *l*, cols. (1) and (2), to the amounts in Gj and Hd, cols. (1) and (2); subtract the totals from Worksheet 3, E, cols. (1) and (2); and enter the results in Worksheet 3, E^3, cols. (1) and (2).]

Worksheet 4. Energy costs & savings

Choose one of the following 5 Approaches to Estimating the Present Value of Energy Costs Over the Study Period:

- ☐ Approach 1—Estimate future energy costs on the basis of U.S. Department of Energy Forecasts, and assume the annual quantity purchased to remain constant.
- ☐ Approach 2—Estimate future energy costs on the basis of U.S. Department of Energy Forecasts, and allow for a changing annual quantity to be purchased.
- ☐ Approach 3—Estimate future energy costs on the basis of some other forecast of future yearly energy costs and assume the annual quantity purchased to remain constant.
- ☐ Approach 4—Estimate future energy costs on the basis of some other forecast of future yearly costs and allow for a changing annual quantity to be purchased.
- ☐ Approach 5—Estimate future energy costs on the basis of a projected constant rate of change in annual energy costs (due either to price or quantity change or a combination thereof) over the study period.

Complete the sections below applicable to the estimation approach chosen:

Section A. Initial Cost of Energy—Applies to Approaches 1 through 5.
For Approaches 1, 2, and 5 complete lines a through e below:
For Approaches 3 and 4, complete only item b below:

	With the Project (1)		Without the Project (Base Case) (2)		Annual Savings Attributable to the Project (3)=(2)−(1)	
	Energy Type 1 ( )	Energy Type 2 ( )	Energy Type 1 ( )	Energy Type 2 ( )	Energy Type 1 ( )	Energy Type 2 ( )
a Today's Price per Unit of Purchased Energy (use your actual price if possible; otherwise default to the average of your region given in Appendix E).	$_____	$_____	$_____	$_____	$_____	$_____
b Annual Quantity to be purchased (In same units as price per unit is stated in (a) above, if applicable.)	_____	_____	_____	_____	_____	_____
c Cost of Annual Energy Purchased at Today's Price ($c=a\times b$)	$_____	$_____	$_____	$_____		
d Other Annual Energy Charges at Today's Prices, e.g., Demand Charge	$_____	$_____	$_____	$_____		
e Total Annual Energy Cost at Today's Prices ($e=c+d$)	$_____	$_____	$_____	$_____	$_____	$_____

Worksheet 4. Energy costs & savings (continued)

Section B. Future Energy Savings—Applies to Approaches 1, 2, 3, and 4.

For Approaches 1 and 2: Go to Appendix B, Part I and follow instructions to derive estimates of future dollar savings for each type of energy and enter below for each year of the study period:

For Approaches 3 and 4: Energy Price Forecasts provided by ______________. [Note: These forecasted prices should include estimated general price inflation if you are basing the discount rate on a market rate of interest as provided for in Worksheet 2.] Multiply the forecasted price for each year of your study period times the reduction in the annual quantity of energy from Section A(b)(3), adjust for any demand or other charges not directly proportioned to quantity, and enter the results below:

Year Ending:

19__ __

SAVINGS—ENERGY TYPE 1: ____________

__ __

SAVINGS—ENERGY TYPE 2: ____________

__ __

Section C. Quantity Adjustment—Applies to Approaches 2 and 4.

Enter a multiplier below for each year of the study period for which you wish to change the estimated quantity of energy saved from the initial estimate. Calculate the multiplier as the ratio of the projected quantity of energy used in the future year to the quantity used in the first year. (No entry is assumed equal to 1.)

Quantity Adjustment Multiplier—ENERGY TYPE 1: ____________

__ __

Quantity Adjustment Multiplier—ENERGY TYPE 2: ____________

__ __

Worksheet 4. Energy costs & savings (Continued)

Section D SPW Discount Factors Applies to *Approaches 1, 2, 3, and 4*.

Go to Appendix A, Table 1 and find the column for the discount rate closest to the rate you specified in Worksheet 1, E. Enter SPW discount factor corresponding to each year of the study period:

Year Ending:

19___ ___

___ ___

Section E Present Value of Each Year's Energy Costs—Applies to Approaches 1, 2, 3, and 4.

For Approaches 1 & 3, multiply each amount in Section B times the corresponding SPW discount factor in Section D and enter the results below for each year:

For Approaches 2 & 4, multiply each amount in Section B times the corresponding quantity multiplier in Section C and the product times the corresponding SPW discount factor in Section D and enter the results below for each year:

Year:

19___ ___

Present Value Savings—ENERGY TYPE 1: ______________

$___ $___

Present Value Savings—ENERGY TYPE 2: ______________

$___ $___

Section F Present Value Total Energy Savings Over the Study Period—Applies to Approaches 1, 2, 3, and 4.

a Present Value Energy Savings for Each Type of Energy:

(Sum across years for each energy type in Section E above)	ENERGY SAVINGS TYPE 1: _____	ENERGY SAVINGS TYPE 2: _____
	(1)	(2)
	$________	$________

b Present Value Energy Savings—*Owner-Occupied Residential:* $________
(b=a(1)+a(2))

c Present Value Energy Savings Adjusted for Income Tax Effects—*Rental Residential or Nonresidential*[a]: $________
(c=b×(1−Composite Marginal Income Tax Rate[b]))

[a] It is assumed that the after-tax value of energy savings to the building owner will be the same whether the owner or the tenant pays the energy costs. (This ignores the effect on consumption of who pays.) If the owner pays, the energy costs are tax deductible; hence, after-tax energy savings are reduced accordingly. If the tenant pays the energy costs, it is assumed that rents are reduced by a corresponding amount from what they would be if the owner paid these costs; hence a reduction in energy costs is assumed to translate into an equal increase in taxable rental income to the owner. With this assumption, the value to the owner can be estimated according to line c in either case.

[b] As computed in Worksheet 2, B(3).

Worksheet 4. Energy costs & savings (continued)

Section G. Present Value of Energy Savings Over the Study Period—Applies Only to Approach 5.

	ENERGY TYPE 1 (1)	ENERGY TYPE 2 (2)
a Average Annual Compound Rate of Change in Energy Costs Forecasted Over the Study Period[a]:	0.___	0.___
b Difference Between the Discount Rate and the Projected Annual Rate of Change in Energy Costs: (Gb=(Worksheet 1, E)−(Worksheet 4, Ga))	0.___	0.___
c Present Value Multiplier [Go to Appendix B, Part II (p. B-24) and follow instructions for finding the appropriate multiplier for energy savings in Table BII. The difference computed in Gb above is used to locate the multiplier.]	_____	_____
d Present Value Energy Savings Over the Study Period (Gd=(Worksheet 4, Ae(3) Energy Type)×(Worksheet 4, Gc))	$_____	$_____

e Present Value Energy Savings—*Owner-Occupied Residential*: $_____
(Ge=Gd(1)+Gd(2))

f Present Value Energy Savings Adjusted for Income Tax Effects—*Rental Residential or Nonresidential*[b]: $_____
(Gf=Ge×(1−Composite Marginal Income Tax Rate[c]))

[a] To specify this rate, it is useful to start by estimating the average annual rate of general price change (inflation or deflation) which you expect to occur over the study period, and then consider the rate of change in energy prices relative to this general rate of change in prices. If you expect energy prices to change at about the same rate as most other prices, then enter your forecasted annual rate of change in general prices in Ga. If you expect energy prices to rise faster than most other prices, adjust the forecasted rate of change in general prices upward to reflect the excess price rise and enter the adjusted rate in Ga. If you expect energy prices to rise slower than most other prices, adjust the rate of change in general prices downward by the amount of the difference and enter the adjusted rate in Ga.

[b] See footnote a, preceding page for assumptions.

[c] As computed in Worksheet 2, B(3).

Worksheet 5. Annually recurring non-energy costs & savings (e.g., routine maintenance)

	With the Project (1)	Without the Project (Base Case) (2)	Savings(+) or Extra Costs(−) Attributable to the Project (3)=(2)−(1)
A Annual Costs (Priced as though incurred at the beginning of the study period)	$______	$______	$______

B Average Annual Compound Rate of Change in Annually Recurring Non-Energy Costs Forecasted Over the Study Period[a]: 0.___

C Difference Between the Discount Rate and the Projected Rate of Change in Annually Recurring Non-Energy Costs: 0.___
(C=Worksheet 1, E−Worksheet 5, B)

D Present Value Multiplier ________
[Go to Appendix B, Part II (p. B-24) and follow instructions for finding the appropriate multiplier for annually recurring non-energy amounts in Table BII. The difference computed in C above is used to locate the multiplier.]

E Present Value Annually Recurring Non-Energy Savings(+) or Extra Costs(−)—*Owner-Occupied Residential:* $______
(E=A(3)×D)

F Present Value Annually Recurring Non-Energy Savings(+) or Extra Costs(−) After Income Tax Effects—*Rental Residential or Nonresidential*[b]: $______
(F=E×(1−Composite Marginal Income Tax Rate[c]))

[a] To specify this rate (as in the case of energy in Worksheet 4, Ga), it is useful to start by estimating the rate of change in general prices (inflation or deflation). If you forecast annually recurring non-energy costs to change at about the same rate as prices in general, enter the rate of general inflation or deflation in B. If you expect annually recurring non-energy costs to increase faster than prices in general, adjust the forecasted rate of change in general prices upward and enter the adjusted rate in B. If you expect these costs to increase slower than prices in general, adjust the forecasted rate of change in general prices downward and enter the adjusted rate in B.

[b] It is assumed that the after-tax value of annually recurring, non-energy savings or extra costs to the building owner will be the same whether the owner or the tenant pays these costs. (See the discussion in footnote a to Worksheet 4, F.)

[c] As computed in Worksheet 2, B(3).

Worksheet 6. Non-annually recurring costs & savings (e.g., repairs and replacements)

A Projected Future Expenditures (Priced as though incurred at the beginning of the study period) — Year[a]: 19____ ____ ____ ____ ____ ____

a *Without the Project*	$____	$____	$____	$____	$____	$____
b *With the Project*	$____	$____	$____	$____	$____	$____
c Savings(+) or Extra Costs(−) Attributable to the Project (c=a−b)	$____	$____	$____	$____	$____	$____

B Average Annual Compound Rate of Change in Non-Annually Recurring Costs Forecasted Over the Study Period[b]: 0.___

C Difference Between the Discount Rate and the Projected Rate of Change in these Costs: 0.___
(C=Worksheet 1, E−Worksheet 6, B)

D Present Value Multipliers ____ ____ ____ ____ ____ ____
[Go to Appendix C, and follow instructions for finding the appropriate multiplier in Table C.1 for each year in which savings or extra costs occur and enter them here. The difference computed in C above is used to locate the multipliers.]

E Present Value of Each Future Year's Amount of Savings(+) or Extra Costs(−) (E=Ac (by year)×D) $____ $____ $____ $____ $____ $____

F Present Value Non-Annually Recurring Savings(+) or Extra Costs(−) Over the Study Period—*Owner-Occupied Residential*: $____
(sum E across)

G Present Value Non-Annually Recurring Savings(+) or Extra Costs(−) After Income Tax Effects—*Rental Residential or Nonresidential*[c]: $____
(G=F×(1−Composite Marginal Income Tax Rate[d]))

---

[a] If you wish to assume beginning-of-year, instead of end-of-year payments (consistent with the computer program approach), enter the amount under the year preceding; e.g., enter a replacement cost expected to occur at the beginning of year 5 in year 4, because end-of-year 4 is approximately the same as beginning of year 5.

[b] For assistance in estimating this rate, see Worksheet 5, footnote a.

[c] It is assumed that the after-tax value of non-annually recurring savings or extra costs to the building owner will be the same whether the owner or the tenant pays these costs. (See the discussion in footnote a to Worksheet 4, F.)

[d] As computed in Worksheet 2, B(3).

Worksheet 7. Change in resale or scrap value

		With the Project (1)	Without the Project (Base Case) (2)	Increase(+) or Decrease(−) Attributable to the Project (3)=(1)−(2)
A	Year of Resale or Disposal ______			
B	Resale/Scrap Amount (Valued as though received at the beginning of the study period)	$______	$______	
C	Amount of Selling/Disposal Costs (Valued as though incurred at the beginning of the study period)	$______	$______	
D	Net Resale/Scrap Proceeds (D=B−C)	$______	$______	$______

E Average Annual Compound Rate of Change in net resale/scrap value forecasted over the study period[a]: 0.____

F Difference between the discount rate and the projected rate of change in net resale/scrap value: 0.____
(F=Worksheet 1, E−Worksheet 7, E)

G Present Value Multiplier ______
[Go to Appendix C and follow instructions for finding the appropriate multipliers(s) in Table C.1 for the year in which the resale or disposal occurs (A above) and enter it here. The difference computed in F above is used to locate the multipliers.]

H Present Value Net Resale/Scrap Increase(+) or Decrease(−)—*Owner-Occupied Residential/Rental Residential or Nonresidential*[b]: $______
(H=D(3)×G)

[a] For assistance in estimating this rate, see Worksheet 5, footnote a.
[b] Capital gains and depreciation recapture taxes are not treated in this Worksheet approach.

Worksheet 8. Total net savings in present value dollars

		Present Value Dollars
A	Energy Savings (From Worksheet 4, F b or Ge for *Owner-Occupied Residential*) (From Worksheet 4, F c or Gf for *Rental Residential or Nonresidential*)	$________
B	Annually Recurring Non-Energy Savings(+) or Cost Increase(−) (From Worksheet 5, E for *Owner-Occupied Residential*) (From Worksheet 5, F for *Rental Residential or Nonresidential*)	$________
C	Non-Annually Recurring Costs Savings(+) or Cost Increase(−) (From Worksheet 6, F for *Owner-Occupied Residential*) (From Worksheet 6, G for *Rental Residential or Nonresidential)*	$________
D	Resale or Scrap Value Increase(+) or Decrease(−) (From Worksheet 7, H for *all types of buildings*)	$________
E	Total Savings (E=A+B+C+D, remembering to observe signs designating increases or decreases)	$________
F	Initial Costs (From Worksheet 3, E or E^1 for *Owner-Occupied Residential*) (From Worksheet 3, E^2 for *Rental Residential*) (From Worksheet 3, E^3 for *Nonresidential*)	$________
G	Net Savings (or Net Losses) of Project[a] (G=E−F)	$________

[a] This completes the net savings evaluations. For guidance in interpreting the results, see Chapter 3, "Net Savings Method."

At this point you may wish to perform sensitivity analysis by reworking the evaluation to see the results based on other data and assumptions. You may also wish to proceed to Series B, Payback Evaluation, and/or Series C, Savings-to-Investment Ratio Evaluation.

SERIES B—PAYBACK EVALUATION
(COMPUTED ON A BEFORE-TAX BASIS)

[Use these worksheets to find approximately when the project will recover its costs]

Worksheet 1. Simple and discounted payback—Applies when future annual cash flows are constant

---

A Do you wish to assume that the quantity of energy saved will remain about constant over the life of the project or until the time to payback, whichever comes first? ☐ Yes ☐ No
If Yes, proceed to B; if No, go to Worksheet 3.

B Do you wish to assume that all future prices will remain unchanged over the life of the project or until the time to payback, whichever comes first? ☐ Yes ☐ No
If Yes, proceed to C; if No, go to Worksheet 3.

C Do you expect any significant future costs or savings that will not recur annually? ☐ Yes ☐ No
If No, proceed to D; if Yes, go to Worksheet 3.

Differential Costs or Savings Attributable to the Project

D Initial Costs (Note: No allowance is made for construction scheduling in the Worksheet Approach. All acquisition costs are lumped together as of the beginning of the first year.) $________

E Total Annual Energy Savings at Today's Prices (Series A-Worksheet 4, Ae(3), summation across energy types) $________

F Amount of Annually Recurring Non-Energy Extra Costs(−) or Savings(+) at Today's Prices (Series A-Worksheet 5, A(3)) $________

G Simple Payback (SPB) ________ years
(G=D÷(E+F))

H Discounted Payback (DPB) ________ years
[First specify a discount rate[a]: ________%. Then go to Appendix A, Table A.4 and find the column for the specified discount rate. Search down that column for the UPW factor closest in value to the simple payback found in line G above. In the left hand column "Period," read off the corresponding number and enter it here.[b]]

---

[a] For assistance, see Chapter 3, " Selecting a Discount Rate or Minimum Rate of Return," and Worksheet 2 of Series A.

[b] Interpolation may be used to obtain a more precise estimate of DPB. For guidance in interpreting the results, see Chapter 3, "Payback Method."

Worksheet 2. Discounted payback/graphical solution—Applies when future cash flows are constant or change at a uniform rate
[To use this Worksheet, it is necessary first to find simple payback which may be done by completing the preceding Worksheet through line G.]

A Simple Payback (SPB): __________ years
(From Series B, Worksheet 1, G)

B Discount Rate (d)[a]: __________ %

C Projected Average Annual Compound Rate of Change in Future Costs (e): __________ %
[Note: Only a single average compound rate of change may be specified for all components of future cash flow.[b]]

D "k" Value __________
[Go to Appendix D and follow instructions for locating the "k" value in Table D.1, based on the value of d given above in line B and the value of e given above in line C. Enter that "k" value here.]

E Appendix D Figure D. __________
[Go to Appendix D, and follow instructions for locating the appropriate figure among figures D.1—D.4, and identify that figure by number here.]

F Discounted Payback (DPB) __________ years[c]
[Go to Appendix D, and follow instructions for graphically determining DPB from SPB using the figure identified in E above.]

---

[a] For assistance, see Chapter 3, "Selecting a Discount Rate or Minimum Acceptable Rate of Return," and Worksheet 2 of Series A.
[b] Note that the rate, e, can be set equal to zero if you wish to assume that future prices remain unchanged. In this case, the graphical solution should be approximately the same as the solution obtained in Worksheet 1 of Series B, section H. If you are working in nominal dollars (as is accommodated in this Worksheet approach) it is advised that the specified "e" value reflect, at a minimum, the projected rate of change in prices in general in the economy. If energy costs comprise the bulk of future costs, the value of "e" should reflect primarily the projected average annual rate of change in energy prices.
[c] For guidance in interpreting the results, see Chapter 3, "Payback Method."

Worksheet 3. Discounted payback—Applies when future cash flows are *not* uniform

[It is *not* necessary first to complete a preceding Worksheet to use this Worksheet.]

A Discount Rate[a]: 0.___

B Complete the following Table:

Year (t)	Initial Investment Cost[b] (1)	Cumulative Present Value O&M Costs (From col. 6 of Section C following) (2)	Cumulative Present Value Repair and Replacement Costs (From col. 7 of Section D following) (3)	Cumulative Present Value Energy Savings (From col. 8 of Section E following) (4)	Cumulative Net Savings (5)=(4)−(1)−(2)−(3)	
0	$______	$0______	$0______	$0______	$______	
1		______	______	______	______	
2		______	______	______	______	
3		______	______	______	______	
4		______	______	______	______	
5		______	______	______	______	
6		______	______	______	______	
7		______	______	______	______	
8		______	______	______	______	Note: When this amount
9		______	______	______	______	changes from
10		______	______	______	______	negative to positive,
11		______	______	______	______	discounted
12		______	______	______	______	payback is
13		______	______	______	______	indicated[c].
14		______	______	______	______	
15		______	______	______	______	

[a] For assistance, see Chapter 3, "Selecting a Discount Rate or Minimum Acceptable Rate of Return," and Worksheet 2 of Series A.
[b] Note: No allowance is made for construction scheduling in the Worksheet Approach. All acquisition costs are lumped together as of the beginning of the first year.
[c] For guidance in interpreting the results, see Chapter 3, "Payback Method."

Worksheet 3. (Continued) Discounted payback—Applies when future cash flows are *not* uniform

C Calculation of Present Value Cumulative O&M Costs

Year (t)	Today's Cost of O& M: With the Project (1)	Today's Cost of O& M: Without the Project (2)	Present Value Cumulative Multiplier[a] (3)	Cumulative Present Value O&M Costs: With the Project (4)=(1)×(3)	Cumulative Present Value O&M Costs: Without the Project (5)=(2)×(3)	Cumulative Increase(+) or Decrease(−) in O&M Costs Attributable to the Project (6)=(4)−(5)
0	$____	$____				
1			____	$____	$____	$____
2			____	____	____	____
3			____	____	____	____
4			____	____	____	____
5			____	____	____	____
6			____	____	____	____
7			____	____	____	____
8			____	____	____	____
9			____	____	____	____
10			____	____	____	____
11			____	____	____	____
12			____	____	____	____
13			____	____	____	____
14			____	____	____	____
15			____	____	____	____

[a] To Find Present Value Cumulative Multipliers:

* First specify the projected average annual rate of change in O&M costs: 0.____.
  (To specify this rate it is useful to start by estimating the rate of change in prices in general and to use that rate if you expect O&M costs to change about the same as the overall rate of price inflation or deflation. Adjust the rate upward or downward if you expect O&M costs to change at a faster or slower rate, respectively.)
* Subtract the projected rate of change, specified above, from the discount rate specified in Series B, Worksheet 3, A and enter the difference here: 0.____.
* Now go to Appendix B, Part II. In Table BII, find the column that corresponds to the difference calculated in the preceding step. Enter in this Worksheet, col. (3) above, a cumulative multiplier from the appropriate còl. of Table BII for each year within the period over which payback is expected to occur.

Worksheet 3. (Continued) Discounted payback—Applies when future cash flows are *not* uniform

D Calculation of Present Value Repair and Replacement Costs

Year (t)	Today's Cost of Repair and Replacement[a] With the Project (1)	Without the Project (2)	Present Value Multiplier[b] (3)	Yearly Present Value Repair and Replacement Cost With the Project (4)=(1)×(3)	Without the Project (5)=(2)×(3)	Change Attributable to the Project (6)=(4)−(5)	Cumulative Increase(+) or Decrease(−) Repair & Replacement Costs Attributable to the Project (7)=sum col. (6)
0	$____	$____	1	$____	$____	$____	____ year 0, col. 6
1							$____ (year 0+1, col. 6)
2							____ (years 0+1+2, col. 6)
3							____ (years 0+1+2+3, col. 6)
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

[a] Note: The Worksheet Approach assumes end-of-year cash flows for *all* future costs; whereas, the Computer Program Approach in Chapter 5 treats replacement costs as beginning-of-year cash flows and other costs as end-of-year cash flows. The Worksheet Approach can be made consistent with the computer program in this regard simply by entering above a given year's replacement cost in the preceding year. For example, a replacement cost expected to occur at the beginning of year 5 would be entered above in year 4, since the end-of-year 4 is approximately equal to the beginning-of-year 5.

[b] Present Value Multiplier:

* First specify the projected average annual rate of change in repair and replacement costs: 0.____ .
  (For assistance in estimating this rate, see step 1 of footnote a, preceding page.)
* Subtract the projected rate of change from the discount rate specified in Series B, Worksheet 3, A, and enter the difference here: 0.____ .
* Now go to Appendix C. In Table C.1, find the column that corresponds to the difference calculated in the preceding step. Enter in Worksheet 3, D(3) a multiplier from that column for each year in which there is an estimated repair or replacement cost.

Worksheet 3. (Continued) Discounted payback—Applies when future cash flows are *not* uniform

E Calculation of Present Value Yearly Energy Savings

	Yearly Quantity of Energy		Price of Energy[a]					
Year (t)	With the Project (1)	Without the Project (2)	With the Project (3)	Without the Project (4)	Yearly Energy Savings (5)=(2)×(4)−(1)×(3)	SPW[b] (6)	Present Value of Yearly Energy Savings (7)=(5)×(6)	Cumulative Present Value of Energy Savings (8)=sum col. (7)
0			$	$				
1					$		$	$ (Year 1, col. 7)
2								(Years 1+2, col. 7)
3								(Years 1+2+3, col. 7)
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								

[a] Energy Prices:

* For "Today's Price," use the price of energy in effect at the time of the analysis if possible. Default values are provided in Appendix E.
* To use U.S. Department of Energy Price Forecasts, go to Appendix B, Part I, and follow instructions for finding the set of price multipliers from the Tables BI.1a to BI.11b which applies most closely to your project. Multiply today's price (cols. (3) and (4), row 0 above) times the price multiplier from the appropriate Appendix BI table for each year to obtain estimates of future prices and enter the results in cols. (3) and (4) for each future year.
* To use your own forecasted rates of change in energy prices, multiply the price of energy in the preceding year times (1 + forecasted rate of change) beginning with today's price. For example, if today's price is, say, $10 per unit and your projected rate of change over year 1 is 5 percent, the first year's price is entered as $10.50 per unit (i.e., $10×1.05). If the second year's projected rate of change is 7 percent, the price for year 2 will be entered as $11.03 (i.e., $10.50×1.07).

[b] Go to Appendix A, Table A.1 and find the col. of SPW multipliers for the discount rate specified above in Series B, Worksheet 3, A. Enter in col. (6) the SPW multiplier corresponding to each year.

SERIES C—SAVINGS-TO-INVESTMENT RATIO (SIR) EVALUATION

[Use this Worksheet to assist in developing project priorities when the budget is insufficient to fund all cost-effective projects]

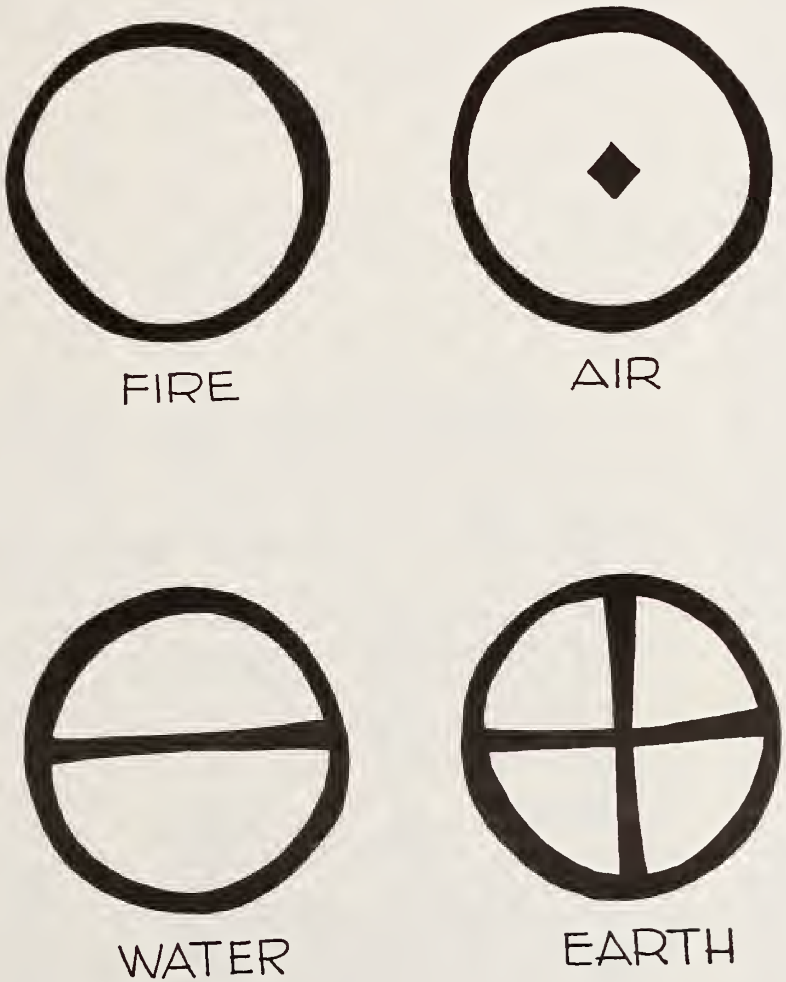
A Denominator—Initial Costs: $________
(Bring forward from Series A, Worksheet 8, F)

B Numerator—Total Savings: $________
(Bring forward from Series A, Worksheet 8, E)

C SIR Ratio[a]: ________
(C=B÷A)

Note: Amounts required to complete this Worksheet are from Series A, Worksheet 8.

[a] For guidance in interpreting the results, see Chapter 3, "Savings-to-Investment Ratio Method."


FIRE
AIR
WATER
EARTH

6. EVALUATING PROJECTS WITH THE COMPUTER PROGRAM

DESCRIPTION OF THE COMPUTER PROGRAM

The chapter serves as a user's guide to the National Bureau of Standards Life-Cycle Cost (NBSLCC) computer program. The program can be used to perform comprehensive cost analyses of buildings and building systems and to compare the economic performances of design alternatives. It computes total life-cycle costs, net present-value savings, the savings-to-investment ratio, and the adjusted internal rate of return. The program is designed to be used with a desk-top microcomputer having an MS-DOS operating system (IBM-PC/XT/AT and compatible microcomputers).[17] Economic evaluations can be computed for commercial and non-commercial buildings. Income tax adjustments and financing effects can be included in the analysis as needed. Long-term energy price projections from the Department of Energy are stored on the disk and can be automatically retrieved for use in the LCC analysis of energy projects at the user's discretion.[18]

The general methodology used in the NBSLCC program to compute life-cycle costs is consistent with Standard E917-83 of the American Society for Testing and Materials (ASTM).[19] The NBSLCC program is a further development of the Building Life Cycle Cost (BLCC) program[20] originally developed at NBS and published by ASTM in support of Standards E917-83, E964-83, E1074-85, and E1057-85.

NBSLCC is a package of programs consisting of an introductory program, five major interrelated subprograms, a worksheet generating program, and a stand-alone program called DISCOUNT for computing discounted cash flows. All of these programs, as well as the files used as examples in this chapter, are contained on a single 5-1/4 inch floppy disk. Disk ordering information and a registration form are provided in the back of this report.

These programs are user oriented in that they prompt the user for data and assumptions as needed, advise the user when entries appear to be improper, permit the user to make changes to input data files quickly, and allow the user to move freely from subprogram to subprogram by menu selection. All entries are made from the keyboard; the video monitor prompts the user and displays the user's entries. A printer is needed to print out the data worksheet and the three reports generated by the NBSLCC program. The DISCOUNT program uses the video monitor for both input and output data display.

This chapter provides instructions for running the NBSLCC system, explains the purpose of each of the subprograms, defines all of the data and assumptions required from the user, and assists the user in interpreting the three reports printed by the NBSLCC subprograms. It also provides brief instructions for running the DISCOUNT program.

The user who is anxious to get started may wish to try running the NBSLCC program immediately after reading the next two sections: "Microcomputer Requirements" and "Installing and Starting the NBSLCC Programs." The interactive nature of the NBSLCC subprograms will provide the user with much of the information needed to proceed through a LCC analysis. Others may wish in addition to read the section "Running the NBSLCC Subprograms" before trying to perform an analysis in order to better understand the nature of each of the five subprograms and their logical sequence of use.

The last three sections of this chapter round out the user's understanding of the NBSLCC program and describe the DISCOUNT program. The section "NBSLCC Data Requirements" provides detailed information on each of the input data requirements. These expanded definitions give the user a better understanding of what is being asked when setting up a building characteristics file. The section "NBSLCC Reports" discusses the three types of printed reports. The section "The DISCOUNT Program" describes the purpose and use of this stand-alone program.

Those who want an in-depth understanding of the structure of the NBSLCC subprograms should refer to Appendices G, H, and I. Appendix G lists the key variable names that are used in the NBSLCC program. Appendix H documents the computational algorithms. Appendix H shows in equation form the derivation of the economic measures printed in the LCC reports. Appendix I describes the program's methodology and assumptions for calculating income tax adjustments.

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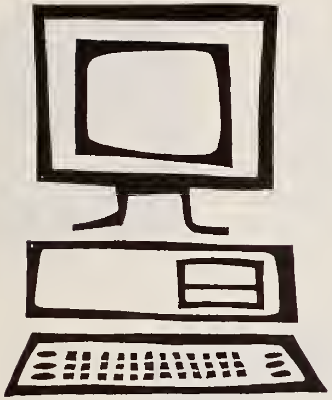
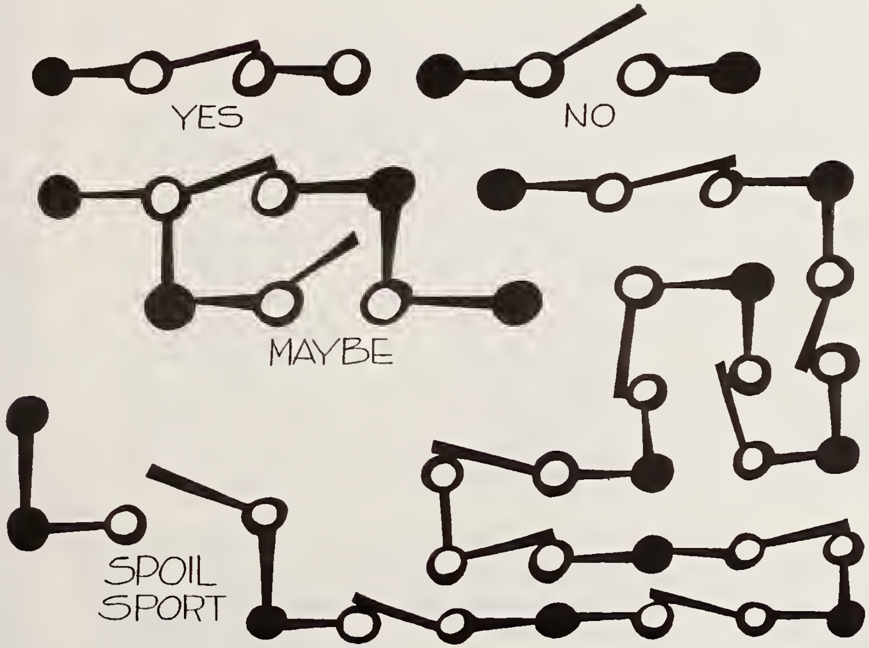
[17] This product identification does not imply a recommendation nor endorsement by the National Bureau of Standards, nor does it imply that the product identified is necessarily the most suitable for the purpose for which it is used.

[18] The DoE energy price projections are revised annually in the fall and the NBSLCC data files are updated accordingly.

[19] American Society for Testing and Materials, *1983 Annual Book of ASTM Standards,* Section 4 (Construction), Volume 04.07, E917-83, "Standard Practice for Measuring Life-Cycle Costs of Buildings and Building Systems," Philadelphia, PA, 1983.

[20] Petersen, S. R., *A User's Guide to the Building Life Cycle Cost (BLCC) Computer Program,* American Society of Testing and Materials, Philadelphia, PA, 1985.





MICROCOMPUTER REQUIREMENTS

The NBSLCC program can be used on most desk-top microcomputer systems having an MS-DOS operating system, one or two 5-1/4 inch disk drives, and a compatible printer. Either a standard or wide carriage line printer can be used. If the NBSLCC subprograms are copied onto a disk containing the disk operating system (DOS) and BASIC interpreter, only one disk drive is needed. However, this will greatly reduce storage space for the data files generated while using NBSLCC. The NBSLCC program can be run on some other microcomputers in BASIC with only minor modifications. Some versions of BASIC may use different symbols for exponentiation and print field declarations and may not recognize the clear screen command (CLS). Approximately 50K of free Random Access Memory (RAM) is needed to run the program after BASIC is loaded. For most CP/M systems with 64K RAM, there is insufficient free RAM after loading BASIC to run the program.

A limitation imposed by the use of BASIC with single precision variables is that only the first seven digits in a larger number are significant, and the last of these is rounded; e.g. 1,234,567,890 is printed as 1,234,568,000. Any dollar amount between \$1,000,000 and \$10,000,000 will be rounded to the nearest ten dollars; e.g., \$1,000,004 will be rounded to \$1,000,000 and \$1,000,005 will be rounded to \$1,000,010. Any number between \$10,000,000, and \$100,000,000 will be rounded to the nearest \$100, etc. Seven significant digits provide sufficient accuracy for most LCC analyses, which typically are limited more by accuracy in data and assumptions than by the precision of calculation.

INSTALLING AND STARTING THE NBSLCC PROGRAMS

All of the programs and files needed to run the NBSLCC program are contained on the NBSLCC diskette. Rather than use the original diskette, it is recommended that you copy these programs onto your own formatted diskette (along with the disk operating system files and BASIC interpreter) or hard disk. The following installation instructions are for an IBM-PC (or compatible microcomputer) with two disk drives. Consult your computer operating guide for copying these files on a single-drive or hard-disk systems.

Installation

Step 1. Insert your own formatted diskette with operating system and BASIC in drive A. It is best if there are no other files on this disk. Insert the NBSLCC disk in drive B. Always insert the diskette with the label side up. Close the doors to the disk drive.

Step 2. If your computer is off, switch on the printer, video monitor, and then the computer.

Step 3. If you do not see the DOS prompt (A>), simultaneously press the System Reset keys (Ctrl> plus <Alt> plus <Del>).

Step 4. If you are prompted for the date, enter the current date (e.g., MM/DD/YY). Otherwise type *DATE* at the A> and enter the date. It is important that you enter the correct year because the base year used in the NBSLCC program is taken from the internal clock.

Step 5. Copy all of the files from the NBSLCC disk in drive B to the system disk in drive A as follows: At the A> type COPY B:*.* A: . The following files will be copied over to your disk in drive A:

BASIC Programs	Building Characteristics Files	LCC Output Files	DoE Energy Price Files
NBSLCC.BAS	LCCFILE1.BCF	LCCFILE1.LCC	ENCOSTXX.SEQ
LCCDATA.BAS	LCCFILE2.BCF	LCCFILE2.LCC	ENCOSTFL.RAN
PRINTBCF.BAS	ALTA.BCF	ALTA.LCC	
LCCMAIN.BAS	ALTB.BCF	ALTB.LCC	
PRINTLCC.BAS	ALTCR.BCF	ALTCR.LCC	
COMPARE.BAS	ALTDR.BCF	ALTDR.LCC	
BCFFORM.BAS			
DISCOUNT.BAS			

The building characteristics files and LCC output files listed here contain data and calculations used in the examples discussed in this User's Guide and are not integral to the NBSLCC program package. You may delete them when you no longer need them.

Step 6. Remove the NBSLCC disk and store it for safekeeping. Installation is complete.

Starting NBSLCC

The following instructions for running the NBSLCC program are based on the installation instructions shown above.

Step 1. Insert your diskette containing BASIC and NBSLCC files in drive A. If you want to save the files that you create on another disk, enter a formatted disk for this purpose in drive B.

Step 2. Follow steps 2, 3, and 4 of the installation instructions above as necessary.

Step 3. At the A>, type: *BASIC NBSLCC /S:156*. (The /S:156 is neeeded to allocate space for the random access files used to retrieve the DoE energy price projections. Some microcomputers use other names for BASIC, e.g., GWBASIC, MBASIC.) The following messages will appear on the video monitor:

NBSLCC consists of 5 subprograms, each with a distinct function:

(1) LCCDATA—A user-interactive program for creating or modifying a BUILDING CHARACTERISTICS FILE (BCF) for a particular building or subsystem design. The BCF is a complete list of all the data and assumptions for that design.
(2) PRINTBCF—Prints the BCF created or modified by (1).
(3) LCCMAIN—Computes the LCC for a building or subsystem, based on its BCF.
(4) PRINTLCC—Prints a detailed LCC report based on the results of (3).
(5) COMPARE—Computes and prints a COMPARATIVE LCC ANALYSIS of two alternative building or subsystem designs.

You must create a BUILDING CHARACTERISTICS FILE for a project with LCCDATA before running PRINTBCF or LCCMAIN. You must compute the LCC of the project with LCCMAIN before running PRINTLCC. You must run LCCMAIN for a base case and at least one alternative design before running COMPARE.

Enter subprogram code to proceed (or <ENTER> to stop):

Step 4. Type the number corresponding to the first subprogram to be used and proceed as directed by instructions on the video monitor. Each of these five subprograms and their input requirements are described in the following section. If you wish to stop the execution of the NBSLCC program at this point, press the <ENTER> key. Execution of this program or any of the other subprograms can be stopped at any point by pressing <Ctrl> <BREAK>.

Step 5. Turn on <Caps Lock>. All alphabetic entries must be entered in upper case letters.

RUNNING THE NBSLCC SUBPROGRAMS

This section describes the five major subprograms of NBSLCC that may be accessed from the main menu of the NBSLCC program, and provides recommended sequences of subprogram operation.

Subprogram (1): LCCDATA. This first subprogram works with the user in an interactive mode to create and modify a building characteristics file for the project to be evaluated. Once created, the building characteristics files contain a complete list of the data and assumptions used in LCC calculations. A building characteristics file must be created and saved before any of the other subprograms can be run.

The building characteristics file is divided into six sections:

(1) Project Title,
(2) Basic Assumptions,
(3) Capital Component and Replacement Cost Data,
(4) Mortgage Loan Data,
(5) Operating and Maintenance Cost Data, and
(6) Energy Cost Data.

A complete listing and description of these data and assumptions are provided in the next section "NBSLCC Data Requirements."

Each time LCCDATA is initiated, it asks the user if a building characteristics file is to be created or modified:

ENTER C TO CREATE NEW FILE OR M TO MODIFY EXISTING FILE

Enter C for create or M for modify. Simply pressing <ENTER> in response to this question displays a menu which allows the user to move to the other subprograms or stop.

If a new file is to be created, the user will be prompted for the file name under which this file will be saved:

NAME OF NEW FILE?

A valid file name must be entered. A valid file name begins with a letter and has no more than eight alphanumeric characters (e.g., HOUSE1). No quotation marks or other punctuation should be used. All building characteristics files are automatically provided with the suffix ".BCF"; this suffix will appear in the directory when listing the data files on the disk but the user should not use this when running the program.

The disk drive designator to store the new file must also be entered:

WHICH DISK TO STORE filename (A, B, C)?

If a previously created file is to be modified, LCCDATA asks for the name of the existing file to be modified and a new file name for saving the modified file:

NAME OF EXISTING FILE TO BE MODIFIED?

WHICH DRIVE TO FIND filename (A, B, C)?

NAME OF NEW FILE?

WHICH DISK TO STORE filename (A, B, C)?

If the modified file is to replace the existing file, save the new file under the old file name. [Important: if the name designated for any new file is the same as that for any existing building characteristics file on the disk, the modified file will replace that existing file. The user is advised to keep a log of all data files created and saved on the disks. Data files which are no longer needed can be deleted from disk storage using the appropriate "erase" or "kill" command. Remember to include the suffix when deleting files.]

LCCDATA prompts the user for data entries as required by the nature of the analysis. For example, tax-related entries are not requested when the tax-exempt status has been designated but are requested otherwise. Entries which are illegal or illogical are rejected. When an improper entry is made, the allowable range for that value is displayed and the user is asked to reenter the data requested.

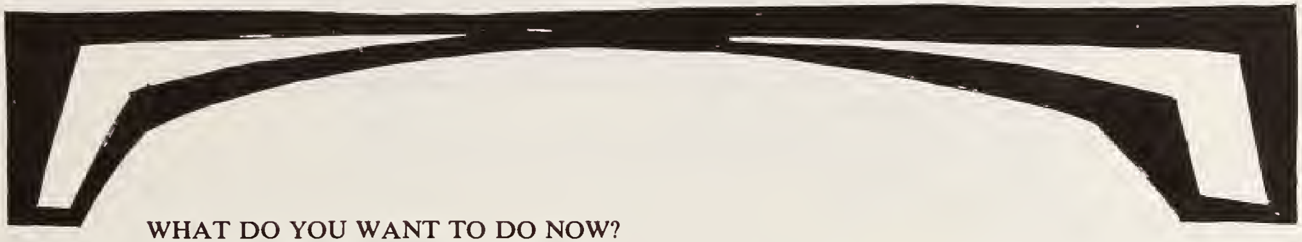
Here are a few important "do's and don'ts" when setting up a building characteristics file:

- Do press the <ENTER> key after each complete response.
- Do enter all percentages as whole numbers, not decimals; e.g., 50% is entered as 50, not 0.50.
- If more than one entry is required on a line, do separate each entry with a comma (,); e.g.: 50,5,10.
- Do not enter $ or % signs with any number.
- Do not use commas to mark off thousands; e.g., enter 1000, not 1,000.

In cases where more than one variable is requested at a time but the user fails to make all of the required entries, a "??" prompt may appear, allowing the omitted variables to be entered at that time. If a "REDO FROM START" prompt appears, you must reenter the entire line of data. (This does not mean that you have to start from the beginning of the file again.)

When creating a new building characteristics file, all relevant data must be entered sequentially as requested. In both the creation and modification modes, a default value will be shown for most data entries as they are requested. By pressing the <ENTER> key for any request, the default value is automatically entered into the new file. In the file creation mode, most of the default values are set at zero; some of these zeros must be changed to correspond to the range of values displayed in the prompt message. If the response is invalid, the range of valid responses is displayed.

After completing the file creation sequence, LCCDATA moves into the file modification mode. This allows the user to make corrections to the file before saving it. In the file modification mode, the user can move to any section of the building characteristics file in order to change one or more data entries in that section. The following menu is displayed in order to permit the user to move into the section where the change is to be made:



WHAT DO YOU WANT TO DO NOW?
(1) MODIFY PROJECT TITLE.
(2) MODIFY BASIC LCC ANALYSIS ASSUMPTIONS.
(3) MODIFY CAPITAL COMPONENT AND REPLACEMENT COST DATA.
(4) MODIFY MORTGAGE DATA.
(5) MODIFY OPERATING & MAINTENANCE COST DATA.
(6) MODIFY ENERGY COST DATA.
(7) SAVE NEW FILE.
(8) STOP.
ENTER CODE NUMBER...? .

When modifying an existing file, the user can move very quickly through any section of that file by pressing the <ENTER> key (i.e., defaulting to the value shown) for all but those entries to be changed. The user must move through the entire section selected for modification in order to return to the menu.

After the desired modifications (if any) are made, the file must be saved before creating/modifying another building characteristics file or before moving to the next subprogram. The file save command is executed by designating the appropriate menu selection (7). The file is saved on the designated diskette, under the name specified at the outset of the run, with the ".BCF" suffix added.

Once the file has been saved, an expanded menu is displayed:

WHAT DO YOU WANT TO DO NOW?
(1) MODIFY PROJECT TITLE.
(2) MODIFY BASIC LCC ANALYSIS ASSUMPTIONS.
(3) MODIFY CAPITAL COMPONENT AND REPLACEMENT COST DATA.
(4) MODIFY MORTGAGE DATA.
(5) MODIFY OPERATING & MAINTENANCE COST DATA.
(6) MODIFY ENERGY COST DATA.
(7) SAVE NEW FILE.
(8) STOP.

ALTERNATIVE TASK CODES:
(9) CREATE/MODIFY ANOTHER BLDG CHARACTERISTICS FILE.
(10) PRINT BLDG CHAR'STICS FILE (GO TO 'PRINTBCF' PROGRAM).
(11) CALCULATE LCC (GO TO 'LCCMAIN' PROGRAM).
(12) PRINT LCC ANALYSIS (GO TO 'PRINTLCC' PROGRAM).
(13) COMPARE LCC OF TWO BUILDINGS (GO TO 'COMPARE' PROGRAM).
ENTER CODE NUMBER...? .

This expanded menu allows the user to make more changes to the building characteristics file just created or modified (1-6), to resave the file (7), to stop (8), to create or modify another building characteristics file (9), or to move to another subprogram operation (10-13). The proper sequence of subprogram operations is described below in "Sequence of NBSLCC Subprogram Operations."

Subprogram (2): PRINTBCF. This second subprogram prints out a summary of a building characteristics file that has been previously created (or modified) by the first subprogram, LCCDATA, and saved on the disk. When added, the user must specify the name and location of the file to be printed. (Do not include the ".BÇF" suffix.):

NAME OF BLDG CHARACTERISTICS FILE TO BE PRINTED?

WHICH DRIVE TO FIND filename (A, B, C)?

An example of the file summary printed by PRINTBCF is shown in Table 6-1. The section "Mortgage Loan Data" does not appear in the example because financing was not taken into account. This printed summary of the building characteristics file contains a complete listing of the values of input variables needed to run the LCCMAIN subprogram (described below) for the designated project.

Once the file has been printed out, a menu is displayed which allows the user to print out another building characteristics file or move to another subprogram operation.

Table 6-1. Building characteristics file for building A (example)

```
BUILDING CHARACTERISTICS FILE
-----------------------------

FILE NAME: LCCFILE1
FILE LAST MODIFIED ON 03-06-1986  11:08:56

PROJECT TITLE: BUILDING A
---------------------------------

BASIC LCC ANALYSIS ASSUMPTIONS:
-------------------------------------
BASE DATE FOR LCC ANALYSIS: 1986
STUDY PERIOD:  25 YEARS
OCCUPANCY DATE: 1988
DISCOUNT AND INTEREST RATES INCLUDE INFLATION (NOMINAL)
GENERAL INFLATION RATE =  6.0%
DISCOUNT RATE: 10.0%
TAX STATUS: FOR PROFIT (1)
MARGINAL FEDERAL INCOME TAX RATE: 25.0%
MARGINAL STATE INCOME TAX RATE:    5.0%
PROPERTY TAX RATE (% OF ASSESSED VALUE):  2.0%
CAPITAL GAINS ADJUSTMENT FACTOR: 40.0%
DEPRECIATION RECAPTURE CODE: 2
DEPRECIATION BASIS ADJ. FACTOR:  0.0
SALES TAX RATE:  0.0%

CAPITAL COMPONENT AND REPLACEMENT COST DATA:
--------------------------------------------
NUMBER OF CAPITAL COMPONENTS: 3
CAPITAL COMPONENT DATA:
COMPONENT NAME                      LAND        BUILDING     EQUIPMENT
INITIAL COST                      100000         500000        50000
PERCENT SUBJECT TO SALES TAX       0.00%          0.00%        0.00%
EXPECTED COMPONENT LIFE(YRS)         999             50           15
DEPRECIATION CODE               NONE (0)       S.L. (1)     S.L. (1)
DEPRECIATION LIFE (YEARS)              0             25           15
DEPR. ACCELERATION RATE            0.00%          0.00%        0.00%
SALVAGE VALUE FACTOR               0.00%          0.00%        0.00%
ADD'L FIRST YR DEPRECIATION        0.00%          0.00%        0.00%
AVG PRICE ESC RT DURING CONST.*    0.00%          0.00%        0.00%
AVG PRICE ESC RT DURING OCC.*      0.00%          0.00%        0.00%
PROP. TAX ASSESSMENT FACTOR       75.00%         75.00%       75.00%
TAX CREDIT RATE                    0.00%          0.00%        0.00%
RESALE VALUE FACTOR              100.00%         50.00%        0.00%
NUMBER OF REPLACEMENTS                 0              0            1

COST-PHASING SCHEDULE BY YEAR OF CONSTRUCTION AND AT OCCUPANCY:
                            1    100.00%         33.30%        0.00%
                            2      0.00%         33.30%       50.00%
             AT OCCUPANCY          0.00%         33.40%       50.00%

REPLACEMENTS TO CAPITAL COMPONENTS:

     REPLACEMENTS TO EQUIPMENT:
REPLACEMENT NUMBER                 1
YEAR OF REPLACEMENT               16
COST OF REPLACEMENT            50000
PERCENT SUBJECT TO SALES TAX   0.00%
DEPRECIATION LIFE (YEARS)         15
SALVAGE VALUE FACTOR           0.00%
EXPECTED REPL. LIFE (YRS)         15
RESALE VALUE FACTOR           33.30%
PROP. TAX ASSESSMENT FACTOR    0.00%


MORTGAGE LOAN DATA:          CONSTRCT.    PERMANENT
---------------------          LOAN        LOAN(S)
LOAN NUMBER                     -             1
% OF TOTAL COST BORROWED      90.00%       90.00%
LOAN TYPE CODE                   2            1
ANNUAL INTEREST RATE          12.00%       12.00%
LIFE OF LOAN (YEARS)             0           30
NUMBER OF PAYMENTS/YR           12           12
POINTS PAID (% OF LOAN)        1.00%        2.00%
```

```
----------------------------------------
OPERATING AND MAINTENANCE COST DATA:
-----------------------------------
ANNUAL RECURRING O AND M COST =  $25000
ANNUAL RATE OF INCREASE FOR A.R.C.* =  0.00%
NUMBER OF NON-ANNUAL RECURRING O AND M COSTS = 10
ANNUAL RATE OF INCREASE FOR N.A.R.C. COSTS* =  0.0%
NON-ANNUAL RECURRING O&M COSTS:
  #  YEAR       AMOUNT
   1    2        $5000
   2    4        $8000
   3    6      , $5000
   4    8       $10000
   5   10        $5000
   6   12        $6000
   7   14        $4000
   8   16       $10000
   9   18        $4000
  10   20       $10000

ENERGY COST DATA:
----------------
NUMBER OF ENERGY TYPES = 2

ENERGY TYPE NO. 1 = ELECTRICITY
AVG ANNUAL CONSUMPTION =     250.0 MILLION BTU
PRICE PER MILLION BTU =$20.00
ANNUAL DEMAND (AND/OR OTHER CHARGE) =     $0
ESCALATION RATE METHOD = 1
ANNUAL RATE OF PRICE INCREASE DURING CONSTRUCTION* =  2.0%
ENERGY PRICE ESCALATION RATES DURING OCCUPANCY*
NUMBER OF DISCRETE TIME INTERVALS =  3
  #  DURATION  ANNUAL
      (YEARS)   RATE
   1     5       2.0%
   2    10       1.0%
   3    10       0.0%

ENERGY TYPE NO. 2 = NATURAL GAS
AVG ANNUAL CONSUMPTION =     250.0 MILLION BTU
PRICE PER MILLION BTU = $7.00
ANNUAL DEMAND (AND/OR OTHER CHARGE) =     $0
ESCALATION RATE METHOD = 1
ANNUAL RATE OF PRICE INCREASE DURING CONSTRUCTION* =  2.0%
ENERGY PRICE ESCALATION RATES DURING OCCUPANCY*
NUMBER OF DISCRETE TIME INTERVALS =  3
  #  DURATION  ANNUAL
      (YEARS)   RATE
   1     5       4.0%
   2    10       2.0%
   3    10       1.0%

 *ALL ESCALATION RATES ARE IN REAL TERMS (I.E., NET OF GENERAL INFLATION.)
```

Subprogram (3): LCCMAIN. This is the "core" subprogram of the NBSLCC program. LCCMAIN computes the present value and annualized value of all costs and tax savings incurred over the study period. When running the LCCMAIN subprogram, the name and location of the building characteristics file for the project to be evaluated must be entered (without ".BCF"):

ENTER BLDG CHARACTERISTICS FILE NAME?

WHICH DISK TO FIND filename (A, B, C)?

Before the LCC analysis is computed, the discount rate saved in the building characteristics file is displayed:

DISCOUNT RATE = 10.0%

ENTER NEW DISCOUNT RATE OR PRESS <ENTER>?

The discount rate to be used in the LCC analysis can be changed at this point by entering a new discount rate. (Remember not to type a percent sign after the number.) Any other change in data or assumptions must be made using the modification mode of the first subprogram, LCCDATA. After the LCC analysis is completed, the LCC computations are saved in a LCC output file named by the user:

ENTER LCC OUTPUT FILE NAME TO STORE RESULTS OF THIS LCC ANALYSIS?

WHICH DISK TO STORE filename (A, B, C)?

This LCC output file is the basis of the comprehensive LCC report printed out using the fourth subprogram, PRINTLCC. A ".LCC" suffix is automatically added to this file name. The file name (without the ".LCC" suffix) is needed when running either the PRINTLCC or COMPARE subprograms. This name can be the same as that used for the corresponding building characteristics file; since the two file types have different suffixes (i.e., ".BCF" and ".LCC") the appropriate file will be called as needed. But note that if you make several LCC output files with the same building characteristics file, each with a different discount rate, you will need a different name than that used for the building characteristics file. As with building characteristics files, it is advisable to keep a log of LCC output files created by LCCMAIN.

After the LCC computations have been completed and the LCC output file saved, a menu is displayed which allows the user to perform another LCC analysis using a different building characteristics file or to move to another subprogram operation.

Subprogram (4): PRINTLCC. This fourth subprogram prints a detailed life-cycle cost report for a designated building, using the LCC output file for that building created by LCCMAIN. Table 6-2 shows an example of this report. When running PRINTLCC, the user must enter the name of the LCC output file (without ".LCC") when asked:

ENTER NAME OF LCC OUTPUT FILE TO BE PRINTED?

WHICH DISK TO FIND filename (A, B, C)?

After the report is printed, a menu is displayed which allows the user to print a life-cycle cost report for another building or move to another subprogram operation.

Table 6-2. Detailed LCC report for building A (example)

NBSLCC ANALYSIS

PART I - INITIAL ASSUMPTIONS AND COST DATA

PROJECT NAME: BUILDING A
RUN DATE:03-06-1986 12:56:35
BLDG. CHAR. FILE: LCCFILE1.BCF, LAST MODIFIED 03-06-1986 11:08:56
LCC OUTPUT FILE: LCCFILE1.LCC, CREATED 03-06-1986 11:31:46
STUDY PERIOD: 25 YEARS (1986 TO 2011)
PLAN/CONSTR. PERIOD: 2 YEARS (1986 TO 1988)
OCCUPANCY PERIOD: 23 YEARS (1988 TO 2011)
GENERAL INFLATION RATE: 6.0%
DISCOUNT RATE: 10.0% (INCLUDING GENERAL INFLATION)
TAX STATUS: FOR PROFIT
INCOME TAX RATE: 28.8% (COMBINED FEDERAL, STATE, LOCAL)
EFFECTIVE CAPITAL GAINS TAX RATE: 11.5%
NOMINAL PROPERTY TAX RATE: 2.00%
NOMINAL SALES TAX RATE: 0.00%

INITIAL CAPITAL COMPONENT COSTS (NOT DISCOUNTED)
(ADJUSTED FOR PRICE CHANGES DURING PLAN/CONST. PERIOD, IF ANY)

INVESTMENT CATEGORY	YEAR	COST PHASING	YEARLY COST	TOTAL COST
LAND	1986	100.0%	$100,000	
TOTAL FOR LAND				$100,000
BUILDING	1986	33.3%	$166,500	
BUILDING	1987	33.3%	$176,490	
BUILDING	1988	33.4%	$187,641	
TOTAL FOR BUILDING				$530,631
EQUIPMENT	1987	50.0%	$26,500	
EQUIPMENT	1988	50.0%	$28,090	
TOTAL FOR EQUIPMENT				$54,590
TOTAL PROJECT COST (ACTUAL)				$685,221

INITIAL CASH REQUIREMENTS (NOT DISCOUNTED)
(UP TO AND INCLUDING OCCUPANCY)

(NOT ADJUSTED FOR INCOME TAX SAVINGS)

	YEAR	PROJECT	'POINTS'	INTEREST	TOTAL
DURING CONSTRUCTION	1986	$26,650	$2,399	$50,705	$79,753
	1987	$20,299	$1,827	$50,705	$72,831
AT OCCUPANCY	1988	$21,573	$12,334	$0	$33,907
TOTAL		$68,522	$16,559	$101,410	$186,491
PLUS PREPAID PROPERTY TAXES AT OCCUPANCY					$10,278
TOTAL CASH REQUIREMENTS					$196,770

BORROWING REQUIREMENTS

(1) TEMPORARY FINANCING (DURING CONSTRUCTION):

YEAR	AMOUNT BORROWED	INTEREST RATE*	POINTS PAID PERCENT	POINTS PAID AMOUNT	TYPE	PAYMENTS/ YEAR
1986	$239,850	12.00%	1.00%	$2,399	INTEREST ONLY	12
1987	$182,691	12.00%	1.00%	$1,827		12
TOTAL	$422,541			$4,225		

(2) PERMANENT FINANCING (AT OCCUPANCY):

LOAN NO.	AMOUNT BORROWED	LIFE	INTR. RATE	POINTS PAID PERCENT	POINTS PAID AMOUNT	TYPE	PAYMENTS/ YEAR
1	$616,699	30 YRS	12.00%	2.00%	$12,334	AMORTIZED	12
TOTAL	$616,699				$12,334		

*INTEREST RATES ARE NOMINAL (I.E., GENERAL INFLATION IS INCLUDED).

ENERGY-RELATED COSTS

ENERGY TYPE	MMBTU/ YEAR	PRICE ($/MMBTU)	DEMAND COST	TOTAL P.V. COST
ELECTRICITY	250.0	$20.00	$0	$84210
NATURAL GAS	250.0	$7.00	$0	$34281

* *

PART II - LIFE-CYCLE COST ANALYSIS
DISCOUNT RATE = 10.0% (INCLUDING GENERAL INFLATION)

PROJECT NAME: BUILDING A   RUN DATE: 03-06-1986/12:56:35

	PRESENT VALUE (1986 DOLLARS)	ANNUAL VALUE** (1986 DOLLARS)
A. CASH REQUIREMENTS AS OF OCCUPANCY (EXCEPT PREPAID PROPERTY TAXES):		
DURING CONSTRUCTION	$120,299	$7,517
AT OCCUPANCY	$28,022	$1,751
SUBTOTAL	$148,322	$9,269
B. FINANCING-RELATED COSTS (AFTER OCCUPANCY):		
PRINCIPAL	$86,469	$5,403
INTEREST	$530,714	$33,164
SUBTOTAL	$617,184	$38,567
C. OPERATING, MAINTENANCE & RELATED COSTS:		
ANNUALLY RECURRING COSTS (NON-ENERGY)	$352,763	$22,044
NON-ANNUALLY RECURRING COSTS	$41,796	$2,612
ENERGY COSTS	$118,491	$7,404
PROPERTY TAXES:		
PREPAID AT OCCUPANCY	$8,494	$531
PAID AFTER OCCUPANCY	$98,205	$6,137
SUBTOTAL	$619,750	$38,728
D. REPLACEMENTS TO CAPITAL COMPONENTS	$26,638	$1,665
E. INCOME TAX ADJUSTMENTS*:		
TAX SAVINGS FROM O AND M COSTS	($175,389)	($10,960)
TAX SAVINGS FROM DEPRECIATION:		
INITIAL INVESTMENT	($51,377)	($3,211)
REPLACEMENTS TO CAPITAL	($2,724)	($170)
TAX SAVINGS FROM SALES TAX:		
INITIAL INVESTMENT	($0)	($0)
REPLACEMENTS TO CAPITAL	($0)	($0)
TAX SAVINGS FROM INTEREST AND POINTS:		
DURING CONSTRUCTION	($2,636)	($165)
DURING OCCUPANCY	($161,313)	($10,080)
TAX CREDITS:		
INITIAL INVESTMENT	($0)	($0)
REPLACEMENTS TO CAPITAL	($0)	($0)
SUBTOTAL	($393,439)	($24,586)
F. REMAINING VALUE AT END OF OCCUPANCY	($135,386)	($8,460)
LESS: CAPITAL GAINS TAX LIABILITY	$13,388	$837
SUBTOTAL	($121,999)	($7,624)
G. TOTAL LIFE-CYCLE PROJECT COST:		
WITHOUT INCOME TAX ADJUSTMENTS	$1,289,894	$80,605
WITH INCOME TAX ADJUSTMENTS	$896,455	$56,019

* *

*INCOME TAX SAVINGS ARE DISCOUNTED FROM THE END OF THE YEAR IN WHICH THEY ARE EARNED; TAX CREDITS AND TAX SAVINGS FROM SALES TAX ON INITIAL INVESTMENT ARE CREDITED AT THE END OF THE FIRST YEAR OF OCCUPANCY.

**ANNUAL VALUE DOES NOT INCLUDE GENERAL INFLATION.

Subprogram (5): COMPARE. The fifth and last of the subprograms, COMPARE, performs a comparative LCC analysis of two building designs or systems (a "base case" and "alternative") from the LCC output files created by LCCMAIN. An example of a comparative analysis is shown in Table 6-3. Two alternative building designs are compared in this example to determine which has the lower LCC.

Individual design modifications can also be evaluated at the component level (e.g., storm windows over existing single-pane windows), without performing a comprehensive analysis of the entire building. In this latter type of analysis, the base case can be set up as a "do-nothing" case with zero first cost, while the alternative case may include the initial cost (and replacement costs, if any) of the modification. In addition, those future cost items related to the component modification (e.g., maintenance and energy costs) must be specified for both cases (i.e., before and after the modification is made). The COMPARE program will then determine whether the design modification is cost effective on an LCC basis.

A comparative analysis requires that the study period, starting date, discount rate, tax status, rates of price change for like components, and other basic assumptions be the same for both designs or systems. In addition, the alternative building design must have a higher initial cost and lower future costs than the base case design. (If an alternative design has both a lower initial cost and lower future costs than the base case, no analysis is needed to show that the alternative design has the lower life-cycle cost.)

The net present-value savings, savings-to-investment ratio, and adjusted internal rate of return are all computed for the alternative building design as compared with the "base-case" design in the comparative analysis. (See Chapter 3, "Choosing a Method," for a description of these measures.)

The user may wish to assume the reinvestment of cash flows at a rate different than the discount rate used originally in the LCC analysis to compute the adjusted internal rate of return. In such case, the LCC analysis of both the base case and alternative building designs should be recalculated with LCCMAIN, using the desired reinvestment rate as the discount rate. (No change is needed in the building characteristics files for the two projects since the change in discount rate can be made while running the LCCMAIN program.) After LCCMAIN has been rerun and new LCC output files have been created for both projects, COMPARE must be rerun with the new LCC output files in order to generate the new adjusted internal rate of return measure.

When the comparative analysis is completed, a menu is displayed which allows the user to perform another comparative analysis or to move to any other subprogram operation.

Table 6-3. Comparative LCC analysis for owner-occupied dwelling (example)

NBSLCC: COMPARATIVE LCC ANALYSIS

BASE CASE = BUILDING A
ALTERNATIVE = BUILDING B

PRINCIPAL STUDY PARAMETERS:

STUDY PERIOD: 25 YEARS
STARTING DATE: 1986
OCCUPANCY DATE: 1988
GENERAL INFLATION RATE: 6.0%
DISCOUNT RATE: 10.0% (NOMINAL)
SALES TAX RATE: 0.0%
TAX STATUS: FOR PROFIT
FED TAX RATE: 25.0%
STATE TAX RATE: 5.0%
BASE CASE LCC FILE: LCCFILE1.LCC
ALTERNATIVE LCC FILE: LCCFILE2.LCC

	COMPARISON OF PRESENT-VALUE COSTS		
	BASE CASE: BUILDING A	ALTERNATIVE: BUILDING B	SAVINGS FROM ALT.
	(1)	(2)	(3)=(1)-(2)
INITIAL INVESTMENT ITEM(S):			
CASH REQUIREMENTS AS OF OCCUPANCY(*)	$148,322	$154,551	-$6,229
PREPAID PROPERTY TAXES	$8,494	$8,891	-$397
INCOME TAX ADJUSTMENTS BEFORE OCCUP.	-$2,636	-$2,747	$111
SUBTOTAL	$154,180	$160,695	-$6,514
FUTURE COST ITEMS:			
PRIN. AND INT. PAYMENTS AFTER OCCUP.	$617,184	$645,998	-$28,814
ANNUAL AND NON-AN. RECURRING COSTS	$394,559	$394,559	$0
PROPERTY TAXES (AFTER OCCUPANCY)	$98,205	$102,395	-$4,191
ENERGY EXPENDITURES	$118,491	$76,088	$42,404
REPLACEMENTS TO CAPITAL	$26,638	$29,301	-$2,664
INCOME TAX ADJUSTMENTS DURING OCCUP.	-$390,803	-$390,447	-$356
RESALE VALUE AT END OF STUDY (NET)	-$121,999	-$126,811	$4,812
SUBTOTAL	$742,275	$731,084	$11,191
TOTAL P.V. LIFE-CYCLE COST	$896,455	$891,779	$4,677

* EXCEPT FOR PREPAID PROPERTY TAX (AT OCCUPANCY)

COMPUTATION OF NET SAVINGS

```
NET SAVINGS   =  P.V. OF FUTURE COST SAVINGS        $11,191
                 LESS INCREASED INITIAL INVEST.     -$6,514
                                                 ------------
                                                     $4,677
```

COMPUTATION OF SAVINGS-TO-INVESTMENT RATIO (SIR)

```
                P.V. OF FUTURE COST SAVINGS
      SIR  =   -----------------------------    =     1.72
                 INCREASED INITIAL INVEST.
```

COMPUTATION OF ADJUSTED INTERNAL RATE OF RETURN (AIRR)
(REINVESTMENT RATE = 10.00%)

```
                                          (1/STUDY PER.)
AIRR = 100 X ((1+REINV. RATE) X SIR                     -1)  =   12.41%
```

Sequence of NBSLCC Subprogram Operations. The NBSLCC subprogram sequence is usually started with the creation of a building characteristics file, since the other subprograms cannot be run until such a file has been created. Thus a "1" is normally entered when the main NBSLCC menu is displayed to call up the first subprogram, LCCDATA.

After completion of the LCCDATA file creation or modification session, or any other subprogram task, a menu will appear which allows the user to rerun that subprogram or execute another subprogram. If a new subprogram is specified, it is automatically loaded and initiated. If, for any reason, the execution of a subprogram is terminated by a menu command, an error, or the <Ctrl> <BREAK> command, the same subprogram can be restarted by typing *RUN*; any other subprogram can be started at this point by typing *RUN "NAME"*, where NAME is the name (not the number) of the subprogram to be executed. (Quotation marks must be entered as shown.)

The flow chart in Figure 6-1 gives the user an overview of the typical sequence of operations for the five major LCC subprograms. However, this sequence is not entirely mandatory. For example, printing the building characteristics file with PRINTBCF does not need to be done before computing the LCC with LCCMAIN. Similarly, once the LCC analyses have been completed for two design alternatives, the comparative analysis can be made using COMPARE without printing the detailed LCC report using PRINTLCC. If a comparison of two design alternatives is required, it is usually faster to run for both the base and alternative cases each of the subprograms LCCDATA, PRINTBCF, LCCMAIN, and PRINTLCC before moving on to the next subprogram in the sequence. This sequence, shown in Figure 6-2, saves subprogram loading time for the second set of calculations.

File Storage. The building characteristics files and LCC output files created and saved during an NBSLCC session can be stored on either the NBSLCC disk itself or on a second formatted disk in another disk drive. In general it is better to save these files on a second disk because the NBSLCC disk has limited additional storage capacity and therefore may fill up. If the disk fills up during the middle of a file save operation this can cause an error which will terminate the run. The disk drive designator is always requested when reading from or writing to a disk file.

Backup Copies of Files. After completing the NBSLCC analyses, you may want to make backup copies of any building characteristics files or LCC files that were created during that session. You can use your computer's "COPY" utility to copy these files to a formatted disk kept for this purpose, or the "BACKUP" utility to make a copy of the entire contents of the disk containing these files. Most microcomputer require that you return to the "SYSTEM" mode before you copy or backup the contents of a disk.

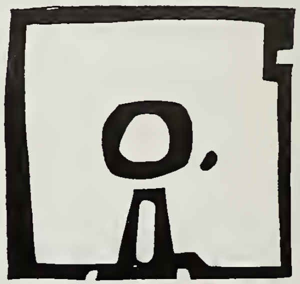


Figure 6–1.

General order of NBSLCC subprogram execution

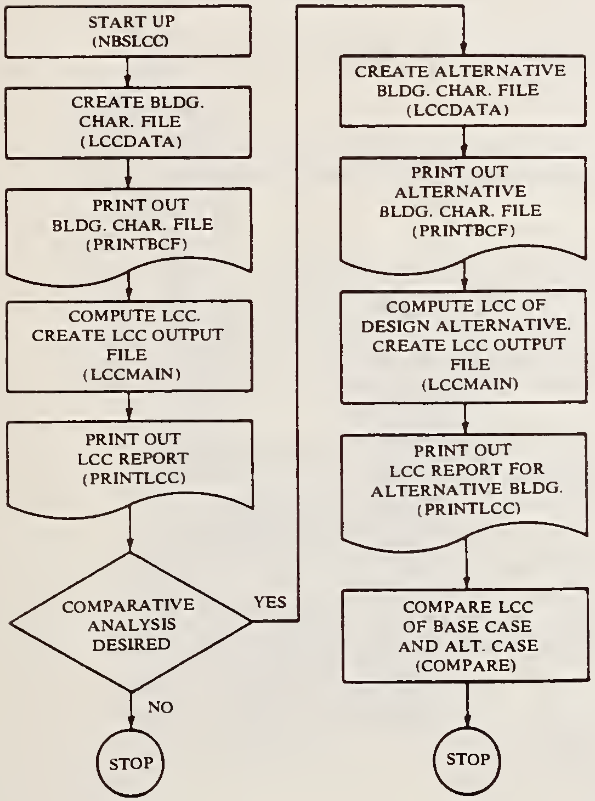
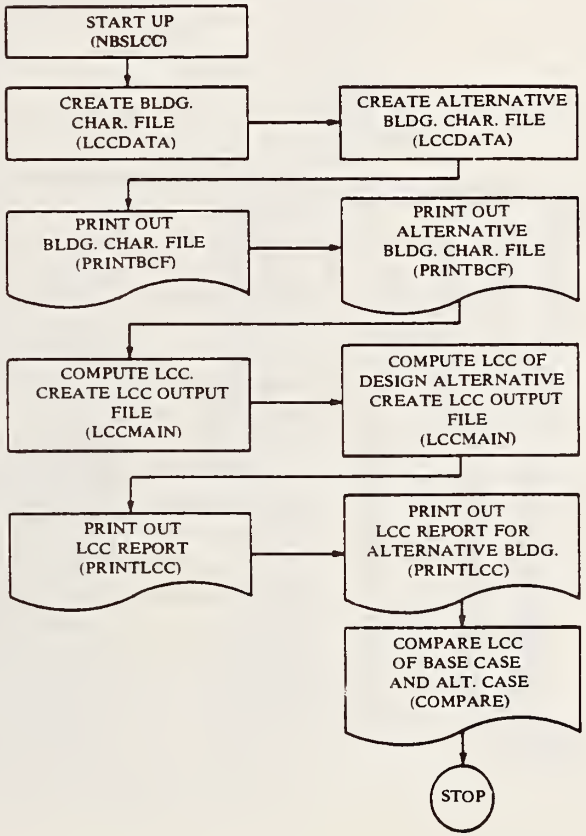


Figure 6–2.

Alternative order of NBSLCC subprogram execution



NBSLCC DATA REQUIREMENTS

A generalized worksheet that can be used to collect and organize the necessary data in preparation for creating the building characteristics file is shown in Table 6-4, sections 1 through 6. This worksheet can be printed out by running the utility program called "BCFFORM". BCFFORM is not an integral NBSLCC subprogram; it should be run under BASIC separately from the NBSLCC analysis session. The user should have assembled the data needed to set up the building characteristics file *before* running the LCCDATA subprogram.

The following definitions of LCC-related variables are presented in the order in which they appear in the building characteristics file as illustrated in Table 6-4:

Table 6-4, Section 1—*Project Title*

- Project Title—The user may supply any name desired to identify the project to be evaluated. Up to 12 characters may be used. A distinct project title should be assigned to each building or subsystem design to be evaluated.

Table 6-4, Section 2—*Basic Assumptions*

- Base Year—The year in which the study period begins. This must be an integer between 1985 and 1990. All cost data must be entered in *constant* dollars as of this date.
- Study Period (Years)—The number of years over which building-related costs will be summed. The study period includes both the planning/construction period, if any, and the occupancy period. It must be an integer between 1 and 50. (Also see Chapter 3, "Setting the Study Period.")
- Occupancy Year—The calendar year in which occupancy of the building begins. This data can be up to 10 years later than the Base Year. A planning/construction period is automatically calculated as the difference between these two dates.
- Discount Rate (%)—The average annual rate of return from the best alternative investment opportunity over the study period. Use the nominal (i.e., inclusive of inflation), after-tax discount rate for for-profit and private-residential projects; use either the nominal or real (i.e., exclusive of inflation) discount rate for tax-exempt projects. Use of a nominal discount rate for evaluating for-profit or private-residential buildings is specified to facilitate the treatment of tax effects.
- Tax Status Code—Use code number as follows:
  1—for profit (commercial and rental properties)
  2—private residential (owner-occupied housing)
  3—tax exempt (non-profit or government buildings)

Table 6-4. Generalized format for building characteristics file

```
                GENERALIZED FORMAT FOR BUILDING CHARACTERISTICS FILE
                ----------------------------------------------------
         (NOTE: ALL RATES OF PRICE INCREASE (PRICE ESCALATION RATES)
                     SHOULD BE NET OF GENERAL INFLATION)

SECTION 1. PROJECT TITLE: ........................
------------------------

SECTION 2. BASIC LCC ANALYSIS ASSUMPTIONS:
-----------------------------------------

BASE YEAR                      ...............
STUDY PERIOD (YRS)             ...............
OCCUPANCY YEAR                 ...............
TAX STATUS CODE                ...............
GENERAL INFLATION RATE         ...............
DISCOUNT RATE (%)              ...............
MARG. FED INCOME TAX RT.(%)    ...............
MARG. ST. INCOME TAX RT.(%)    ...............
PROP. TAX RATE (%)             ...............
CAPITAL GAINS ADJUST. FACTOR   ...............
DEPRECIATION RECAPTURE CODE    ...............
DEPRECIATION BASIS ADJ. FACTOR...............
SALES TAX RATE (%)             ...............

(*) NOMINAL RATES MUST BE USED FOR TAX STATUS CODES 1 AND 2;
EITHER REAL OR NOMINAL RATES CAN BE USED WITH TAX STATUS CODE 3.

SECTION 3. CAPITAL COMPONENT AND REPLACEMENT COST DATA:
--------------------------------------------

NO. OF CAPITAL COMPONENTS: ..........

              COMPONENT NO.      1            2            3

COMPONENT NAME                ..........   ..........   ..........
INITIAL COST                  ..........   ..........   ..........
PERCENT SUB. TO SALES TAX     ..........   ..........   ..........
EXPECTED COMP. LIFE (YRS)     ..........   ..........   ..........
DEPRECIATION CODE             ..........   ..........   ..........
DEPRECIATION LIFE (YRS)       ..........   ..........   ..........
DEPR. ACCELERATION RATE (%)   ..........   ..........   ..........
SALVAGE VALUE FACTOR          ..........   ..........   ..........
ADD'L 1ST YR DEPR. FACTOR     ..........   ..........   ..........
AVG ESC. RATE DURING P/C PER. ..........   ..........   ..........
AVG ESC. RATE DURING OCC.     ..........   ..........   ..........
PROP. TAX ASSESS. FACTOR (%)  ..........   ..........   ..........
TAX CREDIT RATE (%)           ..........   ..........   ..........
RESALE VALUE FACTOR (%)       ..........   ..........   ..........
NUMBER OF REPLACEMENTS        ..........   ..........   ..........


COST-PHASING SCHEDULE BY YEAR OF CONSTR. AND AT OCCUPANCY FOR EACH COMPONENT:
          CONSTRUCTION YEAR 1  .........%   .........%   .........%
          CONSTRUCTION YEAR 2  .........%   .........%   .........%
          CONSTRUCTION YEAR 3  .........%   .........%   .........%
          CONSTRUCTION YEAR 4  .........%   .........%   .........%
          CONSTRUCTION YEAR 5  .........%   .........%   .........%
                 AT OCCUPANCY  .........%   .........%   .........%


              COMPONENT NO.      4            5            6

COMPONENT NAME                ..........   ..........   ..........
INITIAL COST                  ..........   ..........   ..........
PERCENT SUB. TO SALES TAX     ..........   ..........   ..........
EXPECTED COMP. LIFE (YRS)     ..........   ..........   ..........
DEPRECIATION CODE             ..........   ..........   ..........
DEPRECIATION LIFE (YRS)       ..........   ..........   ..........
DEPR. ACCELERATION RATE (%)   ..........   ..........   ..........
SALVAGE VALUE FACTOR          ..........   ..........   ..........
ADD'L 1ST YR DEPR. FACTOR     ..........   ..........   ..........
AVG ESC. RATE DURING P/C PER. ..........   ..........   ..........
AVG ESC. RATE DURING OCC.     ..........   ..........   ..........
PROP. TAX ASSESS. FACTOR (%)  ..........   ..........   ..........
TAX CREDIT RATE (%)           ..........   ..........   ..........
RESALE VALUE FACTOR (%)       ..........   ..........   ..........
NUMBER OF REPLACEMENTS        ..........   ..........   ..........
```

COST-PHASING SCHEDULE BY YEAR OF CONSTR. AND AT OCCUPANCY FOR EACH COMPONENT:

CONSTRUCTION YEAR 1	.........%	.........%	.........%
CONSTRUCTION YEAR 2	.........%	.........%	.........%
CONSTRUCTION YEAR 3	.........%	.........%	.........%
CONSTRUCTION YEAR 4	.........%	.........%	.........%
CONSTRUCTION YEAR 5	.........%	.........%	.........%
AT OCCUPANCY	.........%	.........%	.........%

REPLACEMENTS, TO CAPITAL COMPONENTS:

	REPLACEMENTS TO COMPONENT NO. 1			
	1	2	3	4
YEAR OF REPLACEMENT	....	....	....	....
INIT. COST OF REPLACEMENT (UNADJ)	....	....	....	....
PERCENT SUBJ. TO SALES TAX	....	....	....	....
DEPRECIATION LIFE (YRS)	....	....	....	....
SALVAGE VALUE FACTOR (%)	....	....	....	....
EXPECTED REPLACEMENT LIFE (YRS)	....	....	....	....
RESALE VALUE (% OF INT COST)	....	....	....	....
PROP. TAX ASSESS FACTOR (%)	....	....	....	....

	REPLACEMENTS TO COMPONENT NO. 2			
	1	2	3	4
YEAR OF REPLACEMENT	....	....	....	....
INIT. COST OF REPLACEMENT (UNADJ)	....	....	....	....
PERCENT SUBJ. TO SALES TAX	....	....	....	....
DEPRECIATION LIFE (YRS)	....	....	....	....
SALVAGE VALUE FACTOR (%)	....	....	....	....
EXPECTED REPLACEMENT LIFE (YRS)	....	....	....	....
RESALE VALUE (% OF INT COST)	....	....	....	....
PROP. TAX ASSESS FACTOR (%)	....	....	....	....

	REPLACEMENTS TO COMPONENT NO. 3			
	1	2	3	4
YEAR OF REPLACEMENT	....	....	....	....
INIT. COST OF REPLACEMENT (UNADJ)	....	....	....	....
PERCENT SUBJ. TO SALES TAX	....	....	....	....
DEPRECIATION LIFE (YRS)	....	....	....	....
SALVAGE VALUE FACTOR (%)	....	....	....	....
EXPECTED REPLACEMENT LIFE (YRS)	....	....	....	....
RESALE VALUE (% OF INT COST)	....	....	....	....
PROP. TAX ASSESS FACTOR (%)	....	....	....	....

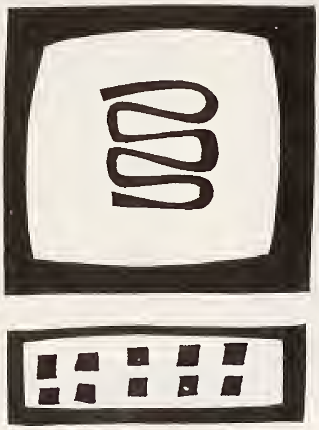


Table 6-4. Generalized format for building characteristics file (continued)

```
DEPRECIATION FACTORS (USED WITH STANDARD TABLE DEPRECIATION METHOD, CODE 4):
(NOTE: THESE FACTORS APPLY TO THE DESIGNATED COMPONENTS AND THEIR REPLACEMENTS)

                                  COMPONENT NO.
           ---------------------------------------------------------------
              1          2          3          4          5          6
           ---------  ---------  ---------  ---------  ---------  ---------
YEAR
  1        ........%  ........%  ........%  ........%  ........%  ........%
  2        ........%  ........%  ........%  ........%  ........%  ........%
  3        ........%  ........%  ........%  ........%  ........%  ........%
  4        ........%  ........%  ........%  ........%  ........%  ........%
  5        ........%  ........%  ........%  ........%  ........%  ........%
  6        ........%  ........%  ........%  ........%  ........%  ........%
  7        ........%  ........%  ........%  ........%  ........%  ........%
  8        ........%  ........%  ........%  ........%  ........%  ........%
  9        ........%  ........%  ........%  ........%  ........%  ........%
 10        ........%  ........%  ........%  ........%  ........%  ........%
 11        ........%  ........%  ........%  ........%  ........%  ........%
 12        ........%  ........%  ........%  ........%  ........%  ........%
 13        ........%  ........%  ........%  ........%  ........%  ........%
 14        ........%  ........%  ........%  ........%  ........%  ........%
 15        ........%  ........%  ........%  ........%  ........%  ........%
 16        ........%  ........%  ........%  ........%  ........%  ........%
 17        ........%  ........%  ........%  ........%  ........%  ........%
 18        ........%  ........%  ........%  ........%  ........%  ........%
 19        ........%  ........%  ........%  ........%  ........%  ........%
 20        ........%  ........%  ........%  ........%  ........%  ........%


SECTION 4. MORTGAGE LOAN DATA:
--------------------------

                         CONSTRUCTION        PERMANENT LOANS:
                             LOAN
                         -----------  ------------------------------------
                                           1         2        3         4
 % OF TOTAL COST BORROWED   ........  .........  ........  ........  ........
 LOAN TYPE CODE             ........  .........  ........  ........  ........
 ANNUAL INTEREST RATE (%)   ........  .........  ........  ........  ........
 LIFE OF LOAN (YRS)         ........  .........  ........  ........  ........
 NUMBER OF PAYMENTS/YR      ........  .........  ........  ........  ........
 POINTS PAID (% OF LOAN AMT) ........ .........  ........  ........  ........


SECTION 5. OPERATING AND MAINTENANCE COST DATA:
-----------------------------------------

 ANNUAL RECURRING COST (BASE-YEAR $'S)      ..........
 AVG. AN. RATE OF INCREASE, ARC             ..........
 NO. OF NON-AN RECURRING COSTS (NARC'S)     ..........
 AVG. AN. RATE OF INCREASE, NARC'S          ..........

             NON-ANNUALLY RECURRING COSTS (BASE-YEAR DOLLARS)
            (NOTE: YEARS BEGIN WITH OCCUPANCY; E.G.,1,2,...,50)
--------------------------------------------------------------------------

NO. YEAR    AMOUNT   NO. YEAR    AMOUNT   NO. YEAR    AMOUNT   NO. YEAR    AMOUNT
 1 ......   ......   14 ......   ......   27 ......   ......   40 ......   ......
 2 ......   ......   15 ......   ......   28 ......   ......   41 ......   ......
 3 ......   ......   16 ......   ......   29 ......   ......   42 ......   ......
 4 ......   ......   17 ......   ......   30 ......   ......   43 ......   ......
 5 ......   ......   18 ......   ......   31 ......   ......   44 ......   ......
 6 ......   ......   19 ......   ......   32 ......   ......   45 ......   ......
 7 ......   ......   20 ......   ......   33 ......   ......   46 ......   ......
 8 ......   ......   21 ......   ......   34 ......   ......   47 ......   ......
 9 ......   ......   22 ......   ......   35 ......   ......   48 ......   ......
10 ......   ......   23 ......   ......   36 ......   ......   49 ......   ......
11 ......   ......   24 ......   ......   37 ......   ......   50 ......   ......
12 ......   ......   25 ......   ......   38 ......   ......
13 ......   ......   26 ......   ......   39 ......   ......
```

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SECTION 6. ENERGY COST DATA:
---------------------------
 NUMBER OF ENERGY TYPES ........
*CUMULATIVE GENERAL INFLATION FROM MID-YEAR 1985 TO DATE ........%

                                              ENERGY TYPE
                                ---------------------------------------------
                                     1                2                3
                                ----------       ---------        ---------
  ENERGY TYPE CODE              ..........       ..........       ..........
  ANNUAL CONSUMP. (MIL. BTU)    ..........       ...........      ...........
**PRICE PER MILLION BTU         $.........       $.........       $........
  DEMAND (OR OTHER) CHARGE      $.........       $.........       $.........
**AVG. AN. RATE OF INCREASE
      DURING PLAN/CONSTRUCTION .........%       .........%       .........%
  PRICE ESCALATION METHOD       ..........       ..........       ..........

**PRICE INCREASES DURING OCCUPANCY (NET OF GENERAL INFLATION):
NO. OF DISCRETE TIME INTERVALS ..........        ..........       ..........
                             ---------------  ---------------  ---------------
                             NO.  DUR.   AN.  NO.  DUR.   AN.  NO.  DUR.   AN.
                                 (YRS)  RATE      (YRS)  RATE      (YRS)  RATE
                             ---------------  ---------------  ---------------
                             1   .....  ....% 1   .....  ....% 1   .....  ....%
                             2   .....  ....% 2   .....  ....% 2   .....  ....%
                             3   .....  ....% 3   .....  ....% 3   .....  ....%
                             4   .....  ....% 4   .....  ....% 4   .....  ....%
                             5   .....  ....% 5   .....  ....% 5   .....  ....%
                             6   .....  ....% 6   .....  ....% 6   .....  ....%
                             7   .....  ....% 7   .....  ....% 7   .....  ....%
                             8   .....  ....% 8   .....  ....% 8   .....  ....%
                             9   .....  ....% 9   .....  ....% 9   .....  ....%
                             10  .....  ....% 10  .....  ....% 10  .....  ....%
-------------------------------------------------------
*NEEDED ONLY WHEN DEFAULTING TO DOE ENERGY PRICE PROJECTIONS ON DISK
**NOT NEEDED WHEN DEFAULTING TO DOE ENERGY PRICE PROJECTIONS
```

When Code 1, the for-profit status, is designated, the NBSLCC program calculates income tax savings due to sales tax, depreciation, operating and maintenance (O&M) costs, and energy costs; capital gains taxes due to asset appreciation (when appropriate); and depreciation recapture taxes. These tax-related computations are not provided when Code 2, the private-residential status, nor Code 3, the tax-exempt status, is designated. Calculation of income tax credits; property taxes; and income tax savings resulting from the deductibility from taxable income of interest and property taxes is performed for both Code 1, the for-profit status, and Code 2, private-residential status, but not for Code 3, the tax-exempt status. When the tax-exempt status is designated, no tax calculations are performed.[21]

- Inflation Rate—This is the underlying rate of general price inflation expected over the entire study period. This is only required if the LCC analysis is computed in nominal terms using a nominal discount rate.
- Marginal Federal Income Tax Rate (%)—The Federal tax rate applied to the last dollar of income to the investor. (Tax status Code 1 or 2 only.) See Appendix I to see how a composite income tax rate is computed based on both the marginal Federal and State income tax rates.
- Marginal State Income Tax Rate (%)—The State tax rate applied to the last dollar of income to the investor. If income taxes are imposed by local jurisdiction, this can be included in the analysis by replacing the State tax rate with a composite State and local rate. (Tax status Code 1 or 2 only.)
- Property Tax Rate (%)—This is the quoted property tax rate for this type of property in this location. Note that the property tax rate is assumed to be the same for all capital components, but that the percentage of each component that is subject to this property tax rate (i.e., the assessment rate) can be specified separately for each component below. (Tax status Code 1 or 2 only.)
- Capital Gains Adjustment Factor (%)—At the end of the study period, if the resale value of the project is greater than its initial cost, the difference is assumed to be taxable as long-term capital gains. The effective capital gains tax rate is usually lower than the

[21] To supply the necessary data for tax-related calculations, the user must be familiar with IRS rules, particularly those related to depreciation, depreciation recapture, and capital gains. The computations are meant to give a realistic estimate of tax effects but obviously cannot account for every possible situation. Furthermore, IRS tax provisions are subject to change. See Appendix I for methodology and assumptions related to income tax adjustments.

Neither the National Bureau of Standards nor the U.S. Department of Energy assumes any liability resulting from errors or omissions in the calculation of tax savings nor in the documentation of the calculations in this report.

ordinary income tax rate. The Capital Gains Adjustment Factor adjusts the ordinary income tax rate to an effective capital gains tax rate. For individuals, this adjustment factor was 40 percent in 1986; if capital gains preference is discontinued, use 100 percent. For corporations, the adjustment factor was 100 percent in 1986 unless the ordinary income tax rate exceeded the maximum tax rate on capital gains (28 percent). In this latter case, an adjustment factor should be selected which reduces the ordinary tax rate to the maximum capital gains rate; e.g., if the ordinary tax rate is 46 percent and the maximum capital gains tax rate is 28 percent, the adjustment factor is (28/46) x 100 = 60.87. Note: For owner-occupied houses, the capital gains tax is usually deferred indefinitely if another house is purchased within a specified amount of time. To defer capital gains taxes indefinitely, enter a zero for this factor.

- Depreciation Recapture Code—At the end of the study period, if the nominal resale value of the project is greater than its depreciated book value (i.e., the remaining undepreciated portion of its actual cost at occupancy), the difference (up to the total amount of depreciation claimed) may be subject to a depreciation recapture tax. This depreciation recapture tax can be computed in one of several different ways, as designated by the following input codes:
  0—no depreciation recapture
  1—recapture as capital gain
  2—recapture as ordinary income
  3—depreciation calculated at straight-line rates, recaptured as capital gains; any excess depreciation (due to accelerated calculation procedures), recaptured as ordinary income

  (Note: IRS rules for recapture vary with the type of property involved, method of depreciation used, and date of asset acquisition.)
- Depreciation Basis Adjustment Factor (%)—If an investment (or energy) tax credit is claimed for any component, this may reduce the original cost basis for depreciation calculations by a specific percentage of the tax credit by which the depreciation basis is reduced. For example, if one half of the tax credit must be deducted from the original cost basis for depreciation, enter 50.
- Sales Tax Rate (%)—The nominal sales tax rate that applies to the cost of major components and replacements. Specification of a positive value causes sales taxes to be calculated by the program from the initial component cost and treated as a tax-deductible expense in the year incurred (for-profit tax status only). The use of a zero rate assumes that sales taxes, if any, are included in the initial cost and receive no differential tax treatment. (See Appendix I, "Methodology and Assumptions Used to Calculate Income Tax Adjustments.") The actual percent of a given component or replacement cost that is subject to sales tax is specified individually for each component and replacement below. (See in Table 6-4, Section 3, "Percent Subject to Sales Tax (%).")

Table 6-4, Section 3—*Capital Component and Replacement Cost Data*

- Number of Capital Components—The project can be divided into as many as six major capital components (for example, a new building project might be divided into land, structure, and equipment). For each component, the variables described in this section must be specified separately. Unless there is some difference in one or more of these variables (other than initial cost), there may be no reason to specify separate components. If one component is of particular interest—for example, energy conserving features in the building envelope—this component can be specified separately. Land, which cannot be depreciated, should be specified as a separate component if the building itself is to be depreciated. "Closing costs" (other than "points" on loans and prepayments of property taxes) and other initial costs which are not expected to influence the value of the building, can be set up as a separate cost component. This cost component should be set up with a zero percent "Resale Value Factor," "Property Tax Assessment Factor," and "Average Price Escalation Rate During Occupancy." If the tax status is "for-profit," these costs generally can be depreciated like any other capital component.

  A capital component which has a shorter life than the study period and must therefore be replaced should be set up as a separate component. Replacements to capital components are discussed below.

  The following variables are to be specified for each component where appropriate:
- Component Name—Use a descriptive term with maximum of 10 characters, (e.g., structure, equipment).
- Initial Cost ($)—The total installed cost of the component, unadjusted for price escalation during construction. [If the planning/construction period is one year or more, the "Cost-Phasing Schedule" and the "Average Price Escalation Rate During the Planning/Construction Period" (discussed below) are used to determine the actual component cost incurred in each year of the planning/construction period and at occupancy.] Do not include sales tax in the initial cost if the tax is to be calculated by the program and deducted from taxable income. (See "Sales Tax Rate" above.)
- Cost Phasing Schedule (by year of the Planning/Construction Period and at occupancy, %) (bottom of Table 6-4)—If the planning/construction period is one year or more prior to occupancy, a schedule to phase in component acquisition costs must be entered. For each year of the planning/construction period, specify the percent of the initial component cost (unadjusted for inflation) that is to be incurred in that year. All costs phased in during any construction year are assumed to be incurred at the beginning of that year. Any costs not phased in during construction are assigned to the first day of the occupancy period.
- Percent Subject to Sales Tax (%)—The nominal sales tax rate specified in Table 6-4, section 2 is applied only to the percent of the actual component cost specified here. This variable will be asked for only if a sales tax rate has been specified. If sales taxes are

computed for a component, they will be included as tax deductible expenses (for profit tax status only).

- Expected Component Life (Years)—The useful life of the component (in years) anticipated by the investor. This is intended to be a realistic assessment of the component life, independent of the depreciation life assigned to the component for income tax purposes. Use an integer between 2 and 100; use 999 for land. (Code 999 locks out depreciation and capital replacement algorithms.)
- Depreciation Method Code—The method to be used for depreciating each capital component is determined by the following codes:

  0—no depreciation calculated
  1—straight line
  2—declining balance (accelerated)
  3—sum of years digits
  4—depreciation table

  If depreciation is to be calculated for a given component, three or more of the following five variables will be requested when running LCCDATA:
- Depreciation Life (Years)—The number of years over which the component will be depreciated. For the depreciation methods 1 through 3, the number must be an integer greater than one and equal to or less than the Expected Component Life or 45, whichever is lower. For depreciation method 4, the table method, the number must be an integer equal to the IRS allowable life for the applicable depreciation category (18 years for real estate as of 1986).
- Depreciation Acceleration Rate (%)—If Depreciation Method Code 2, the declining balance method, is selected, the Acceleration Rate must be specified. For example, for 125% declining balance, enter 125.
- Salvage Value (% of initial cost)—If the IRS depreciation rules require that salvage value be deducted from the initial asset cost before setting up a depreciation schedule, the Salvage Value Factor must be specified. Otherwise enter zero (default). The Salvage Value Factor is specified as a percentage of the initial component cost. Negative values are not allowed. Note: The Salvage Value Factor is specified only for depreciation purposes here; this is not the same as the Resale Value Factor (defined below).
- Additional First Year Depreciation—If additional first year depreciation is allowed, enter this factor as a percent of the actual component cost (net of any sales tax calculated for that component). Additional first year depreciation is deducted from the original depreciation basis before the depreciation schedule is set up for this component.
- Depreciation Factor (%)—If Depreciation Method Code 4, the depreciation table method, is specified, you will be asked for a pre-calculated depreciation factor for each year. These factors may be calculated by the user or taken from a published table of depreciation factors. The sum of these factors cannot exceed 100%. This is the method that should be

used for Accelerated Cost Recovery System (ACRS) depreciation calculations. Space for these depreciation factors is provided on the data collection sheets after the replacement data (Table 6-4, section 3).

- Average Price Escalation Rate During the Planning/Construction Period (%)—This is the average annual rate at which the cost of this component increases during the planning/construction period, if any. No adjustment is made to component costs phased in during the first year of construction since component costs are assumed to be incurred on the first day of the assigned year. All component costs phased in after the first year of the planning/construction period are adjusted using this rate. This escalation rate should be entered net of general price inflation (i.e., in real terms). (For further explanation, see Chapter 3, "Changes in the General Price Level.")
- Average Price Escalation Rate During Occupancy (%)—This is the average annual rate at which the cost of this type of capital component is expected to change during the occupancy period, net of general price inflation. This variable is used in calculating replacement costs for this component, and in establishing the resale value of this component after adjustments for wear, deterioration, and obsolescence. (See "Resale Value Factor" below. For further explanation, see Chapter 3, "Changes in the General Price Level.")
- Property Tax Assessment Factor (%)—This is the percentage of the initial component cost to which the Property Tax Rate, specified in section 2 of Table 6-4, is applied in order to calculate the actual property tax obligation. Property taxes are calculated only during occupancy years, and are assumed to be paid at the beginning of each year, based on the assessed value of that component at that time. In computing the assessed value of the component for each year of occupancy, the initial component cost is decreased annually—in straight line fashion—to its estimated resale value (unadjusted for price changes) at the end of the study period (or at the end of the component life, if this occurs before the end of the study period). These values are then adjusted for price changes using the "Average Price Escalation Rate During Occupancy," and then adjusted by the Property Tax Assessment Factor to determine the amount to which the Property Tax Rate is applied. Note that this is necessarily an approximation technique; the actual assessment depends on the Taxing Authority's evaluation of component value. (Applies to Tax status Code 1 or 2 only.)
- Tax Credit Rate (% of initial cost)—This is used in conjunction with tax status Code 1 or 2 to calculate either an investment or an energy tax credit, or both, when appropriate. The tax credit is assumed to be taken at the end of the first year of occupancy. This factor is entered as a percent of the initial capital cost for that component, (adjusted for price escalation during occupancy, if any). Under tax laws in effect at the time of this report, if the full investment tax credit is taken, the depreciation basis must be reduced by half of the amount of the credit. Alternatively, a partial tax credit may be taken and the depreciation basis left intact. (If the full tax credit is taken, the percentage of the tax credit by which the depreciation basis must be reduced should be specified in Table 6-4, section 2, "Depreciation Basis Adjustment Factor.")

- Resale Value Factor (% of initial cost)—This is the percent of the initial component cost which remains at the end of the study period (or at the end of the component life, if this comes first), unadjusted for price escalation. This factor is intended to reflect a decrease in value due to wear, deterioration, or obsolescence. The resale value is treated as a negative cost element in the life-cycle cost equation even if the investor does not intend to dispose of the property at the end of the study period. In computing the actual resale value of the component, NBSLCC uses the "Average Price Escalation Rate During the Planning/Construction Occupancy Period" for that component to adjust for inflation during the occupancy period.
- Number of Replacements—Replacements of a capital component are generally specified only if they are to be depreciated rather than expensed in the year of replacement. (Expensed items are considered to be operating and maintenance costs.) Capital replacements may be specified under either of two assumptions:

  (1) The actual life of the component is shorter than the study period and the component is entirely replaced.

  (2) A replacement is made only to a portion of the component during the life of the component.

  In the first case, the original component itself ceases to exist. No depreciation or property tax assessment continues for the original component; instead these are computed anew for the replacement. This is the most straightforward application of the replacement option.

  In the second case, the original component itself continues to exist. The depreciation schedule and tax assessment schedule for the component are not altered when the replacement is made. However, new depreciation and tax assessment schedules are set up for the replacement, as though it were a new component. In this case, it is recommended that the Property Tax Assessment Rate and the Resale Value Factor of the replacement be set to zero (see below), and that the Resale Value Factor of the original component be estimated so that it reflects the value that the replacement adds to that component at the end of the study period. In general, this second case should only be used when a depreciation schedule is needed for the partial replacement of the original component. Otherwise it is best to include the cost of this partial replacement in the non-annually-recurring cost schedule (see below).

  A maximum of four capital replacements can be specified for each component. The depreciation method for the replacement is the same as for the component itself. However, the depreciation life can be different unless the depreciation table method is used for the original component. In this latter case, the same depreciation table used for the original component is applied to its replacements.

  For each replacement to a component the following variables must be specified:
- Year of Replacement—The year of occupancy in which the replacement is made, counting from the start of occupancy. Use an integer between 2 and the number of the last year of study period. Replacements, being capital investments, are assumed to be made on the first day of the year of replacement.

- Initial Cost of Replacement—The installed cost of the replacement (in base year dollars). Do not include sales tax if this is to be calculated by the program. The actual replacement cost will be calculated using the "Average Price Escalation Rate During the Planning/ Construction Period" and the "Average Price Escalation Rate During Occupancy" assigned to the original component.
- Percent Subject to Sales Tax (%)—The percentage of the initial replacement cost subject to sales tax at the nominal sales tax rate. This variable is used only when sales taxes on the replacement are deductible for income tax purposes. Otherwise, include the sales tax in the "Initial Cost of Replacement."
- Depreciation Life (Years)—See "Depreciation Life of Capital Components" above.
- Salvage Value (% of initial replacement cost)—See "Salvage Value for Capital Components" above. (This is for depreciation computation purposes only.)
- Expected Useful Life (Years)—The useful life of the replacement (in years) anticipated by the investor. Use an integer between 2 and 100.
- Resale Value Factor (% of initial replacement cost)—This is the percent of the initial replacement cost remaining at the end of the study period (or end of the expected useful life of the replacement, whichever is less) in base year dollars, (i.e., unadjusted for inflation).
- Property Tax Assessment Rate ($)—The percent of the initial replacement cost to which the nominal property tax rate will be applied. (See "Property Tax Assessment Factor" for components for further explanation.)

Table 6-4, Section 4—*Mortgage Loan Data*

Mortgage loans are assumed to apply to the entire project and not to individual capital components. Generally, financing arrangements should only be evaluated as an integral part of the life-cycle cost analysis of a project if the loan interest rate is unique to that project. (See discussion in Chapter 3, "Financing and Taxes.") Three types of loans can be specified:

(1) fully amortized loan with periodic payments of equal amount,
(2) interest only loan with periodic interest payments and repayment of principal at end of loan life, and
(3) both interest payments and principal repayment deferred to end of loan.

All interest rates are assumed to be fixed for the life of the loan. Thus adjustable rate mortgages cannot be evaluated. Temporary financing may be specified during the construction period, but only loan types 2 and 3 can be used for temporary financing. Only a single loan type can be specified for the construction period; the same percentage of annual construction costs is assumed to be borrowed each year. Temporary financing is terminated on the first day of occupancy. At occupancy, up to four different concurrent loans can be specified to finance the project; together they cannot exceed 100% of the initial project cost. The following variables must be specified for each loan:

- Percent of Total Project Cost Borrowed—Total project cost is the sum of all component costs, including inflation adjustments during construction and sales taxes, if applicable.

- Loan Type Code—See codes above.
- Annual Interest Rate (%)—If a real discount rate is used (tax-exempt status only), the annual interest rate on the loan should be entered exclusive of the user's forecast of general price inflation. The interest rate should be quoted before compounding is taken into account, i.e., the interest rate entered is not the effective interest rate.
- Life of Loan (Years)—The loan life (an integer between 1 and 50) can be longer or shorter than the study period; if it is longer, any remaining principal and accrued (unpaid) interest at the end of the study period are included in the life-cycle cost.
- Number of Payments per Year—This is the number of equal payments (an integer between 1 and 12) made at periodic intervals through the year.
- Points Paid (% of loan amount)—This is a loan placement fee assessed as a percentage of the loan amount (i.e., one "point" equals one percent of the loan amount). This loan placement fee is assumed to be deductible for income tax purposes. (See Appendix I for the methods used to calculate tax deductions for interest and points.)

Table 6-4, Section 5—*Operating and Maintenance Cost Data* (other than energy costs)

There are two types of operating and maintenance costs (including repairs and minor replacements) treated in the NBSLCC program: annually recurring costs (ARC's) and non-annually recurring costs (NARC's). The ARC's and NARC's are incurred during occupancy years only, and are assumed to be paid at the end of each year. The values for the ARC and all NARC's are to be specified as of the beginning of the study period, unadjusted for price escalation.

- Annually Recurring Costs ($)—This is the annual cost of all O&M-related costs (except energy costs) which occur in substantially the same amount every year or which change at a relatively constant rate over the study period (in base year dollars).
- Average Annual Rate of Increase, ARC (%)—This is the average annual rate at which the ARC is assumed to change over the entire study period, net of general price inflation. (For further explanation, see Chapter 3, "Changes in the General Price Level.")

The NARC's do not follow a regular pattern. They must be specified individually for each occurrence. (More than one occurrence per year is permitted though all occurrences within a year would be assumed to occur at the end of that year.)

The following variables must be specified:

- Number of Non-Annually Recurring Costs (NARC's)—This the number of NARC's (an integer between 0 and 50), to be incurred over the study period.
- Annual Rate of Increase, NARC's—Similar to "Annual Rate of Increase, ARC". A single rate applies to all NARC's.
- Non-Annually Recurring Costs—For each NARC, the following two variables must be entered, separated by a comma:
  —Year of Occurrence, starting with the occupancy year, year 1 (an integer between 1 and 50).
  —Amount (the cost of each NARC in base-year dollars).

Table 6-4, Section 6—*Energy Cost Data*

Annual energy costs are treated like annually recurring costs except that up to three individual energy types may be specified and the rate of price change does not have to be constant over the entire study period. Annual consumption of each energy type is assumed to be the same in every year during occupancy. (Energy costs are not calculated during the planning/construction period, if any.) Annual energy costs consist of direct energy costs (i.e., those costs computed directly from annual energy consumption in million Btu) and indirect costs (e.g., demand-related or other energy costs that cannot be computed directly from the amount of annual energy consumption).

Base-year energy prices, in dollars per million Btu, can be entered by the user for each energy type, based on local energy prices at the building site. Alternatively, DoE average energy prices for the DoE region and building type can be automatically accessed from the energy price data file (ENCOSTFL) stored on the NBSLCC disk. (See Chapter 3, "Estimating Costs"—"Energy Costs".) These average prices can be adjusted by the user to reflect specific indirect costs for each energy type by entering the indirect costs directly. All energy prices and indirect energy costs must be entered in constant base-year dollars.

The DoE energy price projections in ENCOSTFL may be in a different year's dollars than that needed for the LCC analysis. In such a case, the program will automatically ask the user for the appropriate conversion factor (e.g., the cumulative amount of general inflation from the middle of the year in which the DoE prices are denominated to the current date.

As in the case of the initial energy price data, the user has two alternatives for specifying future energy price data: (1) The DoE projections of energy price escalation rates from the ENCOSTFL may be accessed. (2) The user can enter directly other energy price escalation rates for each energy type for discrete time intervals over the occupancy period. In this second approach, if a construction period is assumed in the analysis, the average escalation rate for each energy type over that period must also be entered. [Note that DoE projections of future price increases can be accessed automatically from the DoE energy price projections in ENCOSTFL even if the DoE initial energy prices are not used in the LCC analysis.]

Energy-related variables are entered as follows:

- Number of Energy Types—This is the number of specific energy types used in the building. (Integer between 0 and 3.)

For each energy type, specify the following variables:

- Energy Type Code:
  1—Electricity
  2—Distillate Fuel Oil
  3—Residual Fuel Oil
  4—Natural Gas
  5—Liquified Petroleum Gas (LPG)
  6—Coal (Steam Coal)

- Annual Energy Consumption (million Btu/yr)—This represents the average annual energy consumption related to this project in each of the occupancy years. The DoE price estimates are based on the following conversion rates:
  1 kWh = 0.003412 million Btu or 1 million Btu = 293.1 kWh
  1 gallon of distillate = 0.13869 million Btu or 1 million Btu = 7.21 gallons of distillate
  1 gallon of residual = 0.14969 million Btu or 1 million Btu = 6.68 gallons of residual
  1 therm of natural gas = 0.10 million Btu or 1 million Btu = 10 therms of natural gas
  1 gallon LPG = 0.0955 million Btu or 1 million Btu = 10.471 gallons of LPG
  1 ton steam coal = 0.0225 million Btu or 1 million Btu = 44.44 tons of steam coal
- Energy price ($/million Btu)—The price per million Btu to be used in calculating direct energy costs for the project. This price should be entered in constant base-year dollars. The base-year DoE energy price for the appropriate energy type, building type, and DoE region will be automatically entered here if the user so specifies. (Pressing <ENTER> at this point defaults to the DoE energy price.)
- Annual Demand (or other) Energy Charge ($/yr)—Annual costs related to energy consumption not directly accounted for in the energy prices used to compute direct energy costs. Example: Charges for peak kilowatt demand summed over the entire year. This cost should be entered in constant base-year dollars. This cost is assumed to increase annually at the same escalation rate specified for the energy price.
- Price Escalation Method:
  1—Escalation rates will be entered by the user.
  2—Escalation rates will be automatically computed from ENCOSTFL.
  If escalation rates are to be entered by the user, the following variables must be specified:
- Number of Discrete Time Intervals—This is the number of discrete energy price escalation rates that are to be specified over the occupancy period. (See Duration and Annual Rate of Energy Price Increase below.) (Integer between 1 and 50.)
  For each discrete rate, specify the following two variables, separated by a comma:
- Duration (years)—The number of years over which a given energy price escalation rate remains constant (occupancy period only). Note: For each energy type, the sum of these intervals must equal or exceed the occupancy period.
- Energy Price Escalation Rate (%)—This is the average annual rate of price increase of this energy type during the corresponding time interval. These rates must be entered in real terms, i.e., net of general price inflation. In addition, if a planning/construction period is used in the analysis, the following variable must be specified for each energy type:
- Energy Price Escalation Rate During Planning/Construction Period (%)—The average rate at which the price of this energy type is expected to change over the planning/construction period, net of general price inflation. (Only needed when the user is entering escalation rates for the study period.)

NBSLCC REPORTS

A report of a life-cycle cost analysis for a building or building system should specify both the major elements of the LCC computations and the key assumptions used in the analysis. In addition, a report of comparative LCC analysis for competing building designs or system alternatives should provide key measures of their relative economic performance. Three different LCC-related reports can be printed at various stages of the NBSLCC analysis to satisfy these requirements:
(1) a building characteristics file, (2) a detailed LCC analysis report, and (3) a comparative LCC analysis for two design alternatives.

Building Characteristics File. This file, printed by subprogram PRINTBCF, provides a comprehensive listing of all the data and assumptions used by the LCCMAIN subprogram in the analysis of a given building. It is divided into six sections. An example of a building characteristics file for a tax-exempt building project was shown in Table 6-1. The format of this file is basically the same for all NBSLCC analyses. However, data related to income taxes are not included for tax-exempt buildings, and data related to depreciation are not included for either the tax-exempt building or the owner-occupied residence. The building characteristics file is created and modified using the LCC-DATA subprogram, as described previously.

Detailed LCC Analysis Report. This report is printed by the subprogram PRINTLCC, based on the LCC output file created and saved on the disk by LCCMAIN. An example of an LCC analysis report for a tax-exempt building project was shown in Table 6-2. The LCC report is divided into two parts: Part I lists the key assumptions used in the LCC computations; the initial capital component costs (before discounting) and their time phasing during the construction period, if any; the investor's initial cash and borrowing requirements, if one or more loans are included in the analysis; and energy-related cost data by energy type. Part II shows the major elements of the LCC computations and the total LCC, both before and after any income tax adjustments.

The LCC elements are presented both in present value terms as of the base date specified in the analysis, and in annual value terms. The annual value is a uniform annual amount which is time-equivalent to the present-value amount. It is obtained by applying the Uniform Capital Recovery discount formula to the present-value amount. (For further explanation, see Chapter 3, "Adjusting Values for Time-Equivalency (Discounting), particularly Table 3-13.)

The major elements of the LCC computations are divided into six sections.

A. Investor's Initial Cash Requirements
B. Financing Payments (after occupancy)
C. Operating, Maintenance, and Related Costs
D. Replacements to Capital Components
E. Income Tax Adjustments
F. Remaining Value at End of Occupancy

These elements are included in Part II of the LCC report as appropriate. If the project is tax-exempt no income tax adjustments are shown; similarly, if mortgage loans are not obtained at occupancy, no financing computations are included in the report.

Note that any interest or loan placement fees ("points") paid on construction loans are included as part of the investor's initial capital requirements during construction. Principal payments on construction loans are not made during the construction period. The principal portion of a construction loan is assumed to be converted to permanent financing at occupancy, although additional cash payments or receipts at the time of occupancy may be needed to balance these accounts.

The Investor's Initial Cash Requirements during Construction and at Occupancy, less the Income Tax Adjustments from interest, "points" and sales tax during construction, if any, represents the investor's total equity at occupancy. This measure of investor's equity serves as the basis for computing the savings-to-investment ratio and internal rate of return when comparing alternative building designs, as discussed below.

Comparative LCC Analysis Report. This report for two alternative building designs is computed and printed by the COMPARE subprogram, based on their LCC output files. An example of this comparative analysis for a tax-exempt building project was shown in Table 6-3. The report lists the major elements of the LCC computations for two buildings or building systems: a base-case design with a lower initial cost and higher operating-related costs, and an alternative design with a higher initial cost and lower operating-related costs. The difference between the cost of the alternative and base cases is reported for each major element of the LCC analysis. Also included are the present-value net benefits (or, if negative, the present-value net losses) attributable to the alternative case, its savings-to-investment ratio, and the rate of return adjusted for reinvestment of cash flows at the discount rate. The methodology for computing these measures of economic performance is provided in Chapter 3, as well as guidance in applying and interpreting them. The computational algorithms are documented in part XIV of Appendix H. Further examples of these three reports are provided in Chapter 7 for economic evaluations of energy conservation in an owner-occupied house and a commercial building.

THE DISCOUNT PROGRAM

DISCOUNT is a program written in BASIC for microcomputer applications. It can perform all of the discounting operations described in Tables 3-10 through 3-15 of Chapter 3, "Adjusting Values to Time-Equivalency (Discounting)." The DISCOUNT program is stored on the same diskette as the NBSLCC programs, but it is executed independently of those programs. The main menu displayed on the video screen when running DISCOUNT is shown in Figure 6-3. The program will determine present, future, and equivalent annual values related to cash flows in different time periods. It also displays the corresponding discount factor for the selected operation. The number of time periods (usually years), discount rate, and, where appropriate, rate of price change, can be entered or changed by the user while running the program.

You must be in the BASIC mode to run DISCOUNT. At the system level, type BASIC DISCOUNT to run this program. In BASIC, simply type RUN "DISCOUNT".

Once running, the DISCOUNT program can be used repeatedly for any of the discounting operations shown in the menu. In order to save time, the discount rate can be temporarily locked in by pressing <L> and specifying the discount rate. If you wish to change the discount rate, use <U> to unlock the rate, or press <L> again to lock in a new rate.

Most of the terms used in the menu can be defined by pressing <D>. This command displays a second menu, as shown in Figure 6-4. The definition of each of these terms will be displayed by entering the corresponding code and pressing the carriage return.

If a discounting operation is desired that is not included in the menu shown, it is possible that it can be accomplished through a combination of steps using the DISCOUNT program. For example, to find the present value of a future amount that is unknown but has been defined in constant dollars (as of the beginning of the study period) and is expected to increase in value at a constant rate, use the following procedure: (1) Find the future value of the present amount (code 1), substituting the rate of price increase for the discount rate. Then (2) determine the present value of that future amount (code 2) using the appropriate discount rate.

Figure 6–3. Main menu from the discount program

DISCOUNTING APPLICATIONS MENU

CODE	TO FIND:
	------------------------------ SINGLE AMOUNTS ------------------------------
1	FUTURE VALUE WHEN PRESENT VALUE IS KNOWN
2	PRESENT VALUE WHEN FUTURE VALUE IS KNOWN
	----------------------- UNIFORM SERIES OF PAYMENTS -----------------------
3	PERIODIC PAYMENT AMOUNT WHEN FUTURE AMOUNT IS KNOWN
4	PERIODIC PAYMENT AMOUNT WHEN PRESENT AMOUNT IS KNOWN
5	FUTURE VALUE WHEN PERIODIC PAYMENT AMOUNT IS KNOWN
6	PRESENT VALUE WHEN PERIODIC PAYMENT AMOUNT IS KNOWN
	--------------------- NON- UNIFORM SERIES OF PAYMENTS ---------------------
7	PRESENT VALUE WHEN PERIODIC PAYMENT AMOUNT INCREASES AT CONSTANT RATE
8	PRESENT VALUE WHEN PERIODIC PAYMENT AMOUNT INCREASES AT CHANGING RATE

L=LOCK IN DISCOUNT RATE	U=UNLOCK DISCOUNT RATE
D=DEFINE TERMS	S=STOP

ENTER APPLICATIONS CODE:

Figure 6–4. Definitions menu from the discount program

DEFINITIONS OF TERMS

CODE	TERM TO BE DEFINED
1	DISCOUNT RATE
2	ESCALATION RATE
3	FUTURE VALUE
4	INTEREST RATE
5	NON- UNIFORM SERIES
6	PERIODIC PAYMENT AMOUNT
7	PRESENT VALUE
8	STUDY PERIOD
9	TIME PERIOD
10	UNIFORM SERIES

R=RETURN TO MAIN MENU   S=STOP

ENTER CODE FOR DEFINITION:

7. PROBLEM ILLUSTRATIONS

This chapter presents several hypothetical examples, ranging from a simple homeowner investment decision to more complex decisions for a commercial building. The examples illustrate the use of the worksheets of Chapter 5 and the computer program of Chapter 6.

RESIDENTIAL HEATING SYSTEM

In mid-1986 the owners of a 20-year-old house in New England, which has base-board hot water convectors and an oil-fired boiler, learn from the annual maintenance inspection that boiler/burner efficiency is only 60 percent. Even though they have insulated the house to capacity and installed storm doors and windows, heating costs continue to be high. The current price of heating oil is $1.18 per gallon and current consumption is about 1,000 gallons per year. The family plans to occupy the house for approximately 10 more years, at which time the house will be sold and the family will move to a warmer climate.

The service person suggests two approaches to improve heating efficiency:

(1) replace the existing burner with a new one; or

(2) replace the entire heating plant (burner and boiler) with a higher efficiency, oil-fired package boiler.

To improve overall energy efficiency of the house, an additional suggestion is to equip the package boiler with a tankless domestic water heater replacing the existing electric water heater.

The cost of purchasing and installing the replacement burner is $520, and its expected effect is to increase system efficiency from 60 percent to 66 percent.

Replacing the burner will not change the $75 cost of the annual maintenance contract. The entire heating system is expected to last at least another 10 years with or without the new burner. The existing burner is not expected to have any significant resale value now or later, and the replacement burner is not expected to have any significant resale value after a few years of use.

The cost of purchasing and installing the new package boiler is quoted at $2,500 without the tankless water heater addition, and its expected effect is to increase heating efficiency from 60 percent to 85 percent. The new boiler can be expected to last about 20 years. A maintenance agreement for it will cost $75, the same as for the existing boiler. The old boiler-burner unit is not expected to have any significant resale value either at the present time or if left in the house another 10 years. The new package boiler is expected to have a resale value after 10 years equal to about half its first cost as measured in 1986 dollars. However, since this value may not be realized in the sale of the house, the family would like to see the result of the analysis both with and without inclusion of resale value.

With the addition of the tankless water heater, the new package boiler will cost $2,900. The new system is expected not only to increase efficiency from 60 percent to 85 percent, but also to replace the existing hot water heater. During the approximately eight months of the year that space heating is required, hot water requirements would be met by the tankless heater at a negligible additional cost in fuel oil. During the remaining four months of the year, fuel oil consumption to operate the boiler for water heating alone is expected to be about 20 gallons per month.

The total electric bill averaged $84.50 per month over the past year for an average monthly consumption of 918 kWh. Of this total, about 45 percent was for domestic water heating. The existing water heater is 12 years old and has little remaining expected life and no resale value if replaced. If the tankless water heater option is not adopted, the family expects to spend $300 within the coming year to replace the electric water heater. It is expected that a replacement electric water heater would last the remaining period of occupancy but would contribute little to resale value of the house at the end of 10 years.

There are no special low interest loans available to finance the purchase. The family has a taxable money market account currently paying 9 percent, in which it has accumulated funds in excess of the level required for emergencies. The funds for upgrading or replacing the heating system and the domestic water heater will be drawn from this account. The only major debt is a 30-year mortgage on the house at 12 percent, that has no prepayment penalty. The family's marginal federal income tax rate is 38 percent, and the State

Table 7-1. Data and assumptions for evaluating the residential heating system problem (sample)

Uniform Assumptions

Study Period: 10 Years
Project Starting Date: 1986
Base Year for Discounting: 1986
Discount Rate: 7% (After-tax, see Table 7-2)

Cost-Related Data (1986 $)

	Alternative A Keep Boiler-Burner and Replace Electric Water Heater with Like System (1)	Alternative B Replace Burner and Electric Water Heater with Like Systems (2)	Alternative C Replace Boiler-Burner with Package Boiler and Replace Electric Water Heater with Like System (3)	Alternative D Replace Boiler-Burner and Electric Water Heater with Package Boiler/Tankless Water Heater (4)
FIRST COST	$300	$820	$2,800	$2,900
ANNUAL O&M (NON-ENERGY) COSTS	$75	$75	$75	$75
RESALE VALUE AFTER 10 YEARS	$0	$0	$0 or $1,250[a]	$0 or $1,450[a]
ENERGY DATA				
Current Oil Price $1.18/gal				
Current Oil Consumption 1,000 gal/yr.				
Space Heating System Efficiency	60%	66%	85%	85%
Quantity of Oil Purchased	1,000 gal/yr.	909 gal/yr. (est.)[b]	706 gal/yr. (est.)[b]	786 gal/yr.(est.)[b]
Current Elect. Price 9.2¢/kWh or $27/10⁶ Btu				
Annual Elect. Consumption for Domestic Water Heating[c]	4,957 kWh	4,957 kWh	4,957 kWh	0 kWh
ENERGY PRICE ESCALATION[a]	Based on	* DoE energy price projections *plus* an assumed 5% general price inflation rate (Appendix B, Part I, Table BI-1a); or * an assumed overall 5% general price inflation rate (Appendix B, Part II, Table BII)[a]		

[a] Where more than one value is given, sensitivity analysis will be performed for the alternative values.
[b] Estimated as follows: Quantity Purchased (Q)=Quantity Required at 100% System Efficiency (L)/System Efficiency (e). Substituting in the given values, 1,000 gal/yr.=L/.60, L=600 gal/yr. With an increase in e to .66, Q=600 gal/.66=909 gal.; with an increase in e to .85, Q=600 gal/.85=706 gal. (Alt. D includes an additional 80 gal/yr. for hot water heating.)
[c] 918 kWh/month × 12 months × .45=4,957 kWh.

income tax rate is 5 percent. Tax-exempt bonds are available with a 6 percent return per annum, but the family prefers the liquidity of the money market account.

The family wishes to estimate the outcome of alternative choices based on two different projections of future energy prices: (1) U.S. Department of Energy price projections, adjusted to reflect the assumption of a general price inflation rate of 5 percent per annum, provided in Appendix B, Part I; and (2) the projection that energy prices will change at the same rate as prices in general, which they assume will be 5 percent per annum, provided in Appendix B, Part II.

Table 7-1 summarizes the data and assumptions. These are used in the evaluation of each of the alternatives listed below:

(A)—KEEP BOILER-BURNER AND REPLACE ELECTRIC WATER HEATER WITH LIKE SYSTEM

(B)—REPLACE BURNER AND ELECTRIC WATER HEATER WITH LIKE SYSTEMS

(C)—REPLACE BOILER-BURNER WITH PACKAGE BOILER AND REPLACE ELECTRIC WATER HEATER WITH LIKE SYSTEM

(D)—REPLACE EXISTING BOILER-BURNER AND ELECTRIC WATER HEATER WITH PACKAGE BOILER/TANKLESS DOMESTIC WATER HEATER

Worksheet Solution. Let us first assume that this family does not have a home computer and elects the worksheet approach to evaluating the alternatives to determine the most cost-effective choice.

To solve this problem, the life-cycle cost or net savings method is appropriate. The net savings method can be carried out by completing Work-

sheet Series A. To reduce paper requirements, the evaluations for the four alternatives are shown condensed on a single set of worksheets and only the applicable worksheets are reproduced. The alternatives are labeled (A), (B), (C), and (D) on the Worksheets, corresponding to the above designations. The Worksheet solution is shown in tables 7.2 through 7.9.

SETTING SUN

Table 7-2. Sample problem solution—Project identification and basic assumptions

Series A—NET SAVINGS EVALUATION

Worksheet 1. Project Identification and Basic Assumptions

A Description: Space & Water Heating

B Objective: To determine ☑ If a Project is Cost Effective

☑ The Cost-Effective Design or Size of a Project

C Building Type: ☑ Owner-occupied Residence ☐ Rental Residence ☐ Commercial

D Study Period: 10 Years.

Planned Holding Period of the Building: 10 Years.

(A) 10
(B) 10
Expected Life of the Project: (C,D) 20 Years.

E Nominal Discount Rate: 0.07

Table 7-3. Sample problem solution—Estimating the discount rate

Worksheet 2. Guidance in Estimating the Discount Rate

Part I. *Homeowner's Discount Rate*

A (1) If the project is to be financed, what is the interest rate at which the money can be borrowed? n.a. %.
(2) The interest rate (highest) on debt outstanding is 12 %.
(3) The highest rate of taxable return, before taxes, available from other investments of comparable risk is 9 %.
(4) Enter here the highest rate from A(1), A(2), and A(3): 12 %.

B (1) Find in the Federal income tax schedule the maximum rate at which your income is taxed and write this as a decimal fraction: 0.38 .
(2) Find in your State income tax form (if applicable) the maximum tax rate at which your income is taxed and write this as a decimal fraction: 0.05 .
(3) Compute a "composite marginal income tax rate." Under tax laws in effect in 1986 this can be done by multiplying the State tax (from B(2)) times the remainder of one minus the Federal tax rate (from B(1)), and adding the product to the Federal tax rate:

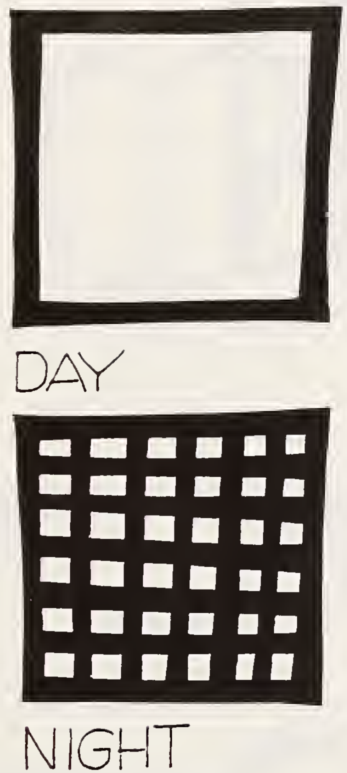
0.05	×	(1.00−0.38)	+	0.38	=	0.41
marginal State tax rate		marginal Federal tax rate		marginal Federal tax rate		composite marginal income tax rate

C Multiply the rate from A(4) times the remainder of one minus the composite marginal income tax rate (from B(3)):

12 %	×	(1−0.41)	=	7 %.
Before tax rate from A(4)		Composite marginal tax rate from B(3)		After-tax rate

D Enter the result of C expressed as a decimal fraction: 0.07.
E Enter here the highest rate of *tax-exempt* return available from other investments of comparable risk, expressed as a decimal fraction: 0.n.a..
F Enter here the higher of the rates in D and E. 0.07.
(Enter this rate on Worksheet 1, line E. This is an estimate of your after-tax, nominal discount rate.)

Notation: n.a. = not applicable



WATER

ALCOHOL

Table 7-4. Sample problem solution—Initial costs

Worksheet 3. Initial Costs

	With the Project (1)	Without the Project (Base Case) (2)	Differential Costs Attributable to the Project (3)=(1)−(2)
E Initial Costs	(B) 520 + 300 = 820 (C) 2500 + 300 = 2800 (D) $2900	(A) $300	(B) 520 (C) 2500 (D) $2600

Table 7-5. Sample problem solution—Energy savings

Series A

Worksheet 4. Energy Costs & Savings

Choose one of the following 5 Approaches to Estimating the Present Value of Energy Costs Over the Study Period:

- [x] Approach 1—Estimate future energy costs on the basis of U.S. Department of Energy Forecasts, and assume the annual quantity purchased to remain constant.
- [ ] Approach 2—Estimate future energy costs on the basis of U.S. Department of Energy Forecasts, and allow for a changing annual quantity to be purchased.
- [ ] Approach 3—Estimate future energy costs on the basis of some other forecast of future yearly energy costs and assume the annual quantity purchased to remain constant.
- [ ] Approach 4—Estimate future energy costs on the basis of some other forecast of future yearly costs and allow for a changing annual quantity to be purchased.
- [x] Approach 5—Estimate future energy costs on the basis of a projected constant rate of change in annual energy costs (due either to price or quantity change or a combination thereof) over the study period.

Complete the sections below applicable to the estimation approach chosen:

Section A. Initial Cost of Energy—Applies to Approaches 1 through 5.
For Approaches 1, 2, and 5 complete lines a through e below:

	With the Project (1)		Without the Project (Base Case) (2)		Annual Savings Attributable to the Project in 1986$ (3)=(2)−(1)	
	Energy Type 1 (oil)	Energy Type 2 (elect.)	Energy Type 1 (oil)	Energy Type 2 (elect.)	Energy Type 1 (oil)	Energy Type 2 (elect.)
a Today's Price per Unit of Purchased Energy (use your actual price if possible; otherwise default to the average of your region given in Appendix E).	(B,C,D) $1.18	(B,C) $0.092	(A) $1.18	$0.092	$—	$—
b Annual Quantity to be purchased (In same units as price per unit is stated in (a) above, if applicable.)	(B) 909 gal (C) 706 gal (D) 786 gal	(B) 4957 kWh (C) 4957 kWh (D) 0	(A) 1000 gal	(A) 4,957 kWh	(B) 91 gal (C) 294 gal (D) 214 gal	(B) 0 kWh (C) 0 kWh (D) 4957 kWh
e Total Annual Cost at Today's Price	(B) 1073 (C) 833 (D) $927	(B) 456 (C) 456 (D) $0	(A) $1180	(A) $456	(B) 107 (C) 347 (D) $253	(B) 0 (C) 0 (D) $456

AUTUMN

PRECIPITATION

AQUARIUS - THE WATER- BEARER

INSULATION

Table 7-5. Sample problem solution—Energy savings (continued)

Series A

Worksheet 4. Energy Costs & Savings (Continued)

Section B. Future Energy Savings—Applies to Approaches 1, 2, 3, and 4.

For Approaches 1 and 2: Go to Appendix B, Part I and follow instructions to derive estimates of future dollar savings for each type of energy and enter below for each year of the study period:

Year Ending:

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
SAVINGS—ENERGY TYPE 1: oil										
(B)	112[a]	122	131	142	157	172	189	207	226	247
(C)	364	394	424	462	509	559	613	670	734	802
(D)	265	287	309	337	371	408	447	489	535	585
SAVINGS—ENERGY TYPE 2: electricity										
(B)	0	0	0	0	0	0	0	0	0	0
(C)	0	0	0	0	0	0	0	0	0	0
(D)	495	542	559	585	611	641	688	714	749	796

Section D. SPW Discount Factors Applies to Approaches 1, 2, 3 and 4.

Go to Appendix A, Table 1 and find the column for the discount rate closest to the rate you specified in Worksheet 1, E. Enter the SPW discount factor corresponding to each year of the study period:

.93	.87	.82	.76	.71	.67	.62	.58	.54	.51

[a] Note: Following instructions in Appendix B, Part I, we first locate the table for New England (Table IB-1a) and find the column distillate fuel and 5% general price inflation. We then observe that the table begins in 1985, but our study period begins in 1986, so we divide the annual energy savings (computed above in Worksheet 4, Section A, line e, column 3) by the index for 1986 to derive a 1985 estimate, i.e., for oil, $107/1.03=$103.88. Now we have a base savings to which the index for each year in the study period can be applied. Since the first year of our study period ends in 1987, we multiply the base savings, $103.88, times the multiplier for 1987 to derive the estimated savings over the first year of the study period, i.e., $103.88×1.08=$112.19, which rounded is $112. For the second year's savings, we multiply the base savings times the 1988 index, i.e., $103.88×1.17=$121.54, rounded to $122, etc.

Table 7-5. Sample problem solution—Energy savings (continued)

Series A

Worksheet 4. Energy Costs & Savings (Continued)

Section E. Present Value of Each Year's Energy Costs—Applies to Approaches 1, 2, 3, and 4.
For Approaches 1 and 3, multiply each amount in Section B times the corresponding SPW discount factor in Section D and enter the results below for each year:

Year:

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Present Value Savings—ENERGY TYPE 1: oil										
(B)	104[a]	106	107	108	111	115	117	120	122	126
(C)	339	343	348	351	361	375	380	389	396	409
(D)	$246	250	253	256	263	273	277	284	289	298
Present Value Savings—ENERGY TYPE 2: electricity										
(B)	0	0	0	0	0	0	0	0	0	0
(C)	0	0	0	0	0	0	0	0	0	0
(D)	$460	472	458	445	434	429	427	414	404	406

Section F. Present Value Total Energy Savings Over the Study Period—Applies to Approaches 1, 2, 3 and 4.

a Present Value Energy Savings for Each Type of Energy: (Sum across years for each energy type in E above)

	ENERGY SAVINGS TYPE 1: oil (1)	ENERGY SAVINGS TYPE 2: elect. (2)
(B)	1136	0
(C)	3691	0
(D)	$2689	$4349

b Present Value Energy Savings—*Owner-Occupied Residential:* (b=a(1)+a(2))

(B) 1136
(C) 3691
(D) $7038

WET INSULATION

[a] $112 (from Sec. B)×.93 (from Sec. D)=$104.

THE SUN

Table 7-5. Sample problem solution—Energy savings (continued)

Series A

Worksheet 4. Energy Costs & Savings (Continued)

Section G. Present Value of Energy Savings Over the Study Period—Applies Only to Approach 5.[a]

		ENERGY TYPE 1 (1)	ENERGY TYPE 2 (2)
a	Average Annual Compound Rate of Change in Energy Costs Forecasted Over the Study Period:	0.05	0.05
b	Difference Between the Discount Rate and the Projected Annual Rate of Change in Energy Costs: (Gb=(Worksheet 1, E)−(Worksheet 4, Ga))	0.02	0.02
c	Present Value Multiplier [Go to Appendix B, Part II (p. B-24) and follow instructions for finding the appropriate multiplier for energy savings in Table BII. The difference computed in Gb above is used to locate the multiplier.]	9	9
d	Present Value Energy Savings Over the Study Period (Gd=c×(Worksheet 4, Ae(3) Energy Type)×(Worksheet 4, Gc))	(B) 963[b] (C) 3123 (D) $2277	(B) 0 (C) 0 (D) $4104
e	Present Value Energy Savings—*Owner-Occupied Residential:* (e=d(1)+d(2))	(B) 963 (C) 3123 (D) $6381	

[a] Completed for the purpose of performing sensitivity analysis.
[b] 9×\$107=\$963; 9×\$347=\$3,123; 9×\$253=\$2,277.

Table 7-6. Sample problem solution—Annual O&M (non-energy) costs

Series A

Worksheet 5. Annually Recurring Non-Energy Costs & Savings (e.g., Routine Maintenance)

	With the Project (1)	Without the Project (Base Case) (2)	Savings(+) or Extra Costs(−) Attributable to the Project (3)=(2)−(1)
	(B) 75		(B) 0
A Annual Costs (Priced at the beginning of the study period)	(C) 75		(C) 0
	(D) $ 75	(A) $ 75	(D) $ 0

COOLING

Results of the Net Savings Evaluation. According to the results shown in Table 7-8, each of the alternatives under consideration (Project Alternatives B, C, or D) is expected to be cost effective, in that each is estimated to result in positive net savings. However, Alternative D (replacing the existing boiler-burner and the electric water heater with a package boiler equipped with a tankless domestic water heater) is estimated to have the highest net savings, and, therefore, to be the most cost effective.

Net savings from Alternative D are estimated at the low end to be $3,781, and at the high end, $5,598. The low end of the range reflects the assumptions that energy prices will rise at the same rate as general price inflation (assumed to be 5 percent per annum), and that the system (which is estimated to have a 20-year life) will not add to the resale value of the house if the house is sold in 10 years. The high end of the range reflects the assumptions that energy prices will increase at real rates corresponding to the U.S. Department of Energy's 1985-86 projections, plus the assumed general rate of price inflation of 5 percent, and that the system will increase the resale value of the house in 10 years by an amount equal to half its first cost as measured in 1986 dollars and adjusted for a general inflation rate of 5 percent.

In contrast, estimated net savings from Alternative C (a package boiler without the tankless domestic water heater) range from a low of $623, to a high of $2,191. Estimated net savings from Alternative B (burner replacement) range from $443 to $616. Hence, it is concluded that the preferred course of action is to replace the existing burner and boiler and electric water heater with a high efficiency package boiler equipped with a tankless domestic water heater.

Table 7-7. Sample problem solution—Resale value

Series A

Worksheet 7. Change in Resale or Scrap Value

		With the Project (1)	Without the Project (Base Case) (2)	Increase(+) or Decrease(−) Attributable to the Project (3)=(1)−(2)
A	Year of Resale or Disposal 10			
B	Resale/Scrap Amount[a] (Valued as though received at the beginning of the study period)	(B) 0 (C) 0 or 1250 (D) $ 0 or 1450	(A) $ 0	
C	Amount of Selling/Disposal Costs (Valued as though incurred at the beginning of the study period)	(B) 0 (C) 0 (D) $ 0	(A) $ 0	
D	Net Resale/Scrap Proceeds (D=B−C)	(B) 0 (C) 0 or 1250 (D) $ 0 or 1450	(A) $ 0	(B) 0 (C) 0 or 1250 (D) $ 0 or 1450

E Average Annual Compound Rate of Change in net resale/scrap value forecasted over the study period[b]: 0.05.

F Difference between the discount rate and the projected rate of change in net resale: 0.02.
(F=Worksheet 1, E−Worksheet 7, E)

G Present Value Multiplier 0.8
[Go to Appendix C and follow instructions for finding the appropriate multiplier(s) in Table C.1 for the year in which the resale or disposal occurs (A above) and enter it here.]

H Present Value Net Resale/Scrap Increase(+) or Decrease(−)—*Owner-Occupied Residential/Rental Residential or Nonresidential*[c]:
(H=D(3)×G)
(B) 0
(C) 0 or 1000[d]
(D) $ 0 or 1160

[a] Multiple values are given for the purpose of performing sensitivity analysis.
[b] Projected to change at the assumed rate of general price inflation of 5% per annum.
[c] Capital gains and depreciation recapture taxes are not treated in this Worksheet approach.
[d] $1,250×0.8=$1,000; $1,450×0.8=$1,160.

Table 7-8. Sample problem solution—Net savings

Series A

Worksheet 8. Total Net Savings in Present Value Dollars

		Alternative B	Alternative C	Alternative D
A	Energy Savings (From Worksheet 4, F(b) or G(e)[a]	$963–1136	$3123–3691	$6381-7038
B	Annually Recurring Non-Energy Savings(+) or Cost Increase(−) (From Worksheet 5)	$ 0	$ 0	$ 0
C	Non-Annually Recurring Costs Savings(+) or Cost Increase(−) (From Worksheet 6, F)	$ 0	$ 0	$ 0
D	Resale or Scrap Value Increase(+) or Decrease(−) (From Worksheet 7, H)[b]	$ 0	$ 0–1000	$ 0 – 1160
E	Total Savings (E=A+B+C+D, remembering to observe signs designating increases or decreases)[c]	$963–1136	$3123–4691	$6381–8198
F	Initial Costs Increase (From Worksheet 3, E)	$520	$2500	$2600
G	Net Savings (or Net Losses) of Project (G=E−F)[c]	$443–616	$623–2191	$3781-5598

[a] Low estimate is from Worksheet 4, G(e) and reflects energy prices escalating at the assumed general price inflation rate of 5%. High estimate is from Worksheet 4, F(b) and reflects energy prices changing at the DoE-projected rates, over and above the assumed general price inflation rate of 5%.

[b] $0 is based on the assumption that no resale will be obtained; the positive amounts on the assumption that the replacement package boiler and tankless water heater will retain half their original value, adjusted for the assumed rate of general price inflation of 5% per annum.

[c] As part of the sensitivity analysis, other combinations could be tested, such as for Alt. C, ($3,123+$1,000)−$2,500=$1,623. However, since it is clear that Alt. C exceeds Alt. B and Alt. D exceeds Alt. C for all combinations of energy savings and resale values, only the low and high ends of the range for each alternative is shown.

Notation: n.a. = not applicable.

Supplementary Evaluation: Payback. Because the family is not sure exactly when it will sell the house and how much, if any, of the project costs can be recovered through resale, a payback evaluation of Alternative D may be of interest to estimate the number of years until energy savings are expected to cover the initial investment. Note, however, that the payback measure is *not* relied upon to make the choice among the alternative versions of the project, because it can give misleading results. (In this case, the payback measure would suggest that there is little difference between B and D.)

SUN WITH THREE RAYS

To provide a quick approximation of payback, simple and discounted payback are calculated using Series B, Worksheet 1, as shown in Table 7-9. The result is a simple payback of 3.7 years and a discounted payback between 4 and 5 years—well within the period the family plans to occupy the house. Hence, the payback evaluation supports the conclusion that this project is worth undertaking.

Table 7-9. Sample problem solution—Payback

Series B—Payback Evaluation

Worksheet 1. Simple and Discounted Payback—Applies When Future Annual Cash Flows are Constant

		Differential Costs or Savings Attributable to the Project
D	Initial Costs (Series A–Worksheet 3, E(3))	(D) $ 2600
E	Total Annual Energy Savings at Today's Prices (Series A–Worksheet 4, Ae(3), summation across energy types)	$ 253 + 456 = 709
F	Amount of Annually Recurring Non-Energy Extra Costs(−) or Savings(+) at Today's Prices (Series A-Worksheet 5, A(3))	$ 0

G Simple Payback (SPB) ($G=D \div (E+F)$) 3.7 years

H Discounted Payback (DPB) 4-5 years
[First specify a discount rate: 7 %. Then go to Appendix A, Table A.4 and find the column for the specified discount rate. Search down that column for the UPW factor closest in value to the simple payback found in line G above. In the left hand column "Period," read off the corresponding number and enter it here.]

Computer Solution. Now let us assume the family has a home computer and uses the "NBSLCC" program described in Chapter 6 to evaluate the project alternatives.

The first step is to prepare building characteristics files for each of the alternatives. This can be done most easily by preparing a file for alternative A and then modifying that file for each alternative, saving the base case file and the file for each modification.

Tables 7-10, 7-11, 7-12, and 7-13 show the building characteristics files for the base case, designated ALTA and for Alternatives B, C, and D, designated ALTB, ALTC, and ALTD, respectively. Tables 7-14, 7-15, 7-16 and 7-17 show the life-cycle cost analysis for the base case and each alternative. Tables 7-18, 7-19, and 7-20 show the results of comparing Alternatives B, C, and D, respectively, against the base case, A, using DoE-projected energy prices and assuming that resale value is realized for Alternatives C and D. Table 7-21 summarizes the results of using NBSLCC to perform sensitivity analysis of the alternative assumptions stated in Table 7-1 regarding energy prices and resale value.

The results show Alternative D to be the most cost-effective choice, regardless of which assumptions are made about energy price projections and resale value. For Alternative D, net savings are estimated to range from $3,794 to $5,645. From Table 7-20, it may be seen that the savings-to-investment ratio is estimated at 3.17, and the internal rate of return at 20 percent.

Please note that it is not necessary to print out all the tables to perform the computer analysis. Screen display of the building characateristics files and the life cycle cost results is possible. A "hard copy" of the comparative report alone will generally suffice since it contains a summary of principal study parameters, intermediate values, and final results. A printout of all three kinds of reports as shown here, however, provides a more detailed account of the analysis.

Comparing the computer program results with the worksheet results shows that there is no substantial difference between the two. If net savings were rounded to the nearest $100, there would be no difference between the results of the Worksheet Approach and the computer approach for any of the project alternatives evaluated. The differences that exist reflect less precision in rounding in the Worksheet Approach, particularly in the Appendix C multipliers.

Another difference is the economic measures calculated. The Worksheet Approach provides calculation of net savings, payback and savings-to-investment ratio (the latter was not required to solve this problem). The computer program calculates life-cycle costs, net savings, savings-to-investment ratio and adjusted internal rate of return, the last three measures automatically being provided when the "compare" subroutine is run. It does not compute payback.

Table 7-10. Building characteristics file for alternative A, keep boiler-burner and replace electric water heater with like system

```
BUILDING CHARACTERISTICS FILE
-----------------------------

FILE NAME: ALTA
FILE LAST MODIFIED ON 02-12-1986  04:30:48

PROJECT TITLE: HEATING SYSTEM-ALTA
---------------------------------

BASIC LCC ANALYSIS ASSUMPTIONS:
-------------------------------------
BASE DATE FOR LCC ANALYSIS: 1986
STUDY PERIOD:  10 YEARS
OCCUPANCY DATE: 1986
DISCOUNT AND INTEREST RATES INCLUDE INFLATION (NOMINAL)
GENERAL INFLATION RATE =  5.0%
DISCOUNT RATE:  7.0%
TAX STATUS: PRIVATE RESIDENCE (2)
MARGINAL FEDERAL INCOME TAX RATE: 38.0%
MARGINAL STATE INCOME TAX RATE:    5.0%
PROPERTY TAX RATE (% OF ASSESSED VALUE):  0.0%
CAPITAL GAINS ADJUSTMENT FACTOR:  0.0%
DEPRECIATION RECAPTURE CODE: 0
DEPRECIATION BASIS ADJ. FACTOR:  0.0
SALES TAX RATE:  0.0%

CAPITAL COMPONENT AND REPLACEMENT COST DATA:
--------------------------------------------
NUMBER OF CAPITAL COMPONENTS: 2
CAPITAL COMPONENT DATA:
COMPONENT NAME                   BURNER/BOI    HOT WATER
INITIAL COST                          0           300
PERCENT SUBJECT TO SALES TAX        0.00%        0.00%
EXPECTED COMPONENT LIFE(YRS)         10           10
DEPRECIATION CODE                 NONE (0)      NONE (0)
DEPRECIATION LIFE (YEARS)             0            0
DEPR. ACCELERATION RATE             0.00%        0.00%
SALVAGE VALUE FACTOR                0.00%        0.00%
ADD'L FIRST YR DEPRECIATION         0.00%        0.00%
AVG PRICE ESC RT DURING CONST.*     0.00%        0.00%
AVG PRICE ESC RT DURING OCC.*       0.00%        0.00%
PROP. TAX ASSESSMENT FACTOR         0.00%        0.00%
TAX CREDIT RATE                     0.00%        0.00%
RESALE VALUE FACTOR                 0.00%        0.00%
NUMBER OF REPLACEMENTS                0            0

COST-PHASING SCHEDULE BY YEAR OF CONSTRUCTION AND AT OCCUPANCY:
               AT OCCUPANCY       100.00%      100.00%

NO REPLACEMENTS TO ANY CAPITAL COMPONENTS


OPERATING AND MAINTENANCE COST DATA:
-----------------------------------
ANNUAL RECURRING O AND M COST =     $75
ANNUAL RATE OF INCREASE FOR A.R.C.* =  0.00%
NUMBER OF NON-ANNUAL RECURRING O AND M COSTS = 0
ANNUAL RATE OF INCREASE FOR N.A.R.C. COSTS* =  0.0%
ENERGY COST DATA:
----------------
NUMBER OF ENERGY TYPES = 2

ENERGY TYPE NO. 1 = DISTILLATE OIL
AVG ANNUAL CONSUMPTION =      149.7 MILLION BTU
PRICE PER MILLION BTU = $7.88
ANNUAL DEMAND (AND/OR OTHER CHARGE) =      $0
ESCALATION RATE METHOD = 2
ENERGY PRICE ESCALATION RATES DURING STUDY PERIOD*
  YEAR   RATE     YEAR   RATE
  1986   0.13%    1991   4.82%
  1987   2.96%    1992   4.49%
  1988   2.88%    1993   4.40%
  1989   3.05%    1994   4.22%
  1990   4.94%    1995   3.75%
```

ENERGY TYPE NO. 2 = ELECTRICITY
AVG ANNUAL CONSUMPTION =   16.9 MILLION BTU
PRICE PER MILLION BTU =$26.96
ANNUAL DEMAND (AND/OR OTHER CHARGE) = $0
ESCALATION RATE METHOD = 2
ENERGY PRICE ESCALATION RATES DURING STUDY PERIOD*

YEAR	RATE	YEAR	RATE
1986	3.34%	1991	-0.19%
1987	4.38%	1992	2.21%
1988	-2.12%	1993	-1.29%
1989	-0.19%	1994	-0.04%
1990	-0.37%	1995	1.30%

*ALL ESCALATION RATES ARE IN REAL TERMS (I.E., NET OF GENERAL INFLATION.)

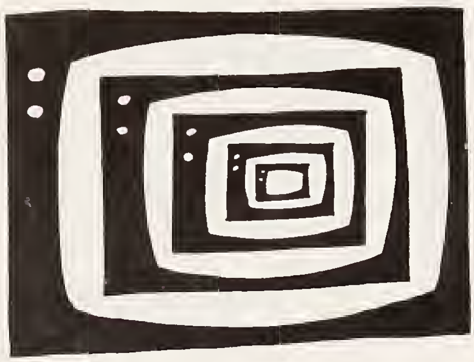


Table 7-11. Building characteristics file for alternative B, replace burner and electric water heater with like system

```
BUILDING CHARACTERISTICS FILE
-----------------------------

FILE NAME: ALTB
FILE LAST MODIFIED ON 02-12-1986  04:35:12

PROJECT TITLE: HEATING SYSTEM-ALTB
--------------------------------

BASIC LCC ANALYSIS ASSUMPTIONS:
------------------------------------
BASE DATE FOR LCC ANALYSIS: 1986
STUDY PERIOD:  10 YEARS
OCCUPANCY DATE: 1986
DISCOUNT AND INTEREST RATES INCLUDE INFLATION (NOMINAL)
GENERAL INFLATION RATE =  5.0%
DISCOUNT RATE:  7.0%
TAX STATUS: PRIVATE RESIDENCE (2)
MARGINAL FEDERAL INCOME TAX RATE: 38.0%
MARGINAL STATE INCOME TAX RATE:    5.0%
PROPERTY TAX RATE (% OF ASSESSED VALUE):  0.0%
CAPITAL GAINS ADJUSTMENT FACTOR:  0.0%
DEPRECIATION RECAPTURE CODE: 0
DEPRECIATION BASIS ADJ. FACTOR:  0.0
SALES TAX RATE:  0.0%

CAPITAL COMPONENT AND REPLACEMENT COST DATA:
--------------------------------------------
NUMBER OF CAPITAL COMPONENTS: 2
CAPITAL COMPONENT DATA:
COMPONENT NAME                    BURNER/BOI    HOT WATER
INITIAL COST                          520          300
PERCENT SUBJECT TO SALES TAX        0.00%        0.00%
EXPECTED COMPONENT LIFE(YRS)           10           10
DEPRECIATION CODE                 NONE (0)     NONE (0)
DEPRECIATION LIFE (YEARS)               0            0
DEPR. ACCELERATION RATE             0.00%        0.00%
SALVAGE VALUE FACTOR                0.00%        0.00%
ADD'L FIRST YR DEPRECIATION         0.00%        0.00%
AVG PRICE ESC RT DURING CONST.*     0.00%        0.00%
AVG PRICE ESC RT DURING OCC.*       0.00%        0.00%
PROP. TAX ASSESSMENT FACTOR         0.00%        0.00%
TAX CREDIT RATE                     0.00%        0.00%
RESALE VALUE FACTOR                 0.00%        0.00%
NUMBER OF REPLACEMENTS                  0            0

COST-PHASING SCHEDULE BY YEAR OF CONSTRUCTION AND AT OCCUPANCY:
               AT OCCUPANCY       100.00%      100.00%

NO REPLACEMENTS TO ANY CAPITAL COMPONENTS


OPERATING AND MAINTENANCE COST DATA:
-----------------------------------
ANNUAL RECURRING O AND M COST =     $75
ANNUAL RATE OF INCREASE FOR A.R.C.* =  0.00%
NUMBER OF NON-ANNUAL RECURRING O AND M COSTS = 0
ANNUAL RATE OF INCREASE FOR N.A.R.C. COSTS* =  0.0%
ENERGY COST DATA:
----------------
NUMBER OF ENERGY TYPES = 2

ENERGY TYPE NO. 1 = DISTILLATE OIL
AVG ANNUAL CONSUMPTION =     136.1 MILLION BTU
PRICE PER MILLION BTU = $7.88
ANNUAL DEMAND (AND/OR OTHER CHARGE) =     $0
ESCALATION RATE METHOD = 2
ENERGY PRICE ESCALATION RATES DURING STUDY PERIOD*
  YEAR   RATE     YEAR   RATE
  1986   0.13%    1991   4.82%
  1987   2.96%    1992   4.49%
  1988   2.88%    1993   4.40%
  1989   3.05%    1994   4.22%
  1990   4.94%    1995   3.75%
```

```
ENERGY TYPE NO. 2 = ELECTRICITY
AVG ANNUAL CONSUMPTION =      16.9 MILLION BTU
PRICE PER MILLION BTU =$26.96
ANNUAL DEMAND (AND/OR OTHER CHARGE) =     $0
ESCALATION RATE METHOD = 2
ENERGY PRICE ESCALATION RATES DURING STUDY PERIOD*
  YEAR    RATE      YEAR    RATE
  1986    3.34%     1991   -0.19%
  1987    4.38%     1992    2.21%
  1988   -2.12%     1993   -1.29%
  1989   -0.19%     1994   -0.04%
  1990   -0.37%     1995    1.30%

 *ALL ESCALATION RATES ARE IN REAL TERMS (I.E., NET OF GENERAL INFLATION.)
```

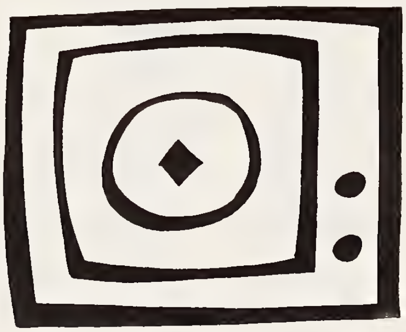


Table 7-12. Building characteristic file for alternative C, replace boiler-burner with package boiler and replace electric water heater with like system

```
BUILDING CHARACTERISTICS FILE
-----------------------------

FILE NAME: ALTCR
FILE LAST MODIFIED ON 02-12-1986   05:53:23

PROJECT TITLE: HEATING SYSTEM-ALTCR
--------------------------------

BASIC LCC ANALYSIS ASSUMPTIONS:
------------------------------------
BASE DATE FOR LCC ANALYSIS: 1986
STUDY PERIOD:  10 YEARS
OCCUPANCY DATE: 1986
DISCOUNT AND INTEREST RATES INCLUDE INFLATION (NOMINAL)
GENERAL INFLATION RATE =  5.0%
DISCOUNT RATE:  7.0%
TAX STATUS: PRIVATE RESIDENCE (2)
MARGINAL FEDERAL INCOME TAX RATE: 38.0%
MARGINAL STATE INCOME TAX RATE:    5.0%
PROPERTY TAX RATE (% OF ASSESSED VALUE):  0.0%
CAPITAL GAINS ADJUSTMENT FACTOR:  0.0%
DEPRECIATION RECAPTURE CODE: 0
DEPRECIATION BASIS ADJ. FACTOR:  0.0
SALES TAX RATE:  0.0%

CAPITAL COMPONENT AND REPLACEMENT COST DATA:
-------------------------------------------
NUMBER OF CAPITAL COMPONENTS: 2
CAPITAL COMPONENT DATA:
COMPONENT NAME                       PACKAGE BO    HOT WATER
INITIAL COST                           2500           300
PERCENT SUBJECT TO SALES TAX          0.00%         0.00%
EXPECTED COMPONENT LIFE(YRS)            20            10
DEPRECIATION CODE                    NONE (0)      NONE (0)
DEPRECIATION LIFE (YEARS)               0             0
DEPR. ACCELERATION RATE               0.00%         0.00%
SALVAGE VALUE FACTOR                  0.00%         0.00%
ADD'L FIRST YR DEPRECIATION           0.00%         0.00%
AVG PRICE ESC RT DURING CONST.*       0.00%         0.00%
AVG PRICE ESC RT DURING OCC.*         0.00%         0.00%
PROP. TAX ASSESSMENT FACTOR           0.00%         0.00%
TAX CREDIT RATE                       0.00%         0.00%
RESALE VALUE FACTOR                  50.00%         0.00%
NUMBER OF REPLACEMENTS                  0             0

COST-PHASING SCHEDULE BY YEAR OF CONSTRUCTION AND AT OCCUPANCY:
                AT OCCUPANCY       100.00%       100.00%

NO REPLACEMENTS TO ANY CAPITAL COMPONENTS


OPERATING AND MAINTENANCE COST DATA:
-----------------------------------
ANNUAL RECURRING O AND M COST =      $75
ANNUAL RATE OF INCREASE FOR A.R.C.* =  0.00%
NUMBER OF NON-ANNUAL RECURRING O AND M COSTS = 0
ANNUAL RATE OF INCREASE FOR N.A.R.C. COSTS* =  0.0%
ENERGY COST DATA:
----------------
NUMBER OF ENERGY TYPES = 2

ENERGY TYPE NO. 1 = DISTILLATE OIL
AVG ANNUAL CONSUMPTION =      105.7 MILLION BTU
PRICE PER MILLION BTU = $7.88
ANNUAL DEMAND (AND/OR OTHER CHARGE) =      $0
ESCALATION RATE METHOD = 2
ENERGY PRICE ESCALATION RATES DURING STUDY PERIOD*
  YEAR   RATE      YEAR   RATE
  1986   0.13%     1991   4.82%
  1987   2.96%     1992   4.49%
  1988   2.88%     1993   4.40%
  1989   3.05%     1994   4.22%
  1990   4.94%     1995   3.75%
```

ENERGY TYPE NO. 2 = ELECTRICITY
AVG ANNUAL CONSUMPTION = 16.9 MILLION BTU
PRICE PER MILLION BTU =$26.96
ANNUAL DEMAND (AND/OR OTHER CHARGE) = $0
ESCALATION RATE METHOD = 2
ENERGY PRICE ESCALATION RATES DURING STUDY PERIOD*

YEAR	RATE	YEAR	RATE
1986	3.34%	1991	-0.19%
1987	4.38%	1992	2.21%
1988	-2.12%	1993	-1.29%
1989	-0.19%	1994	-0.04%
1990	-0.37%	1995	1.30%

*ALL ESCALATION RATES ARE IN REAL TERMS (I.E., NET OF GENERAL INFLATION.)

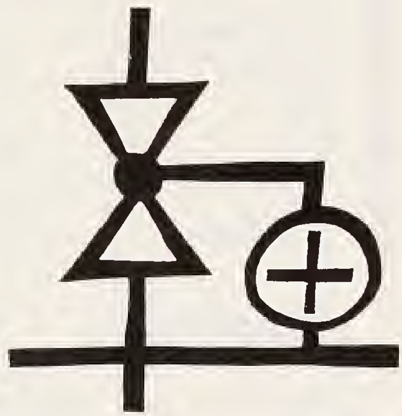


Table 7-13. Building characteristics file for alternative D, replace boiler-burner and electric water heater with package boiler/tankless domestic water heater

```
BUILDING CHARACTERISTICS FILE
-----------------------------

FILE NAME: ALTDR
FILE LAST MODIFIED ON 02-12-1986  05:48:33

PROJECT TITLE: HEATING SYSTEM-ALTDR
---------------------------------

BASIC LCC ANALYSIS ASSUMPTIONS:
-------------------------------------
BASE DATE FOR LCC ANALYSIS: 1986
STUDY PERIOD:  10 YEARS
OCCUPANCY DATE: 1986
DISCOUNT AND INTEREST RATES INCLUDE INFLATION (NOMINAL)
GENERAL INFLATION RATE =  5.0%
DISCOUNT RATE:  7.0%
TAX STATUS: PRIVATE RESIDENCE (2)
MARGINAL FEDERAL INCOME TAX RATE: 38.0%
MARGINAL STATE INCOME TAX RATE:    5.0%
PROPERTY TAX RATE (% OF ASSESSED VALUE):  0.0%
CAPITAL GAINS ADJUSTMENT FACTOR:  0.0%
DEPRECIATION RECAPTURE CODE: 0
DEPRECIATION BASIS ADJ. FACTOR:  0.0
SALES TAX RATE:  0.0%

CAPITAL COMPONENT AND REPLACEMENT COST DATA:
--------------------------------------------
NUMBER OF CAPITAL COMPONENTS: 1
CAPITAL COMPONENT DATA:
COMPONENT NAME                     PACKAGE BO
INITIAL COST                         2900
PERCENT SUBJECT TO SALES TAX        0.00%
EXPECTED COMPONENT LIFE(YRS)           20
DEPRECIATION CODE                 NONE (0)
DEPRECIATION LIFE (YEARS)               0
DEPR. ACCELERATION RATE             0.00%
SALVAGE VALUE FACTOR                0.00%
ADD'L FIRST YR DEPRECIATION         0.00%
AVG PRICE ESC RT DURING CONST.*     0.00%
AVG PRICE ESC RT DURING OCC.*       0.00%
PROP. TAX ASSESSMENT FACTOR         0.00%
TAX CREDIT RATE                     0.00%
RESALE VALUE FACTOR                50.00%
NUMBER OF REPLACEMENTS                  0

COST-PHASING SCHEDULE BY YEAR OF CONSTRUCTION AND AT OCCUPANCY:
               AT OCCUPANCY       100.00%

NO REPLACEMENTS TO ANY CAPITAL COMPONENTS


OPERATING AND MAINTENANCE COST DATA:
-----------------------------------
ANNUAL RECURRING O AND M COST =     $75
ANNUAL RATE OF INCREASE FOR A.R.C.* =  0.00%
NUMBER OF NON-ANNUAL RECURRING O AND M COSTS = 0
ANNUAL RATE OF INCREASE FOR N.A.R.C. COSTS* =  0.0%
ENERGY COST DATA:
----------------
NUMBER OF ENERGY TYPES = 2

ENERGY TYPE NO. 1 = DISTILLATE OIL
AVG ANNUAL CONSUMPTION =      117.7 MILLION BTU
PRICE PER MILLION BTU = $7.88
ANNUAL DEMAND (AND/OR OTHER CHARGE) =      $0
ESCALATION RATE METHOD = 2
ENERGY PRICE ESCALATION RATES DURING STUDY PERIOD*
  YEAR   RATE     YEAR   RATE
  1986   0.13%    1991   4.82%
  1987   2.96%    1992   4.49%
  1988   2.88%    1993   4.40%
  1989   3.05%    1994   4.22%
  1990   4.94%    1995   3.75%
```

```
ENERGY TYPE NO. 2 = ELECTRICITY
AVG ANNUAL CONSUMPTION =        0.0 MILLION BTU
PRICE PER MILLION BTU =$26.96
ANNUAL DEMAND (AND/OR OTHER CHARGE) =      $0
ESCALATION RATE METHOD = 2
ENERGY PRICE ESCALATION RATES DURING STUDY PERIOD*
  YEAR   RATE      YEAR   RATE
  1986   3.34%     1991  -0.19%
  1987   4.38%     1992   2.21%
  1988   2.12%     1993  -1.29%
  1989  -0.19%     1994  -0.04%
  1990  -0.37%     1995   1.30%

 *ALL ESCALATION RATES ARE IN REAL TERMS (I.E., NET OF GENERAL INFLATION.)
```

Table 7-14. LCC analysis of alternative A

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
*                         N B S L C C   A N A L Y S I S                        *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                 PART I - INITIAL ASSUMPTIONS AND COST DATA
  -------------------------------------------------------------------------

       PROJECT NAME:  HEATING SYSTEM-ALTA
       RUN DATE:03-06-1986 15:20:48
       BLDG. CHAR. FILE: ALTA.BCF, LAST MODIFIED 02-12-1986  04:30:48
       LCC OUTPUT FILE:  ALTA.LCC, CREATED 03-06-1986 14:31:51
       STUDY PERIOD:        10 YEARS (1986 TO 1996)
       GENERAL INFLATION RATE:  5.0%
       DISCOUNT RATE:   7.0%    (INCLUDING GENERAL INFLATION)
       TAX STATUS: PRIVATE RESIDENCE (TAX PAYING)
       INCOME TAX RATE:  41.1%  (COMBINED FEDERAL, STATE, LOCAL)
       EFFECTIVE CAPITAL GAINS TAX RATE:   0.0%
       NOMINAL PROPERTY TAX RATE:   0.00%
       NOMINAL SALES TAX RATE:  0.00%

                INITIAL CAPITAL COMPONENT COSTS (NOT DISCOUNTED)
  -------------------------------------------------------------------------

                                                                  TOTAL COST
                                                                 ------------
     TOTAL FOR BURNER/BOILER                                              $0
     TOTAL FOR HOT WATER HEATER                                         $300
                                                                 ------------
     TOTAL PROJECT COST (ACTUAL)                                        $300

                          ENERGY-RELATED COSTS
  -------------------------------------------------------------------------
        ENERGY      MMBTU/     PRICE     DEMAND      TOTAL
         TYPE        YEAR    ($/MMBTU)    COST     P.V. COST
      ----------- -------- ----------  -------   ----------
      DISTILLATE    149.7     $7.88         $0      $12581
      ELECTRICITY    16.9    $26.96         $0       $4352

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                      PART II  -  LIFE-CYCLE COST ANALYSIS
              DISCOUNT RATE =  7.0%  (INCLUDING GENERAL INFLATION)
  -------------------------------------------------------------------------
PROJECT NAME: HEATING SYSTEM-ALTA                 RUN DATE: 03-06-1986/15:20:48

                                               PRESENT VALUE      ANNUAL VALUE**
                                              (1986 DOLLARS)     (1986 DOLLARS)
                                              --------------     --------------

 A. CASH REQUIREMENTS AS OF OCCUPANCY                  $300                $33

 C. OPERATING, MAINTENANCE & RELATED COSTS:
    ANNUALLY RECURRING COSTS (NON-ENERGY)              $677                $75
    ENERGY COSTS                                    $16,933             $1,876
                                                ------------       ------------
     SUBTOTAL                                       $17,610             $1,951

 F. REMAINING VALUE AT END OF OCCUPANCY      (           $0)    (          $0)

 G. TOTAL LIFE-CYCLE PROJECT COST:
    WITHOUT INCOME TAX ADJUSTMENTS                  $17,910             $1,984
       WITH INCOME TAX ADJUSTMENTS                  $17,910             $1,984
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
 *INCOME TAX SAVINGS ARE DISCOUNTED FROM THE END OF THE YEAR IN WHICH THEY ARE
  EARNED; TAX CREDITS AND TAX SAVINGS FROM SALES TAX ON INITIAL INVESTMENT ARE
  CREDITED AT THE END OF THE FIRST YEAR OF OCCUPANCY.
**ANNUAL VALUE DOES NOT INCLUDE GENERAL INFLATION.
```

Table 7-15. LCC analysis of alternative B

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
*                        N B S L C C   A N A L Y S I S                        *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                PART I - INITIAL ASSUMPTIONS AND COST DATA
     -------------------------------------------------------------------------

          PROJECT NAME:  HEATING SYSTEM-ALTB
          RUN DATE:03-06-1986 15:25:12
          BLDG. CHAR. FILE: ALTB.BCF, LAST MODIFIED 02-12-1986  04:35:12
          LCC OUTPUT FILE:  ALTB.LCC, CREATED 03-06-1986 14:34:19
          STUDY PERIOD:        10 YEARS (1986 TO 1996)
          GENERAL INFLATION RATE:  5.0%
          DISCOUNT RATE:   7.0%    (INCLUDING GENERAL INFLATION)
          TAX STATUS: PRIVATE RESIDENCE (TAX PAYING)
          INCOME TAX RATE:  41.1%  (COMBINED FEDERAL, STATE, LOCAL)
          EFFECTIVE CAPITAL GAINS TAX RATE:   0.0%
          NOMINAL PROPERTY TAX RATE:   0.00%
          NOMINAL SALES TAX RATE:  0.00%

              INITIAL CAPITAL COMPONENT COSTS (NOT DISCOUNTED)
     -------------------------------------------------------------------------

                                                                  TOTAL COST
                                                                 ------------
       TOTAL FOR BURNER/BOILER                                           $520
       TOTAL FOR HOT WATER HEATER                                        $300
                                                                 ------------
       TOTAL PROJECT COST (ACTUAL)                                       $820

                           ENERGY-RELATED COSTS
     -------------------------------------------------------------------------
          ENERGY      MMBTU/     PRICE     DEMAND      TOTAL
           TYPE        YEAR    ($/MMBTU)    COST     P.V. COST
         ----------- -------- ---------- -------   ----------
         DISTILLATE     136.1     $7.88       $0       $11436
         ELECTRICITY     16.9    $26.96       $0        $4352

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                   PART II  -  LIFE-CYCLE COST ANALYSIS
              DISCOUNT RATE =  7.0%  (INCLUDING GENERAL INFLATION)
     -------------------------------------------------------------------------
 PROJECT NAME: HEATING SYSTEM-ALTB             RUN DATE: 03-06-1986/15:25:13

                                               PRESENT VALUE     ANNUAL VALUE**
                                              (1986 DOLLARS)    (1986 DOLLARS)
                                              --------------    --------------

  A. CASH REQUIREMENTS AS OF OCCUPANCY                  $820               $91

  C. OPERATING, MAINTENANCE & RELATED COSTS:
     ANNUALLY RECURRING COSTS (NON-ENERGY)              $677               $75
     ENERGY COSTS                                    $15,788            $1,749
                                                ------------      ------------
      SUBTOTAL                                       $16,465            $1,824

  F. REMAINING VALUE AT END OF OCCUPANCY    (            $0)   (           $0)

  G. TOTAL LIFE-CYCLE PROJECT COST:
     WITHOUT INCOME TAX ADJUSTMENTS                  $17,285            $1,915
        WITH INCOME TAX ADJUSTMENTS                  $17,285            $1,915

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
 *INCOME TAX SAVINGS ARE DISCOUNTED FROM THE END OF THE YEAR IN WHICH THEY ARE
  EARNED; TAX CREDITS AND TAX SAVINGS FROM SALES TAX ON INITIAL INVESTMENT ARE
  CREDITED AT THE END OF THE FIRST YEAR OF OCCUPANCY.
**ANNUAL VALUE DOES NOT INCLUDE GENERAL INFLATION.
```

Table 7-16. LCC analysis of alternative C (includes resale value)

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
*                  N B S L C C    A N A L Y S I S                             *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

              PART I - INITIAL ASSUMPTIONS AND COST DATA
 ------------------------------------------------------------------------

      PROJECT NAME:  HEATING SYSTEM-ALTCR
      RUN DATE:03-06-1986 15:27:57
      BLDG. CHAR. FILE: ALTCR.BCF, LAST MODIFIED 02-12-1986  05:53:23
      LCC OUTPUT FILE:  ALTCR.LCC, CREATED 03-06-1986 14:35:27
      STUDY PERIOD:         10 YEARS (1986 TO 1996)
      GENERAL INFLATION RATE:  5.0%
      DISCOUNT RATE:   7.0%    (INCLUDING GENERAL INFLATION)
      TAX STATUS: PRIVATE RESIDENCE (TAX PAYING)
      INCOME TAX RATE:  41.1%  (COMBINED FEDERAL, STATE, LOCAL)
      EFFECTIVE CAPITAL GAINS TAX RATE:   0.0%
      NOMINAL PROPERTY TAX RATE:   0.00%
      NOMINAL SALES TAX RATE:  0.00%

             INITIAL CAPITAL COMPONENT COSTS (NOT DISCOUNTED)
 ------------------------------------------------------------------------

                                                            TOTAL COST
                                                           ------------
    TOTAL FOR PACKAGE BOILER                                    $2,500
    TOTAL FOR HOT WATER HEATER                                    $300
                                                           ------------
    TOTAL PROJECT COST (ACTUAL)                                 $2,800

                        ENERGY-RELATED COSTS
 ------------------------------------------------------------------------
         ENERGY     MMBTU/     PRICE      DEMAND      TOTAL
          TYPE       YEAR    ($/MMBTU)     COST     P.V. COST
       ----------- -------- ----------  -------   ----------
       DISTILLATE    105.7     $7.88          $0        $8882
       ELECTRICITY    16.9    $26.96          $0        $4352

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                  PART II  -  LIFE-CYCLE COST ANALYSIS
              DISCOUNT RATE =  7.0%  (INCLUDING GENERAL INFLATION)
 ------------------------------------------------------------------------
PROJECT NAME: HEATING SYSTEM-ALTCR            RUN DATE: 03-06-1986/15:27:57

                                              PRESENT VALUE    ANNUAL VALUE**
                                             (1986 DOLLARS)   (1986 DOLLARS)
                                             --------------   --------------

 A. CASH REQUIREMENTS AS OF OCCUPANCY               $2,800             $310

 C. OPERATING, MAINTENANCE & RELATED COSTS:
    ANNUALLY RECURRING COSTS (NON-ENERGY)             $677              $75
    ENERGY COSTS                                   $13,234           $1,466
                                              ------------     ------------
     SUBTOTAL                                      $13,911           $1,541

 F. REMAINING VALUE AT END OF OCCUPANCY     (       $1,035)   (       $115)

 G. TOTAL LIFE-CYCLE PROJECT COST:
    WITHOUT INCOME TAX ADJUSTMENTS                 $15,676           $1,736
       WITH INCOME TAX ADJUSTMENTS                 $15,676           $1,736
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
 *INCOME TAX SAVINGS ARE DISCOUNTED FROM THE END OF THE YEAR IN WHICH THEY ARE
  EARNED; TAX CREDITS AND TAX SAVINGS FROM SALES TAX ON INITIAL INVESTMENT ARE
  CREDITED AT THE END OF THE FIRST YEAR OF OCCUPANCY.
 **ANNUAL VALUE DOES NOT INCLUDE GENERAL INFLATION.
```

Table 7-17. LCC analysis of alternative D (includes resale value)

* *

N B S L C C   A N A L Y S I S

* *

PART I - INITIAL ASSUMPTIONS AND COST DATA

PROJECT NAME: HEATING SYSTEM-ALTDR
RUN DATE:03-06-1986 15:30:29
BLDG. CHAR. FILE: ALTDR.BCF, LAST MODIFIED 02-12-1986 05:48:33
LCC OUTPUT FILE: ALTDR.LCC, CREATED 03-06-1986 14:36:10
STUDY PERIOD: 10 YEARS (1986 TO 1996)
GENERAL INFLATION RATE: 5.0%
DISCOUNT RATE: 7.0% (INCLUDING GENERAL INFLATION)
TAX STATUS: PRIVATE RESIDENCE (TAX PAYING)
INCOME TAX RATE: 41.1% (COMBINED FEDERAL, STATE, LOCAL)
EFFECTIVE CAPITAL GAINS TAX RATE: 0.0%
NOMINAL PROPERTY TAX RATE: 0.00%
NOMINAL SALES TAX RATE: 0.00%

INITIAL CAPITAL COMPONENT COSTS (NOT DISCOUNTED)

	TOTAL COST
TOTAL FOR PACKAGE BOILER/TANKLESS WA	$2,900
TOTAL PROJECT COST (ACTUAL)	$2,900

ENERGY-RELATED COSTS

ENERGY TYPE	MMBTU/ YEAR	PRICE ($/MMBTU)	DEMAND COST	TOTAL P.V. COST
DISTILLATE	117.7	$7.88	$0	$9889
ELECTRICITY	0.0	$26.96	$0	$0

* *

* *

PART II - LIFE-CYCLE COST ANALYSIS

DISCOUNT RATE = 7.0% (INCLUDING GENERAL INFLATION)

PROJECT NAME: HEATING SYSTEM-ALTDR   RUN DATE: 03-06-1986/15:30:29

	PRESENT VALUE (1986 DOLLARS)	ANNUAL VALUE** (1986 DOLLARS)
A. CASH REQUIREMENTS AS OF OCCUPANCY	$2,900	$321
C. OPERATING, MAINTENANCE & RELATED COSTS:		
ANNUALLY RECURRING COSTS (NON-ENERGY)	$677	$75
ENERGY COSTS	$9,889	$1,095
SUBTOTAL	$10,566	$1,170
F. REMAINING VALUE AT END OF OCCUPANCY	($1,201)	($133)
G. TOTAL LIFE-CYCLE PROJECT COST:		
WITHOUT INCOME TAX ADJUSTMENTS	$12,265	$1,359
WITH INCOME TAX ADJUSTMENTS	$12,265	$1,359

* *

*INCOME TAX SAVINGS ARE DISCOUNTED FROM THE END OF THE YEAR IN WHICH THEY ARE EARNED; TAX CREDITS AND TAX SAVINGS FROM SALES TAX ON INITIAL INVESTMENT ARE CREDITED AT THE END OF THE FIRST YEAR OF OCCUPANCY.

**ANNUAL VALUE DOES NOT INCLUDE GENERAL INFLATION.

Table 7-18. Comparative analysis of alternative B versus alternative A (base case)
(Based on DoE-Energy price projections)

COMPARATIVE LCC ANALYSIS: HEATING SYSTEM-ALTA AND HEATING SYSTEM-ALTB

PRINCIPAL STUDY PARAMETERS:

STUDY PERIOD: 10 YEARS
STARTING DATE: 1986
OCCUPANCY DATE: 1986
GENERAL INFLATION RATE: 5.0%
DISCOUNT RATE: 7.0% (NOMINAL)
SALES TAX RATE: 0.0%
TAX STATUS: PRIVATE RESIDENTIAL
FED TAX RATE: 38.0%
STATE TAX RATE: 5.0%
BASE CASE LCC FILE: ALTA.LCC
ALTERNATIVE LCC FILE: ALTB.LCC

	COMPARISON OF PRESENT-VALUE COSTS		
	BASE CASE: HEATING SYSTE	ALTERNATIVE: HEATING SYSTE	SAVINGS FROM ALT.
	(1)	(2)	(3)=(1)-(2)
INITIAL INVESTMENT ITEM(S):			
CASH REQUIREMENTS AS OF OCCUPANCY(*)	$300	$820	-$520
SUBTOTAL	$300	$820	-$520
FUTURE COST ITEMS:			
ANNUAL AND NON-AN. RECURRING COSTS	$677	$677	$0
ENERGY EXPENDITURES	$16,933	$15,788	$1,145
SUBTOTAL	$17,610	$16,465	$1,145
TOTAL P.V. LIFE-CYCLE COST	$17,910	$17,285	$625

* EXCEPT FOR PREPAID PROPERTY TAX (AT OCCUPANCY)

COMPUTATION OF NET SAVINGS

```
NET SAVINGS   =  P.V. OF FUTURE COST SAVINGS        $1,145
                LESS INCREASED INITIAL INVEST.      -$520
                                                -----------
                                                     $625
```

COMPUTATION OF SAVINGS-TO-INVESTMENT RATIO (SIR)

```
                P.V. OF FUTURE COST SAVINGS
        SIR  =  ---------------------------    =     2.20
                 INCREASED INITIAL INVEST.
```

COMPUTATION OF ADJUSTED INTERNAL RATE OF RETURN (AIRR)
(REINVESTMENT RATE = 7.00%)

```
                                          (1/STUDY PER.)
AIRR = 100 X ((1+REINV. RATE) X SIR                      -1)  =   15.79%
```

Table 7-19. Comparative analysis of alternative C versus alternative A (base case)
(Based on DoE-Energy price projections and resale value for alternative C)

COMPARATIVE LCC ANALYSIS: HEATING SYSTEM-ALTA AND HEATING SYSTEM-ALTCR

PRINCIPAL STUDY PARAMETERS:

STUDY PERIOD: 10 YEARS
STARTING DATE: 1986
OCCUPANCY DATE: 1986
GENERAL INFLATION RATE: 5.0%
DISCOUNT RATE: 7.0% (NOMINAL)
SALES TAX RATE: 0.0%
TAX STATUS: PRIVATE RESIDENTIAL
FED TAX RATE: 38.0%
STATE TAX RATE: 5.0%
BASE CASE LCC FILE: ALTA.LCC
ALTERNATIVE LCC FILE: ALTCR.LCC

	COMPARISON OF PRESENT-VALUE COSTS		
	BASE CASE: HEATING SYSTE	ALTERNATIVE: HEATING SYSTE	SAVINGS FROM ALT.
	(1)	(2)	(3)=(1)-(2)
INITIAL INVESTMENT ITEM(S):			
CASH REQUIREMENTS AS OF OCCUPANCY(*)	$300	$2,800	-$2,500
SUBTOTAL	$300	$2,800	-$2,500
FUTURE COST ITEMS:			
ANNUAL AND NON-AN. RECURRING COSTS	$677	$677	$0
ENERGY EXPENDITURES	$16,933	$13,234	$3,699
RESALE VALUE AT END OF STUDY (NET)	$0	-$1,035	$1,035
SUBTOTAL	$17,610	$12,876	$4,734
TOTAL P.V. LIFE-CYCLE COST	$17,910	$15,676	$2,234

* EXCEPT FOR PREPAID PROPERTY TAX (AT OCCUPANCY)

COMPUTATION OF NET SAVINGS

NET SAVINGS =	P.V. OF FUTURE COST SAVINGS	$4,734
	LESS INCREASED INITIAL INVEST.	-$2,500
		$2,234

COMPUTATION OF SAVINGS-TO-INVESTMENT RATIO (SIR)

$$\text{SIR} = \frac{\text{P.V. OF FUTURE COST SAVINGS}}{\text{INCREASED INITIAL INVEST.}} = 1.89$$

COMPUTATION OF ADJUSTED INTERNAL RATE OF RETURN (AIRR)
(REINVESTMENT RATE = 7.00%)

$$\text{AIRR} = 100 \text{ X } ((1+\text{REINV. RATE}) \text{ X SIR}^{(1/\text{STUDY PER.})} - 1) = 14.05\%$$

Table 7-20. Comparative analysis of alternative D versus alternative A (base case) (Based on DoE-Energy price projections and resale value for alternative D)

```
 COMPARATIVE LCC ANALYSIS: HEATING SYSTEM-ALTA AND HEATING SYSTEM-ALTDR
================================================================================

                 PRINCIPAL STUDY PARAMETERS:
                 ---------------------------
                 STUDY PERIOD:  10 YEARS
                 STARTING DATE:  1986
                 OCCUPANCY DATE: 1986
                 GENERAL INFLATION RATE:  5.0%
                 DISCOUNT RATE:  7.0% (NOMINAL)
                 SALES TAX RATE:  0.0%
                 TAX STATUS: PRIVATE RESIDENTIAL
                 FED TAX RATE: 38.0%
                 STATE TAX RATE:  5.0%
                 BASE CASE LCC FILE: ALTA.LCC
                 ALTERNATIVE LCC FILE: ALTDR.LCC
================================================================================
                                      COMPARISON OF PRESENT-VALUE COSTS
                                      ----------------------------------------
                                       BASE CASE:  ALTERNATIVE:      SAVINGS
                                      HEATING SYSTE  HEATING SYSTE  FROM ALT.
                                      ----------------------------------------
                                           (1)           (2)       (3)=(1)-(2)
INITIAL INVESTMENT ITEM(S):           -----------   -----------   -----------
 CASH REQUIREMENTS AS OF OCCUPANCY(*)        $300        $2,900       -$2,600
                                       ---------     ---------     ---------
     SUBTOTAL                                $300        $2,900       -$2,600

FUTURE COST ITEMS:
 ANNUAL AND NON-AN. RECURRING COSTS          $677          $677            $0
 ENERGY EXPENDITURES                      $16,933        $9,889        $7,044
 RESALE VALUE AT END OF STUDY (NET)            $0       -$1,201        $1,201
                                       ---------     ---------     ---------
     SUBTOTAL                             $17,610        $9,365        $8,245

                                       ---------     ---------     ---------
   TOTAL P.V. LIFE-CYCLE COST             $17,910       $12,265        $5,645

  * EXCEPT FOR PREPAID PROPERTY TAX (AT OCCUPANCY)
================================================================================

                      COMPUTATION OF NET SAVINGS
                      --------------------------

         NET SAVINGS   =  P.V. OF FUTURE COST SAVINGS           $8,245
                          LESS INCREASED INITIAL INVEST.       -$2,600
                                                          ------------
                                                                $5,645


================================================================================

             COMPUTATION OF SAVINGS-TO-INVESTMENT RATIO (SIR)
             ------------------------------------------------

                          P.V. OF FUTURE COST SAVINGS
                 SIR  =  ---------------------------    =      3.17
                           INCREASED INITIAL INVEST.

================================================================================

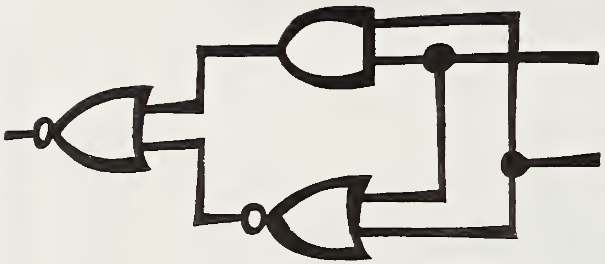
            COMPUTATION OF ADJUSTED INTERNAL RATE OF RETURN (AIRR)
                         (REINVESTMENT RATE =  7.00%)
            ----------------------------------------------------

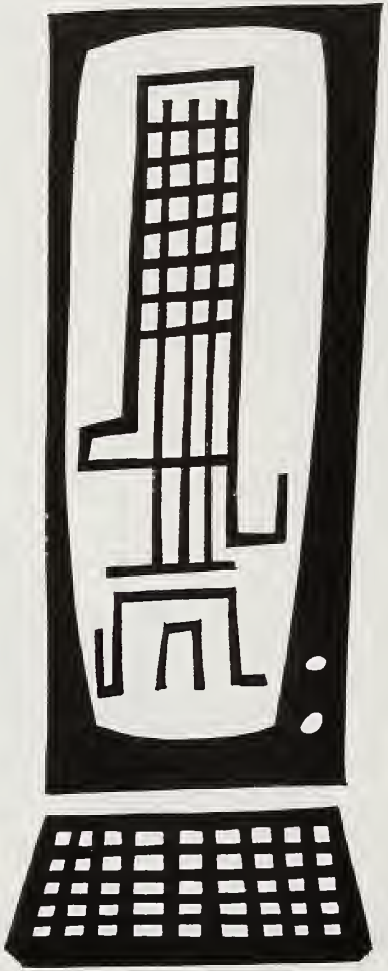
                                             (1/STUDY PER.)
        AIRR = 100 X ((1+REINV. RATE) X SIR                 -1)  =    20.09%


================================================================================
```

Table 7-21. Summary of results of sensitivity analysis of residential heating

Assumptions				Net Savings in Present Value $		
Energy Prices		Resale Value				
DoE-Projections Plus 5% General Inflation Rate	5%General Inflation Rate Only	No Resale Value Received for Alt. C&D	Resale Value Received for Alt. C&D	Alt. B	Alt. C	Alt. D
	X	X		449	631	3,794
X		X		625	1,199	4,444
	X		X	449	1,666	4,995
X			X	625	2,234	5,645





COMMERCIAL OFFICE BUILDING

A business located in the Fort Worth-Dallas area of Texas is planning an office building to house its headquarters. The company plans to occupy the building for the foreseeable future. The owners are concerned about the energy efficiency of the building and have asked the architectural/engineering (A&E) firm to provide estimates of the long-run and first costs of the building with and without various energy conserving design and equipment options that the firm has proposed. Financing arrangements are currently underway, and the owners may encounter a budget constraint which will limit expenditures on energy conservation options even if the options are estimated to be cost effective.

The A&E firm has used the "NBSLCC" computer program (see Chapter 6 for a description of NBSLCC) to develop a proposal for energy conservation. In order to simplify the decision and retain owner flexibility while finances are being negotiated, the firm decided as a "first cut" at the problem to condense the options into two packages, and then to provide further breakdown of the options as needed. In discussions with the owners, the firm identified approximate budget levels to be targeted for the two packages: Package 1—not to exceed $100,000; Package 2—not to exceed $200,000. This approach allowed the firm's analyst to evaluate project design/size alternatives, controlling for project interdependencies. (See Chapter 4, "Choosing Among Alternative Approaches, Designs, and Sizes" and "Finding the Cost-Effective Combinations of Interdependent Projects," for further discussions of the approach.)

Package 1 consists of projects that are estimated to have a relatively high yield per dollar

spent, but stops far short of exhausting the potential for cost-effective energy conservation. Package 2 consists of some of the same projects that are contained in Package 1, unchanged, plus some of the projects of Package 1 in an expanded version, plus some new projects. Package 2 is expected to result in higher long-term net dollar savings, but to yield lower marginal and average returns per dollar invested than Package 1.

The approach followed by the A&E firm to develop the energy conservation packages, the informational requirements, and the recommendations to the building owners are outlined below:

The firm's objective was to provide the building owners with the possibility of a more energy efficient building, while taking into account the possible budget constraint, as well as aesthetic concerns, space and functional requirements, building code provisions, energy availability, and local suppliers of materials and maintenance support. Using the "NBSLCC" computer program, the A&E firm proceeded in the following steps:

(1) It first evaluated the life-cycle costs of the building without special energy conservation features to identify the major opportunities for energy conservation and to establish a base case.

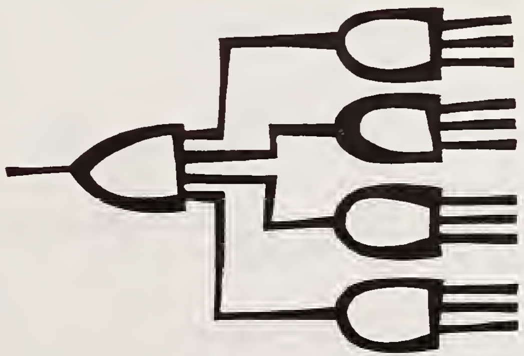
(2) It proposed technically feasible energy conservation projects and evaluated the life-cycle costs of the building with each of the projects, repeating the LCC evaluation for alternative designs and sizes.

(3) Next, it ran the NBSLCC "compare" subprogram, comparing the LCC of each project in its least costly version against the LCC of the base case, and the LCC of each more costly design/size alternative of a project against the LCC of the design/size just below it in cost.

(4) From these results, an initial screening for cost effectiveness was made, whereby any project or alternative design or size of a project with an SIR less than 1 (i.e., that failed to yield positive net benefits) was eliminated from further consideration. Any project alternative design or size with an SIR greater than 1 but less than the SIR of a more costly version of the same project was temporarily set aside until the final round of budget allocations, as described below in step (7). The SIR's of the remaining design/size alternatives were recalculated to reflect the set-asides.

(5) After the initial screening, the firm ranked the remaining projects and project design/size alternatives in descending order of their SIR's, as calculated by the "compare" subprogram described above in step (3).

(6) To construct the first package, the firm first selected the first-ranked project (the one with the highest SIR), and then reran the "LCC" and "compare" subprograms for those lower ordered projects which were expected to be significantly altered by implementation of the first selected, higher priority project. This was done for each design/size alternative of each project interrelated with the first selected. For example, if a project which reduced the building's energy load were first selected, then the SIR's of space heating equipment of alternative designs and sizes would be reevaluated, taking into account the changed load. The project with the next highest SIR was then selected, and the computer runs were repeated for the remaining projects and project alternatives expected to be significantly altered by the second selection, etc.



REALIZATION OF THE BOOLEAN FUNCTION

Each time a design/size of a project was reached which had been previously selected in a lower cost design/size, the initial version of the project was replaced with the alternative, and cumulative costs and cumulative benefits were adjusted to reflect the substitution. Additional projects were added to the package and more costly designs/sizes were substituted for previously selected projects, while cumulating investment costs and adjusting for interdependencies, until the maximum targeted investment budget of $100,000 for Package 1 was exhausted.

(7) To construct Package 2, the above process was continued: previously accepted projects were replaced with more costly designs/sizes and new projects were accepted, adjusting for project interdependencies, until the maximum targeted investment budget of $200,000 for Package 2 was exhausted. In order to arrive at packages with costs close to the budgeted amounts, project alternatives which were previously temporarily set aside (step (4)) because their SIR's were less than those of more costly versions of the same project (but still greater than 1.0), were reconsidered for possible selection provided no other version of the project had been already selected.[22]

[22] To ensure that the ranking technique results in the combination of projects which will maximize the overall net benefits from the given budget, it is a good idea to compare the life-cycle costs or net benefits of trial combinations of projects as a check.

Package 1 was constructed to fit very closely the $100,000 targeted budget. Package 2 was closed at $195,000 because the next project on the list would have carried the amount over the $200,000 targeted amount.

Having developed the two packages, the firm then used the "NBSLCC" computer program to provide evaluations of the overall economic performance of the packages and to report the results to the clients. The information required for the aggregate analyses and reports is described below and summarized in Table 7-22.

The land purchase will be completed, and construction is expected to begin, by mid-1986. The cost of purchasing the land is estimated to be $800,000. The building will be constructed and equipped over a period of 2 years, and occupancy is planned for mid-1988. Construction costs without inclusion of the special energy conserving design features are estimated at $3.5 million in mid-1986 dollars. These costs will be incurred according to the following schedule: one-third upon initiation of construction, one-third at the beginning of the second year, one-third at the time of occupancy.

Equipment costs without inclusion of the special energy conserving equipment are estimated in mid-1986 dollars at $500,000 for equipment designated as real property and $275,000 for equipment designated as tangible personal property. These costs are separated because different depreciation schedules apply to the two types of equipment. (The tangible personal property is eligible for a 5-year depreciation writeoff under the ACRS, and for an investment tax credit. To avoid reduction of the depreciation basis, the normal 10 percent tax credit is reduced to 8 percent.) The equipment costs will be incurred according to the following schedule: one-half at the beginning of the second year, and one-half at occupancy.

Table 7-22. Data and assumptions for evaluating commercial office building problem (sample)

Assumptions

Study Period: 25 years
Project Starting Date: 1986
Occupancy Date: 1988
Base Year for Discounting: 1986
Discount Rate: 15% (after-tax, nominal)
General Rate of Price Inflation: 5% compounded annually
Federal Marginal Income Tax Rate: 46%
State Marginal Income Tax Rate: 4%

Cost-Related Data (1986 $)

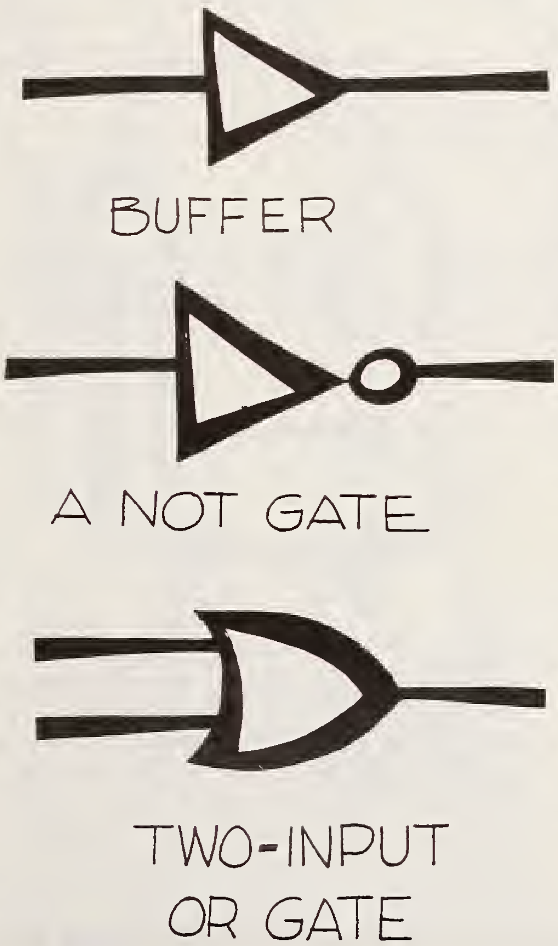
		Bldg. Without Additional Energy Conserv. (Base Case)	Bldg. with Package 1	Bldg. with Package 2
LAND COSTS		$800,000	$800,000	$800,000
CONSTRUCTION COSTS		$3,500,000	$3,550,000	$3,597,500
Expenditure Schedule	33% in 1986 33% in 1987 34% in 1988			
EQUIPMENT COSTS				
Real		$500,000	$533,333	$565,000
Personal		$275,000/ every 10th year	$291,667/ every 10th year	$307,500/ every 10th year
Expenditure Schedule	50% in 1987 50% in 1988			
MAINTENANCE AND REPAIR COSTS				
Major Repairs to Building		$300,000/ 15 years	$310,000/ 15 years	$315,000/ 15 years
Real Property Equipment Repairs		$100,000/ 15th year	$110,000/ 15th year	$115,000/ 15th year
Annual O&M (Non-Energy) Costs		$150,000	$155,000	$158,000
Routine Repair Costs		$50,000/ every 5th yr	$60,000/ every 5th yr	$62,000/ every 5th yr
ENERGY DATA				
Current Electricity Price $20.95/10^{6}Btu				
Electricity Consumption		$4,200\times10^6$ Btu	$2,940\times10^6$ Btu	$2,310\times10^6$ Btu
Current Natural Gas Price $5.75/10^6 /Btu				
Natural Gas Consumption		$10,000\times10^6$ Btu	$7,500\times10^6$ Btu	$6,200\times10^6$ Btu
Future Prices	Based on DoE Energy Price Projections Contained in "NBSLCC" Data File			

Without conservation improvements, major repairs to the building, costing $300,000 in mid-1986 dollars, and to the real property equipment, costing $100,000, are estimated to occur in about 15 years. The personal property equipment is expected to require total replacement every 10 years. Routine annual maintenance costs are estimated at $150,000, and routine repair costs at $50,000 every fifth year. Without conservation improvements, the building's annual electricity consumption is expected to be about 4,200x10^6Btu and natural gas consumption about 10,000x10^6Btu. Electricity is priced at $20.95/$10^6$Btu and natural gas at $5.75/$10^6$Btu at the beginning of the study period.

Approximately one-half the initial cost of each energy conservation package ($50,000 for Package 1 and $97,500 for Package 2) is for construction and one-half for equipment. Two-thirds of the equipment costs are classed as real property, and one-third as tangible personal property. Schedules of disbursement are assumed to follow the schedules of construction and equipment costs given above.

Energy Conservation Package 1 is expected to increase major building repair costs in the 15th year by about $10,000 and real property equipment costs by a like amount. Package 2 is expected to increase major building repair costs in the 15th year by about $15,000 and real property equipment costs by a like amount. Packages 1 and 2 are expected to add about $5,000 and $8,000, respectively, to annual routine maintenance costs, and $10,000 and $12,000, respectively, to routine repair costs every 5 years. With Packages 1 and 2, tangible personal property equipment will continue to require full replacement every 10 years. Property taxes are assumed to be unaffected by the energy conservation improvements.

Package 1 is expected to reduce electricity consumption by 30 percent and natural gas consumption by 25 percent. Package 2 is expected to reduce electricity consumption by 45 percent and natural gas consumption by 38 percent. Future energy prices are based on the U.S. Department of Energy's projections provided on Version 1.0 of the NBSLCC program disk. (These are consistent with the price indices given in Appendix B, Part I.)



To establish a discount rate for taking into account the firm's opportunity cost of capital, the analysts estimated the firm's marginal weighted cost of capital, using Worksheet 2 of Series A, and made the assumption that the building project lies within the risk range of the firm's normal operations. The resulting after-tax rate of 15 percent was considered a proxy for the firm's opportunity cost, and was used in the analysis as a nominal after-tax discount rate.

The study period was set at 25 years to reflect the planned long-term occupancy of the building and the availability of DoE-energy price projections. It was assumed that there is no remaining value for the energy conservation improvements at the end of the 25-year study period.

Table 7-23 shows the results of the comparative LCC analysis for the building with Package 1 versus the building without it (Base Case). Net present value savings from Package 1 are estimated at $97,662. This means that the savings from the energy conservation projects in Package 1 are estimated to cover all their costs, including the required 15 percent rate of return, and to yield nearly $100,000 in additional savings. The SIR on Package 1 is 2.09. This means that on the average, it is estimated that $2.09 will be recovered for every $1.00 invested, over-and-above the required 15 percent return.

The last entry in Table 7-23 shows the internal rate of return estimated at 18.45 percent. Since this yield is greater than the minimum required rate of return of 15 percent, it is attractive. Each of these three measures of economic performance indicate that Package 1 is well worth accepting, provided adequate funding is available.

Table 7-23. Comparative LCC analysis: Office building with package 1 versus without it

```
  COMPARATIVE LCC ANALYSIS: OFFICE BLDG-WITHOUT IMPROVEMENTS AND
OFFICE BLDG-WITH PACKAGE 1
===============================================================================

                 PRINCIPAL STUDY PARAMETERS:
                 ---------------------------
                 STUDY PERIOD:  25 YEARS
                 STARTING DATE:  1986
                 OCCUPANCY DATE: 1988
                 GENERAL INFLATION RATE:  5.0%
                 DISCOUNT RATE: 15.0% (NOMINAL)
                 SALES TAX RATE:  0.0%
                 TAX STATUS: FOR PROFIT
                 FED TAX RATE: 46.0%
                 STATE TAX RATE:  4.0%
                 BASE CASE LCC FILE: BASECASE.LCC
                 ALTERNATIVE LCC FILE: PACK1.LCC
===============================================================================
                                            COMPARISON OF PRESENT-VALUE COSTS
                                      -----------------------------------------
                                        BASE CASE:   ALTERNATIVE:     SAVINGS
                                      OFFICE BLDG-W  OFFICE BLDG-W   FROM ALT.
                                      -----------------------------------------
                                           (1)            (2)       (3)=(1)-(2)
INITIAL INVESTMENT ITEM(S):           ------------   ------------   -----------
 CASH REQUIREMENTS AS OF OCCUPANCY(*)  $4,678,450     $4,767,854      -$89,404
                                       ---------      ---------      ---------
     SUBTOTAL                          $4,678,450     $4,767,854      -$89,404

FUTURE COST ITEMS:
 ANNUAL AND NON-AN. RECURRING COSTS    $1,296,810     $1,351,563      -$54,753
 ENERGY EXPENDITURES                   $1,406,516     $1,018,072      $388,444
 REPLACEMENTS TO CAPITAL                 $129,472       $137,319       -$7,847
 INCOME TAX ADJUSTMENTS DURING OCCUP. -$2,074,525    -$1,935,748     -$138,777
                                       ---------      ---------      ---------
     SUBTOTAL                            $758,272       $571,206      $187,066

                                       ---------      ---------      ---------
   TOTAL P.V. LIFE-CYCLE COST          $5,436,722     $5,339,060       $97,662

  * EXCEPT FOR PREPAID PROPERTY TAX (AT OCCUPANCY)
===============================================================================

                        COMPUTATION OF NET SAVINGS
                        --------------------------

         NET SAVINGS   =  P.V. OF FUTURE COST SAVINGS        $187,066
                           LESS INCREASED INITIAL INVEST.     -$89,404
                                                          -------------
                                                              $97,662


===============================================================================

               COMPUTATION OF SAVINGS-TO-INVESTMENT RATIO (SIR)
               ------------------------------------------------

                        P.V. OF FUTURE COST SAVINGS
             SIR   =  ---------------------------     =      2.09
                         INCREASED INITIAL INVEST.

===============================================================================

              COMPUTATION OF ADJUSTED INTERNAL RATE OF RETURN (AIRR)
                           (REINVESTMENT RATE = 15.00%)
              -----------------------------------------------------

                                              (1/STUDY PER.)
           AIRR = 100 X ((1+REINV. RATE) X SIR              -1)  =    18.45%


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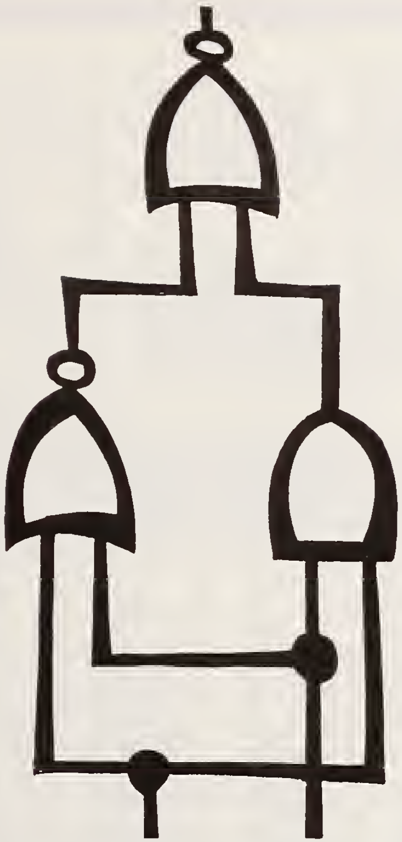
Table 7-24 shows the results of comparing the building's life-cycle costs with Package 2 versus without it (Base Case). In this case, net savings are estimated at $114,232, more than with Package 1. The SIR is estimated at 1.66, and the adjusted internal rate of return at 17.34 percent, both less than the comparable measures for Package 1. These results are presented in order to illustrate the point made earlier: that is, the measures of SIR and internal rate of return computed on total costs and savings are not reliable for determining the optimal level of investment, but the net savings measure is a reliable means of finding the optimal investment level. To use the SIR or the internal rate of return to find this level, it is necessary to compute these measures on incremental, or marginal, changes in costs and savings. Incremental analysis can be done by the NBSLCC program simply by specifying appropriately the base case and alternative case for comparison.

Table 7-25 shows the results of the incremental comparison of the life-cycle costs of the building with Package 2 versus the building with Package 1. This is the correct comparison for using the SIR or internal rate of return to determine if the additional $95,000 cost of Package 2 is economically worthwhile. The results indicate that Package 2 is preferable to Package 1, provided the additional funds are available and assuming cash flows are certain. In addition to covering all its additional costs, including the 15 percent required rate of return, Package 2 is estimated to result in an extra $16,570 of savings over and above that resulting from Package 1. The additional outlay is estimated to return on the average $1.20 on each $1.00 invested, in addition to returning the required 15 percent. The estimated yield is 15.82 percent, slightly higher than the 15 percent minimum acceptable rate of return.



Although the additional energy conservation options offered by Package 2 were estimated to be cost effective based on the set of data and assumptions given, the estimated net savings are relatively small and could be eliminated by relatively minor changes in assumptions. The estimated net savings for Package 1, being larger, are more likely to remain positive if data and assumptions are changed. Given that there were doubts about the data and assumptions employed, sensitivity analysis appeared advisable.

An area of uncertainty in performing the analysis was income tax effects, because proposals for substantial changes in Federal tax law were pending at the time the analysis was performed. To reflect this uncertainty, a sensitivity analysis was performed to test the impact on net savings resulting from potential changes in Federal income tax provisions. (See Chapter 3, "Steps in an Economic Evaluation," for a discussion of sensitivity analysis.) The analysis was repeated with alternative tax rates and depreciation schedules. Specifically, the new runs were made with a marginal income tax rate of 35 percent instead of 46 percent, straight-line depreciation instead of accelerated depreciation, and a 25-year depreciation period for real property and a 10-year period for personal property instead of the 18-year and 5-year periods used in the preceding analysis.[23] A further area of uncertainty was the appropriate discount rate to use to reflect the firm's long-range opportunity cost of investing in energy conservation. A case could be made that real interest rates were unusually high at the time of the analysis and likely to decline. This argument supported the use of a lower rate, specifically a case was made for a rate of 12.5 percent. One of the owners also made a case for using a higher rate than the company's marginal weighted cost of capital on the grounds that future energy costs are highly uncertain and the investment might be more risky than their normal operations. Specifically a case was made for a rate of 17.5 percent. To provide a range of estimates over upper and lower boundaries of potential discount rates for the firm, sensitivity analysis was also done for 10 and 20 percent discount rates.

[23] This is not to imply that these changes will actually be made in the tax code, but rather to illustrate the use of sensitivity analysis to test the sensitivity of the outcome to alternative input values.

Table 7-24. Comparative LCC analysis: Office building with package 2 versus without it

COMPARATIVE LCC ANALYSIS: OFFICE BLDG-WITHOUT IMPROVEMENTS AND OFFICE BLDG-WITH PACKAGE 2

PRINCIPAL STUDY PARAMETERS:

STUDY PERIOD: 25 YEARS
STARTING DATE: 1986
OCCUPANCY DATE: 1988
GENERAL INFLATION RATE: 5.0%
DISCOUNT RATE: 15.0% (NOMINAL)
SALES TAX RATE: 0.0%
TAX STATUS: FOR PROFIT
FED TAX RATE: 46.0%
STATE TAX RATE: 4.0%
BASE CASE LCC FILE: BASECASE.LCC
ALTERNATIVE LCC FILE: PACK2.LCC

COMPARISON OF PRESENT-VALUE COSTS

	BASE CASE: OFFICE BLDG-W	ALTERNATIVE: OFFICE BLDG-W	SAVINGS FROM ALT.
	(1)	(2)	(3)=(1)-(2)
INITIAL INVESTMENT ITEM(S):			
CASH REQUIREMENTS AS OF OCCUPANCY(*)	$4,678,450	$4,852,789	-$174,339
SUBTOTAL	$4,678,450	$4,852,789	-$174,339
FUTURE COST ITEMS:			
ANNUAL AND NON-AN. RECURRING COSTS	$1,296,810	$1,379,138	-$82,328
ENERGY EXPENDITURES	$1,406,516	$820,499	$586,017
REPLACEMENTS TO CAPITAL	$129,472	$144,773	-$15,301
INCOME TAX ADJUSTMENTS DURING OCCUP.	-$2,074,525	-$1,874,709	-$199,816
SUBTOTAL	$758,272	$469,701	$288,571
TOTAL P.V. LIFE-CYCLE COST	$5,436,722	$5,322,490	$114,232

* EXCEPT FOR PREPAID PROPERTY TAX (AT OCCUPANCY)

COMPUTATION OF NET SAVINGS

```
NET SAVINGS  =  P.V. OF FUTURE COST SAVINGS       $288,571
                LESS INCREASED INITIAL INVEST.    -$174,339
                                                 ----------
                                                  $114,232
```

COMPUTATION OF SAVINGS-TO-INVESTMENT RATIO (SIR)

$$\text{SIR} = \frac{\text{P.V. OF FUTURE COST SAVINGS}}{\text{INCREASED INITIAL INVEST.}} = 1.66$$

COMPUTATION OF ADJUSTED INTERNAL RATE OF RETURN (AIRR)
(REINVESTMENT RATE = 15.00%)

$$\text{AIRR} = 100 \times ((1+\text{REINV. RATE}) \times \text{SIR}^{(1/\text{STUDY PER.})} - 1) = 17.34\%$$

Table 7-25. Comparative LCC analysis: Office building with package 2 versus package 1

```
  COMPARATIVE LCC ANALYSIS: OFFICE BLDG-WITH PACKAGE 1 AND
OFFICE BLDG-WITH PACKAGE 2
==============================================================================

                 PRINCIPAL STUDY PARAMETERS:
                 ---------------------------
                 STUDY PERIOD:  25 YEARS
                 STARTING DATE:  1986
                 OCCUPANCY DATE: 1988
                 GENERAL INFLATION RATE:  5.0%
                 DISCOUNT RATE: 15.0% (NOMINAL)
                 SALES TAX RATE:  0.0%
                 TAX STATUS: FOR PROFIT
                 FED TAX RATE: 46.0%
                 STATE TAX RATE:  4.0%
                 BASE CASE LCC FILE: PACK1.LCC
                 ALTERNATIVE LCC FILE: PACK2.LCC
==============================================================================
                                          COMPARISON OF PRESENT-VALUE COSTS
                                        -----------------------------------------
                                          BASE CASE:   ALTERNATIVE:     SAVINGS
                                        OFFICE BLDG-W  OFFICE BLDG-W   FROM ALT.
                                        -----------------------------------------
                                             (1)           (2)        (3)=(1)-(2)
INITIAL INVESTMENT ITEM(S):             ------------  ------------   -----------
 CASH REQUIREMENTS AS OF OCCUPANCY(*)   $4,767,854    $4,852,789       -$84,935
                                        ----------    ----------     ----------
     SUBTOTAL                           $4,767,854    $4,852,789       -$84,935

FUTURE COST ITEMS:
 ANNUAL AND NON-AN. RECURRING COSTS     $1,351,563    $1,379,138       -$27,575
 ENERGY EXPENDITURES                    $1,018,072      $820,499       $197,573
 REPLACEMENTS TO CAPITAL                  $137,319      $144,773        -$7,454
 INCOME TAX ADJUSTMENTS DURING OCCUP. -$1,935,748   -$1,874,709       -$61,039
                                        ----------    ----------     ----------
     SUBTOTAL                             $571,206      $469,701       $101,505

                                        ----------    ----------     ----------
   TOTAL P.V. LIFE-CYCLE COST           $5,339,060    $5,322,490        $16,570

  * EXCEPT FOR PREPAID PROPERTY TAX (AT OCCUPANCY)
==============================================================================

                      COMPUTATION OF NET SAVINGS
                      --------------------------

        NET SAVINGS    =  P.V. OF FUTURE COST SAVINGS        $101,505
                        LESS INCREASED INITIAL INVEST.       -$84,935
                                                          -----------
                                                              $16,570

==============================================================================

             COMPUTATION OF SAVINGS-TO-INVESTMENT RATIO (SIR)
             ------------------------------------------------

                      P.V. OF FUTURE COST SAVINGS
              SIR  =  ---------------------------   =    1.20
                        INCREASED INITIAL INVEST.

==============================================================================

          COMPUTATION OF ADJUSTED INTERNAL RATE OF RETURN (AIRR)
                     (REINVESTMENT RATE = 15.00%)
          ------------------------------------------------------

                                         (1/STUDY PER.)
      AIRR = 100 X ((1+REINV. RATE) X SIR              -1)  =    15.82%


==============================================================================
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The results of the sensitivity analysis are displayed in Table 7-26. The following effects are evident from the table: Lowering the discount rate makes the energy conservation investments appear more cost effective, and raising the discount rate, less cost effective. Depreciating the investments over a longer period of time reduces their estimated cost effectiveness.

Lowering the Federal income tax rate improves their estimated cost effectiveness. The combined effect of lengthening the depreciation time and lowering the Federal income tax rate is to increase the estimated cost effectiveness of the investments for a given discount rate. The effect of changing the discount rate greatly outweighs the effect of these particular changes in depreciation and income tax rates. Estimated net present value savings from Package 1 range from a low of $30.9 thousand (based on straight-line depreciation, no investment tax credits, a 46 percent marginal Federal income tax rate and a 20 percent discount rate) to a high of $263.6 thousand (based on straight-line depreciation, no investment tax credit, a 35 percent marginal income tax rate, and a 10 percent discount rate). Estimated net savings from Package 1 remain substantial across the various assumptions of the sensitivity analysis, supporting the conclusion that it is likely to be an economically worthwhile investment. In contrast, the estimated cost effectiveness of expanding the investment to Package 2 is vulnerable to the alternative assumptions of the sensitivity analysis. At higher discount rates and with slower depreciation, the additional costs of Package 2 are not fully covered by additional savings, calling into question the economic viability of expanding the investment in energy conservation from the level provided by Package 1 to that provided by Package 2, even if permitted by the budget.

The next step was to provide a breakdown of

Table 7-26. Sensitivity analysis: Office building problem (sample)[a]

Discount Rate \ Assumptions	D-B (175%) Deprec. Over 18 Years. 8% Tax Credit for Personal Property. 46% Mar. Federal Income Tax Rate.	S-L Deprec. Over 25 Years. 0 Tax Credit. 46% Mar. Federal Income Tax Rate.	S-L Deprec. Over 25 Years. 0 Tax Credit 35% Mar. Income Tax Rate
PACKAGE 1 VS. BASE CASE — Net Present Value Savings ($1,000's)/Savings-to-Investment Ratio[b]			
10.0%	218.7/3.32	207.6/3.20	263.6/3.79
12.5%	146.9/2.60	137.1/2.49	179.1/2.95
15.0%	97.7/2.09	88.9/1.99	121.2/2.36
17.5%	63.0/1.72	55.1/1.63	80.6/19.3
20.0%	33.0/1.45	30.9/1.36	51.5/1.61
PACKAGE 2 VS. PACKAGE 1			
10.0%	77.2/1.86	66.6/1.74	93.3/2.04
12.5%	41.2/1.47	33.8/1.36	51.7/1.59
15.0%	16.6/1.20	8.2/1.10	23.4/1.28
17.5%	−0.6/0.99	−8.2/0.90	3.8/1.05
20.0%	−12.9/0.84	−19.7/0.76	−10.1/0.87

[a] The sensitivity analysis was performed by making multiple runs of the NBSLCC Computer Program, modifying the BCF files for changes in depreciation methods and tax rates, and specifying alternative discount rates when running the LCC-MAIN subprogram. The results of the various computer runs are summarized here.

[b] The net present savings in thousands of dollars are given to the left of the slash and the savings-to-investment ratio to the right.

Notation: D-B = Declining balance depreciation method.
S-L = Straight-line depreciation method.

the components of Package 2 into several subpackages, and to subject these subpackages to sensitivity testing. The purpose was to provide further guidance on project selection in the event that funding was sufficient to cover more than Package 1.

The final step in the evaluation was to report the results of the analysis to the owners. The report consisted of (1) the tabular reports generated by the NBSLCC program, (2) textual descriptions and data for the proposed energy conservation improvements, including discussions of any effects not fully captured by the NBSLCC computer analysis, (3) the results of the sensitivity analyses, and (4) recommendations on the decision.

The report emphasized the strong estimated cost effectiveness of Package 1 and recommended that efforts be made to include, at a minimum, these improvements. It pointed out that the additional expenditure needed to increase the level of energy conservation to that provided by Package 2 was also estimated to be cost effective under the "best-guess" assumptions. In fact, Package 2 was estimated to bring the building close to an optimum level in terms of the economically efficient use of energy and other resources. However, uncertainty in the analysis weakened the case for Package 2, particularly with a limited budget. With less favorable depreciation provisions and a higher discount rate, the incremental net savings of Package 2 became negative. This outcome meant that enough of the project expansions and new projects in Package 2 became uneconomical to cause the entire increment to appear uneconomical. It was recommended, therefore, that if the available budget should exceed the level required to fund Package 1, that some, but not all, of the options in Package 2 be added. The breakdown of Package 2 into subpackages (not shown here) was presented to the building owners as a guide to allocating funds in excess of these required for Package 1.

8. PUTTING IT INTO PRACTICE

Chapter 1 explained the need for continuing efforts to upgrade the energy efficiency of buildings, taking into account the long-run costs of energy and other resources in determining the kinds, amounts, and combinations of projects to undertake. Chapter 2 provided background on two initial steps in getting started which were outside the focus of the book but essential to the process: identifying the energy users and identifying potential energy conservation actions. Chapter 3 acquainted you with the pertinent methods of economic evaluation and their applications, the kinds of information you will need, and possible sources of information. Chapter 4 illustrated how to use the methods of Chapter 3 to make decisions about project approach, design, and size; combining interrelated projects; and setting project priorities. Chapters 5 and 6 provided tools for making the necessary calculations: worksheets and a computer program. Chapter 7 demonstrated the use of the worksheets and computer program in sample problems for residential and commercial buildings. With these aids, you are ready to put the methods of economic evaluation into practice to increase the long-run economic efficiency of your buildings.

In putting the methods into practice, keep in mind the following tips:

(1) Remember that economic evaluation is typically an on-going procedure to be repeated at various stages of a project's life: initial planning, construction, operation, replacement, and termination.

(2) It is not always possible to quantify adequately all important effects; but unquantified, as well as quantified, effects should be considered in making the final choice.

(3) In reporting the results of your evaluation to others, it is important to set forth clearly the alternatives considered and the key assumptions and data, as well as the objective(s) and constraints.

(4) Sensitivity analysis, whereby the outcome of the analysis is tested for sensitivity to changes in key inputs, is useful for assessing how the economic viability of a project would likely change if the data and assumptions were to change.

(5) Aids to calculations, such as the worksheets and computer program provided in Chapters 5 and 6, must be used with good judgment and a basic understanding of the methods of evaluation and their applications in order to produce sound economic evaluations.

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APPENDIX A

FACTORS FOR FINDING PRESENT VALUES, FUTURE VALUES, AND ANNUAL VALUES

Table A.1 Single Present Worth (SPW) factors (multipliers)—for finding the present value of a future amount

INSTRUCTIONS: Find the column of factors for the discount rate closest to that in Series A, Worksheet 1, E, and locate the SPW factor which corresponds to the year in which the future amount is expected to occur. By multiplying the SPW factor times the future amount, the present value equivalent is found.

Table A.2 Single Compound Amount (SCA) factors (multipliers)—for finding the future value of a present amount

INSTRUCTIONS: Find the column of factors for the rate of change in prices closest to that specified for the component in question, and locate the SCA multiplier which corresponds to the period (year) the future amount is expected to occur. By multiplying the SCA factor times the value today of an amount that is expected to occur in the future, the future value amount is found.

Table A.3 Uniform Capital Recovery (UCR) factors (multipliers)—for finding the uniform annual equivalent of a present amount

INSTRUCTIONS: Find the column of factors for the discount rate closest to that in Series A, Worksheet 1, E, and locate the UCR factor which corresponds to the number of periods (years) of the study period in Series A, Worksheet 1, D. By multiplying the UCR factor times the present amount, the annual value equivalent is found.

Table A.4 Uniform Present Worth (UPW) factors (multipliers)—for finding the present value of a uniformly recurring future amount

INSTRUCTIONS: Find the column of factors for the discount rate closest to that in Series A, Worksheet 1, E, and locate the UPW factor which corresponds to the number of periods (years) over which the future amount is expected uniformly to recur. By multiplying the UPW factor times the annually recurring amount, the present value equivalent is found.

Table A.1. Single Present Worth (SPW) factors (multipliers)—for finding the present value of a future amount[a]

	Discount Rate																	
Period	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	12%	14%	15%	16%	18%	20%	24%	28%
1	.99	.98	.97	.96	.95	.94	.93	.93	.92	.91	.89	.88	.87	.86	.85	.83	.81	.78
2	.98	.96	.94	.92	.91	.89	.87	.86	.84	.83	.80	.77	.76	.74	.72	.69	.65	.61
3	.97	.94	.92	.89	.86	.84	.82	.79	.77	.75	.71	.68	.66	.64	.61	.58	.52	.48
4	.96	.92	.89	.85	.82	.79	.76	.74	.71	.68	.64	.59	.57	.55	.52	.48	.42	.37
5	.95	.91	.86	.82	.78	.75	.71	.68	.65	.62	.57	.52	.50	.48	.44	.40	.34	.29
6	.94	.89	.84	.79	.75	.71	.67	.63	.60	.56	.51	.46	.43	.41	.37	.33	.28	.23
7	.93	.87	.81	.76	.71	.67	.62	.58	.55	.51	.45	.40	.38	.35	.31	.28	.22	.18
8	.92	.85	.79	.73	.68	.63	.58	.54	.50	.47	.40	.35	.33	.31	.27	.23	.18	.14
9	.91	.84	.77	.70	.64	.59	.54	.50	.46	.42	.36	.31	.28	.26	.23	.19	.14	.11
10	.91	.82	.74	.68	.61	.56	.51	.46	.42	.39	.32	.27	.25	.23	.19	.16	.12	.08
11	.90	.80	.72	.65	.58	.53	.48	.43	.39	.35	.29	.24	.21	.20	.16	.13	.09	.07
12	.89	.79	.70	.62	.56	.50	.44	.40	.36	.32	.26	.21	.19	.17	.14	.11	.08	.05
13	.88	.77	.68	.60	.53	.47	.42	.37	.33	.29	.23	.18	.16	.15	.12	.09	.06	.04
14	.87	.76	.66	.58	.51	.44	.39	.34	.30	.26	.20	.16	.14	.13	.10	.08	.05	.03
15	.86	.74	.64	.56	.48	.42	.36	.32	.24	.24	.18	.14	.12	.11	.08	.06	.04	.02
16	.85	.73	.62	.53	.46	.39	.34	.29	.25	.22	.16	.12	.11	.09	.07	.05	.03	.02
17	.84	.71	.61	.51	.44	.37	.32	.27	.23	.20	.15	.11	.09	.08	.06	.05	.03	.02
18	.84	.70	.59	.49	.42	.35	.30	.25	.21	.18	.13	.09	.08	.07	.05	.04	.02	.01
19	.83	.69	.57	.47	.40	.33	.28	.23	.19	.16	.12	.08	.07	.06	.04	.03	.02	.01
20	.82	.67	.55	.46	.38	.31	.26	.21	.18	.15	.10	.07	.06	.05	.04	.03	.01	.01
21	.81	.66	.54	.44	.36	.29	.24	.20	.16	.14	.09	.06	.05	.04	.03	.02	.01	.01
22	.80	.65	.52	.42	.34	.28	.23	.18	.15	.12	.08	.06	.05	.04	.03	.02	.01	.00
23	.80	.63	.51	.41	.33	.26	.21	.17	.14	.11	.07	.05	.04	.03	.02	.02	.01	.00
24	.79	.62	.49	.39	.31	.25	.20	.16	.13	.10	.07	.04	.03	.03	.02	.01	.01	.00
25	.78	.48	.38	.30	.23	.18	.15	.12	.09	.06	.04	.03	.02	.02	.01	.00	.00	.00
30	.74	.55	.41	.31	.23	.17	.13	.10	.08	.06	.03	.02	.02	.01	.01	.00	.00	.00

[a] See Table 3-11 for formula and example of use.

Table A.2. Single Compound Amount (SCA) factors (multipliers)—for finding the future value of a present amount[a]

Period	Discount Rate 1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	12%	14%	15%	16%	18%	20%	24%	28%
1	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.12	1.14	1.15	1.16	1.18	1.20	1.24	1.28
2	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.17	1.19	1.21	1.25	1.20	1.32	1.35	1.39	1.44	1.54	1.64
3	1.03	1.06	1.09	1.12	1.16	1.19	1.23	1.26	1.30	1.33	1.40	1.48	1.52	1.56	1.64	1.73	1.91	2.10
4	1.04	1.08	1.13	1.17	1.22	1.26	1.31	1.36	1.41	1.46	1.57	1.69	1.75	1.81	1.94	2.07	2.36	2.68
5	1.05	1.10	1.16	1.22	1.28	1.34	1.40	1.47	1.54	1.61	1.76	1.93	2.01	2.10	2.29	2.49	2.93	3.44
6	1.06	1.13	1.19	1.27	1.34	1.42	1.50	1.59	1.68	1.77	1.97	2.20	2.31	2.44	2.70	3.00	3.64	4.40
7	1.07	1.15	1.23	1.32	1.41	1.50	1.61	1.71	1.83	1.95	2.21	2.50	2.66	2.83	3.19	3.58	4.51	5.63
8	1.08	1.17	1.27	1.37	1.48	1.59	1.72	1.85	1.99	2.14	2.48	2.85	3.06	3.28	3.76	4.30	5.59	7.21
9	1.09	1.20	1.30	1.42	1.55	1.69	1.84	2.00	2.17	2.36	2.77	3.25	3.52	3.80	4.44	5.16	6.93	9.22
10	1.10	1.22	1.34	1.48	1.63	1.79	2.00	2.16	2.37	2.59	3.11	3.71	4.05	4.41	5.23	6.19	8.59	11.81
11	1.12	1.24	1.38	1.54	1.71	1.90	2.10	2.33	2.58	2.85	3.48	4.23	4.65	5.12	6.18	7.43	10.70	15.10
12	1.13	1.27	1.43	1.60	1.80	2.01	2.25	2.52	2.81	3.14	3.90	4.82	5.35	5.94	7.29	8.92	13.20	19.30
13	1.14	1.29	1.47	1.67	1.89	2.13	2.41	2.72	3.07	3.45	4.36	5.49	6.15	6.89	8.60	10.70	16.40	24.80
14	1.15	1.32	1.51	1.73	1.98	2.26	2.58	2.94	3.34	3.80	4.89	6.26	7.08	7.99	10.10	12.80	20.30	31.70
15	1.16	1.35	1.56	1.80	2.08	2.40	2.76	3.17	3.64	4.18	5.47	7.14	8.14	9.27	12.10	15.40	25.20	40.60
16	1.17	1.37	1.60	1.87	2.18	2.54	2.95	3.43	3.97	4.60	6.13	8.14	9.36	10.70	14.10	18.50	31.20	51.90
17	1.18	1.40	1.65	1.95	2.29	2.69	3.16	3.70	4.33	5.05	6.89	9.28	10.80	12.50	16.70	22.20	38.70	66.50
18	1.20	1.43	1.70	2.03	2.41	2.85	3.38	4.00	4.72	5.56	7.69	10.61	12.40	14.50	19.70	26.60	48.00	85.10
19	1.21	1.46	1.75	2.11	2.53	3.03	3.62	4.32	5.14	6.12	8.61	12.10	14.20	16.80	23.20	31.90	59.60	109.00
20	1.22	1.49	1.81	2.19	2.65	3.21	3.87	4.66	5.60	6.73	9.65	13.70	16.40	19.50	27.40	38.30	73.90	139.00
21	1.23	1.52	1.86	2.28	2.79	3.40	4.14	5.03	6.11	7.40	10.80	15.70	18.80	22.60	32.30	46.00	91.60	178.00
22	1.24	1.55	1.92	2.37	2.93	3.60	4.43	5.44	6.66	8.14	12.10	17.90	21.60	26.20	38.10	55.20	114.00	228.00
23	1.26	1.58	1.97	2.46	3.07	3.82	4.74	5.87	7.26	8.95	13.60	20.40	24.90	30.40	45.00	66.20	141.00	292.00
24	1.27	1.61	2.03	2.56	3.23	4.05	5.07	6.34	7.91	9.85	15.20	23.20	28.60	35.20	53.10	79.50	175.00	374.00
25	1.28	1.64	2.09	2.67	3.39	4.29	5.43	6.85	8.62	10.80	17.00	26.50	32.90	40.90	62.70	95.40	217.00	479.00
30	1.35	1.81	2.43	3.24	4.32	5.74	7.61	10.10	13.30	17.40	30.00	51.00	66.20	85.80	143.00	237.00	635.00	1650.00

[a] See Table 3-10 for formula and example of use.

Table A.3. Uniform Capital Recovery (UCR) factors (multipliers)—for finding the uniform annual equivalent of a present amount[a]

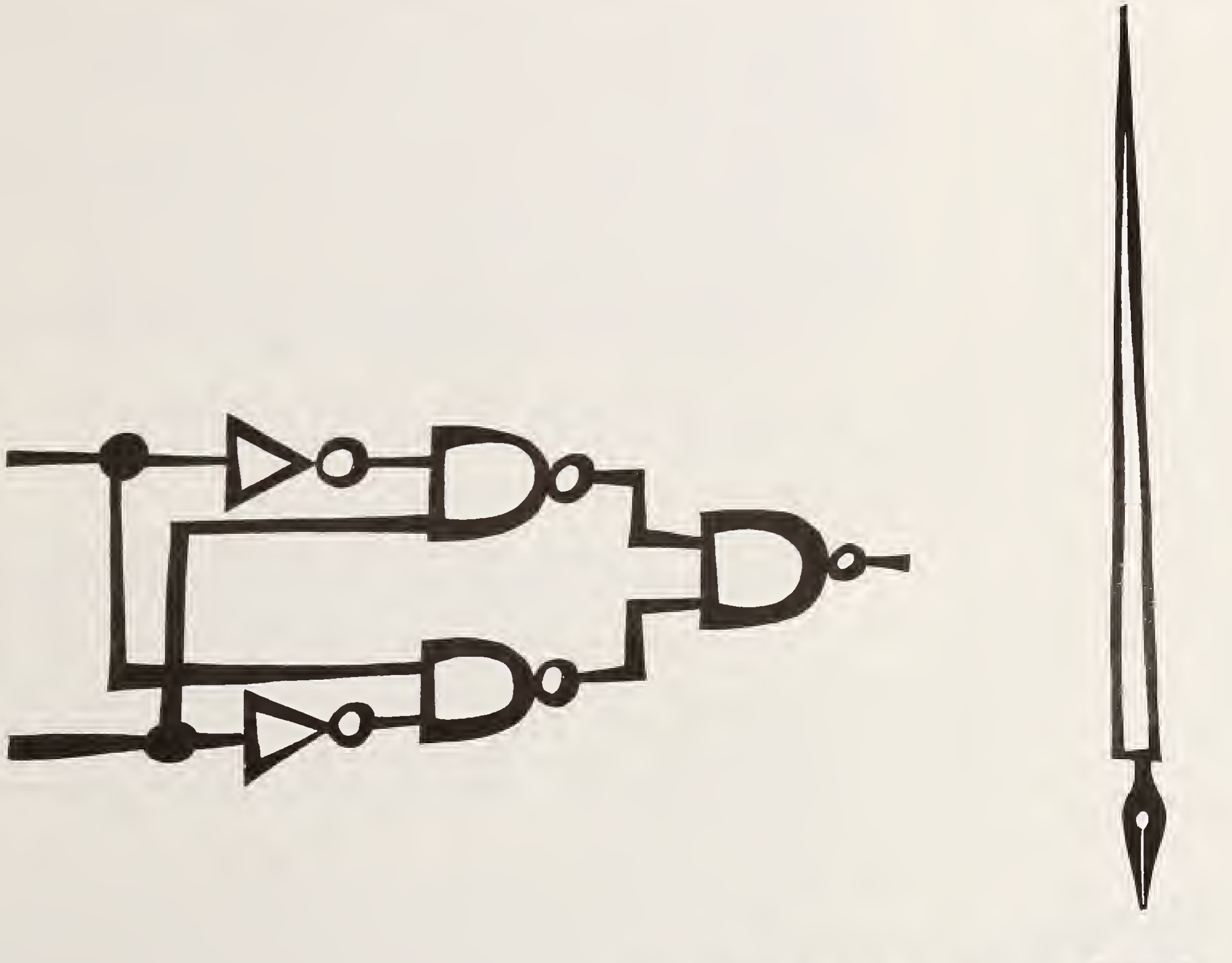
	Discount Rate																	
Period	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	12%	14%	15%	16%	18%	20%	24%	28%
1	1.00	1.00	1.00	1.00	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.20	1.20	1.20	1.20	1.20	1.30
2	.57	.52	.52	.53	.52	.55	.55	.56	.57	.58	.59	.61	.62	.62	.64	.65	.69	.70
3	.34	.35	.35	.36	.37	.37	.38	.39	.40	.40	.42	.43	.44	.45	.46	.47	.50	.54
4	.26	.26	.27	.28	.28	.29	.30	.30	.31	.32	.33	.34	.35	.36	.37	.39	.42	.45
5	.21	.21	.22	.22	.23	.24	.24	.25	.26	.26	.28	.29	.30	.31	.32	.33	.36	.39
6	.17	.18	.18	.19	.20	.20	.21	.22	.22	.23	.24	.26	.26	.27	.29	.30	.33	.36
7	.15	.15	.16	.17	.17	.18	.19	.19	.20	.21	.22	.23	.24	.25	.26	.28	.31	.34
8	.13	.14	.14	.15	.15	.16	.17	.17	.18	.19	.20	.22	.22	.23	.25	.26	.29	.33
9	.12	.12	.13	.13	.14	.15	.15	.16	.17	.17	.19	.20	.21	.22	.23	.25	.28	.31
10	.11	.11	.12	.12	.13	.14	.14	.15	.16	.16	.18	.19	.20	.21	.22	.24	.27	.31
11	.08	.10	.11	.11	.12	.13	.13	.14	.15	.15	.17	.18	.19	.20	.21	.23	.26	.30
12	.09	.09	.10	.11	.11	.12	.13	.13	.14	.15	.16	.18	.18	.19	.21	.23	.26	.30
13	.08	.09	.09	.10	.11	.11	.12	.13	.13	.14	.16	.17	.18	.19	.20	.22	.26	.29
14	.08	.08	.09	.09	.10	.11	.11	.12	.13	.14	.15	.17	.17	.18	.20	.21	.25	.29
15	.07	.08	.08	.09	.10	.10	.11	.12	.12	.13	.15	.16	.17	.18	.20	.21	.25	.29
16	.07	.07	.08	.09	.09	.10	.11	.11	.12	.13	.14	.16	.17	.18	.19	.21	.25	.29
17	.06	.07	.08	.08	.09	.10	.10	.11	.12	.12	.14	.16	.17	.17	.19	.21	.25	.28
18	.06	.07	.07	.08	.09	.09	.10	.11	.11	.12	.14	.15	.16	.17	.19	.21	.25	.28
19	.06	.06	.07	.08	.08	.09	.10	.10	.11	.12	.14	.15	.16	.17	.19	.21	.24	.28
20	.06	.06	.07	.07	.08	.09	.09	.10	.11	.12	.13	.15	.16	.17	.19	.21	.24	.28
21	.05	.06	.06	.07	.08	.09	.09	.10	.11	.12	.13	.15	.16	.17	.19	.20	.24	.28
22	.05	.06	.06	.07	.08	.08	.09	.10	.11	.11	.13	.15	.16	.17	.18	.20	.24	.28
23	.05	.05	.06	.07	.07	.08	.08	.10	.10	.11	.13	.15	.16	.17	.18	.20	.24	.28
24	.05	.05	.06	.07	.07	.08	.08	.10	.10	.11	.13	.15	.16	.16	.18	.20	.24	.28
25	.05	.05	.06	.06	.07	.08	.09	.09	.10	.11	.13	.15	.15	.16	.18	.20	.24	.28
30	.04	.04	.05	.06	.07	.07	.08	.09	.10	.11	.12	.14	.15	.16	.18	.20	.24	.28

[a] See Table 3-13 for formula and example of use.

Table A.4. Uniform Present Worth (UPW) factors (multipliers)—for finding the present value of a uniformly recurring future amount[a]

	Discount Rate																	
Period	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	12%	14%	15%	16%	18%	20%	24%	28%
1	.99	.98	.97	.96	.95	.94	.94	.93	.92	.91	.89	.88	.87	.86	.85	.83	.81	.78
2	1.97	1.94	1.91	1.89	1.86	1.83	1.81	1.78	1.76	1.74	1.69	1.65	1.63	1.61	1.57	1.53	1.46	1.39
3	2.94	2.88	2.83	2.78	2.72	2.67	2.62	2.58	2.53	2.49	2.40	2.32	2.28	2.25	2.17	2.11	1.98	1.87
4	3.90	3.81	3.72	3.63	3.55	3.47	3.39	3.31	3.24	3.17	3.04	2.91	2.86	2.80	2.69	2.59	2.40	2.24
5	4.85	4.71	4.58	4.45	4.33	4.21	4.10	3.99	3.89	3.79	3.61	3.43	3.35	3.27	3.13	2.99	2.75	2.53
6	5.80	5.60	5.42	5.24	5.08	4.92	4.77	4.62	4.49	4.36	4.11	3.89	3.78	3.69	3.50	3.33	3.02	2.76
7	6.73	6.47	6.23	6.00	5.79	5.58	5.39	5.21	5.03	4.87	4.56	4.29	4.16	4.04	3.81	3.61	3.24	2.94
8	7.65	7.33	7.02	6.73	6.46	6.21	5.97	5.75	5.54	5.34	4.97	4.64	4.49	4.34	4.08	3.84	3.42	3.08
9	8.57	8.16	7.79	7.44	7.11	6.80	6.52	6.25	6.00	5.76	5.33	4.95	4.77	4.61	4.30	4.03	3.57	3.18
10	9.47	8.98	8.53	8.11	7.72	7.36	7.02	6.71	6.42	6.15	5.65	5.22	5.02	4.83	4.49	4.19	3.68	3.27
11	10.37	9.79	9.25	8.76	8.31	7.89	7.50	7.14	6.81	6.50	5.94	5.45	5.23	5.03	4.66	4.33	3.78	3.34
12	11.25	10.58	9.95	9.39	8.86	8.38	7.94	7.54	7.16	6.81	6.19	5.66	5.42	5.20	4.79	4.44	3.85	3.39
13	12.13	11.35	10.64	9.99	9.39	8.85	8.36	7.90	7.49	7.10	6.42	5.84	5.58	5.34	4.91	4.53	3.91	3.43
14	13.00	12.11	11.30	10.56	9.90	9.30	8.75	8.24	7.79	7.37	6.63	6.00	5.72	5.47	5.00	4.61	3.96	3.46
15	13.87	12.85	11.94	11.12	10.38	9.71	9.11	8.56	8.06	7.61	6.81	6.14	5.85	5.58	5.09	4.68	4.00	3.48
16	14.72	13.58	12.56	11.65	10.84	10.11	9.45	8.85	8.31	7.82	6.97	6.27	5.95	5.67	5.16	4.73	4.03	3.50
17	15.56	14.29	13.17	12.17	11.27	10.48	9.76	9.12	8.54	8.02	7.12	6.37	6.05	5.75	5.22	4.78	4.06	3.52
18	16.40	14.99	13.75	12.66	11.69	10.83	10.06	9.37	8.76	8.20	7.25	6.47	6.13	5.82	5.27	4.81	4.08	3.53
19	17.23	15.68	14.32	13.13	12.09	11.16	10.34	9.60	8.95	8.37	7.37	6.55	6.20	5.88	5.32	4.84	4.10	3.54
20	18.05	16.35	14.88	13.59	12.46	11.47	10.59	9.82	9.13	8.51	7.47	6.62	6.26	5.93	5.35	4.87	4.11	3.55
21	18.86	17.01	15.42	14.03	12.82	11.76	10.84	10.02	9.29	8.65	7.56	6.69	6.31	5.97	5.38	4.89	4.12	3.55
22	19.66	17.66	15.94	14.45	13.16	12.04	11.06	10.20	9.44	8.77	7.65	6.74	6.36	6.01	5.41	4.91	4.13	3.56
23	20.46	18.29	16.44	14.86	13.49	12.30	11.27	10.37	9.58	8.88	7.72	6.79	6.40	6.04	5.43	4.93	4.14	3.56
24	21.24	18.91	16.94	15.25	13.80	12.55	11.47	10.53	9.71	8.99	7.78	6.84	6.43	6.07	5.45	4.94	4.14	3.56
25	22.02	19.52	17.41	15.62	14.09	12.78	11.65	10.67	9.82	9.08	7.84	6.87	6.46	6.10	5.47	4.95	4.15	3.56
30	25.81	22.40	19.60	17.29	15.37	13.76	12.41	11.26	10.27	9.43	8.06	7.00	6.57	6.18	5.52	4.98	4.16	3.57

[a] See Table 3-12 for formula and example of use.



APPENDIX B. PART I

INDICES (MULTIPLIERS) FOR COMPUTING PRESENT VALUE ENERGY SAVINGS ACCORDING TO APPROACHES 1 AND 2 LISTED IN WORKSHEET 4

APPROACHES 1 and 2—use **Tables BI–1a** through **BI–11b**

[Note: These tables are updated in the fall of each year and published by the National Bureau of Standards in Lippiatt, *et al.*, *Energy Prices and Discount Factors for Life-Cycle Cost Analysis*, NBSIR (year of publication, last 2-digits)–3273. To receive update notices, the user must complete and return the customer service card in the back of this report.]

INSTRUCTIONS:

- Find the BI table that applies to your geographical region as indicated by the table heading, e.g., Table BI–1 applies to DoE Region 1 which consists of Maine, New Hampshire, Vermont, Massachusetts, Connecticut, and Rhode Island.

- Choose version (a) of that table if your application is residential, e.g., Table BI–1a, and version (b) if your application is commercial, e.g., Table BI–1b.

- Find the set of columns for the energy type in question.

- From this set of columns, select the column that most closely reflects your assumption regarding future general price inflation as indicated by the "General Price Inflation Rate" (GPIR). The choices are GPIR=0, i.e., a stable purchasing power of the dollar; GPIR=5%, i.e., an average annual inflation rate of 5%; GPIR=10%, i.e., an average annual inflation rate of 10%; and GPIR=15%, i.e., an average annual inflation rate of 15%. Note that the assumption regarding the GPIR should be consistently reflected in all parts of the evaluation, including the discount rate. (The indices combine your assumption about general price inflation (as specified by the choice of GPIR) with the U.S. Department of Energy's forecast of real changes in energy prices which exclude purely inflationary or deflationary changes.)

- Find the year marking the beginning of your study period in the first column, "year".

- If your study period begins with the first year listed in the table, multiply the annual dollar savings at today's prices from Worksheet 4, Section A(e) (3) times the index for each year of the study period beginning with the next index following 1.00 (assumes end-of-year cash flows), and enter each product in Series A, Worksheet 4, Section B, under the appropriate year.

  [Example: If your study period begins in mid-1985, the first year's savings would be calculated as $A(e)(3)x1986 multiplier.]

* If your study period begins after the first year listed in the table, it is necessary to derive an estimated savings amount to correspond to the first year index of 1.00. This can be done by dividing the savings from Worksheet 4, Section A(e)(3), for the energy type and project alternative being considered, by the index for the first year of the study period. Then multiply the derived amount times the index for each year of the study period, beginning with the index following the base-year of the study period, and enter each product in Worksheet 4, Section B with the appropriate year.

[Example: If your study period begins in mid-1986, and the table begins in mid-1985, divide the 1986 dollar amount from A(e)(3) by the 1986 index to derive the mid-1985 amount. Then multiply the derived mid-1985 amount times the index for 1987 to estimate the first year's savings, multiply the derived mid-1985 amount times the index for 1988 to derive the second year's savings, etc.]

Table BI-1a. Energy price indices for use during 1985–1986[a], based on U.S. Department of Energy (DoE)-projected constant dollar energy prices adjusted for General Price Inflation Rates (GPIR) of 0, 5, 10, and 15 percent

DoE Region 1: Maine, New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island.

RESIDENTIAL PRICING

	ELECTRICITY GPIR				DISTILLATE FUEL GPIR				LIQUEFIED PETROLEUM GAS GPIR				NATURAL GAS GPIR			
YEAR	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%
1985	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1986	1.01	1.06	1.11	1.16	0.98	1.03	1.08	1.13	0.98	1.03	1.08	1.13	1.00	1.05	1.10	1.15
1987	1.04	1.15	1.26	1.38	0.98	1.08	1.19	1.30	0.98	1.08	1.19	1.30	1.04	1.15	1.26	1.38
1988	1.09	1.26	1.45	1.66	1.01	1.17	1.35	1.54	1.01	1.17	1.35	1.54	1.09	1.26	1.45	1.65
1989	1.07	1.30	1.56	1.86	1.04	1.26	1.52	1.82	1.04	1.26	1.52	1.82	1.15	1.40	1.68	2.01
1990	1.06	1.36	1.71	2.14	1.07	1.37	1.73	2.16	1.07	1.37	1.73	2.16	1.21	1.55	1.95	2.44
1991	1.06	1.42	1.88	2.45	1.12	1.51	1.99	2.60	1.12	1.51	1.99	2.60	1.27	1.71	2.26	2.94
1992	1.06	1.49	2.06	2.81	1.18	1.66	2.30	3.14	1.18	1.66	2.30	3.14	1.35	1.89	2.62	3.58
1993	1.08	1.60	2.32	3.31	1.23	1.82	2.64	3.77	1.23	1.82	2.64	3.77	1.41	2.08	3.02	4.31
1994	1.07	1.66	2.52	3.76	1.29	1.99	3.03	4.52	1.29	2.00	3.03	4.52	1.47	2.28	3.47	5.18
1995	1.07	1.74	2.77	4.32	1.34	2.18	3.48	5.42	1.34	2.18	3.48	5.42	1.53	2.49	3.96	6.17
1996	1.08	1.85	3.08	5.03	1.39	2.38	3.97	6.47	1.39	2.38	3.96	6.47	1.59	2.71	4.52	7.38
1997	1.10	1.97	3.44	5.86	1.44	2.59	4.52	7.71	1.44	2.59	4.52	7.71	1.65	2.96	5.17	8.81
1998	1.11	2.09	3.83	6.82	1.50	2.82	5.16	9.20	1.49	2.82	5.16	9.19	1.71	3.23	5.91	10.53
1999	1.12	2.23	4.27	7.95	1.55	3.07	5.89	10.98	1.55	3.06	5.88	10.95	1.78	3.52	6.75	12.57
2000	1.14	2.37	4.76	9.26	1.61	3.34	6.72	13.09	1.60	3.33	6.70	13.05	1.85	3.84	7.71	15.02
2001	1.15	2.51	5.27	10.74	1.66	3.62	7.62	15.52	1.65	3.61	7.60	15.47	1.91	4.17	8.77	17.87
2002	1.16	2.65	5.85	12.45	1.71	3.92	8.64	18.41	1.70	3.91	8.61	18.34	1.98	4.53	9.98	21.25
2003	1.17	2.81	6.49	14.44	1.76	4.24	9.80	21.80	1.76	4.23	9.76	21.73	2.04	4.91	11.35	25.27
2004	1.18	2.97	7.19	16.74	1.82	4.59	11.11	25.85	1.81	4.57	11.07	25.76	2.11	5.34	12.92	30.07
2005	1.19	3.15	7.98	19.41	1.87	4.97	12.60	30.65	1.87	4.95	12.55	30.53	2.19	5.80	14.70	35.76
2006	1.18	3.29	8.74	22.23	1.94	5.41	14.38	36.57	1.93	5.39	14.32	36.41	2.26	6.31	16.75	42.61
2007	1.18	3.44	9.58	25.47	2.02	5.90	16.42	43.66	2.01	5.87	16.34	43.45	2.35	6.86	19.10	50.79
2008	1.17	3.60	10.49	29.17	2.09	6.43	18.75	52.12	2.08	6.40	18.65	51.84	2.43	7.47	21.77	60.53
2009	1.17	3.77	11.50	33.42	2.17	7.01	21.41	62.21	2.16	6.97	21.28	61.84	2.52	8.13	24.83	72.16
2010	1.16	3.94	12.60	38.28	2.26	7.64	24.45	74.29	2.24	7.59	24.29	73.79	2.61	8.85	28.31	86.01

[a] Taken from Section 4, Series "S" tables, Barbara C. Lippiatt, Stephen F. Weber, and Rosalie T. Ruegg, *Energy Prices and Discount Factors for Life-Cycle Cost Analysis; Annual Supplement to NBS Handbook 135 and NBS Special Publication 709; 1985 Edition,* National Bureau of Standards, NBSIR-85-3273, November 1985 (updated annually).

Table BI-2a. Energy price indices for use during 1985–1986[a], based on U.S. Department of Energy (DoE)-projected constant dollar energy prices adjusted for General Price Inflation Rates (GPIR) of 0, 5, 10, and 15 percent

DoE Region 2: New York, New Jersey, Puerto Rico, Virgin Islands.

RESIDENTIAL PRICING

	ELECTRICITY GPIR				DISTILLATE FUEL GPIR				LIQUEFIED PETROLEUM GAS GPIR				NATURAL GAS GPIR			
YEAR	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%
1985	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1986	0.98	1.03	1.08	1.13	0.98	1.03	1.08	1.13	0.98	1.03	1.08	1.13	1.00	1.05	1.10	1.15
1987	1.01	1.12	1.23	1.34	0.98	1.08	1.19	1.30	0.98	1.08	1.19	1.30	1.02	1.12	1.23	1.35
1988	1.05	1.22	1.40	1.60	1.01	1.17	1.34	1.54	1.01	1.17	1.35	1.54	1.04	1.21	1.39	1.58
1989	1.03	1.25	1.51	1.80	1.04	1.26	1.52	1.82	1.04	1.26	1.52	1.82	1.09	1.32	1.59	1.90
1990	1.01	1.29	1.63	2.04	1.07	1.37	1.72	2.15	1.07	1.37	1.72	2.15	1.13	1.45	1.83	2.28
1991	1.00	1.34	1.77	2.30	1.12	1.50	1.99	2.60	1.12	1.50	1.99	2.59	1.18	1.58	2.09	2.73
1992	0.99	1.39	1.92	2.62	1.17	1.65	2.29	3.12	1.17	1.65	2.29	3.12	1.23	1.74	2.41	3.28
1993	0.98	1.45	2.10	2.99	1.23	1.81	2.63	3.76	1.23	1.81	2.63	3.75	1.29	1.90	2.76	3.93
1994	0.98	1.51	2.30	3.43	1.28	1.98	3.02	4.50	1.28	1.98	3.01	4.50	1.34	2.08	3.16	4.71
1995	0.97	1.59	2.53	3.94	1.33	2.17	3.46	5.40	1.33	2.17	3.45	5.39	1.39	2.26	3.60	5.62
1996	0.99	1.69	2.81	4.59	1.38	2.37	3.95	6.43	1.38	2.36	3.94	6.42	1.44	2.47	4.12	6.72
1997	1.00	1.79	3.14	5.35	1.43	2.58	4.50	7.68	1.43	2.57	4.49	7.66	1.50	2.69	4.70	8.02
1998	1.01	1.91	3.49	6.23	1.49	2.81	5.14	9.15	1.48	2.80	5.12	9.13	1.56	2.94	5.37	9.58
1999	1.03	2.03	3.89	7.26	1.54	3.06	5.86	10.92	1.54	3.05	5.84	10.89	1.62	3.20	6.14	11.44
2000	1.04	2.16	4.34	8.45	1.60	3.33	6.69	13.03	1.60	3.32	6.66	12.98	1.68	3.49	7.01	13.66
2001	1.05	2.29	4.81	9.80	1.65	3.60	7.58	15.45	1.64	3.59	7.55	15.38	1.74	3.79	7.98	16.25
2002	1.06	2.42	5.34	11.36	1.70	3.90	8.60	18.31	1.69	3.88	8.56	18.23	1.80	4.12	9.08	19.34
2003	1.06	2.56	5.92	13.18	1.75	4.22	9.75	21.69	1.75	4.20	9.71	21.60	1.86	4.47	10.33	22.99
2004	1.07	2.71	6.56	15.27	1.81	4.57	11.05	25.72	1.80	4.55	11.00	25.60	1.92	4.86	11.76	27.36
2005	1.08	2.87	7.28	17.71	1.86	4.94	12.53	30.49	1.85	4.92	12.47	30.35	1.99	5.28	13.38	32.54
2006	1.08	3.00	7.98	20.29	1.93	5.39	14.31	36.40	1.92	5.36	14.24	36.21	2.06	5.74	15.25	38.78
2007	1.07	3.14	8.74	23.24	2.01	5.87	16.34	43.46	2.00	5.84	16.24	43.19	2.14	6.25	17.38	46.22
2008	1.07	3.28	9.57	26.62	2.08	6.40	18.66	51.88	2.07	6.36	18.53	51.52	2.21	6.80	19.82	55.09
2009	1.07	3.44	10.49	30.50	2.16	6.98	21.30	61.92	2.15	6.93	21.16	61.49	2.29	7.40	22.59	65.65
2010	1.06	3.59	11.50	34.93	2.25	7.61	24.33	73.93	2.23	7.54	24.14	73.33	2.38	8.05	25.76	78.27

[a] For source, see footnote a, Table BI-1a.

Table BI-3a. Energy price indices for use during 1985–1986[a], based on U.S. Department of Energy (DoE)-projected constant dollar energy prices adjusted for General Price Inflation Rates (GPIR) of 0, 5, 10, and 15 percent

DoE Region 3: Pennsylvania, Maryland, West Virginia, Virginia, District of Columbia, Delaware.

RESIDENTIAL PRICING

	ELECTRICITY GPIR				DISTILLATE FUEL GPIR				LIQUEFIED PETROLEUM GAS GPIR				NATURAL GAS GPIR			
YEAR	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%
1985	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1986	0.99	1.04	1.09	1.13	0.98	1.03	1.08	1.13	0.98	1.03	1.08	1.13	1.01	1.06	1.11	1.16
1987	1.00	1.10	1.21	1.32	0.98	1.08	1.19	1.30	0.98	1.08	1.19	1.30	1.03	1.13	1.24	1.36
1988	1.00	1.16	1.33	1.52	1.01	1.17	1.35	1.54	1.01	1.17	1.35	1.54	1.06	1.23	1.41	1.61
1989	0.98	1.19	1.44	1.72	1.04	1.26	1.52	1.82	1.04	1.26	1.52	1.82	1.11	1.35	1.62	1.94
1990	0.97	1.24	1.57	1.96	1.07	1.37	1.73	2.16	1.07	1.37	1.73	2.16	1.16	1.48	1.87	2.33
1991	0.97	1.30	1.72	2.25	1.13	1.51	2.00	2.61	1.13	1.51	1.99	2.60	1.20	1.61	2.13	2.79
1992	0.97	1.37	1.90	2.59	1.18	1.66	2.30	3.14	1.18	1.66	2.30	3.14	1.26	1.77	2.45	3.35
1993	0.97	1.44	2.09	2.98	1.23	1.82	2.65	3.78	1.23	1.82	2.65	3.78	1.31	1.93	2.80	4.00
1994	0.98	1.52	2.32	3.46	1.29	2.00	3.04	4.54	1.29	2.00	3.04	4.53	1.36	2.11	3.21	4.78
1995	0.98	1.60	2.55	3.98	1.34	2.19	3.49	5.44	1.34	2.19	3.48	5.43	1.41	2.30	3.66	5.70
1996	1.00	1.71	2.85	4.64	1.39	2.39	3.98	6.49	1.39	2.38	3.97	6.48	1.46	2.50	4.18	6.81
1997	1.01	1.81	3.17	5.41	1.45	2.60	4.54	7.74	1.44	2.59	4.53	7.73	1.52	2.73	4.78	8.14
1998	1.02	1.93	3.53	6.30	1.50	2.83	5.18	9.23	1.50	2.82	5.17	9.21	1.58	2.98	5.46	9.73
1999	1.04	2.05	3.94	7.34	1.56	3.08	5.91	11.02	1.55	3.07	5.89	10.98	1.64	3.25	6.23	11.62
2000	1.05	2.18	4.39	8.55	1.61	3.36	6.74	13.14	1.61	3.34	6.72	13.09	1.71	3.55	7.12	13.88
2001	1.06	2.31	4.87	9.91	1.66	3.63	7.65	15.57	1.66	3.62	7.62	15.52	1.76	3.85	8.10	16.50
2002	1.07	2.45	5.40	11.49	1.71	3.93	8.67	18.45	1.71	3.92	8.63	18.38	1.82	4.18	9.22	19.63
2003	1.08	2.59	5.99	13.33	1.77	4.26	9.83	21.88	1.76	4.24	9.79	21.79	1.89	4.54	10.49	23.34
2004	1.09	2.74	6.64	15.45	1.82	4.61	11.15	25.95	1.81	4.58	11.10	25.82	1.95	4.93	11.94	27.78
2005	1.09	2.90	7.36	17.91	1.88	4.99	12.64	30.76	1.87	4.96	12.58	30.61	2.02	5.36	13.58	33.04
2006	1.09	3.04	8.07	20.52	1.95	5.43	14.43	36.71	1.94	5.41	14.36	36.52	2.09	5.83	15.48	39.37
2007	1.09	3.18	8.84	23.50	2.02	5.92	16.48	43.81	2.01	5.89	16.38	43.56	2.17	6.34	17.65	46.93
2008	1.08	3.32	9.69	26.92	2.10	6.46	18.82	52.32	2.09	6.41	18.70	51.99	2.25	6.90	20.13	55.95
2009	1.08	3.47	10.61	30.84	2.18	7.03	21.48	62.42	2.17	6.99	21.33	62.00	2.33	7.51	22.94	66.66
2010	1.07	3.63	11.63	35.32	2.26	7.67	24.53	74.52	2.25	7.61	24.34	73.96	2.41	8.17	26.14	79.43

[a] For source, see footnote a, Table BI-1a.

Table BI-4a. Energy price indices for use during 1985–1986[a], based on U.S. Department of Energy (DoE)-projected constant dollar energy prices adjusted for General Price Inflation Rates (GPIR) of 0, 5, 10, and 15 percent

DoE Region 4: Kentucky, Tennessee, North Carolina, South Carolina, Mississippi, Alabama, Georgia, Florida, Canal Zone.

RESIDENTIAL PRICING

	ELECTRICITY GPIR				DISTILLATE FUEL GPIR				LIQUEFIED PETROLEUM GAS GPIR				NATURAL GAS GPIR			
YEAR	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%
1985	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1986	0.98	1.03	1.08	1.13	0.98	1.03	1.08	1.13	0.98	1.03	1.08	1.13	1.00	1.05	1.10	1.15
1987	0.97	1.07	1.18	1.29	0.98	1.08	1.19	1.30	0.98	1.08	1.19	1.30	1.04	1.15	1.26	1.37
1988	0.97	1.12	1.29	1.47	1.01	1.17	1.35	1.54	1.01	1.17	1.35	1.54	1.09	1.27	1.46	1.66
1989	0.97	1.18	1.42	1.69	1.04	1.26	1.52	1.82	1.04	1.27	1.52	1.82	1.16	1.41	1.70	2.03
1990	0.96	1.22	1.54	1.92	1.07	1.37	1.73	2.16	1.07	1.37	1.73	2.16	1.24	1.59	2.00	2.50
1991	0.95	1.27	1.68	2.20	1.13	1.51	2.00	2.60	1.13	1.51	2.00	2.61	1.32	1.77	2.34	3.05
1992	0.94	1.33	1.84	2.51	1.18	1.66	2.30	3.14	1.18	1.66	2.30	3.14	1.41	1.98	2.75	3.75
1993	0.92	1.36	1.98	2.82	1.23	1.82	2.65	3.78	1.24	1.83	2.65	3.78	1.49	2.20	3.19	4.56
1994	0.91	1.40	2.14	3.19	1.29	2.00	3.04	4.54	1.29	2.00	3.04	4.54	1.58	2.45	3.72	5.55
1995	0.89	1.45	2.31	3.61	1.34	2.19	3.49	5.44	1.35	2.19	3.49	5.44	1.66	2.70	4.30	6.70
1996	0.90	1.55	2.58	4.21	1.39	2.39	3.98	6.49	1.39	2.38	3.98	6.49	1.72	2.94	4.91	8.01
1997	0.92	1.64	2.87	4.90	1.45	2.60	4.54	7.74	1.45	2.60	4.54	7.73	1.79	3.21	5.61	9.57
1998	0.93	1.75	3.20	5.71	1.50	2.83	5.18	9.23	1.50	2.83	5.18	9.23	1.86	3.50	6.41	11.42
1999	0.94	1.86	3.57	6.65	1.56	3.08	5.91	11.02	1.55	3.08	5.90	11.00	1.93	3.82	7.32	13.64
2000	0.95	1.98	3.98	7.74	1.61	3.36	6.75	13.14	1.61	3.35	6.73	13.11	2.00	4.16	8.37	16.30
2001	0.96	2.09	4.41	8.98	1.66	3.63	7.65	15.58	1.66	3.62	7.63	15.53	2.07	4.52	9.52	19.39
2002	0.97	2.22	4.89	10.41	1.72	3.93	8.67	18.46	1.71	3.92	8.65	18.41	2.14	4.91	10.83	23.07
2003	0.98	2.35	5.42	12.07	1.77	4.26	9.84	21.89	1.76	4.24	9.80	21.82	2.22	5.33	12.32	27.43
2004	0.98	2.48	6.01	13.99	1.82	4.61	11.15	25.94	1.82	4.59	11.11	25.86	2.29	5.80	14.03	32.64
2005	0.99	2.63	6.67	16.23	1.88	4.99	12.64	30.76	1.87	4.97	12.60	30.64	2.37	6.29	15.96	38.82
2006	0.99	2.75	7.31	18.59	1.95	5.43	14.43	36.71	1.94	5.41	14.37	36.56	2.46	6.85	18.18	46.25
2007	0.98	2.88	8.01	21.30	2.03	5.93	16.49	43.84	2.02	5.89	16.40	43.61	2.55	7.45	20.74	55.15
2008	0.98	3.01	8.77	24.38	2.10	6.46	18.82	52.32	2.09	6.42	18.73	52.06	2.64	8.11	23.64	65.71
2009	0.98	3.15	9.61	27.93	2.18	7.04	21.50	62.48	2.17	7.00	21.36	62.09	2.74	8.82	26.94	78.30
2010	0.97	3.29	10.53	32.00	2.26	7.67	24.53	74.54	2.25	7.62	24.38	74.08	2.84	9.60	30.73	93.36

[a] For source, see footnote a, Table BI-1a.

Table BI-5a. Energy price indices for use during 1985–1986[a], based on U.S. Department of Energy (DoE)-projected constant dollar energy prices adjusted for General Price Inflation Rates (GPIR) of 0, 5, 10, and 15 percent

DoE Region 5: Minnesota, Wisconsin, Michigan, Illinois, Indiana, Ohio.

RESIDENTIAL PRICING

	ELECTRICITY GPIR				DISTILLATE FUEL GPIR				LIQUEFIED PETROLEUM GAS GPIR				NATURAL GAS GPIR			
YEAR	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%
1985	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1986	1.03	1.08	1.13	1.18	0.98	1.03	1.08	1.13	0.98	1.03	1.08	1.13	1.01	1.06	1.11	1.16
1987	1.04	1.15	1.26	1.38	0.98	1.08	1.19	1.30	0.98	1.08	1.19	1.30	1.03	1.13	1.24	1.36
1988	1.03	1.19	1.37	1.56	1.01	1.17	1.35	1.54	1.01	1.17	1.34	1.54	1.06	1.23	1.41	1.62
1989	1.00	1.22	1.46	1.75	1.04	1.27	1.53	1.83	1.04	1.27	1.53	1.82	1.11	1.35	1.63	1.94
1990	0.98	1.25	1.57	1.96	1.08	1.37	1.73	2.16	1.08	1.37	1.73	2.16	1.17	1.50	1.89	2.36
1991	0.96	1.28	1.69	2.21	1.13	1.52	2.01	2.62	1.13	1.52	2.01	2.62	1.24	1.66	2.19	2.86
1992	0.94	1.32	1.83	2.50	1.19	1.67	2.32	3.16	1.19	1.67	2.32	3.16	1.32	1.85	2.57	3.50
1993	0.92	1.36	1.98	2.82	1.25	1.84	2.67	3.82	1.24	1.84	2.67	3.81	1.39	2.06	2.99	4.26
1994	0.91	1.41	2.14	3.19	1.30	2.02	3.07	4.59	1.30	2.02	3.07	4.58	1.47	2.29	3.47	5.18
1995	0.90	1.46	2.33	3.63	1.36	2.22	3.53	5.51	1.36	2.21	3.53	5.50	1.55	2.52	4.02	6.27
1996	0.91	1.55	2.59	4.23	1.41	2.42	4.03	6.57	1.41	2.41	4.02	6.56	1.61	2.75	4.59	7.48
1997	0.92	1.65	2.89	4.93	1.46	2.63	4.60	7.84	1.46	2.62	4.59	7.82	1.67	3.00	5.25	8.94
1998	0.93	1.76	3.22	5.74	1.52	2.87	5.25	9.35	1.52	2.86	5.23	9.32	1.74	3.27	5.99	10.68
1999	0.94	1.87	3.59	6.69	1.58	3.12	5.98	11.15	1.57	3.11	5.96	11.11	1.80	3.57	6.85	12.76
2000	0.96	1.99	4.00	7.79	1.63	3.40	6.83	13.30	1.63	3.39	6.80	13.25	1.87	3.89	7.82	15.24
2001	0.97	2.11	4.44	9.03	1.69	3.68	7.74	15.77	1.68	3.66	7.71	15.71	1.94	4.23	8.90	18.13
2002	0.97	2.23	4.92	10.47	1.74	3.98	8.78	18.70	1.73	3.96	8.74	18.61	2.00	4.59	10.13	21.56
2003	0.98	2.36	5.45	12.14	1.79	4.31	9.96	22.16	1.78	4.29	9.91	22.05	2.07	4.98	11.52	25.63
2004	0.99	2.50	6.05	14.07	1.85	4.67	11.30	26.28	1.84	4.64	11.23	26.14	2.14	5.41	13.10	30.49
2005	1.00	2.65	6.71	16.32	1.90	5.05	12.80	31.15	1.89	5.02	12.73	30.98	2.22	5.88	14.92	36.29
2006	0.99	2.77	7.35	18.69	1.98	5.51	14.62	37.19	1.96	5.47	14.53	36.95	2.30	6.40	17.00	43.24
2007	0.99	2.89	8.05	21.41	2.05	6.00	16.69	44.38	2.04	5.96	16.58	44.08	2.38	6.96	19.38	51.53
2008	0.99	3.03	8.82	24.53	2.13	6.54	19.05	52.96	2.11	6.49	18.93	52.61	2.47	7.58	22.10	61.43
2009	0.98	3.17	9.67	28.10	2.21	7.13	21.76	63.24	2.19	7.07	21.59	62.75	2.56	8.25	25.20	73.23
2010	0.98	3.31	10.59	32.19	2.29	7.77	24.85	75.50	2.27	7.70	24.64	74.87	2.65	8.98	28.72	87.25

[a] For source, see footnote a, Table BI-1a.

Table BI-6a. Energy price indices for use during 1985–1986[a], based on U.S. Department of Energy (DoE)-projected constant dollar energy prices adjusted for General Price Inflation Rates (GPIR) of 0, 5, 10, and 15 percent

DoE Region 6: Texas, New Mexico, Oklahoma, Arkansas, Louisiana.

RESIDENTIAL PRICING

	ELECTRICITY GPIR				DISTILLATE FUEL GPIR				LIQUEFIED PETROLEUM GAS GPIR				NATURAL GAS GPIR			
YEAR	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%
1985	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1986	1.03	1.08	1.13	1.19	0.98	1.02	1.07	1.12	0.98	1.03	1.07	1.12	1.03	1.08	1.13	1.18
1987	1.05	1.16	1.27	1.39	0.98	1.08	1.18	1.29	0.98	1.08	1.18	1.29	1.07	1.18	1.30	1.42
1988	1.05	1.22	1.40	1.60	1.01	1.17	1.35	1.54	1.01	1.17	1.35	1.54	1.12	1.30	1.49	1.71
1989	1.05	1.28	1.54	1.85	1.05	1.28	1.54	1.84	1.05	1.28	1.54	1.84	1.18	1.43	1.72	2.06
1990	1.06	1.35	1.70	2.13	1.09	1.39	1.75	2.19	1.09	1.39	1.76	2.19	1.25	1.60	2.01	2.52
1991	1.07	1.44	1.90	2.48	1.16	1.55	2.05	2.68	1.16	1.55	2.05	2.68	1.32	1.77	2.34	3.06
1992	1.08	1.53	2.11	2.88	1.22	1.72	2.38	3.26	1.22	1.72	2.39	3.26	1.40	1.98	2.74	3.73
1993	1.10	1.62	2.36	3.36	1.29	1.91	2.77	3.95	1.29	1.91	2.77	3.95	1.48	2.19	3.18	4.54
1994	1.11	1.72	2.62	3.91	1.36	2.11	3.20	4.78	1.36	2.11	3.20	4.78	1.57	2.43	3.70	5.52
1995	1.13	1.84	2.94	4.58	1.43	2.32	3.70	5.77	1.43	2.32	3.70	5.77	1.65	2.69	4.29	6.69
1996	1.15	1.96	3.27	5.34	1.48	2.53	4.22	6.88	1.48	2.53	4.22	6.88	1.72	2.94	4.90	7.99
1997	1.16	2.09	3.65	6.21	1.54	2.76	4.82	8.22	1.53	2.75	4.81	8.20	1.78	3.20	5.60	9.54
1998	1.18	2.22	4.06	7.24	1.59	3.00	5.50	9.80	1.59	3.00	5.49	9.78	1.85	3.49	6.40	11.40
1999	1.19	2.36	4.53	8.43	1.65	3.27	6.27	11.69	1.65	3.26	6.26	11.66	1.92	3.81	7.31	13.61
2000	1.21	2.51	5.04	9.82	1.71	3.56	7.16	13.94	1.71	3.55	7.13	13.90	2.00	4.15	8.35	16.26
2001	1.22	2.66	5.59	11.39	1.77	3.86	8.12	16.53	1.76	3.84	8.09	16.47	2.07	4.51	9.50	19.34
2002	1.23	2.81	6.20	13.21	1.82	4.17	9.20	19.60	1.81	4.16	9.17	19.53	2.14	4.90	10.81	23.01
2003	1.24	2.98	6.88	15.31	1.88	4.51	10.43	23.21	1.87	4.50	10.40	23.14	2.21	5.32	12.29	27.36
2004	1.25	3.15	7.63	17.75	1.93	4.89	11.83	27.52	1.93	4.87	11.79	27.43	2.29	5.78	13.99	32.55
2005	1.26	3.34	8.46	20.58	1.99	5.29	13.41	32.62	1.99	5.27	13.36	32.51	2.37	6.28	15.91	38.71
2006	1.25	3.49	9.27	23.58	2.07	5.77	15.32	38.95	2.06	5.74	15.25	38.78	2.45	6.83	18.14	46.13
2007	1.25	3.65	10.16	27.01	2.15	6.28	17.48	46.48	2.14	6.25	17.40	46.27	2.54	7.43	20.68	54.98
2008	1.24	3.82	11.13	30.94	2.23	6.85	19.97	55.52	2.22	6.81	19.86	55.21	2.63	8.09	23.57	65.53
2009	1.24	3.99	12.19	35.44	2.32	7.47	22.80	66.27	2.30	7.42	22.65	65.83	2.73	8.80	26.88	78.12
2010	1.23	4.18	13.36	40.60	2.40	8.14	26.04	79.10	2.39	8.08	25.86	78.56	2.83	9.57	30.63	93.07

[a] For source, see footnote a, Table BI-1a.

Table BI-7a. Energy price indices for use during 1985–1986[a], based on U.S. Department of Energy (DoE)-projected constant dollar energy prices adjusted for General Price Inflation Rates (GPIR) of 0, 5, 10, and 15 percent

DoE Region 7: Kansas, Missouri, Iowa, Nebraska.

RESIDENTIAL PRICING

	ELECTRICITY GPIR				DISTILLATE FUEL GPIR				LIQUEFIED PETROLEUM GAS GPIR				NATURAL GAS GPIR			
YEAR	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%
1985	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1986	1.05	1.10	1.15	1.21	0.98	1.03	1.08	1.12	0.98	1.03	1.08	1.12	1.00	1.05	1.10	1.15
1987	1.02	1.12	1.23	1.35	0.98	1.08	1.19	1.30	0.98	1.08	1.19	1.30	1.04	1.14	1.26	1.37
1988	0.98	1.14	1.31	1.50	1.01	1.17	1.35	1.54	1.01	1.17	1.35	1.54	1.10	1.27	1.46	1.67
1989	0.96	1.16	1.40	1.67	1.05	1.27	1.53	1.83	1.04	1.27	1.53	1.83	1.15	1.40	1.68	2.01
1990	0.95	1.21	1.52	1.90	1.08	1.38	1.74	2.17	1.08	1.38	1.74	2.17	1.23	1.57	1.99	2.48
1991	0.94	1.26	1.66	2.17	1.14	1.53	2.02	2.64	1.14	1.53	2.02	2.64	1.31	1.75	2.31	3.02
1992	0.92	1.30	1.80	2.46	1.20	1.69	2.34	3.19	1.20	1.69	2.34	3.19	1.39	1.96	2.72	3.71
1993	0.91	1.34	1.95	2.78	1.26	1.86	2.70	3.86	1.26	1.86	2.70	3.85	1.47	2.17	3.15	4.50
1994	0.90	1.39	2.11	3.15	1.32	2.05	3.11	4.64	1.32	2.05	3.11	4.64	1.56	2.42	3.68	5.48
1995	0.88	1.44	2.29	3.58	1.38	2.25	3.58	5.59	1.38	2.25	3.58	5.58	1.64	2.67	4.25	6.62
1996	0.90	1.53	2.56	4.17	1.43	2.45	4.09	6.66	1.43	2.45	4.08	6.65	1.70	2.91	4.85	7.91
1997	0.91	1.63	2.85	4.85	1.49	2.67	4.66	7.95	1.48	2.66	4.65	7.93	1.77	3.17	5.54	9.45
1998	0.92	1.73	3.17	5.65	1.54	2.91	5.32	9.49	1.54	2.90	5.31	9.46	1.83	3.46	6.33	11.29
1999	0.93	1.84	3.53	6.59	1.60	3.17	6.08	11.32	1.59	3.16	6.06	11.28	1.90	3.77	7.23	13.48
2000	0.94	1.96	3.94	7.67	1.66	3.45	6.93	13.50	1.65	3.44	6.90	13.45	1.98	4.11	8.27	16.10
2001	0.95	2.07	4.37	8.89	1.71	3.73	7.86	16.00	1.70	3.72	7.83	15.94	2.05	4.47	9.40	19.14
2002	0.96	2.20	4.84	10.31	1.76	4.04	8.91	18.97	1.75	4.02	8.87	18.88	2.12	4.85	10.70	22.77
2003	0.97	2.33	5.37	11.96	1.82	4.37	10.11	22.50	1.81	4.35	10.05	22.38	2.19	5.27	12.18	27.10
2004	0.97	2.46	5.96	13.86	1.87	4.73	11.45	26.65	1.86	4.71	11.41	26.54	2.26	5.72	13.85	32.22
2005	0.98	2.61	6.61	16.08	1.93	5.12	12.99	31.59	1.92	5.10	12.93	31.45	2.34	6.21	15.76	38.33
2006	0.98	2.73	7.24	18.41	2.00	5.58	14.83	37.73	1.99	5.55	14.75	37.51	2.43	6.76	17.97	45.69
2007	0.97	2.85	7.93	21.09	2.08	6.08	16.93	45.02	2.07	6.05	16.83	44.75	2.52	7.36	20.47	54.44
2008	0.97	2.98	8.69	24.17	2.16	6.63	19.34	53.77	2.14	6.59	19.21	53.39	2.61	8.01	23.34	64.88
2009	0.97	3.12	9.53	27.69	2.24	7.23	22.08	64.16	2.22	7.18	21.91	63.69	2.70	8.71	26.61	77.33
2010	0.96	3.26	10.44	31.72	2.33	7.88	25.20	76.57	2.31	7.82	25.02	76.01	2.80	9.48	30.34	92.19

[a] For source, see footnote a, Table BI-1a.

Table BI-8a. Energy price indices for use during 1985–1986[a], based on U.S. Department of Energy (DoE)-projected constant dollar energy prices adjusted for General Price Inflation Rates (GPIR) of 0, 5, 10, and 15 percent

DoE Region 8: Montana, North Dakota, South Dakota, Wyoming, Utah, Colorado.

RESIDENTIAL PRICING

	ELECTRICITY GPIR				DISTILLATE FUEL GPIR				LIQUEFIED PETROLEUM GAS GPIR				NATURAL GAS GPIR			
YEAR	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%
1985	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1986	1.01	1.06	1.11	1.16	0.98	1.03	1.08	1.12	0.98	1.03	1.08	1.12	1.00	1.05	1.10	1.15
1987	1.00	1.11	1.22	1.33	0.98	1.08	1.19	1.30	0.98	1.08	1.19	1.30	1.03	1.13	1.24	1.36
1988	1.00	1.16	1.33	1.52	1.01	1.17	1.35	1.54	1.01	1.17	1.35	1.54	1.05	1.22	1.40	1.60
1989	0.99	1.21	1.45	1.74	1.05	1.27	1.53	1.83	1:05	1.27	1.53	1.83	1.07	1.30	1.56	1.86
1990	0.98	1.25	1.58	1.97	1.08	1.38	1.74	2.18	1.08	1.38	1.74	2.18	1.13	1.45	1.82	2.28
1991	0.97	1.30	1.71	2.24	1.14	1.53	2.03	2.64	1.14	1.53	2.02	2.64	1.19	1.59	2.10	2.75
1992	0.96	1.35	1.87	2.55	1.20	1.69	2.35	3.20	1.20	1.69	2.35	3.20	1.25	1.77	2.45	3.34
1993	0.94	1.39	2.02	2.88	1.27	1.87	2.71	3.87	1.26	1.87	2.71	3.87	1.32	1.95	2.82	4.03
1994	0.93	1.44	2.19	3.27	1.33	2.06	3.13	4.67	1.32	2.06	3.12	4.66	1.39	2.16	3.28	4.90
1995	0.93	1.52	2.42	3.77	1.39	2.26	3.60	5.62	1.39	2.26	3.60	5.62	1.46	2.38	3.79	5.91
1996	0.94	1.61	2.69	4.39	1.44	2.46	4.11	6.70	1.44	2.46	4.11	6.69	1.52	2.60	4.34	7.07
1997	0.96	1.72	3.00	5.11	1.49	2.68	4.69	7.99	1.49	2.68	4.68	7.98	1.58	2.83	4.95	8.44
1998	0.97	1.83	3.34	5.96	1.55	2.92	5.35	9.54	1.55	2.91	5.34	9.51	1.64	3.09	5.66	10.08
1999	0.98	1.94	3.72	6.94	1.61	3.19	6.11	11.38	1.60	3.17	6.09	11.35	1.70	3.37	6.46	12.05
2000	0.99	2.06	4.15	8.08	1.67	3.47	6.97	13.57	1.66	3.45	6.94	13.52	1.77	3.68	7.39	14.39
2001	1.00	2.19	4.60	9.37	1.72	3.75	7.90	16.09	1.71	3.74	7.87	16.03	1.83	3.99	8.40	17.11
2002	1.01	2.31	5.10	10.87	1.77	4.06	8.96	19.07	1.77	4.05	8.92	18.99	1.89	4.33	9.56	20.35
2003	1.02	2.45	5.66	12.60	1.83	4.40	10.16	22.62	1.82	4.38	10.11	22.51	1.96	4.71	10.87	24.20
2004	1.03	2.59	6.28	14.61	1.88	4.76	11.52	26.81	1.87	4.74	11.47	26.68	2.02	5.11	12.37	28.80
2005	1.03	2.75	6.96	16.93	1.94	5.15	13.06	31.77	1.93	5.13	13.00	31.63	2.09	5.55	14.07	34.23
2006	1.03	2.87	7.63	19.40	2.02	5.61	14.91	37.93	2.00	5.58	14.83	37.72	2.17	6.04	16.05	40.83
2007	1.03	3.00	8.36	22.22	2.09	6.12	17.03	45.28	2.08	6.08	16.92	44.99	2.25	6.57	18.29	48.64
2008	1.02	3.14	9.16	25.45	2.17	6.67	19.44	54.03	2.16	6.63	19.32	53.70	2.33	7.15	20.85	57.97
2009	1.02	3.29	10.04	29.17	2.25	7.27	22.20	64.51	2.24	7.22	22.04	64.05	2.41	7.79	23.78	69.11
2010	1.01	3.44	10.99	33.40	2.34	7.92	25.35	77.03	2.32	7.86	25.14	76.39	2.50	8.47	27.11	82.36

[a] For source, see footnote a, Table BI-1a.

Table BI-9a. Energy price indices for use during 1985–1986[a], based on U.S. Department of Energy (DoE)-projected constant dollar energy prices adjusted for General Price Inflation Rates (GPIR) of 0, 5, 10, and 15 percent

DoE Region 9: California, Nevada, Arizona, Hawaii, Trust Territory of the Pacific Islands, American Samoa, Guam.

RESIDENTIAL PRICING

	ELECTRICITY GPIR				DISTILLATE FUEL GPIR				LIQUEFIED PETROLEUM GAS GPIR				NATURAL GAS GPIR			
YEAR	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%
1985	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1986	1.06	1.11	1.16	1.22	0.98	1.03	1.08	1.13	0.98	1.03	1.08	1.13	0.97	1.02	1.07	1.12
1987	1.06	1.17	1.29	1.41	0.98	1.08	1.19	1.30	0.98	1.08	1.19	1.30	1.01	1.12	1.23	1.34
1988	1.05	1.21	1.39	1.59	1.01	1.17	1.35	1.54	1.01	1.17	1.35	1.54	1.04	1.20	1.38	1.58
1989	1.04	1.27	1.53	1.82	1.04	1.27	1.53	1.82	1.04	1.27	1.53	1.83	1.16	1.40	1.69	2.02
1990	1.05	1.34	1.69	2.11	1.08	1.38	1.74	2.17	1.08	1.38	1.74	2.17	1.23	1.57	1.99	2.48
1991	1.06	1.41	1.87	2.44	1.14	1.52	2.01	2.63	1.14	1.52	2.01	2.63	1.30	1.74	2.30	3.01
1992	1.07	1.50	2.08	2.84	1.19	1.68	2.33	3.18	1.19	1.68	2.33	3.18	1.38	1.94	2.69	3.67
1993	1.08	1.60	2.32	3.32	1.25	1.85	2.68	3.83	1.25	1.85	2.69	3.83	1.45	2.15	3.11	4.44
1994	1.11	1.72	2.62	3.90	1.31	2.03	3.09	4.61	1.31	2.03	3.09	4.61	1.53	2.38	3.61	5.39
1995	1.13	1.83	2.92	4.55	1.37	2.23	3.56	5.55	1.37	2.23	3.56	5.55	1.60	2.61	4.16	6.49
1996	1.14	1.95	3.25	5.30	1.42	2.43	4.06	6.62	1.42	2.43	4.05	6.61	1.67	2.85	4.75	7.75
1997	1.16	2.07	3.63	6.18	1.47	2.65	4.63	7.89	1.47	2.65	4.62	7.88	1.73	3.11	5.43	9.26
1998	1.17	2.21	4.04	7.20	1.53	2.89	5.29	9.42	1.53	2.88	5.27	9.39	1.80	3.39	6.21	11.06
1999	1.19	2.35	4.50	8.39	1.59	3.14	6.03	11.23	1.58	3.13	6.01	11.20	1.87	3.70	7.09	13.21
2000	1.20	2.50	5.01	9.77	1.65	3.42	6.88	13.40	1.64	3.41	6.86	13.35	1.94	4.03	8.10	15.77
2001	1.21	2.64	5.56	11.33	1.70	3.70	7.80	15.88	1.69	3.69	7.77	15.82	2.01	4.38	9.22	18.77
2002	1.22	2.80	6.17	13.14	1.75	4.01	8.85	18.84	1.74	4.00	8.81	18.76	2.07	4.75	10.48	22.31
2003	1.23	2.96	6.84	15.23	1.80	4.34	10.03	22.32	1.80	4.32	9.98	22.22	2.14	5.16	11.92	26.54
2004	1.24	3.14	7.59	17.66	1.86	4.70	11.37	26.45	1.85	4.68	11.32	26.34	2.22	5.61	13.57	31.59
2005	1.25	3.32	8.41	20.47	1.92	5.08	12.89	31.36	1.91	5.06	12.83	31.22	2.29	6.09	15.44	37.55
2006	1.25	3.47	9.22	23.45	1.99	5.54	14.73	37.45	1.98	5.52	14.65	37.26	2.38	6.63	17.61	44.78
2007	1.24	3.63	10.10	26.86	2.06	6.04	16.81	44.69	2.05	6.01	16.72	44.45	2.47	7.21	20.07	53.36
2008	1.24	3.80	11.07	30.77	2.14	6.58	19.19	53.34	2.13	6.54	19.08	53.03	2.56	7.85	22.88	63.61
2009	1.23	3.97	12.13	35.25	2.23	7.18	21.92	63.69	2.21	7.13	21.76	63.25	2.65	8.54	26.07	75.78
2010	1.23	4.15	13.29	40.37	2.31	7.82	25.02	76.00	2.29	7.76	24.84	75.48	2.74	9.29	29.74	90.36

[a] For source, see footnote a, Table BI-1a.

Table BI-10a. Energy price indices for use during 1985–1986[a], based on U.S. Department of Energy (DoE)-projected constant dollar energy prices adjusted for General Price Inflation Rates (GPIR) of 0, 5, 10, and 15 percent

DoE Region 10: Washington, Oregon, Idaho, Alaska.

RESIDENTIAL PRICING

	ELECTRICITY GPIR				DISTILLATE FUEL GPIR				LIQUEFIED PETROLEUM GAS GPIR				NATURAL GAS GPIR			
YEAR	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%
1985	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1986	0.95	1.00	1.05	1.10	0.98	1.03	1.08	1.13	0.98	1.03	1.08	1.13	0.99	1.04	1.09	1.14
1987	0.95	1.04	1.15	1.25	0.98	1.08	1.19	1.30	0.98	1.08	1.19	1.30	0.99	1.10	1.20	1.32
1988	0.96	1.11	1.27	1.45	1.01	1.17	1.35	1.54	1.01	1.17	1.35	1.54	0.99	1.15	1.32	1.51
1989	0.96	1.16	1.40	1.67	1.04	1.26	1.52	1.82	1.04	1.27	1.52	1.82	1.05	1.27	1.53	1.83
1990	0.97	1.24	1.56	1.95	1.07	1.37	1.73	2.16	1.07	1.37	1.73	2.16	1.10	1.40	1.77	2.21
1991	1.00	1.34	1.77	2.31	1.13	1.51	2.00	2.61	1.13	1.51	2.00	2.61	1.13	1.52	2.01	2.62
1992	1.02	1.43	1.98	2.70	1.18	1.66	2.30	3.14	1.18	1.66	2.30	3.14	1.18	1.67	2.31	3.15
1993	1.00	1.47	2.14	3.05	1.24	1.83	2.65	3.78	1.24	1.83	2.65	3.78	1.23	1.81	2.63	3.75
1994	1.02	1.58	2.40	3.58	1.29	2.00	3.04	4.54	1.29	2.00	3.04	4.54	1.28	1.99	3.02	4.51
1995	1.05	1.71	2.72	4.24	1.35	2.19	3.49	5.44	1.35	2.19	3.49	5.45	1.33	2.17	3.45	5.38
1996	1.06	1.82	3.03	4.94	1.40	2.39	3.99	6.50	1.40	2.39	3.98	6.49	1.38	2.36	3.94	6.43
1997	1.08	1.93	3.38	5.76	1.45	2.60	4.55	7.75	1.45	2.60	4.54	7.74	1.44	2.58	4.51	7.69
1998	1.09	2.06	3.76	6.71	1.50	2.83	5.19	9.24	1.50	2.83	5.18	9.23	1.49	2.82	5.15	9.19
1999	1.10	2.19	4.19	7.81	1.56	3.09	5.92	11.03	1.55	3.08	5.90	11.00	1.55	3.07	5.89	10.97
2000	1.12	2.32	4.67	9.10	1.62	3.36	6.75	13.15	1.61	3.35	6.73	13.12	1.61	3.35	6.73	13.10
2001	1.13	2.46	5.18	10.55	1.67	3.64	7.66	15.59	1.66	3.63	7.63	15.55	1.66	3.63	7.65	15.58
2002	1.14	2.61	5.75	12.23	1.72	3.94	8.68	18.48	1.71	3.93	8.66	18.43	1.72	3.95	8.70	18.53
2003	1.15	2.76	6.37	14.18	1.77	4.26	9.85	21.92	1.77	4.25	9.82	21.85	1.78	4.29	9.91	22.05
2004	1.16	2.92	7.07	16.45	1.83	4.61	11.16	25.97	1.82	4.60	11.13	25.89	1.84	4.66	11.27	26.22
2005	1.16	3.09	7.83	19.06	1.88	4.99	12.66	30.79	1.87	4.97	12.61	30.68	1.91	5.06	12.83	31.20
2006	1.16	3.23	8.59	21.84	1.95	5.44	14.45	36.76	1.94	5.42	14.39	36.60	1.97	5.50	14.61	37.17
2007	1.16	3.38	9.41	25.01	2.03	5.93	16.50	43.87	2.02	5.90	16.42	43.67	2.05	5.99	16.67	44.32
2008	1.15	3.54	10.31	28.67	2.10	6.46	18.84	52.36	2.09	6.43	18.74	52.09	2.12	6.52	19.00	52.81
2009	1.15	3.70	11.29	32.82	2.18	7.04	21.52	62.53	2.17	7.00	21.38	62.13	2.20	7.09	21.65	62.93
2010	1.14	3.87	12.38	37.62	2.27	7.68	24.57	74.65	2.25	7.63	24.40	74.14	2.28	7.72	24.70	75.03

[a] For source, see footnote a, Table BI-1a.

Table BI-11a. Energy price indices for use during 1985–1986[a], based on U.S. Department of Energy (DoE)-projected constant dollar energy prices adjusted for General Price Inflation Rates (GPIR) of 0, 5, 10, and 15 percent

United States Average

RESIDENTIAL PRICING

	ELECTRICITY GPIR				DISTILLATE FUEL GPIR				LIQUEFIED PETROLEUM GAS GPIR				NATURAL GAS GPIR			
YEAR	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%
1985	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1986	1.01	1.06	1.11	1.16	0.98	1.03	1.08	1.13	0.98	1.03	1.08	1.13	1.00	1.05	1.10	1.15
1987	1.01	1.12	1.23	1.34	0.98	1.08	1.19	1.30	0.98	1.08	1.19	1.30	1.03	1.13	1.24	1.36
1988	1.01	1.17	1.35	1.54	1.01	1.17	1.35	1.54	1.01	1.17	1.35	1.54	1.06	1.23	1.41	1.62
1989	1.00	1.22	1.47	1.75	1.04	1.27	1.52	1.82	1.04	1.27	1.53	1.82	1.12	1.36	1.64	1.96
1990	0.99	1.27	1.60	2.00	1.07	1.37	1.73	2.16	1.08	1.37	1.73	2.16	1.18	1.51	1.91	2.38
1991	0.99	1.32	1.75	2.29	1.13	1.51	2.00	2.61	1.13	1.52	2.01	2.62	1.24	1.67	2.20	2.88
1992	0.99	1.39	1.92	2.62	1.18	1.66	2.30	3.14	1.19	1.68	2.32	3.17	1.32	1.85	2.57	3.51
1993	0.98	1.45	2.10	3.00	1.24	1.83	2.65	3.78	1.25	1.84	2.68	3.82	1.39	2.05	2.97	4.24
1994	0.98	1.52	2.30	3.44	1.29	2.00	3.04	4.54	1.31	2.03	3.08	4.59	1.46	2.26	3.44	5.13
1995	0.98	1.59	2.54	3.96	1.35	2.19	3.49	5.44	1.36	2.22	3.54	5.52	1.53	2.49	3.96	6.18
1996	0.99	1.69	2.83	4.61	1.40	2.39	3.98	6.50	1.41	2.42	4.04	6.58	1.59	2.71	4.52	7.38
1997	1.00	1.80	3.15	5.37	1.45	2.60	4.55	7.75	1.47	2.63	4.60	7.84	1.65	2.96	5.17	8.81
1998	1.02	1.92	3.51	6.25	1.50	2.83	5.19	9.24	1.52	2.87	5.25	9.36	1.71	3.23	5.90	10.52
1999	1.03	2.04	3.91	7.29	1.56	3.09	5.92	11.03	1.58	3.12	5.99	11.15	1.78	3.52	6.74	12.57
2000	1.04	2.17	4.36	8.49	1.62	3.36	6.75	13.15	1.63	3.40	6.82	13.29	1.85	3.84	7.71	15.01
2001	1.05	2.30	4.83	9.84	1.67	3.64	7.65	15.58	1.68	3.68	7.74	15.76	1.91	4.17	8.77	17.86
2002	1.06	2.43	5.36	11.41	1.72	3.94	8.68	18.48	1.74	3.98	8.77	18.68	1.97	4.53	9.98	21.25
2003	1.07	2.57	5.94	13.23	1.77	4.26	9.84	21.90	1.79	4.31	9.95	22.14	2.04	4.91	11.35	25.27
2004	1.08	2.72	6.59	15.34	1.82	4.61	11.16	25.97	1.84	4.66	11.27	26.23	2.11	5.34	12.92	30.07
2005	1.09	2.88	7.31	17.78	1.88	4.99	12.65	30.78	1.90	5.04	12.78	31.08	2.19	5.80	14.70	35.76
2006	1.08	3.02	8.01	20.37	1.95	5.44	14.44	36.74	1.97	5.49	14.58	37.09	2.26	6.31	16.76	42.62
2007	1.08	3.15	8.78	23.34	2.03	5.93	16.50	43.87	2.04	5.98	16.64	44.24	2.35	6.86	19.10	50.80
2008	1.07	3.30	9.61	26.73	2.10	6.46	18.83	52.35	2.12	6.51	18.99	52.79	2.43	7.47	21.78	60.55
2009	1.07	3.45	10.54	30.62	2.18	7.04	21.51	62.50	2.20	7.10	21.67	62.99	2.52	8.13	24.82	72.14
2010	1.07	3.61	11.55	35.08	2.27	7.67	24.56	74.61	2.28	7.73	24.73	75.15	2.61	8.85	28.31	86.01

[a] For source, see footnote a, Table BI-1a.

Table BI-1b. Energy price indices for use during 1985–1986[a], based on U.S. Department of Energy (DoE)-projected constant dollar energy prices adjusted for General Price Inflation Rates (GPIR) of 0, 5, 10, and 15 percent

DoE Region 1: Maine, New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island.

COMMERCIAL PRICING

	ELECTRICITY GPIR				DISTILLATE FUEL GPIR				LIQUEFIED PETROLEUM GAS GPIR				NATURAL GAS GPIR				STEAM COAL GPIR			
YEAR	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%
1985	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1986	1.01	1.06	1.11	1.16	0.98	1.03	1.08	1.12	1.00	1.05	1.10	1.15	1.00	1.04	1.09	1.14	1.01	1.06	1.11	1.16
1987	1.04	1.15	1.26	1.38	0.98	1.08	1.19	1.30	1.01	1.11	1.22	1.33	1.04	1.15	1.26	1.38	1.02	1.13	1.24	1.35
1988	1.09	1.26	1.45	1.66	1.01	1.17	1.35	1.54	1.04	1.20	1.38	1.58	1.10	1.27	1.46	1.67	1.04	1.20	1.38	1.57
1989	1.07	1.30	1.56	1.86	1.05	1.27	1.53	1.83	1.07	1.30	1.56	1.87	1.17	1.42	1.72	2.05	1.05	1.28	1.54	1.84
1990	1.06	1.36	1.71	2.14	1.08	1.38	1.74	2.18	1.11	1.42	1.79	2.23	1.25	1.59	2.01	2.51	1.07	1.37	1.73	2.16
1991	1.06	1.42	1.88	2.45	1.14	1.53	2.02	2.64	1.15	1.54	2.04	2.67	1.32	1.77	2.34	3.06	1.09	1.47	1.94	2.53
1992	1.06	1.49	2.06	2.81	1.20	1.69	2.35	3.20	1.20	1.68	2.33	3.18	1.41	1.99	2.75	3.75	1.11	1.56	2.16	2.95
1993	1.08	1.60	2.32	3.31	1.26	1.87	2.71	3.87	1.24	1.83	2.66	3.79	1.48	2.19	3.18	4.54	1.13	1.66	2.41	3.45
1994	1.07	1.66	2.52	3.75	1.33	2.06	3.13	4.67	1.28	1.99	3.03	4.52	1.56	2.42	3.68	5.50	1.14	1.77	2.70	4.02
1995	1.07	1.74	2.77	4.32	1.39	2.26	3.60	5.62	1.33	2.16	3.44	5.37	1.63	2.65	4.22	6.59	1.16	1.90	3.02	4.71
1996	1.08	1.85	3.08	5.03	1.44	2.47	4.12	6.71	1.38	2.37	3.95	6.44	1.70	2.90	4.84	7.89	1.18	2.02	3.36	5.48
1997	1.10	1.97	3.44	5.86	1.50	2.70	4.71	8.03	1.44	2.59	4.53	7.71	1.77	3.17	5.54	9.45	1.19	2.14	3.74	6.38
1998	1.11	2.09	3.83	6.83	1.56	2.94	5.38	9.60	1.50	2.83	5.18	9.24	1.84	3.47	6.35	11.31	1.21	2.28	4.17	7.43
1999	1.12	2.23	4.27	7.96	1.62	3.21	6.16	11.48	1.57	3.10	5.94	11.08	1.91	3.79	7.27	13.54	1.22	2.42	4.65	8.66
2000	1.14	2.37	4.76	9.27	1.69	3.50	7.04	13.71	1.63	3.39	6.81	13.27	1.99	4.14	8.33	16.22	1.24	2.57	5.17	10.08
2001	1.15	2.51	5.28	10.75	1.74	3.80	7.99	16.28	1.69	3.68	7.75	15.79	2.06	4.51	9.49	19.32	1.25	2.73	5.74	11.69
2002	1.16	2.66	5.86	12.47	1.80	4.12	9.08	19.32	1.74	4.00	8.81	18.76	2.14	4.90	10.81	23.01	1.26	2.89	6.37	13.56
2003	1.17	2.81	6.49	14.46	1.85	4.46	10.31	22.95	1.80	4.34	10.03	22.32	2.21	5.33	12.31	27.41	1.27	3.05	7.04	15.68
2004	1.18	2.98	7.21	16.77	1.91	4.84	11.70	27.24	1.87	4.71	11.41	26.55	2.29	5.80	14.03	32.64	1.28	3.23	7.81	18.18
2005	1.19	3.15	7.99	19.44	1.98	5.24	13.29	32.34	1.93	5.12	12.98	31.57	2.38	6.30	15.99	38.89	1.29	3.42	8.66	21.08
2006	1.18	3.30	8.76	22.27	2.05	5.72	15.20	38.67	2.01	5.59	14.85	37.78	2.47	6.87	18.26	46.43	1.30	3.62	9.61	24.43
2007	1.18	3.45	9.60	25.52	2.13	6.24	17.38	46.20	2.09	6.11	17.01	45.22	2.56	7.49	20.85	55.43	1.31	3.82	10.63	28.25
2008	1.17	3.61	10.52	29.23	2.22	6.82	19.87	55.24	2.17	6.68	19.47	54.13	2.66	8.17	23.80	66.17	1.32	4.04	11.78	32.75
2009	1.17	3.77	11.53	33.49	2.31	7.44	22.71	66.00	2.26	7.30	22.30	64.80	2.76	8.90	27.19	79.03	1.33	4.28	13.06	37.97
2010	1.17	3.95	12.63	38.37	2.40	8.11	25.96	78.89	2.36	7.99	25.55	77.63	2.87	9.71	31.06	94.36	1.34	4.53	14.48	44.01

[a] For source, see footnote a, Table BI-1a.

Table BI-2b. Energy price indices for use during 1985–1986[a], based on U.S. Department of Energy (DoE)-projected constant dollar energy prices adjusted for General Price Inflation Rates (GPIR) of 0, 5, 10, and 15 percent

DoE Region 2: New York, New Jersey, Puerto Rico, Virgin Islands.

COMMERCIAL PRICING

	ELECTRICITY GPIR				DISTILLATE FUEL GPIR				LIQUEFIED PETROLEUM GAS GPIR				NATURAL GAS GPIR				STEAM COAL GPIR			
YEAR	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%
1985	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1986	0.98	1.03	1.08	1.13	0.98	1.03	1.07	1.12	1.00	1.05	1.10	1.15	1.00	1.05	1.10	1.15	1.01	1.06	1.11	1.16
1987	1.01	1.12	1.23	1.34	0.98	1.08	1.19	1.30	1.01	1.11	1.22	1.33	1.01	1.11	1.22	1.34	1.02	1.13	1.24	1.36
1988	1.05	1.22	1.40	1.60	1.01	1.17	1.35	1.54	1.04	1.20	1.38	1.58	1.04	1.20	1.38	1.57	1.03	1.20	1.38	1.57
1989	1.03	1.26	1.51	1.81	1.05	1.27	1.53	1.83	1.07	1.30	1.57	1.87	1.08	1.32	1.59	1.89	1.05	1.28	1.54	1.84
1990	1.01	1.29	1.63	2.04	1.08	1.38	1.75	2.18	1.12	1.42	1.80	2.24	1.14	1.45	1.83	2.29	1.07	1.36	1.72	2.14
1991	1.00	1.34	1.77	2.30	1.15	1.54	2.03	2.66	1.16	1.55	2.05	2.68	1.19	1.59	2.10	2.74	1.08	1.45	1.91	2.50
1992	0.99	1.39	1.92	2.62	1.21	1.70	2.36	3.22	1.20	1.69	2.35	3.20	1.25	1.76	2.43	3.32	1.09	1.54	2.13	2.90
1993	0.98	1.45	2.10	2.99	1.27	1.88	2.73	3.90	1.25	1.85	2.68	3.82	1.30	1.93	2.80	3.99	1.10	1.63	2.37	3.38
1994	0.97	1.51	2.30	3.43	1.34	2.07	3.15	4.71	1.29	2.01	3.05	4.56	1.37	2.12	3.22	4.81	1.12	1.73	2.63	3.93
1995	0.97	1.58	2.52	3.93	1.40	2.28	3.64	5.67	1.34	2.19	3.48	5.43	1.42	2.32	3.69	5.75	1.13	1.85	2.94	4.58
1996	0.99	1.69	2.81	4.59	1.46	2.49	4.16	6.78	1.40	2.39	3.99	6.51	1.48	2.53	4.22	6.89	1.15	1.96	3.27	5.33
1997	1.00	1.79	3.13	5.34	1.51	2.72	4.75	8.10	1.46	2.62	4.57	7.80	1.54	2.77	4.84	8.25	1.16	2.09	3.65	6.22
1998	1.01	1.91	3.49	6.23	1.58	2.97	5.44	9.69	1.52	2.86	5.24	9.34	1.61	3.03	5.54	9.88	1.17	2.21	4.05	7.23
1999	1.03	2.03	3.89	7.25	1.64	3.24	6.21	11.58	1.58	3.13	6.01	11.20	1.67	3.31	6.34	11.82	1.19	2.36	4.52	8.43
2000	1.04	2.16	4.34	8.45	1.70	3.54	7.11	13.85	1.65	3.43	6.89	13.41	1.74	3.62	7.27	14.16	1.20	2.50	5.03	9.79
2001	1.05	2.29	4.81	9.80	1.76	3.83	8.07	16.43	1.71	3.72	7.83	15.96	1.80	3.93	8.28	16.86	1.22	2.65	5.59	11.38
2002	1.06	2.42	5.34	11.36	1.81	4.15	9.16	19.50	1.76	4.04	8.91	18.96	1.87	4.28	9.44	20.09	1.22	2.81	6.19	13.17
2003	1.06	2.56	5.92	13.18	1.87	4.50	10.41	23.17	1.82	4.39	10.13	22.55	1.93	4.65	10.75	23.93	1.23	2.97	6.85	15.25
2004	1.07	2.71	6.57	15.28	1.93	4.88	11.82	27.51	1.88	4.76	11.53	26.82	2.00	5.06	12.25	28.51	1.24	3.14	7.59	17.66
2005	1.08	2.87	7.28	17.72	2.00	5.29	13.42	32.66	1.95	5.17	13.11	31.90	2.07	5.50	13.95	33.95	1.25	3.32	8.43	20.51
2006	1.08	3.00	7.98	20.30	2.07	5.78	15.34	39.03	2.03	5.65	15.01	38.18	2.15	6.00	15.93	40.52	1.26	3.51	9.33	23.74
2007	1.07	3.14	8.75	23.25	2.15	6.30	17.54	46.64	2.11	6.18	17.19	45.70	2.24	6.54	18.21	48.41	1.27	3.71	10.34	27.48
2008	1.07	3.29	9.58	26.64	2.24	6.88	20.05	55.73	2.20	6.75	19.69	54.72	2.32	7.13	20.79	57.78	1.28	3.93	11.44	31.81
2009	1.07	3.44	10.51	30.53	2.33	7.50	22.92	66.60	2.29	7.38	22.53	65.48	2.41	7.77	23.73	68.97	1.29	4.16	12.71	36.94
2010	1.06	3.60	11.51	34.98	2.42	8.19	26.21	79.62	2.38	8.07	25.81	78.41	2.50	8.47	27.11	82.37	1.30	4.40	14.07	42.75

[a] For source, see footnote a, Table BI-1a.

Table BI-3b. Energy price indices for use during 1985–1986[a], based on U.S. Department of Energy (DoE)-projected constant dollar energy prices adjusted for General Price Inflation Rates (GPIR) of 0, 5, 10, and 15 percent

DoE Region 3: Pennsylvania, Maryland, West Virginia, Virginia, District of Columbia, Delaware.

COMMERCIAL PRICING

	ELECTRICITY GPIR				DISTILLATE FUEL GPIR				LIQUEFIED PETROLEUM GAS GPIR				NATURAL GAS GPIR				STEAM COAL GPIR			
YEAR	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%
1985	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1986	0.99	1.04	1.09	1.13	0.98	1.03	1.07	1.12	1.00	1.05	1.10	1.15	1.00	1.05	1.10	1.15	1.01	1.06	1.12	1.17
1987	1.00	1.10	1.21	1.32	0.98	1.08	1.18	1.29	1.01	1.11	1.22	1.33	1.02	1.12	1.23	1.34	1.02	1.13	1.24	1.35
1988	1.00	1.16	1.33	1.52	1.01	1.17	1.35	1.54	1.04	1.20	1.38	1.58	1.04	1.21	1.39	1.59	1.04	1.20	1.38	1.58
1989	0.98	1.19	1.44	1.72	1.05	1.28	1.54	1.84	1.07	1.31	1.57	1.88	1.09	1.33	1.60	1.91	1.05	1.28	1.54	1.84
1990	0.97	1.24	1.57	1.96	1.09	1.39	1.76	2.19	1.12	1.43	1.81	2.26	1.14	1.46	1.84	2.29	1.07	1.37	1.72	2.15
1991	0.97	1.30	1.72	2.25	1.16	1.55	2.05	2.68	1.17	1.57	2.07	2.71	1.19	1.59	2.10	2.75	1.08	1.45	1.92	2.51
1992	0.97	1.37	1.90	2.59	1.22	1.72	2.38	3.25	1.22	1.71	2.37	3.24	1.24	1.75	2.42	3.30	1.09	1.54	2.13	2.91
1993	0.97	1.44	2.09	2.98	1.29	1.91	2.77	3.95	1.27	1.87	2.72	3.87	1.29	1.91	2.77	3.95	1.11	1.64	2.37	3.39
1994	0.98	1.52	2.32	3.45	1.36	2.11	3.20	4.78	1.32	2.04	3.10	4.63	1.34	2.08	3.17	4.72	1.12	1.74	2.64	3.95
1995	0.98	1.60	2.55	3.98	1.43	2.32	3.70	5.77	1.36	2.22	3.54	5.52	1.39	2.27	3.61	5.63	1.14	1.85	2.95	4.59
1996	1.00	1.71	2.85	4.64	1.48	2.53	4.23	6.89	1.42	2.43	4.06	6.62	1.45	2.48	4.14	6.75	1.15	1.97	3.28	5.35
1997	1.01	1.82	3.17	5.41	1.54	2.76	4.83	8.24	1.48	2.66	4.65	7.92	1.51	2.71	4.74	8.08	1.16	2.09	3.65	6.23
1998	1.02	1.93	3.54	6.30	1.60	3.02	5.53	9.85	1.54	2.91	5.33	9.50	1.57	2.97	5.43	9.68	1.18	2.23	4.08	7.27
1999	1.04	2.06	3.94	7.35	1.66	3.29	6.32	11.77	1.61	3.18	6.11	11.38	1.64	3.24	6.22	11.58	1.20	2.37	4.54	8.46
2000	1.05	2.19	4.39	8.56	1.73	3.60	7.22	14.07	1.68	3.49	7.00	13.64	1.70	3.54	7.12	13.87	1.21	2.52	5.06	9.85
2001	1.06	2.31	4.87	9.92	1.79	3.90	8.20	16.71	1.73	3.78	7.96	16.22	1.76	3.85	8.11	16.51	1.22	2.66	5.60	11.41
2002	1.07	2.45	5.40	11.51	1.84	4.22	9.32	19.84	1.79	4.11	9.06	19.28	1.83	4.19	9.24	19.68	1.23	2.82	6.21	13.23
2003	1.08	2.59	5.99	13.34	1.90	4.58	10.58	23.55	1.85	4.46	10.30	22.93	1.89	4.56	10.53	23.44	1.24	2.98	6.88	15.32
2004	1.09	2.75	6.65	15.47	1.96	4.96	12.01	27.95	1.92	4.84	11.71	27.26	1.96	4.96	12.00	27.92	1.25	3.15	7.63	17.76
2005	1.10	2.91	7.38	17.94	2.03	5.38	13.64	33.19	1.98	5.26	13.33	32.44	2.03	5.39	13.68	33.27	1.26	3.34	8.46	20.57
2006	1.09	3.04	8.08	20.55	2.11	5.87	15.59	39.66	2.06	5.75	15.26	38.82	2.11	5.88	15.62	39.73	1.27	3.53	9.37	23.83
2007	1.09	3.18	8.86	23.55	2.19	6.41	17.83	47.40	2.15	6.28	17.48	46.48	2.19	6.41	17.83	47.41	1.28	3.73	10.38	27.61
2008	1.08	3.33	9.71	26.99	2.28	6.99	20.39	56.68	2.23	6.86	20.01	55.62	2.27	6.98	20.36	56.59	1.29	3.95	11.51	31.99
2009	1.08	3.48	10.64	30.91	2.37	7.63	23.31	67.74	2.33	7.51	22.92	66.62	2.36	7.62	23.26	67.60	1.29	4.17	12.75	37.05
2010	1.08	3.64	11.66	35.42	2.46	8.33	26.64	80.94	2.42	8.20	26.24	79.74	2.45	8.30	26.56	80.70	1.30	4.41	14.13	42.92

[a] For source, see footnote a, Table BI-1a.

Table BI-4b. Energy price indices for use during 1985–1986[a], based on U.S. Department of Energy (DoE)-projected constant dollar energy prices adjusted for General Price Inflation Rates (GPIR) of 0, 5, 10, and 15 percent

DoE Region 4: Kentucky, Tennessee, North Carolina, South Carolina, Mississippi, Alabama, Georgia, Florida, Canal Zone.

COMMERCIAL PRICING

	ELECTRICITY GPIR				DISTILLATE FUEL GPIR				LIQUEFIED PETROLEUM GAS GPIR				NATURAL GAS GPIR				STEAM COAL GPIR			
YEAR	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%
1985	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1986	0.98	1.03	1.08	1.13	0.97	1.02	1.07	1.12	1.00	1.05	1.10	1.15	0.99	1.04	1.09	1.14	1.02	1.07	1.12	1.17
1987	0.97	1.07	1.18	1.29	0.98	1.08	1.18	1.29	1.01	1.11	1.22	1.33	1.02	1.12	1.23	1.35	1.03	1.14	1.25	1.36
1988	0.97	1.12	1.29	1.47	1.01	1.17	1.35	1.54	1.04	1.20	1.38	1.58	1.07	1.24	1.42	1.63	1.04	1.20	1.39	1.58
1989	0.97	1.18	1.42	1.69	1.05	1.28	1.54	1.84	1.07	1.31	1.57	1.88	1.13	1.38	1.66	1.98	1.06	1.28	1.55	1.85
1990	0.96	1.22	1.54	1.93	1.09	1.39	1.76	2.20	1.12	1.43	1.80	2.25	1.22	1.56	1.96	2.45	1.08	1.37	1.73	2.17
1991	0.95	1.27	1.68	2.20	1.16	1.55	2.05	2.68	1.16	1.56	2.06	2.69	1.30	1.74	2.30	3.00	1.09	1.46	1.93	2.53
1992	0.94	1.33	1.84	2.51	1.23	1.73	2.40	3.27	1.21	1.70	2.36	3.22	1.39	1.96	2.71	3.71	1.10	1.55	2.15	2.93
1993	0.92	1.37	1.98	2.83	1.30	1.92	2.78	3.97	1.26	1.86	2.69	3.84	1.47	2.18	3.16	4.51	1.12	1.65	2.40	3.42
1994	0.91	1.41	2.14	3.19	1.37	2.12	3.22	4.81	1.30	2.02	3.07	4.59	1.57	2.43	3.69	5.51	1.13	1.76	2.67	3.98
1995	0.89	1.46	2.32	3.61	1.44	2.34	3.73	5.81	1.35	2.20	3.51	5.47	1.65	2.69	4.28	6.67	1.15	1.87	2.98	4.64
1996	0.91	1.55	2.58	4.21	1.49	2.55	4.26	6.95	1.41	2.41	4.02	6.55	1.72	2.94	4.90	7.99	1.16	1.99	3.32	5.41
1997	0.92	1.65	2.88	4.91	1.55	2.79	4.87	8.31	1.47	2.63	4.60	7.85	1.79	3.21	5.61	9.57	1.17	2.11	3.68	6.28
1998	0.93	1.75	3.21	5.72	1.61	3.04	5.57	9.93	1.53	2.88	5.28	9.41	1.86	3.51	6.43	11.45	1.19	2.24	4.10	7.31
1999	0.94	1.86	3.58	6.66	1.68	3.32	6.37	11.87	1.59	3.15	6.05	11.27	1.94	3.83	7.35	13.70	1.20	2.38	4.57	8.52
2000	0.95	1.98	3.98	7.76	1.74	3.62	7.28	14.18	1.66	3.45	6.93	13.50	2.02	4.19	8.43	16.42	1.22	2.54	5.09	9.92
2001	0.96	2.10	4.42	9.00	1.80	3.93	8.27	16.84	1.72	3.75	7.88	16.06	2.09	4.56	9.60	19.54	1.23	2.68	5.65	11.51
2002	0.97	2.22	4.90	10.44	1.86	4.26	9.40	20.00	1.77	4.07	8.97	19.09	2.16	4.96	10.94	23.28	1.24	2.84	6.27	13.34
2003	0.98	2.35	5.44	12.11	1.92	4.62	10.67	23.74	1.83	4.42	10.20	22.70	2.24	5.39	12.46	27.73	1.25	3.01	6.95	15.47
2004	0.99	2.49	6.03	14.04	1.98	5.00	12.11	28.17	1.90	4.79	11.60	27.00	2.32	5.87	14.20	33.04	1.26	3.18	7.71	17.93
2005	0.99	2.64	6.69	16.27	2.04	5.42	13.75	33.46	1.96	5.20	13.19	32.10	2.40	6.38	16.18	39.36	1.27	3.37	8.55	20.79
2006	0.99	2.76	7.33	18.64	2.12	5.92	15.72	39.98	2.04	5.69	15.12	38.45	2.50	6.96	18.48	47.00	1.28	3.55	9.44	24.01
2007	0.99	2.89	8.03	21.36	2.21	6.46	17.98	47.82	2.13	6.22	17.31	46.03	2.59	7.58	21.10	56.09	1.29	3.76	10.47	27.83
2008	0.98	3.02	8.81	24.48	2.30	7.05	20.56	57.15	2.21	6.80	19.82	55.11	2.69	8.27	24.10	67.00	1.30	3.98	11.60	32.26
2009	0.98	3.16	9.65	28.05	2.39	7.70	23.50	68.30	2.30	7.43	22.69	65.94	2.79	9.01	27.52	79.97	1.31	4.21	12.86	37.39
2010	0.98	3.31	10.58	32.13	2.48	8.40	26.87	81.63	2.40	8.12	25.99	78.97	2.90	9.82	31.42	95.46	1.32	4.46	14.26	43.33

[a] For source, see footnote a, Table BI-1a.

Table BI-5b. Energy price indices for use during 1985–1986[a], based on U.S. Department of Energy (DoE)-projected constant dollar energy prices adjusted for General Price Inflation Rates (GPIR) of 0, 5, 10, and 15 percent

DoE Region 5: Minnesota, Wisconsin, Michigan, Illinois, Indiana, Ohio.

COMMERCIAL PRICING

	ELECTRICITY GPIR				DISTILLATE FUEL GPIR				LIQUEFIED PETROLEUM GAS GPIR				NATURAL GAS GPIR				STEAM COAL GPIR			
YEAR	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%
1985	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1986	1.03	1.08	1.13	1.18	0.97	1.02	1.07	1.12	1.00	1.05	1.10	1.15	1.00	1.05	1.10	1.15	1.01	1.06	1.12	1.17
1987	1.04	1.15	1.26	1.38	0.98	1.08	1.18	1.29	1.01	1.11	1.22	1.33	1.02	1.13	1.24	1.35	1.02	1.13	1.24	1.35
1988	1.03	1.19	1.37	1.56	1.01	1.17	1.35	1.54	1.03	1.20	1.37	1.57	1.06	1.22	1.41	1.61	1.03	1.20	1.37	1.57
1989	1.00	1.22	1.46	1.75	1.05	1.28	1.54	1.84	1.06	1.29	1.56	1.86	1.11	1.34	1.62	1.93	1.05	1.27	1.53	1.83
1990	0.98	1.25	1.57	1.96	1.09	1.39	1.76	2.19	1.10	1.40	1.77	2.21	1.17	1.49	1.88	2.35	1.07	1.36	1.72	2.14
1991	0.96	1.28	1.69	2.21	1.16	1.55	2.05	2.68	1.14	1.53	2.02	2.64	1.24	1.66	2.19	2.86	1.08	1.45	1.91	2.50
1992	0.94	1.32	1.83	2.50	1.23	1.73	2.39	3.26	1.18	1.66	2.29	3.13	1.32	1.86	2.58	3.52	1.09	1.54	2.13	2.91
1993	0.92	1.36	1.98	2.82	1.29	1.91	2.78	3.96	1.22	1.80	2.61	3.72	1.40	2.07	3.00	4.28	1.11	1.64	2.37	3.39
1994	0.90	1.40	2.13	3.18	1.36	2.12	3.22	4.80	1.26	1.95	2.96	4.42	1.48	2.30	3.50	5.22	1.12	1.73	2.63	3.93
1995	0.90	1.46	2.32	3.62	1.43	2.33	3.72	5.80	1.30	2.11	3.36	5.25	1.56	2.55	4.05	6.32	1.13	1.84	2.93	4.57
1996	0.91	1.55	2.59	4.22	1.49	2.55	4.25	6.92	1.35	2.31	3.86	6.29	1.63	2.78	4.64	7.56	1.14	1.96	3.27	5.33
1997	0.92	1.65	2.89	4.92	1.55	2.78	4.86	8.28	1.41	2.53	4.42	7.54	1.69	3.04	5.32	9.06	1.16	2.08	3.64	6.20
1998	0.93	1.76	3.22	5.73	1.61	3.03	5.55	9.89	1.47	2.77	5.07	9.03	1.76	3.33	6.09	10.85	1.17	2.21	4.05	7.22
1999	0.94	1.87	3.59	6.68	1.67	3.31	6.35	11.83	1.53	3.03	5.81	10.82	1.84	3.63	6.97	12.99	1.19	2.36	4.53	8.43
2000	0.96	1.99	4.00	7.78	1.74	3.61	7.26	14.14	1.59	3.31	6.65	12.96	1.91	3.97	7.98	15.55	1.21	2.51	5.04	9.81
2001	0.96	2.10	4.43	9.02	1.79	3.92	8.25	16.79	1.65	3.60	7.57	15.41	1.98	4.32	9.09	18.52	1.21	2.65	5.58	11.37
2002	0.97	2.23	4.92	10.47	1.85	4.24	9.36	19.93	1.70	3.91	8.61	18.34	2.05	4.70	10.37	22.07	1.22	2.81	6.19	13.17
2003	0.98	2.36	5.45	12.13	1.91	4.60	10.63	23.67	1.76	4.24	9.80	21.80	2.12	5.11	11.80	26.27	1.23	2.97	6.86	15.27
2004	0.99	2.50	6.05	14.07	1.97	4.99	12.08	28.10	1.82	4.60	11.14	25.92	2.20	5.56	13.46	31.32	1.24	3.14	7.60	17.69
2005	1.00	2.65	6.71	16.32	2.04	5.41	13.72	33.37	1.88	5.00	12.67	30.82	2.28	6.04	15.32	37.28	1.25	3.32	8.43	20.50
2006	0.99	2.77	7.35	18.69	2.12	5.90	15.67	39.86	1.96	5.46	14.51	36.90	2.36	6.59	17.50	44.51	1.26	3.51	9.34	23.75
2007	0.99	2.90	8.06	21.42	2.20	6.44	17.93	47.66	2.04	5.97	16.61	44.18	2.46	7.18	19.99	53.15	1.27	3.72	10.35	27.51
2008	0.99	3.03	8.83	24.54	2.29	7.03	20.49	56.95	2.12	6.53	19.03	52.89	2.55	7.83	22.83	63.48	1.28	3.93	11.46	31.87
2009	0.98	3.17	9.68	28.12	2.38	7.67	23.41	68.04	2.21	7.13	21.79	63.31	2.65	8.54	26.07	75.76	1.29	4.16	12.70	36.92
2010	0.98	3.31	10.60	32.21	2.47	8.37	26.78	81.36	2.30	7.80	24.94	75.78	2.75	9.31	29.78	90.48	1.30	4.40	14.08	42.76

[a] For source, see footnote a, Table BI-1a.

Table BI-6b. Energy price indices for use during 1985–1986[a], based on U.S. Department of Energy (DoE)-projected constant dollar energy prices adjusted for General Price Inflation Rates (GPIR) of 0, 5, 10, and 15 percent

DoE Region 6: Texas, New Mexico, Oklahoma, Arkansas, Louisiana.

COMMERCIAL PRICING

	ELECTRICITY GPIR				DISTILLATE FUEL GPIR				LIQUEFIED PETROLEUM GAS GPIR				NATURAL GAS GPIR				STEAM COAL GPIR			
YEAR	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%
1985	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1986	1.03	1.08	1.13	1.19	0.97	1.02	1.07	1.12	1.00	1.05	1.10	1.15	1.01	1.06	1.11	1.16	1.02	1.07	1.12	1.17
1987	1.05	1.16	1.27	1.39	0.98	1.08	1.18	1.29	1.01	1.11	1.22	1.33	1.05	1.15	1.27	1.38	1.03	1.13	1.24	1.36
1988	1.06	1.22	1.41	1.61	1.02	1.18	1.35	1.55	1.04	1.21	1.39	1.59	1.09	1.26	1.45	1.65	1.03	1.19	1.37	1.57
1989	1.06	1.28	1.55	1.85	1.06	1.28	1.55	1.85	1.09	1.32	1.59	1.90	1.13	1.38	1.66	1.98	1.05	1.27	1.53	1.83
1990	1.06	1.35	1.70	2.13	1.10	1.40	1.77	2.21	1.14	1.45	1.83	2.29	1.20	1.53	1.93	2.41	1.07	1.36	1.72	2.14
1991	1.08	1.44	1.90	2.49	1.17	1.57	2.07	2.71	1.19	1.59	2.11	2.75	1.27	1.70	2.25	2.93	1.08	1.45	1.92	2.50
1992	1.09	1.53	2.12	2.89	1.24	1.75	2.42	3.30	1.24	1.75	2.42	3.30	1.35	1.90	2.63	3.59	1.10	1.54	2.14	2.92
1993	1.10	1.63	2.36	3.37	1.32	1.94	2.82	4.03	1.30	1.91	2.78	3.96	1.43	2.11	3.06	4.37	1.11	1.64	2.38	3.40
1994	1.11	1.73	2.63	3.92	1.39	2.15	3.27	4.88	1.35	2.09	3.18	4.75	1.51	2.35	3.57	5.33	1.13	1.75	2.66	3.96
1995	1.14	1.85	2.95	4.59	1.46	2.38	3.80	5.92	1.41	2.29	3.65	5.69	1.60	2.61	4.15	6.47	1.15	1.87	2.98	4.64
1996	1.15	1.97	3.28	5.35	1.52	2.60	4.34	7.07	1.46	2.50	4.18	6.81	1.66	2.85	4.75	7.74	1.16	1.99	3.32	5.41
1997	1.17	2.09	3.66	6.24	1.58	2.84	4.96	8.45	1.53	2.74	4.79	8.17	1.73	3.11	5.44	9.27	1.18	2.11	3.70	6.30
1998	1.18	2.23	4.08	7.27	1.64	3.10	5.67	10.11	1.59	3.00	5.49	9.78	1.80	3.40	6.23	11.10	1.19	2.25	4.12	7.34
1999	1.20	2.37	4.55	8.47	1.71	3.38	6.48	12.08	1.66	3.28	6.29	11.72	1.88	3.72	7.13	13.29	1.21	2.39	4.59	8.55
2000	1.21	2.52	5.07	9.87	1.77	3.69	7.41	14.43	1.73	3.59	7.21	14.05	1.95	4.06	8.17	15.91	1.22	2.54	5.11	9.95
2001	1.22	2.67	5.62	11.44	1.83	4.00	8.41	17.14	1.78	3.90	8.20	16.70	2.03	4.42	9.31	18.95	1.23	2.68	5.64	11.50
2002	1.23	2.83	6.23	13.27	1.89	4.33	9.56	20.34	1.85	4.23	9.33	19.86	2.10	4.81	10.60	22.58	1.24	2.84	6.26	13.33
2003	1.24	2.99	6.91	15.39	1.95	4.70	10.86	24.17	1.91	4.59	10.61	23.61	2.17	5.23	12.08	26.89	1.25	3.01	6.94	15.45
2004	1.25	3.17	7.67	17.84	2.02	5.09	12.33	28.69	1.97	4.99	12.07	28.08	2.25	5.69	13.77	32.04	1.26	3.18	7.70	17.92
2005	1.26	3.35	8.50	20.69	2.08	5.52	14.00	34.06	2.04	5.41	13.73	33.39	2.33	6.19	15.68	38.16	1.27	3.37	8.54	20.77
2006	1.26	3.51	9.32	23.70	2.16	6.03	16.01	40.72	2.12	5.92	15.71	39.96	2.42	6.75	17.92	45.58	1.28	3.56	9.47	24.08
2007	1.25	3.67	10.21	27.15	2.25	6.58	18.30	48.65	2.21	6.47	18.00	47.85	2.51	7.35	20.46	54.41	1.29	3.77	10.50	27.91
2008	1.25	3.84	11.20	31.12	2.34	7.17	20.91	58.14	2.30	7.07	20.62	57.32	2.61	8.02	23.37	64.96	1.29	3.98	11.59	32.22
2009	1.25	4.02	12.27	35.65	2.43	7.83	23.91	69.48	2.40	7.73	23.61	68.61	2.71	8.74	26.69	77.57	1.30	4.21	12.85	37.34
2010	1.24	4.20	13.44	40.84	2.52	8.55	27.35	83.10	2.49	8.44	27.01	82.08	2.81	9.52	30.46	92.56	1.31	4.45	14.24	43.28

[a] For source, see footnote a, Table BI-1a.

Table BI-7b. Energy price indices for use during 1985–1986[a], based on U.S. Department of Energy (DoE)-projected constant dollar energy prices adjusted for General Price Inflation Rates (GPIR) of 0, 5, 10, and 15 percent

DoE Region 7: Kansas, Missouri, Iowa, Nebraska.

COMMERCIAL PRICING

	ELECTRICITY GPIR				DISTILLATE FUEL GPIR				LIQUEFIED PETROLEUM GAS GPIR				NATURAL GAS GPIR				STEAM COAL GPIR			
YEAR	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%
1985	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1986	1.05	1.10	1.16	1.21	0.97	1.02	1.07	1.12	1.00	1.05	1.10	1.15	0.99	1.04	1.09	1.14	1.01	1.06	1.11	1.16
1987	1.02	1.12	1.23	1.35	0.98	1.08	1.18	1.29	1.01	1.11	1.22	1.33	1.04	1.14	1.26	1.37	1.02	1.12	1.23	1.35
1988	0.98	1.14	1.31	1.50	1.01	1.17	1.35	1.54	1.03	1.19	1.37	1.56	1.10	1.27	1.46	1.67	1.03	1.19	1.37	1.56
1989	0.95	1.16	1.40	1.67	1.05	1.28	1.54	1.84	1.05	1.28	1.54	1.83	1.15	1.40	1.69	2.01	1.04	1.26	1.52	1.81
1990	0.94	1.21	1.52	1.90	1.09	1.40	1.76	2.20	1.08	1.38	1.74	2.17	1.24	1.59	2.01	2.50	1.05	1.34	1.69	2.11
1991	0.94	1.25	1.66	2.17	1.17	1.56	2.06	2.70	1.11	1.49	1.97	2.57	1.32	1.77	2.34	3.06	1.06	1.42	1.88	2.45
1992	0.92	1.30	1.80	2.45	1.24	1.74	2.41	3.29	1.14	1.60	2.22	3.03	1.42	1.99	2.76	3.77	1.07	1.51	2.09	2.85
1993	0.91	1.34	1.94	2.77	1.31	1.93	2.80	4.00	1.17	1.73	2.51	3.58	1.50	2.22	3.22	4.59	1.08	1.60	2.32	3.31
1994	0.89	1.39	2.11	3.14	1.38	2.14	3.25	4.84	1.20	1.86	2.83	4.23	1.59	2.47	3.76	5.61	1.10	1.70	2.58	3.86
1995	0.88	1.43	2.28	3.56	1.45	2.36	3.76	5.86	1.23	2.01	3.20	4.99	1.68	2.74	4.36	6.79	1.11	1.80	2.87	4.47
1996	0.89	1.53	2.55	4.15	1.51	2.57	4.29	7.00	1.28	2.20	3.67	5.98	1.75	2.99	4.99	8.13	1.12	1.91	3.19	5.20
1997	0.90	1.62	2.84	4.84	1.56	2.81	4.91	8.37	1.34	2.40	4.20	7.16	1.82	3.27	5.71	9.74	1.13	2.03	3.55	6.06
1998	0.92	1.73	3.16	5.63	1.63	3.07	5.62	10.01	1.40	2.63	4.82	8.59	1.90	3.57	6.54	11.66	1.15	2.16	3.96	7.05
1999	0.93	1.84	3.52	6.57	1.69	3.35	6.42	11.96	1.45	2.88	5.52	10.29	1.97	3.91	7.49	13.96	1.16	2.31	4.42	8.24
2000	0.94	1.95	3.93	7.65	1.76	3.65	7.34	14.30	1.52	3.15	6.33	12.33	2.05	4.27	8.58	16.71	1.18	2.45	4.92	9.59
2001	0.95	2.07	4.36	8.87	1.81	3.96	8.33	16.97	1.57	3.42	7.19	14.65	2.13	4.64	9.77	19.90	1.19	2.59	5.46	11.11
2002	0.96	2.19	4.83	10.29	1.87	4.29	9.47	20.15	1.62	3.71	8.19	17.43	2.20	5.05	11.14	23.73	1.20	2.74	6.05	12.87
2003	0.96	2.32	5.36	11.93	1.93	4.65	10.75	23.93	1.68	4.03	9.31	20.73	2.28	5.49	12.69	28.25	1.21	2.90	6.70	14.92
2004	0.97	2.46	5.94	13.83	2.00	5.05	12.21	28.41	1.73	4.38	10.59	24.65	2.37	5.98	14.47	33.66	1.21	3.07	7.43	17.29
2005	0.98	2.60	6.59	16.04	2.06	5.47	13.87	33.73	1.79	4.75	12.04	29.30	2.45	6.50	16.48	40.10	1.22	3.25	8.23	20.03
2006	0.98	2.72	7.22	18.37	2.14	5.97	15.84	40.30	1.86	5.19	13.79	35.07	2.54	7.09	18.82	47.87	1.23	3.43	9.12	23.20
2007	0.97	2.85	7.92	21.06	2.23	6.51	18.12	48.19	1.94	5.68	15.80	42.01	2.64	7.72	21.48	57.12	1.24	3.63	10.11	26.88
2008	0.97	2.98	8.68	24.12	2.31	7.11	20.72	57.59	2.02	6.20	18.08	50.26	2.74	8.42	24.55	68.24	1.25	3.84	11.20	31.14
2009	0.97	3.11	9.51	27.65	2.40	7.75	23.68	68.82	2.10	6.78	20.71	60.20	2.85	9.18	28.04	81.48	1.26	4.06	12.41	36.08
2010	0.96	3.26	10.42	31.67	2.50	8.46	27.07	82.24	2.19	7.41	23.72	72.07	2.96	10.01	32.02	97.29	1.27	4.30	13.75	41.79

[a] For source, see footnote a, Table BI-1a.

Table BI-8b. Energy price indices for use during 1985–1986[a], based on U.S. Department of Energy (DoE)-projected constant dollar energy prices adjusted for General Price Inflation Rates (GPIR) of 0, 5, 10, and 15 percent

DoE Region 8: Montana, North Dakota, South Dakota, Wyoming, Utah, Colorado.

COMMERCIAL PRICING

	ELECTRICITY GPIR				DISTILLATE FUEL GPIR				LIQUEFIED PETROLEUM GAS GPIR				NATURAL GAS GPIR				STEAM COAL GPIR			
YEAR	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%
1985	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1986	1.01	1.06	1.11	1.16	0.97	1.02	1.07	1.12	1.00	1.05	1.10	1.15	1.01	1.06	1.11	1.16	1.03	1.08	1.13	1.18
1987	1.01	1.11	1.22	1.33	0.98	1.08	1.18	1.29	1.01	1.11	1.22	1.33	1.03	1.13	1.24	1.36	1.04	1.14	1.25	1.37
1988	1.00	1.16	1.33	1.52	1.01	1.17	1.35	1.54	1.04	1.21	1.39	1.59	1.04	1.21	1.39	1.59	1.05	1.21	1.39	1.59
1989	0.99	1.21	1.45	1.73	1.05	1.28	1.54	1.84	1.08	1.32	1.59	1.90	1.05	1.28	1.54	1.84	1.06	1.29	1.56	1.86
1990	0.98	1.25	1.58	1.97	1.09	1.39	1.76	2.19	1.13	1.45	1.83	2.28	1.11	1.42	1.79	2.24	1.07	1.37	1.73	2.16
1991	0.97	1.30	1.71	2.24	1.16	1.55	2.05	2.68	1.19	1.59	2.10	2.75	1.17	1.56	2.06	2.70	1.09	1.46	1.93	2.53
1992	0.96	1.35	1.87	2.55	1.23	1.73	2.39	3.26	1.24	1.74	2.42	3.30	1.23	1.73	2.40	3.27	1.10	1.55	2.15	2.93
1993	0.94	1.39	2.01	2.88	1.29	1.91	2.77	3.96	1.29	1.91	2.77	3.95	1.29	1.91	2.77	3.95	1.11	1.64	2.38	3.40
1994	0.93	1.44	2.19	3.27	1.36	2.11	3.21	4.79	1.35	2.09	3.17	4.73	1.36	2.12	3.21	4.80	1.13	1.75	2.66	3.97
1995	0.93	1.51	2.41	3.76	1.43	2.33	3.71	5.79	1.40	2.28	3.63	5.65	1.43	2.33	3.71	5.78	1.14	1.85	2.95	4.60
1996	0.94	1.61	2.69	4.38	1.49	2.55	4.25	6.93	1.46	2.49	4.16	6.78	1.49	2.55	4.25	6.92	1.15	1.96	3.27	5.34
1997	0.95	1.71	2.99	5.10	1.55	2.78	4.86	8.28	1.52	2.73	4.77	8.13	1.55	2.78	4.86	8.29	1.17	2.09	3.66	6.23
1998	0.97	1.82	3.34	5.94	1.61	3.03	5.55	9.90	1.58	2.98	5.46	9.74	1.61	3.04	5.57	9.93	1.17	2.21	4.05	7.23
1999	0.98	1.94	3.72	6.93	1.67	3.31	6.35	11.83	1.65	3.26	6.26	11.66	1.68	3.32	6.38	11.88	1.19	2.36	4.53	8.44
2000	0.99	2.06	4.14	8.07	1.74	3.61	7.26	14.14	1.72	3.57	7.17	13.97	1.75	3.63	7.30	14.22	1.21	2.52	5.06	9.85
2001	1.00	2.18	4.59	9.36	1.79	3.91	8.24	16.78	1.78	3.88	8.16	16.62	1.81	3.95	8.32	16.95	1.22	2.66	5.61	11.42
2002	1.01	2.31	5.10	10.85	1.85	4.25	9.36	19.93	1.84	4.21	9.28	19.75	1.88	4.30	9.48	20.18	1.23	2.82	6.21	13.23
2003	1.02	2.45	5.65	12.58	1.91	4.60	10.63	23.67	1.90	4.57	10.56	23.50	1.94	4.67	10.80	24.04	1.24	2.98	6.89	15.33
2004	1.03	2.59	6.27	14.59	1.97	4.99	12.08	28.10	1.96	4.96	12.00	27.93	2.01	5.09	12.31	28.66	1.25	3.15	7.63	17.76
2005	1.03	2.74	6.96	16.92	2.04	5.41	13.72	33.37	2.03	5.39	13.66	33.24	2.08	5.53	14.02	34.12	1.26	3.33	8.46	20.57
2006	1.03	2.87	7.62	19.39	2.12	5.90	15.67	39.86	2.11	5.88	15.63	39.75	2.16	6.03	16.01	40.72	1.27	3.53	9.37	23.83
2007	1.03	3.00	8.35	22.21	2.20	6.44	17.92	47.65	2.20	6.44	17.91	47.62	2.25	6.57	18.28	48.62	1.28	3.73	10.38	27.60
2008	1.02	3.14	9.15	25.45	2.29	7.03	20.48	56.94	2.29	7.03	20.51	57.00	2.33	7.16	20.89	58.06	1.28	3.95	11.50	31.97
2009	1.02	3.28	10.03	29.16	2.38	7.67	23.42	68.07	2.38	7.69	23.49	68.26	2.42	7.81	23.85	69.31	1.29	4.17	12.74	37.03
2010	1.01	3.44	10.99	33.40	2.47	8.37	26.77	81.33	2.48	8.40	26.88	81.68	2.52	8.52	27.25	82.80	1.30	4.41	14.11	42.89

[a] For source, see footnote a, Table BI-1a.

Table BI-9b. Energy price indices for use during 1985–1986[a], based on U.S. Department of Energy (DoE)-projected constant dollar energy prices adjusted for General Price Inflation Rates (GPIR) of 0, 5, 10, and 15 percent

DoE Region 9: California, Nevada, Arizona, Hawaii, Trust Territory of the Pacific Islands, American Samoa, Guam.

COMMERCIAL PRICING

	ELECTRICITY GPIR				DISTILLATE FUEL GPIR				LIQUEFIED PETROLEUM GAS GPIR				NATURAL GAS GPIR				STEAM COAL GPIR			
YEAR	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%
1985	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1986	1.06	1.11	1.16	1.22	0.97	1.02	1.07	1.12	1.00	1.05	1.10	1.15	0.95	1.00	1.05	1.09	1.11	1.17	1.22	1.28
1987	1.06	1.17	1.29	1.41	0.98	1.08	1.18	1.29	1.01	1.11	1.22	1.33	0.97	1.07	1.18	1.29	1.11	1.23	1.35	1.47
1988	1.05	1.21	1.39	1.59	1.01	1.17	1.35	1.54	1.03	1.20	1.38	1.57	0.98	1.13	1.30	1.48	1.13	1.31	1.50	1.72
1989	1.04	1.27	1.53	1.82	1.06	1.28	1.55	1.85	1.07	1.30	1.56	1.86	1.09	1.32	1.59	1.90	1.15	1.40	1.69	2.02
1990	1.05	1.34	1.69	2.11	1.10	1.40	1.77	2.21	1.11	1.41	1.78	2.23	1.14	1.45	1.83	2.29	1.17	1.50	1.89	2.36
1991	1.06	1.42	1.87	2.44	1.17	1.57	2.07	2.71	1.15	1.54	2.04	2.66	1.18	1.58	2.09	2.72	1.20	1.60	2.12	2.77
1992	1.07	1.50	2.08	2.84	1.24	1.75	2.42	3.31	1.19	1.68	2.33	3.17	1.23	1.73	2.39	3.27	1.22	1.72	2.38	3.25
1993	1.09	1.60	2.33	3.32	1.32	1.95	2.82	4.03	1.24	1.83	2.65	3.78	1.27	1.88	2.73	3.90	1.23	1.82	2.65	3.78
1994	1.11	1.72	2.62	3.90	1.39	2.15	3.27	4.88	1.28	1.98	3.02	4.50	1.33	2.06	3.12	4.66	1.26	1.95	2.97	4.43
1995	1.13	1.84	2.92	4.56	1.46	2.38	3.80	5.92	1.32	2.15	3.43	5.35	1.37	2.23	3.56	5.55	1.29	2.10	3.34	5.21
1996	1.14	1.95	3.26	5.31	1.52	2.60	4.34	7.08	1.38	2.36	3.93	6.41	1.43	2.44	4.07	6.64	1.31	2.23	3.73	6.08
1997	1.16	2.08	3.63	6.19	1.58	2.84	4.96	8.46	1.44	2.58	4.51	7.69	1.49	2.67	4.66	7.95	1.32	2.37	4.14	7.07
1998	1.17	2.21	4.05	7.21	1.64	3.10	5.67	10.10	1.50	2.82	5.16	9.20	1.55	2.92	5.34	9.52	1.34	2.53	4.63	8.24
1999	1.19	2.35	4.51	8.40	1.71	3.38	6.48	12.08	1.56	3.09	5.92	11.02	1.61	3.19	6.12	11.40	1.35	2.68	5.14	9.58
2000	1.20	2.50	5.02	9.79	1.78	3.69	7.42	14.44	1.62	3.38	6.79	13.22	1.68	3.49	7.00	13.64	1.37	2.85	5.74	11.17
2001	1.21	2.65	5.58	11.35	1.83	4.00	8.42	17.15	1.68	3.67	7.72	15.72	1.74	3.79	7.98	16.26	1.38	3.02	6.35	12.94
2002	1.22	2.80	6.18	13.16	1.89	4.34	9.56	20.36	1.74	3.98	8.78	18.69	1.80	4.12	9.10	19.37	1.39	3.19	7.04	14.98
2003	1.23	2.97	6.86	15.26	1.95	4.70	10.86	24.17	1.80	4.32	9.99	22.23	1.86	4.49	10.36	23.06	1.40	3.37	7.79	17.35
2004	1.24	3.14	7.61	17.70	2.02	5.09	12.33	28.69	1.86	4.69	11.36	26.43	1.93	4.88	11.81	27.48	1.42	3.58	8.66	20.16
2005	1.25	3.33	8.44	20.53	2.08	5.52	14.00	34.06	1.92	5.09	12.91	31.42	2.00	5.31	13.45	32.73	1.43	3.78	9.59	23.34
2006	1.25	3.48	9.25	23.52	2.16	6.03	16.01	40.72	2.00	5.57	14.79	37.61	2.08	5.78	15.36	39.06	1.44	4.00	10.62	27.02
2007	1.24	3.64	10.13	26.94	2.25	6.58	18.30	48.66	2.08	6.09	16.94	45.03	2.16	6.31	17.55	46.67	1.44	4.23	11.76	31.28
2008	1.24	3.81	11.10	30.87	2.34	7.18	20.92	58.15	2.17	6.65	19.40	53.92	2.24	6.87	20.04	55.71	1.46	4.48	13.07	36.32
2009	1.24	3.98	12.17	35.36	2.43	7.83	23.92	69.50	2.25	7.27	22.20	64.52	2.32	7.49	22.89	66.51	1.47	4.74	14.47	42.05
2010	1.23	4.17	13.34	40.53	2.53	8.55	27.36	83.13	2.35	7.95	25.43	77.26	2.41	8.17	26.13	79.41	1.48	5.01	16.02	48.67

[a] For source, see footnote a, Table BI-1a.

Table BI-10b. Energy price indices for use during 1985–1986[a], based on U.S. Department of Energy (DoE)-projected constant dollar energy prices adjusted for General Price Inflation Rates (GPIR) of 0, 5, 10, and 15 percent

DoE Region 10: Washington, Oregon, Idaho, Alaska.

COMMERCIAL PRICING

	ELECTRICITY GPIR				DISTILLATE FUEL GPIR				LIQUEFIED PETROLEUM GAS GPIR				NATURAL GAS GPIR				STEAM COAL GPIR			
YEAR	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%
1985	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1986	0.95	1.00	1.05	1.10	0.97	1.02	1.07	1.12	1.00	1.05	1.10	1.15	1.00	1.05	1.10	1.14	1.00	1.05	1.10	1.15
1987	0.95	1.04	1.14	1.25	0.98	1.08	1.18	1.29	1.00	1.11	1.22	1.33	1.00	1.10	1.21	1.32	1.01	1.11	1.22	1.33
1988	0.96	1.11	1.27	1.45	1.01	1.17	1.35	1.54	1.03	1.19	1.37	1.57	1.00	1.16	1.33	1.52	1.02	1.18	1.36	1.55
1989	0.96	1.16	1.40	1.67	1.05	1.28	1.54	1.84	1.06	1.29	1.55	1.85	1.06	1.29	1.56	1.86	1.03	1.25	1.51	1.80
1990	0.97	1.24	1.56	1.95	1.09	1.39	1.76	2.19	1.09	1.40	1.76	2.20	1.12	1.43	1.81	2.25	1.04	1.32	1.67	2.09
1991	1.00	1.34	1.77	2.31	1.16	1.55	2.05	2.68	1.13	1.51	2.00	2.61	1.16	1.56	2.06	2.69	1.06	1.41	1.87	2.44
1992	1.02	1.43	1.98	2.71	1.23	1.73	2.39	3.26	1.17	1.64	2.28	3.11	1.22	1.71	2.37	3.24	1.07	1.50	2.08	2.84
1993	1.00	1.47	2.14	3.05	1.30	1.92	2.78	3.97	1.20	1.78	2.58	3.69	1.27	1.87	2.71	3.87	1.08	1.59	2.31	3.30
1994	1.02	1.58	2.40	3.58	1.36	2.12	3.22	4.80	1.24	1.93	2.93	4.37	1.33	2.06	3.14	4.68	1.09	1.69	2.58	3.84
1995	1.05	1.71	2.72	4.24	1.43	2.34	3.72	5.80	1.28	2.09	3.32	5.18	1.38	2.25	3.59	5.60	1.11	1.81	2.88	4.50
1996	1.06	1.82	3.03	4.94	1.49	2.55	4.25	6.93	1.33	2.28	3.80	6.20	1.44	2.47	4.11	6.71	1.12	1.92	3.20	5.22
1997	1.08	1.93	3.38	5.76	1.55	2.78	4.86	8.29	1.39	2.49	4.36	7.43	1.50	2.70	4.71	8.03	1.14	2.04	3.57	6.08
1998	1.09	2.06	3.76	6.71	1.61	3.03	5.56	9.90	1.45	2.73	5.00	8.91	1.56	2.95	5.40	9.62	1.15	2.17	3.98	7.09
1999	1.11	2.19	4.20	7.82	1.67	3.31	6.35	11.84	1.51	2.99	5.73	10.67	1.63	3.22	6.18	11.51	1.17	2.31	4.43	8.26
2000	1.12	2.33	4.68	9.11	1.74	3.62	7.26	14.15	1.57	3.27	6.57	12.79	1.69	3.52	7.08	13.79	1.18	2.46	4.94	9.61
2001	1.13	2.47	5.19	10.57	1.79	3.92	8.25	16.79	1.63	3.55	7.47	15.22	1.75	3.83	8.06	16.42	1.19	2.60	5.48	11.16
2002	1.14	2.61	5.75	12.25	1.85	4.25	9.37	19.95	1.68	3.85	8.49	18.09	1.82	4.16	9.18	19.55	1.20	2.75	6.07	12.91
2003	1.15	2.76	6.38	14.21	1.91	4.61	10.64	23.69	1.74	4.18	9.66	21.51	1.88	4.53	10.46	23.29	1.21	2.91	6.73	14.99
2004	1.16	2.92	7.08	16.47	1.98	4.99	12.09	28.13	1.80	4.54	10.99	25.57	1.95	4.93	11.93	27.75	1.22	3.08	7.45	17.34
2005	1.17	3.10	7.85	19.10	2.04	5.41	13.73	33.39	1.86	4.93	12.51	30.42	2.02	5.36	13.59	33.05	1.23	3.25	8.25	20.06
2006	1.16	3.24	8.60	21.87	2.12	5.90	15.69	39.89	1.93	5.39	14.32	36.42	2.10	5.84	15.52	39.47	1.24	3.45	9.15	23.28
2007	1.16	3.39	9.43	25.07	2.20	6.45	17.94	47.70	2.01	5.89	16.39	43.59	2.18	6.37	17.72	47.12	1.24	3.64	10.13	26.94
2008	1.15	3.55	10.34	28.73	2.29	7.03	20.50	56.99	2.10	6.44	18.77	52.18	2.26	6.94	20.24	56.26	1.26	3.86	11.24	31.25
2009	1.15	3.71	11.33	32.93	2.38	7.68	23.45	68.14	2.18	7.04	21.50	62.49	2.35	7.57	23.11	67.17	1.26	4.07	12.44	36.15
2010	1.15	3.88	12.41	37.70	2.47	8.37	26.79	81.41	2.27	7.70	24.63	74.82	2.44	8.25	26.39	80.18	1.27	4.31	13.80	41.94

[a] For source, see footnote a, Table BI-1a.

Table BI-11b. Energy price indices for use during 1985–1986[a], based on U.S. Department of Energy (DoE)-projected constant dollar energy prices adjusted for General Price Inflation Rates (GPIR) of 0, 5, 10, and 15 percent

United States Average

COMMERCIAL PRICING

	ELECTRICITY GPIR				DISTILLATE FUEL GPIR				LIQUEFIED PETROLEUM GAS GPIR				NATURAL GAS GPIR				STEAM COAL GPIR			
YEAR	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%	0%	5%	10%	15%
1985	1.00	1.00	1 00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1986	1.01	1.06	1.11	1.16	0.97	1.02	1.07	1.12	1.00	1.05	1.10	1.15	1.00	1.05	1.10	1.15	1.01	1.07	1.12	1.17
1987	1.02	1.12	1.23	1.35	0.98	1.08	1.18	1.29	1.00	1.11	1.21	1.33	1.02	1.12	1.23	1.35	1.02	1.13	1.24	1.35
1988	1.02	1.18	1.36	1.55	1.01	1.17	1.35	1.54	1.04	1.20	1.38	1.57	1.05	1.22	1.40	1.60	1.04	1.20	1.38	1.58
1989	1.01	1.22	1.47	1.76	1.05	1.27	1.53	1.83	1.07	1.30	1.57	1.87	1.11	1.35	1.62	1.94	1.05	1.27	1.53	1.83
1990	1.00	1.27	1.61	2.01	1.09	1.38	1.75	2.18	1.11	1.42	1.79	2.24	1.17	1.50	1.89	2.36	1.07	1.36	1.72	2.15
1991	0.99	1.33	1.76	2.30	1.15	1.54	2.04	2.67	1.16	1.55	2.05	2.68	1.24	1.66	2.19	2.86	1.08	1.45	1.92	2.50
1992	0.99	1.39	1.93	2.63	1.22	1.71	2.37	3.24	1.20	1.70	2.35	3.20	1.31	1.84	2.55	3.49	1.09	1.54	2.13	2.90
1993	0.99	1.46	2.11	3.02	1.28	1.90	2.75	3.93	1.25	1.85	2.68	3.82	1.38	2.04	2.95	4.21	1.11	1.63	2.37	3.38
1994	0.98	1.53	2.32	3.46	1.35	2.09	3.18	4.74	1.30	2.01	3.06	4.56	1.45	2.25	3.43	5.11	1.12	1.74	2.64	3.94
1995	0.99	1.61	2.56	3.99	1.42	2.31	3.67	5.73	1.35	2.19	3.49	5.44	1.52	2.48	3.95	6.16	1.13	1.84	2.93	4.57
1996	1.00	1.71	2.85	4.65	1.47	2.52	4.20	6.85	1.40	2.39	3.99	6.51	1.58	2.71	4.52	7.37	1.14	1.96	3.26	5.32
1997	1.01	1.82	3.18	5.41	1.53	2.75	4.80	8.19	1.46	2.62	4.58	7.81	1.65	2.96	5.18	8.83	1.16	2.09	3.65	6.22
1998	1.02	1.93	3.54	6.31	1.59	3.00	5.49	9.79	1.52	2.87	5.25	9.36	1.72	3.24	5.93	10.57	1.18	2.22	4.07	7.25
1999	1.04	2.06	3.94	7.35	1.65	3.27	6.28	11.70	1.58	3.14	6.02	11.21	1.79	3.54	6.79	12.65	1.19	2.36	4.53	8.44
2000	1.05	2.19	4.40	8.56	1.72	3.57	7.18	13.98	1.65	3.43	6.90	13.43	1.86	3.87	7.78	15.15	1.21	2.51	5.04	9.82
2001	1.06	2.32	4.87	9.93	1.77	3.87	8.15	16.60	1.71	3.73	7.85	15.98	1.93	4.21	8.85	18.03	1.22	2.66	5.59	11.38
2002	1.07	2.45	5.41	11.51	1.83	4.20	9.26	19.71	1.77	4.05	8.93	19.01	2.00	4.58	10.09	21.48	1.23	2.81	6.20	13.19
2003	1.08	2.60	6.00	13.35	1.89	4.55	10.51	23.39	1.82	4.39	10.14	22.58	2.07	4.98	11.50	25.59	1.24	2.97	6.87	15.29
2004	1.09	2.75	6.65	15.48	1.95	4.93	11.94	27.79	1.89	4.77	11.54	26.85	2.14	5.41	13.10	30.49	1.25	3.15	7.62	17.72
2005	1.10	2.91	7.38	17.95	2.01	5.35	13.55	32.97	1.95	5.18	13.13	31.94	2.22	5.89	14.93	36.32	1.25	3.33	8.44	20.54
2006	1.09	3.04	8.09	20.57	2.09	5.84	15.50	39.43	2.03	5.66	15.03	38.23	2.30	6.42	17.04	43.34	1.26	3.52	9.36	23.80
2007	1.09	3.19	8.86	23.57	2.18	6.37	17.72	47.12	2.12	6.19	17.22	45.78	2.39	7.00	19.47	51.78	1.27	3.71	10.33	27.47
2008	1.08	3.33	9.71	27.00	2.26	6.95	20.25	56.30	2.20	6.76	19.71	54.78	2.48	7.63	22.24	61.82	1.28	3.93	11.45	31.83
2009	1.08	3.49	10.65	30.94	2.35	7.59	23.17	67.32	2.29	7.39	22.58	65.62	2.58	8.32	25.40	73.81	1.29	4.16	12.69	36.88
2010	1.08	3.65	11.67	35.45	2.44	8.27	26.48	80.44	2.39	8.08	25.85	78.54	2.68	9.07	29.00	88.12	1.30	4.40	14.06	42.73

[a] For source, see footnote a, Table BI-1a.

APPENDIX B. PART II

MULTIPLIERS FOR COMPUTING PRESENT VALUE ENERGY SAVINGS ACCORDING TO APPROACH 5 LISTED IN WORKSHEET 4 AND FOR COMPUTING PRESENT VALUE OF OTHER ANNUALLY RECURRING AMOUNTS SUCH AS OPERATING AND MAINTENANCE COSTS

INSTRUCTIONS for finding the multiplier(s) for computing present value energy savings according to Approach 5 (Worksheet 4):

* Find the column of Table BII which corresponds most closely to the difference between the discount rate and your projected average annual compound rate of change in energy prices as computed in Worksheet 4, Gb.
* Find the row which corresponds to the length of the study period as given in Worksheet 1, D.
* At the column/row intersection find the multiplier, and enter that multiplier in Series A, Worksheet 4, Gc.
* Repeat this process for each energy type.

INSTRUCTIONS for finding the multiplier(s) for computing present value of annually recurring non-energy amounts, e.g., operating and maintenance costs or savings:

* Use Table BII according to instructions provided above for energy savings; *except*, base the multiplier on the difference between the discount rate and your projected rate of change in the cost of the particular recurring cost in question (rather than on the change in energy prices), and enter the multiplier in Series A, Worksheet 5, D.

  [Note: For completing Series A Worksheets (Net Savings), only one multiplier is needed for each cash flow: the one corresponding to the length of the study period. For completing Series B Worksheet 3 (Payback), a multiplier is needed for each year until the payback year is identified.]

Table BII. Uniform Present Worth Modified (UPW†) factors (cumulative multipliers)—for computing present value of energy savings and of other annually recurring amounts (e.g., O&M costs)[a]

Study Period	Discount Rate Minus Projected Rate of Change in Cost of Energy (or Non-Energy Component)												
	−6	−5	−4	−3	−2	−1	0	1	2	3	4	5	6
1	1	1	1	1	1	1	1	1	1	1	1	1	.9
2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3	3	3	3	3
4	5	4	4	4	4	4	4	4	4	4	4	4	3
5	6	6	6	5	5	5	5	5	5	5	4	4	4
6	7	7	7	7	6	6	6	6	6	5	5	5	5
7	9	8	8	8	8	7	7	7	7	6	6	6	6
8	10	10	9	9	9	8	8	8	7	7	7	7	7
9	12	11	11	10	10	9	9	9	8	8	8	7	7
10	14	13	12	12	11	11	10	10	9	9	8	8	7
11	16	15	14	13	12	12	11	10	10	9	9	8	8
12	18	16	15	14	14	13	12	11	11	10	10	9	9
13	20	18	17	16	15	14	13	12	11	11	10	10	9
14	22	20	19	17	16	15	14	13	12	11	11	10	9
15	24	22	20	19	17	16	15	14	13	12	11	11	10
16	27	24	22	20	19	17	16	15	14	13	12	11	10
17	29	26	24	22	20	18	17	16	14	13	12	12	11
18	32	28	26	24	21	20	18	17	15	14	13	12	11
19	35	31	28	25	23	21	19	17	16	15	13	12	11
20	38	33	30	27	24	22	20	18	17	15	14	13	12
21	41	36	32	29	26	23	21	19	17	16	14	13	12
22	44	38	34	31	27	24	22	20	18	16	15	14	12
23	48	41	36	32	29	26	23	21	19	17	15	14	13
24	52	44	39	34	30	27	24	21	19	17	16	14	13
25	56	47	41	36	32	28	25	22	20	18	16	15	13
26	60	50	44	38	34	29	26	23	21	18	16	15	13
27	64	54	47	40	35	31	27	24	21	19	17	15	14
28	69	57	49	43	37	32	28	25	22	19	17	15	14
29	74	61	52	45	39	33	29	25	22	20	18	16	14
30	79	65	55	47	40	35	30	26	23	20	18	16	14

[a] See Table 3-15 for formula and example of use.

APPENDIX C

MULTIPLIERS FOR COMPUTING PRESENT VALUE OF NON-ANNUALLY RECURRING AMOUNTS (E.G., REPAIR AND REPLACEMENT COSTS AND RESALE OR SCRAP VALUE)

TABLE C.1

INSTRUCTIONS: Find the column of Table C.1 which corresponds most closely to the difference between the discount rate and your projected rate of change in non-annually recurring amounts such as repair and replacement costs (as computed in Worksheet 6, C) or in salvage or scrap value, (as computed in Worksheet 7, F). Within that column, find the multiplier that corresponds to each year for which an amount has been entered on the respective Worksheet, and enter the multiplier(s) on the Worksheet.

Table C.1. Single Present Worth Modified (SPW†) factors (multipliers)—for computing present value of non-annually recurring amounts (e.g., repair and replacement costs and resale or scrap value)[a]

	Discount Rate Minus Projected Rate of Change in Non-Annually Recurring Amount												
Year	−6	−5	−4	−3	−2	−1	0	1	2	3	4	5	6
1	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9
2	1.1	1.1	1.1	1.1	1.0	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9
3	1.2	1.1	1.1	1.1	1.1	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9
4	1.2	1.2	1.2	1.1	1.1	1.0	1.0	1.0	0.9	0.9	0.9	0.8	0.8
5	1.3	1.3	1.2	1.1	1.1	1.0	1.0	1.0	0.9	0.9	0.8	0.8	0.8
6	1.4	1.3	1.2	1.2	1.1	1.1	1.0	0.9	0.9	0.8	0.8	0.8	0.7
7	1.5	1.4	1.3	1.2	1.1	1.1	1.0	0.9	0.9	0.8	0.8	0.7	0.7
8	1.5	1.4	1.3	1.2	1.2	1.1	1.0	0.9	0.9	0.8	0.7	0.7	0.6
9	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9	0.8	0.8	0.7	0.7	0.6
10	1.7	1.6	1.4	1.3	1.2	1.1	1.0	0.9	0.8	0.8	0.7	0.6	0.6
11	1.8	1.6	1.5	1.4	1.2	1.1	1.0	0.9	0.8	0.7	0.7	0.6	0.6
12	1.9	1.7	1.5	1.4	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.6	0.5
13	2.0	1.8	1.6	1.4	1.3	1.1	1.0	0.9	0.8	0.7	0.6	0.6	0.5
14	2.1	1.9	1.7	1.5	1.3	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.5
15	2.3	2.0	1.7	1.5	1.3	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4
16	2.4	2.1	1.8	1.6	1.3	1.2	1.0	0.9	0.7	0.6	0.6	0.5	0.4
17	2.5	2.2	1.9	1.6	1.4	1.2	1.0	0.9	0.7	0.6	0.5	0.5	0.4
18	2.6	2.3	1.9	1.6	1.4	1.2	1.0	0.9	0.7	0.6	0.5	0.4	0.4
19	2.8	2.4	2.0	1.7	1.4	1.2	1.0	0.8	0.7	0.6	0.5	0.4	0.4
20	2.9	2.5	2.1	1.7	1.4	1.2	1.0	0.8	0.7	0.6	0.5	0.4	0.4
21	3.1	2.6	2.1	1.8	1.5	1.2	1.0	0.8	0.7	0.6	0.5	0.4	0.3
22	3.3	2.7	2.2	1.8	1.5	1.2	1.0	0.8	0.7	0.5	0.4	0.4	0.3
23	3.5	2.8	2.3	1.9	1.5	1.2	1.0	0.8	0.7	0.5	0.4	0.4	0.3
24	3.7	3.0	2.4	1.9	1.6	1.2	1.0	0.8	0.6	0.5	0.4	0.3	0.3
25	3.9	3.1	2.5	2.0	1.6	1.2	1.0	0.8	0.6	0.5	0.4	0.3	0.3
26	4.1	3.2	2.6	2.0	1.6	1.3	1.0	0.8	0.6	0.5	0.4	0.3	0.2
27	4.3	3.4	2.7	2.1	1.6	1.3	1.0	0.8	0.6	0.5	0.4	0.3	0.2
28	4.5	3.6	2.8	2.2	1.7	1.3	1.0	0.8	0.6	0.5	0.4	0.3	0.2
29	4.8	3.7	2.9	2.2	1.7	1.3	1.0	0.8	0.6	0.5	0.3	0.3	0.2
30	5.1	3.9	3.0	2.3	1.7	1.3	1.0	0.8	0.6	0.4	0.3	0.3	0.2

[a] See Table 3-14 for formula and example of use.

APPENDIX D

GRAPHICAL SOLUTION OF DISCOUNTED PAYBACK[a]

INSTRUCTIONS for using **Table D.1** and **Figures D.1–D.4** to estimate discounted payback from simple payback when annual savings are uniform or increase at a relatively constant rate:

* Use Table D.1 to find the applicable "k" value needed for the graphical solution of discounted payback when simple payback is known. In the column of Table D.1 headed "d%" find your discount rate as specified in Series B, Worksheet 2, B. In the top row headed "e%" find the projected rate of change in future costs as specified in Series B, Worksheet 2, C. Now find the "k" value in the matrix which corresponds to the two rates, and enter it in Series B, Worksheet 2, D.

* Search through the Figures D.1–D.4 to find the figure that contains both the k value found in Table D.1 and the SPB value entered in Series B, Worksheet 2, A. Identify that figure by number in Series B, Worksheet 2, E.

* Using the figure identified in the preceding step, locate the SPB value, as specified in Series B, Worksheet 2, A, on the horizontal axis of the figure. Draw a line upward perpendicular from the SPB value to intersect the curve representing the k value specified in Series B, Worksheet 2, D. Now draw a line from the point of intersection left, perpendicular to the vertical axis. Read off the corresponding DPB value and enter it in Series B, Worksheet 2, F.

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[a] This graphical solution technique for discounted payback is from Harold Marshall, *Recommended Practice for Measuring Simple and Discounted Payback for Investments in Buildings and Building Systems*, National Bureau of Standards, NBSIR 84–2850, March 1984.

Table D.1. Matrix of "k" values for combinations of discount rates (d) and price change (e)

d% \ e %	−4	−3	−2	−1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
−2	0.98	0.99	1.00	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17
−1	0.97	0.98	0.99	1.00	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16
0	0.96	0.97	0.98	0.99	1.00	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15
1	0.95	0.96	0.97	0.98	0.99	1.00	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14
2	0.94	0.95	0.96	0.97	0.98	0.99	1.00	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13
3	0.93	0.94	0.95	0.96	0.97	0.98	0.99	1.00	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12
4	0.92	0.93	0.94	0.95	0.96	0.97	0.98	0.99	1.00	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11
5	0.91	0.92	0.93	0.94	0.95	0.96	0.97	0.98	0.99	1.00	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10
6	0.91	0.92	0.92	0.93	0.94	0.95	0.96	0.97	0.98	0.99	1.00	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.08
.7	0.90	0.91	0.92	0.93	0.93	0.94	0.95	0.96	0.97	0.98	0.99	1.00	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.07
8	0.89	0.90	0.91	0.92	0.93	0.94	0.94	0.95	0.96	0.97	0.98	0.99	1.00	1.01	1.02	1.03	1.04	1.05	1.06	1.06
9	0.88	0.89	0.90	0.91	0.92	0.93	0.94	0.94	0.95	0.96	0.97	0.98	0.99	1.00	1.01	1.02	1.03	1.04	1.05	1.06
10	0.87	0.88	0.89	0.90	0.91	0.92	0.93	0.94	0.95	0.95	0.96	0.97	0.98	0.99	1.00	1.01	1.02	1.03	1.04	1.05
11	0.86	0.87	0.88	0.89	0.90	0.91	0.92	0.93	0.94	0.95	0.95	0.96	0.97	0.98	0.99	1.00	1.01	1.02	1.03	1.04
12	0.86	0.87	0.88	0.88	0.89	0.90	0.91	0.92	0.93	0.94	0.95	0.96	0.96	0.97	0.98	0.99	1.00	1.01	1.02	1.03
13	0.85	0.86	0.87	0.88	0.88	0.89	0.90	0.91	0.92	0.93	0.94	0.95	0.96	0.96	0.97	0.98	0.99	1.00	1.01	1.02
14	0.84	0.85	0.86	0.87	0.88	0.89	0.89	0.90	0.91	0.92	0.93	0.94	0.95	0.96	0.96	0.97	0.98	0.99	1.00	1.01
15	0.83	0.84	0.85	0.86	0.87	0.88	0.89	0.90	0.90	0.91	0.92	0.93	0.94	0.95	0.96	0.97	0.97	0.98	0.99	1.00
16	0.83	0.84	0.84	0.85	0.86	0.87	0.88	0.89	0.90	0.91	0.91	0.92	0.93	0.94	0.95	0.96	0.97	0.97	0.98	0.99
17	0.82	0.83	0.84	0.85	0.85	0.86	0.87	0.88	0.89	0.90	0.91	0.91	0.92	0.93	0.94	0.95	0.96	0.97	0.97	0.98
18	0.81	0.82	0.83	0.84	0.85	0.86	0.86	0.87	0.88	0.89	0.90	0.91	0.92	0.92	0.93	0.94	0.95	0.96	0.97	0.97
19	0.81	0.82	0.82	0.83	0.84	0.85	0.86	0.87	0.87	0.88	0.89	0.90	0.91	0.92	0.92	0.93	0.94	0.95	0.96	0.97
20	0.80	0.81	0.82	0.82	0.83	0.84	0.85	0.86	0.87	0.88	0.88	0.89	0.90	0.91	0.92	0.93	0.93	0.94	0.95	0.96
21	0.79	0.80	0.81	0.82	0.83	0.83	0.84	0.85	0.86	0.87	0.88	0.88	0.89	0.90	0.91	0.92	0.93	0.93	0.94	0.95
22	0.79	0.80	0.80	0.81	0.82	0.83	0.84	0.84	0.85	0.86	0.87	0.88	0.89	0.89	0.90	0.91	0.92	0.93	0.93	0.94
23	0.78	0.79	0.80	0.80	0.81	0.82	0.83	0.84	0.85	0.85	0.86	0.87	0.88	0.89	0.89	0.90	0.91	0.92	0.93	0.93
24	0.77	0.78	0.79	0.80	0.81	0.81	0.82	0.83	0.84	0.85	0.85	0.86	0.87	0.88	0.89	0.90	0.90	0.91	0.92	0.93
25	0.77	0.78	0.78	0.79	0.80	0.81	0.82	0.82	0.83	0.84	0.85	0.86	0.86	0.87	0.88	0.89	0.90	0.90	0.91	0.92

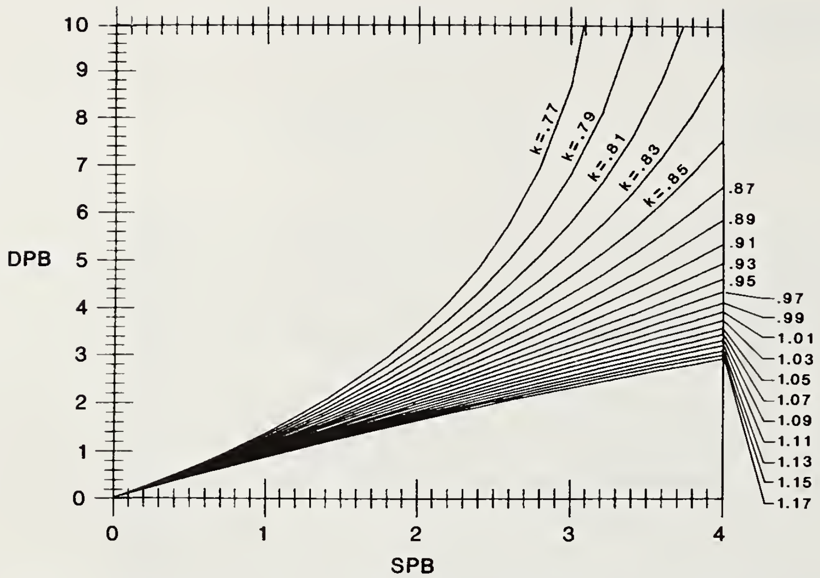

FIGURE D.1 Graphical Solution of Discounted Payback Based on a Simple Payback of 0 to 4 Years, k=0.77 to 1.17 (odd)

SOURCE: Harold Marshall, Recommended Practice for Measuring Simple and Discounted Payback, NBSIR 84-2850, p. 31.

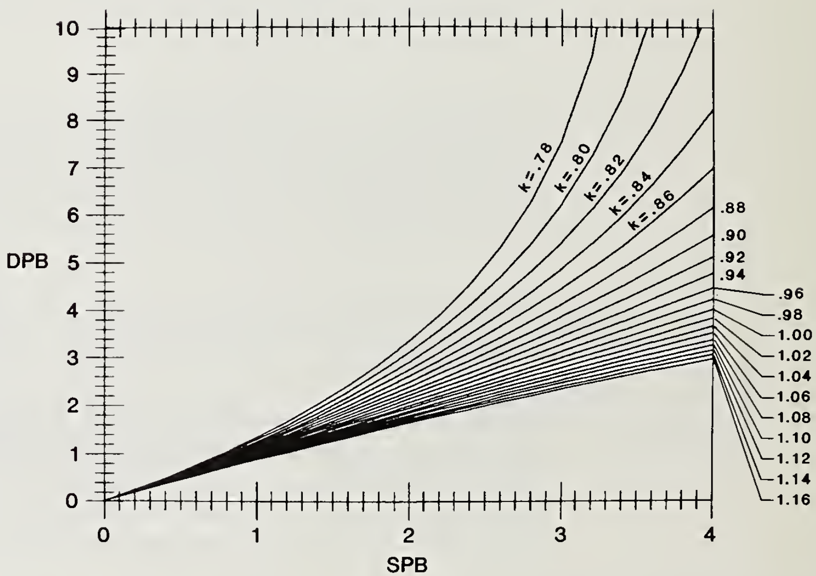

FIGURE D.2 Graphical Solution of Discounted Payback Based on a Simple Payback of 0 to 4 Years, k=0.78 to 1.16 (even)

SOURCE: Harold Marshall, Recommended Practice for Measuring Simple and Discounted Payback, NBSIR 84-2850, p. 32.

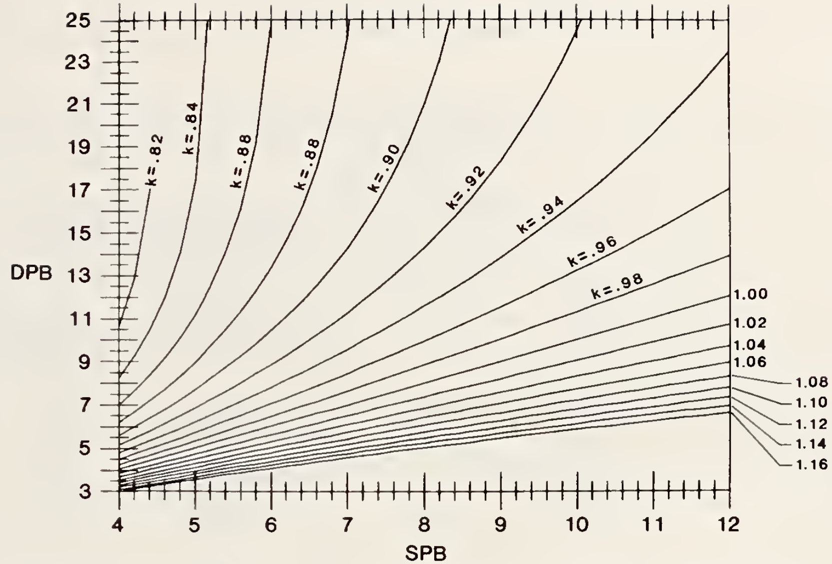

FIGURE D.4 Graphical Solution of Discounted Payback Based on a Simple Payback of 4 to 12 Years, k = 0.82 to 1.16 (even)

SOURCE: Harold Marshall, Recommended Practice for Measuring Simple and Discounted Payback, NBSIR 84-2850, p. 34.

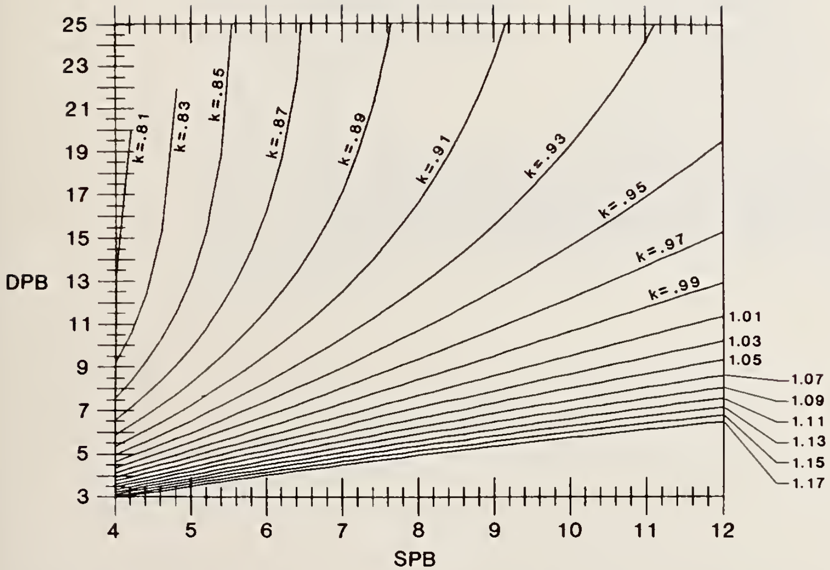

FIGURE D.3 Graphical Solution of Discounted Payback Based on a Simple Payback of 4 to 12 Years, k = 0.81 to 1.17 (odd)

SOURCE: Harold Marshall, Recommended Practice for Measuring Simple and Discounted Payback, NBSIR 84-2850, p. 33.

APPENDIX E

AVERAGE REGIONAL ENERGY PRICES ESTIMATED BY THE U.S. DEPARTMENT OF ENERGY

INSTRUCTIONS: Use the prices in Table E.1 as default values for the price per unit of energy at the beginning of the study period *only* if you do not know the actual energy price in effect at that time. If you know the actual price, use it.

If you wish to state the price in terms of some other unit than $/million Btu, you may wish to use the following equivalencies to restate price:

3,412 Btu/kWh of electricity	95,500 Btu/gal of LPG	22,500 Btu/ton of steam coal
138,690 Btu/gal of distillate	1,016 Btu/ft^3 of natural gas	125,071 Btu/gal of gasoline
	149,690 Btu/gal of residual	

[Note: The price estimates are updated annually in the fall and published by the National Bureau of Standards in Lippiatt, *et al.*, *Energy Prices and Discount Factors for Life-Cycle Cost Analysis*, NBSIR (last 2 digits of current year)–3273.]

Table E.1. Regional average mid-1985 energy prices estimated by the U.S. Department of Energy[a]
(mid-1985 $/million Btu)

Region/States	RESIDENTIAL Elec	Dist	LPG	Natgas	COMMERCIAL Elec	Dist	Resid	Natgas	Coal
1/ME, NH, VT, MA, CT, RI	$26.11	$7.84	$8.41	$7.90	$26.03	$6.85	$5.70	$6.28	$2.96
2/NY, NJ, PR, VI	29.05	8.02	8.61	7.88	28.05	6.64	5.49	6.71	2.50
3/PA, MD, WV, DC, DE	21.72	7.75	8.32	6.66	21.42	6.28	5.13	5.99	2.22
4/KY, TN, NC, SC, MS, AL, GA, FL, CANAL ZONE	19.32	7.73	8.29	6.08	19.55	6.10	5.33	5.38	2.03
5/MN, WI, MI, IL, IN, OH	21.49	7.38	7.93	5.96	21.21	6.16	6.32	5.49	2.22
6/TX, NM, OK, AR, LA	20.21	6.25	6.71	5.70	19.56	5.78	4.62	5.29	2.04
7/KS, MO, IA, NE	22.43	7.00	7.52	5.45	21.81	5.95	8.05	4.66	2.27
8/MT, ND, SD, WY, UT, CO	19.74	6.86	7.37	5.33	19.01	6.17	4.72	5.39	1.13
9/CA, NV, AZ, HI, PAC. ISL., AM. SAMOA, GU	20.07	7.19	7.71	5.53	19.83	5.77	5.80	6.32	2.17
10/WA, OR, ID, AK	10.46	7.70	8.26	7.42	10.42	6.16	6.69	6.85	2.80
11/US AVERAGE	20.54	7.75	7.81	6.16	20.78	6.34	5.32	5.68	2.16

[a] Compiled from tables Ca-1 through Ca-11 contained in Barbara C. Lippiatt, Stephen F. Weber, and Rosalie T. Ruegg, *Energy Prices and Discount Factors for Life-Cycle Cost Analysis; Annual Supplement to NBS Handbook 135 and NBS Special Publication 709; 1985 Edition*, National Bureau of Standards, NBSIR 85-3273, November 1985 (updated annually). These forecasts are expected to be next updated in late Fall 1986. A Mid-1985 price can be adjusted to a future time by multiplying it times (1 + the rate of price change during the elapsed time since mid-1985). The energy price indices in Appendix B, Part I can be used to adjust the above prices to a different time based on DoE real projections and an assumed rate of general price inflation (GPIR).

APPENDIX F

TABLES FOR ESTIMATING PRESENT VALUE DEPRECIATION WRITEOFFS

Table F.1 Multipliers for estimating present value depreciation of buildings and building components based on 15-year ACRS and building or component placed in service the first month of a taxable year.

INSTRUCTIONS: Go to Table F.1. Find the number in column 1 closest to your intended study period as specified in Series A, Worksheet 1, D, and the number in column headings 2-9 closest to your after-tax discount rate as specified in Series A, Worksheet 1, E. Enter the corresponding multiplier in Series A, Worksheet 3, Hb.

Table F.2 Multipliers for estimating present value depreciation of business equipment based on 5-year ACRS.

INSTRUCTIONS: Go to Table F.2. Find the number in column 1 closest to your intended holding period, and the number in column headings 2-9 closest to your after-tax discount rate. Enter the corresponding multiplier in Worksheet 3, Ib.

Table F.1. Multipliers for estimating present value depreciation of buildings and building components based on 15-year ACRS and building or component placed in service the first month of a taxable year

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Study Period (Years)	After-Tax Discount Rate (From Worksheet 1, E)							
	6	8	10	12	14	16	18	20
1	.11	.11	.11	.11	.11	.10	.10	.10
2	.20	.20	.19	.19	.19	.17	.17	.17
3	.28	.27	.26	.25	.25	.23	.22	.22
4	.34	.33	.31	.30	.30	.27	.26	.26
5	.39	.38	.35	.34	.34	.30	.29	.29
6	.43	.42	.38	.37	.37	.32	.31	.31
7	.47	.46	.41	.40	.39	.34	.33	.33
8	.51	.49	.44	.42	.41	.36	.35	.34
9	.55	.52	.47	.44	.43	.38	.36	.35
10	.58	.54	.49	.46	.44	.39	.37	.36
11	.61	.56	.51	.47	.45	.40	.38	.37
12	.63	.58	.53	.48	.46	.41	.39	.38
13	.65	.60	.54	.49	.47	.42	.40	.38
14	.67	.62	.55	.50	.48	.43	.40	.39
15 and Beyond	.69	.64	.56	.51	.49	.44	.41	.39

Table F.2. Multipliers for estimating present value depreciation of business equipment based on 5-year ACRS

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Study Period (Years)	After-Tax Discount Rate (From Worksheet 1, E)							
	6	8	10	12	14	16	18	20
1	.14	.14	.14	.13	.13	.13	.13	.12
2	.34	.33	.32	.31	.30	.29	.29	.27
3	.52	.50	.48	.46	.44	.42	.42	.39
4	.69	.65	.62	.59	.56	.54	.53	.49
5	.85	.79	.75	.71	.67	.64	.62	.57

APPENDIX G

KEY VARIABLES USED IN THE NBSLCC PROGRAM

A$	=	PROJECT TITLE
P1	=	PLANNING/CONSTRUCTION PERIOD (years)
*P2	=	OCCUPANCY PERIOD (years) (P3-P1)
P3	=	STUDY PERIOD (years)
P4	=	AMORTIZATION PERIOD (IN YEARS) FOR INTEREST AND "POINTS" PAID ON CONSTRUCTION LOANS (used to calculate tax deductions in "for-profit" status only)
Y1	=	BASE DATE FOR LCC ANALYSIS AND DISCOUNTING (year)
Y2	=	OCCUPANCY DATE (year)
Y4	=	FIRST YEAR IN DOE ENERGY PRICE FILE (ENCOSTFL)
Y5	=	CONSTANT DOLLAR BASE IN DOE ENERGY PRICE FILE
Y6		NUMBER OF YEARS IN DOE ENERGY PRICE FILE
I1	=	DISCOUNT RATE
*I2	=	1+I1
IR	=	GENERAL INFLATION RATE (avg. for study period)
RN	=	REAL OR NOMINAL DISCOUNT RATE DECLARATION: 1=REAL 2=NOMINAL
*T1	=	COMPOSITE INCOME TAX RATE (federal, state, local)
T2	=	PROPERTY TAX RATE (nominal, i.e., as a percent of assessed value)
T3	=	PERCENT OF CAPITAL GAINS SUBJECT TO INCOME TAX (usually 40%)
T4	=	TAX STATUS 1. FOR PROFIT 2. OWNER-OCCUPIED RESIDENTIAL 3. TAX EXEMPT
T5	=	SALES TAX RATE
T6	=	DEPRECIATION RECAPTURE CODE: 1. GAIN IN EXCESS OF ORIGINAL COST IS TREATED AS CAPITAL GAINS: ADDITIONAL GAIN (in excess of remaining basis) IS TREATED AS ORDINARY INCOME;

*Asterisked variables are calculated by the computer program.

2. ALL GAIN IS TREATED AS CAPITAL GAIN;
3. ALL GAIN (in excess of remaining basis) CALCULATED USING THE STRAIGHT LINE METHOD IS TREATED AS CAPITAL GAIN; ADDITIONAL GAIN DUE TO EXCESS OF ACCELERATED DEPRECIATION OVER STRAIGHT-LINE DEPRECIATION IS TREATED AS ORDINARY INCOME.

T7 = BUILDING TYPE FOR DOE ENERGY PRICE FILE:
1=RESIDENTIAL
2=COMMERCIAL
3=INDUSTRIAL

T8 = FEDERAL INCOME TAX RATE (MARGINAL)

T9 = STATE & LOCAL INCOME TAX RATE (MARGINAL)

T0 = DEPRECIATION BASIS ADJUSTMENT FACTOR

CAPITAL COMPONENT VARIABLES

C1 = NUMBER OF CAPITAL COMPONENTS TO BE TREATED SEPARATELY (e.g, land, building, equipment)

FOR EACH CAPITAL COMPONENT, I =1 to C1:

C$(I) = NAME OF THE Ith COMPONENT

C(I,1) = INITIAL COST OF THE Ith COMPONENT (less sales tax, if any) AS OF THE START OF CONSTRUCTION (unadjusted for price increases)

C(I,2) = DEPRECIATION LIFE OF Ith COMPONENT

C(I,3) = DEPRECIATION CODE FOR Ith COMPONENT:
0. NO DEPRECIATION CALCULATION
1. STRAIGHT LINE
2. DECLINING BALANCE (accelerated)
3. SUM OF YEARS DIGITS
4. STANDARD TABLE

C(I,4) = *ACCELERATION RATE* IF DECLINING BALANCE METHOD IS USED FOR Ith COMPONENT

C(I,5) = PERCENT OF C(I,1) WHICH YIELDS *SALVAGE VALUE* (unadjusted for inflation) OF Ith COMPONENT

C(I,6) = PERCENT OF C(I,1) ALLOWABLE AS ADDITIONAL *FIRST YEAR DEPRECIATION*

C(I,7) = AVERAGE ANNUAL PRICE ESCALATION RATE FOR Ith COMPONENT AND ITS REPLACEMENTS DURING OCCUPANCY (% change in real terms, i.e., net of general inflation)

C(I,8) = FIRST YEAR *ASSESSMENT RATE* FOR PROPERTY TAXES (percent of initial cost, less sales tax) FOR Ith COMPONENT

C(I,9) = *TAX CREDIT* FACTOR FOR Ith COMPONENT (percent of actual cost, less sales tax)

C(I,10) = ACTUAL EXPECTED USEFUL LIFE OF Ith COMPONENT, IN YEARS (use 999 for land)

C(I,11) = PERCENT OF C(I,1) ESTIMATED TO REMAIN AS *RESALE VALUE*, UNADJUSTED FOR INFLATION, AT THE END OF ITS USEFUL LIFE OR END OF THE STUDY PERIOD (whichever comes first)

C(I,12) = NUMBER OF REPLACEMENTS TO THE Ith COMPONENT DURING THE STUDY PERIOD

*C(I,13) = MINIMUM OF [OCCUPANCY PERIOD; USEFUL LIFE] FOR Ith COMPONENT

*C(I,14) = TOTAL NOMINAL COST OF Ith COMPONENT (i.e., adjusted to include price increases during construction, but not to include sales tax, if any)

C(I,15) = ANNUAL PRICE ESCALATION RATE DURING PLANNING/CONSTRUCTION PERIOD FOR THE Ith COMPONENT (% change in real terms, i.e., net of general inflation)

C(I,16) = PERCENTAGE OF Ith COMPONENT COST SUBJECT TO SALES TAX

*C(I,17) = TOTAL SALES TAX PAID FOR Ith COMPONENT

*DA(I) = RESALE VALUE OF COMPONENT I IF REMAINING AT END OF STUDY PERIOD

*DB(I) = RESALE VALUE OF COMPONENT I IF DISPOSED OF BEFORE END OF STUDY PERIOD

Q(I,J) = PERCENT OF THE TOTAL ACQUISITION COST (unadjusted for inflation) OF THE Ith COMPONENT ALLOCATED TO THE Jth YEAR OF CONSTRUCTION (J=1 to P1) OR BEGINNING OF OCCUPANCY (J=P1+1)

*T1(I,J) = CONSTRUCTION/ACQUISITION EXPENDITURE FOR Ith COMPONENT IN CONSTRUCTION YEAR J

*T2(I,J) = SALES TAX FOR Ith COMPONENT IN CONSTRUCTION YEAR J

REPLACEMENT VARIABLES

FOR EACH REPLACEMENT (K=1 TO C(I,12)) TO THE Ith CAPITAL COMPONENT:

R1(I,K) = YEAR OF REPLACEMENT, COUNTING FROM START OF OCCUPANCY (e.g., 5=beginning of 5th year of occupancy)

R2(I,K) = INITIAL COST OF REPLACEMENT (as of beginning of study period, unadjusted for price increases)
R3(I,K) = PERCENTAGE OF (I,K)th REPLACEMENT COST SUBJECT TO SALES TAX
R4(I,K) = DEPRECIATION LIFE OF REPLACEMENT (for income tax purposes only)
R5(I,K) = SALVAGE VALUE AT END OF DEPRECIATION SCHEDULE AS A PERCENT OF R2(I,K)(unadjusted for price increases, for depreciation purposes only)
R6(I,K) = ACTUAL EXPECTED USEFUL LIFE OF REPLACEMENT K TO COMPONENT I
R7(I,K) = PERCENT OF R2(I,K) ESTIMATED TO REMAIN AS RESALE VALUE, UNADJUSTED FOR PRICE INCREASES, AT END OF ITS USEFUL LIFE OR END OF THE STUDY PERIOD (whichever comes first)
R8(I,K) = PROPERTY TAX ASSESSMENT FACTOR FOR REPLACEMENT K TO COMPONENT I.
*R9(I,K) = ACTUAL COST OF REPLACEMENT (i.e., adjusted to include price increases)
*RA(I,K) = RESALE VALUE OF REPLACEMENT K TO COMPONENT I IF REMAINING AT END OF STUDY PERIOD
*RB(I,K) = RESALE VALUE OF REPLACEMENT K TO COMPONENT I IF DISPOSED OF BEFORE END OF STUDY PERIOD.

O&M COST VARIABLES

M1 = ANNUALLY RECURRING O&M COSTS (unadjusted for price increases from beginning of study period)
M2 = ANNUAL PRICE ESCALATION RATE FOR ANNUALLY RECURRING O&M COSTS (% change in real terms, i.e., net of general inflation)
M3 = UPW FACTOR FOR ANNUALLY RECURRING O&M COSTS (including price increases during construction)
M4 = NUMBER OF NON-ANNUALLY RECURRING COSTS
M5 = ANNUAL PRICE ESCALATION RATE FOR NON-ANNUALLY RECURRING O&M COSTS (% change in real terms, i.e., net of general inflation)
M(1,J) = YEAR OF OCCURRENCE OF Jth NON-ANNUALLY RECURRING O&M COST (1=end of first year of occupancy)
M(2,J) = AMOUNT OF Jth NON-ANNUALLY RECURRING O&M COST (unadjusted for price increases)

DEPRECIATION VARIABLES FOR CAPITAL COST COMPONENTS

*D1(1,I)	=	CUMULATIVE STRAIGHT-LINE DEPRECIATION ALLOWABLE FOR Ith COMPONENT
*D1(2,I)	=	CUMULATIVE DEPRECIATION ACTUALLY CLAIMED FOR Ith COMPONENT
*D2(1,J)	=	ANNUAL STRAIGHT-LINE DEPRECIATION ALLOWABLE IN YEAR J FOR EACH COMPONENT OR REPLACEMENT
*D2(2,J)	=	ANNUAL DEPRECIATION ACTUALLY CLAIMED IN YEAR J FOR EACH COMPONENT OR REPLACEMENT
*D3(I,K)	=	CUMULATIVE STRAIGHT-LINE DEPRECIATION ALLOWABLE FOR REPLACEMENT K TO COMPONENT I
*D4(I,K)	=	CUMULATIVE DEPRECIATION ACTUALLY CLAIMED FOR REPLACEMENT K TO COMPONENT I
*D5(I,J)	=	STANDARD DEPRECIATION TABLE VALUES FOR Ith COMPONENT (J=1 TO C(I,2))

ENERGY COST VARIABLES:

E1	=	NUMBER OF ENERGY TYPES USED

FOR EACH ENERGY TYPE:

E(I)	=	ENERGY NAME CODES: 1—ELECTRICITY 2—DISTILLATE FUEL OIL 3—RESIDUAL FUEL OIL 4—NATURAL GAS 5—LIQUEFIED PETROLEUM GAS (LPG) 6—COAL (OR STEAM COAL)
EM(I)	=	ENERGY PRICE ESCALATION CODES: 1—RATES ENTERED BY USER 2—RATES ACCESSED FROM ENCOSTFL
E1(1,I)	=	ENERGY PRICE FOR Ith ENERGY TYPE (in $/million Btu, in base-year dollars)
E1(2,I)	=	NUMBER OF DISCRETE ENERGY PRICE ESCALATION RATES TO BE USED (starting at occupancy date) FOR Ith ENERGY TYPE
*E1(3,I)	=	UPW* FACTOR FOR Ith ENERGY TYPE (as of the date of occupancy)
*E1(4,I)	=	PRESENT VALUE COST OF ALL USE OF ENERGY TYPE I OVER STUDY PERIOD
E1(5,I)	=	ANNUAL RATE OF INCREASE IN PRICE OF Ith ENERGY TYPE PERIOD (discounted from end of year for income tax purposes)

DURING PLANNING/CONSTRUCTION PERIOD (% change in real terms, i.e., net of general inflation)

*E1(6,I)	=	ANNUAL ENERGY COST FOR ENERGY TYPE I AT THE BEGINNING OF OCCUPANCY (including energy price increases during planning/construction if any)
E2(I,J)	=	LENGTH OF Jth TIME INTERVAL FOR Ith ENERGY TYPE (years) (J=1 to E1(2,I))
E3(I,J)	=	ENERGY PRICE ESCALATION RATE IN Jth TIME PERIOD (J=1 TO E1(2,I))
E4(I)	=	ANNUAL ENERGY CONSUMPTION (million Btu/yr) for Ith ENERGY TYPE
E5(I)	=	ANNUAL INDIRECT ENERGY COST ($/yr) for the Ith ENERGY TYPE (in base-year dollars)

FINANCING VARIABLES

TEMPORARY FINANCING (I=1 TO P1):

F(I,1)	=	PERCENT OF YEAR I CONSTRUCTION COSTS FINANCED
*F(I,2)	=	LENGTH OF LOAN MADE IN YEAR I (years, P1−I+1)
*F(I,9)	=	TOTAL INTEREST PAID ON LOAN MADE IN YEAR I
*F(I,15)	=	TOTAL INTEREST PAID IN YEAR I
*F(I,16)	=	TOTAL "POINTS" AND INTEREST PAID IN YEAR I
*N(1,I)	=	TOTAL CAPITAL EXPENDITURE IN Ith YEAR OF CONSTRUCTION (including sales tax)
*N(2,I)	=	INVESTOR'S CASH REQUIREMENTS (not including points or interest paid for loan) IN Ith YEAR OF CONSTRUCTION

PERMANENT FINANCING (I=P1+1 to P1+F1):

F1	=	NUMBER OF PERMANENT FINANCING ARRANGEMENTS MADE
*F2	=	TOTAL PERCENT OF PROJECT FINANCED
F(I,1)	=	PERCENT OF TOTAL PROJECT COST FINANCED BY Ith LOAN
F(I,2)	=	LIFE OF Ith LOAN (years)
*F(I,8)	=	MINIMUM OF [F(I,2)) OR P2] FOR Ith LOAN
*F(I,9)	=	UPW OF PAYMENTS ON Ith LOAN
*F(I,15)	=	LUMP SUM PRINCIPAL REPAYMENT MADE AT END OF LOAN

FOR BOTH TEMPORARY AND PERMANENT FINANCING (I=1 to P1+F1):

F(I,3)	=	ANNUAL INTEREST RATE (NOMINAL, i.e., BEFORE

COMPOUNDING)

F(I,4) = NUMBER OF PAYMENTS PER YEAR

F(I,5) = POINTS PAID FOR FINANCING (i.e., loan placement fee, in percent of loan amount)

F(I,6) = LOAN TYPE

1. AMORTIZED IN EQUAL PAYMENTS
2. INTEREST ONLY; PRINCIPAL DEFERRED TO END OF LOAN
3. INTEREST AND PRINCIPAL DEFERRED TO END OF LOAN

*F(I,7) = RATIO OF LOAN PAYMENT PER TIME PERIOD TO LOAN AMOUNT

*F(I,10) = Ith LOAN AMOUNT

*F(I,11) = POINTS COST FOR Ith LOAN

*F(I,12) = TOTAL INTEREST PAID ON Ith LOAN DISCOUNTED FROM END OF YEAR

*F(I,13) = TOTAL INTEREST PAID ON Ith LOAN DISCOUNTED FROM TIME OF PAYMENT

*F(I,14) = PRINCIPAL PAYMENTS DISCOUNTED FROM TIME OF PAYMENT

SUMMATION VARIABLES (ALL COMPUTED BY THE LCCMAIN PROGRAM)

NOTE: All T(1,I) variables are in actual dollars (including price increases during planning/construction period), not discounted

T(1,1) = TOTAL PROJECT COST INCLUDING INFLATION AND SALES TAX

T(1,2) = TOTAL INVESTOR CASH DURING PLANNING/CONSTRUCTION PERIOD (not including points or interest)

T(1,3) = TOTAL AMOUNT BORROWED DURING PLANNING/CONSTRUCTION PERIOD

T(1,4) = TOTAL POINTS PAID FOR CONSTRUCTION LOANS

T(1,5) = TOTAL INTEREST PAID ON CONSTRUCTION LOANS

T(1,6) = ADDITIONAL INVESTOR'S CASH AT OCCUPANCY FOR COMPONENTS ONLY

T(1,7) = TOTAL AMOUNT BORROWED AT OCCUPANCY

T(1,8) = TOTAL POINTS PAID ON PERMANENT LOANS AT OCCUPANCY

T(1,9) = PREPAID PROPERTY TAXES AT OCCUPANCY

NOTE: All T(2,I) and T(3,I) variables are discounted to base date (Y1)

T(2,1) = TOTAL SALES TAX PAID DURING PLANNING/CONSTRUCTION

T(2,2)	=	TOTAL INVESTOR'S CASH FOR COMPONENTS DURING PLANNING/ CONSTRUCTION PERIOD
T(2,3)	=	TOTAL POINTS PAID ON CONSTRUCTION LOANS
T(2,4)	=	TOTAL INTEREST PAID ON CONSTRUCTION LOANS
T(2,5)	=	PREPAID PROPERTY TAXES AT OCCUPANCY
T(2,6)	=	ADDITIONAL INVESTOR'S CASH AT OCCUPANCY FOR COMPONENTS
T(2,7)	=	TOTAL POINTS PAID FOR PERMANENT LOANS AT OCCUPANCY
T(2,8)	=	TOTAL INTEREST PAID ON PERMANENT LOANS (discounted from time of payment)
T(2,9)	=	TOTAL INTEREST PAID ON PERMANENT LOANS (discounted from end of year of payment)
T(2,10)	=	TOTAL PRINCIPAL PAYMENTS ON PERMANENT LOANS
T(2,11)	=	TOTAL SALES TAX ON CAPITAL COMPONENTS PAID AT OCCUPANCY (discounted from end of year for income tax purposes)
T(2,12)	=	TOTAL SALES TAX ON REPLACEMENTS TO CAPITAL COMPONENTS (discounted from end of year for income tax purposes)
T(2,13)	=	TOTAL DEPRECIATION ALLOWANCE ON CAPITAL COMPONENTS
T(2,14)	=	TOTAL DEPRECIATION ALLOWANCE ON REPLACEMENTS TO COMPONENTS
T(2,15)	=	INVESTMENT TAX CREDITS FOR CAPITAL COMPONENTS (discounted from end of year)
T(2,16)	=	INVESTMENT TAX CREDITS FOR REPLACEMENTS (discounted from end of year)
T(2,17)	=	RESALE VALUE OF CAPITAL COMPONENTS AND REPLACEMENTS REMAINING AT END OF STUDY PERIOD
T(2,18)	=	RESALE VALUE OF COMPONENTS AND REPLACEMENTS DISPOSED OF BEFORE THE END OF STUDY PERIOD
T(2,19)	=	CAPITAL GAINS AND DEPRECIATION RECAPTURE TAX ON CAPITAL COMPONENTS AND REPLACEMENTS REMAINING AT END OF STUDY PERIOD
T(2,20)	=	CAPITAL GAINS AND DEPRECIATION RECAPTURE TAX ON COMPONENTS AND REPLACEMENTS DISPOSED OF BEFORE END OF STUDY PERIOD
T(2,21)	=	TOTAL ANNUALLY RECURRING O&M COSTS
T(2,22)	=	TOTAL NON-ANNUALLY RECURRING O&M COSTS
T(2,23)	=	TOTAL PROPERTY TAX PAYMENTS FOR CAPITAL COMPONENTS
T(2,24)	=	TOTAL PROPERTY TAX PAYMENTS FOR REPLACEMENTS
T(2,25)	=	TOTAL ENERGY COSTS
T(2,27)	=	TOTAL COST OF REPLACEMENTS, INCLUDING SALES TAX

T(3,1)	=	TOTAL RESALE VALUE OF PROJECT
T(3,2)	=	TOTAL CAPITAL GAINS AND DEPRECIATION RECAPTURE TAX
T(3,3)	=	NET RESALE VALUE OF PROJECT
T(3,4)	=	TOTAL PROPERTY TAXES PAID
T(3,5)	=	TOTAL RECURRING & NON-RECURRING O&M COSTS
T(3,6)	=	TOTAL SALES TAXES PAID
T(3,7)	=	TOTAL CASH REQUIREMENTS AS OF OCCUPANCY (except prepaid property taxes)
T(3,8)	=	TOTAL INTEREST PAID AFTER OCCUPANCY (discounted from end of year)
T(3,9)	=	TOTAL FINANCING COSTS AFTER OCCUPANCY (including principal payments on permanent loans)
T(3,10)	=	TOTAL INCOME TAX DEDUCTIONS DURING OCCUPANCY
T(3,11)	=	TOTAL INCOME TAX SAVINGS DURING PLANNING/CONSTRUCTION PERIOD (from points, interest, and sales tax)
T(3,12)	=	TOTAL, PRESENT VALUE, LIFE-CYCLE PROJECT COST BEFORE TAX ADJUSTMENTS
T(3,15)	=	TOTAL PVLCC AFTER TAX ADJUSTMENTS
T(3,16)	=	PRESENT VALUE OF ALL O&M, ENERGY COSTS and PROPERTY TAXES THAT ARE TAX DEDUCTIBLE (discounted from end of year)
T(3,17)	=	TOTAL OF ALL TAX SAVINGS AND TAX CREDITS DURING OCCUPANCY
T(3,18)	=	T(2,27), TOTAL COST OF REPLACEMENTS
T(3,19)	=	PV OF ENERGY COSTS
T(3,20)	=	PV OF AMORTIZED "POINTS" PAYMENTS (PERMANENT FINANCING ONLY)
T(3,21)	=	PV OF ANY UNAMORTIZED "POINTS" AT END OF STUDY PERIOD (PERMANENT FINANCING ONLY)
T(3,22)	=	PV OF THAT PORTION OF "POINTS" AND INTEREST INCURRED DURING PLANNING/CONSTRUCTION PERIOD THAT IS TAX DEDUCTIBLE IN YEAR INCURRED.
T(3,23)	=	PV OF THAT PORTION OF "POINTS" AND INTEREST INCURRED DURING PLANNING/CONSTRUCTION PERIOD THAT MUST BE AMORTIZED DURING OCCUPANCY.
T(3,24)	=	PV OF THAT PORTION OF "POINTS" AND INTEREST INCURRED DURING PLANNING/CONSTRUCTION PERIOD THAT IS NOT AMORTIZED BY END OF STUDY PERIOD.

NOTE: All T(4,I) and T(5,I) variables are annual value equivalents of present-value costs incurred over the entire study period (P3): T(4,I)=ANNUAL VALUE OF T(2,I), where T(2,I) is in present value; T(5,I)=ANNUAL VALUE OF T(3,I), where T(3,I) is in present value.

APPENDIX H

KEY EQUATIONS USED IN LCCMAIN SUBPROGRAM

NOTE: All variables are listed in Appendix G except for variables D0–D9 and DA–DD. These latter variables are used for intermediate calculations and have no unique purpose. Convert all factors defined in percent form to decimal form (e.g., 75%=0.75) before using these equations. The mathematical symbol "**" means "raised to the power."

I. Initial cost calculations

A. For each capital component, I=1 TO C1

1. Compute portion of Ith component cost incurred in each year of construction and/or first year of occupancy, T1(I,J):

   For J=1 to P1+1
   T1(I,J)=C(I,1)*Q(I,J)*(1+C(I,15))**(J−1).
   (Note: if P1=0, then Q(I,1)=1.)

2. Compute sales tax (if any) on component costs, T2(I,J):

   T2(I,J)=T1(I,J)*C(I,16)*T5.

3. Compute total cost of Ith component, less sales tax, C(I,14):

   $$C(I,14)=\sum_{J=1}^{P1+1} T1(I,J).$$

4. Compute total sales tax, C(I,17):

   $$C(I,17)=\sum_{J=1}^{P1+1} T2(I,J).$$

5. Compute total sales tax, discounted from end of year, C(I,18):

   $$C(I,18)=\sum_{J=1}^{P1+1} T2(I,J)/(1+I1)^{**}J.$$

B. Sum all initial costs incurred in each year of planning/construction period and at occupancy, N(1,J):

For J=1 to P1+1

$$N(1,J)=\sum_{I=1}^{C1} T1(I,J)+T2(I,J).$$

C. Sum all initial costs, including sales tax, T(1,1):

$$T(1,1)=\sum_{I=1}^{C1} C(I,14)+C(I,17).$$

D. Sum total sales tax paid on components, discounted from end of year for income tax deduction purposes.

1. Total sales tax paid during planning/construction years only, T(2,1):

$$T(2,1)=\sum_{I=1}^{C1}\ \sum_{J=1}^{P1} T2(I,J)/(1+I1)^{**}J$$

2. Total sales tax paid at occupancy, T(2,11):

$$T(2,11)=\sum_{I=1}^{C1} T2(I,P1+1)/(1+I1)^{**}(P1+1)$$

II. Investment tax credits

A. Present value (PV) of tax credits for components, T(2,15):

$$T(2,15)=\sum_{I=1}^{C1} \frac{C(I,9)^{*}C(I,14)}{1+I1}$$

B. PV of tax credits for replacements, T(2,16):

$$T(2,16)=\sum_{I=1}^{C1}\ \sum_{K=1}^{C(I,12)} \frac{R9(I,K)^{*}C(I,9)}{(1+I1)^{**}R1(I,K)}$$

III. Financing calculations

NOTE: Temporary financing during planning/construction period is calculated for the sum of expenditures on components incurred in each year of planning/construction period, I=1 to P1. Permanent financing is calculated for each permanent loan at occupancy, I=P1+1 to P1+F1. Up to four permanent loans can be specified at occupancy, but the total amount borrowed cannot exceed 100 percent of the project cost, including sales tax.

A. Amount borrowed, F(I,10):

1. During planning/construction period, for each year of planning/construction period, I=1 to P1:

   $$F(I,10)=N(1,I)*F(I,1).$$

2. At occupancy, for each permanent loan, I=P1+1 to P1+F1:

   $$F(I,10)=F(I,1)*T(1,1).$$

B. Total borrowed:

1. During planning/construction period, T(1,3):

   $$T(1,3)=\sum_{I=1}^{P1} F(I,10).$$

2. At occupancy, T(1,7):

   $$T(1,7)=\sum_{I=P1+1}^{P1+F1} F(I,10).$$

C. Loan placement fees ("points") during construction and occupancy, F(I,11):

   $$F(I,11)=F(I,10)*F(I,5).$$

D. Total points paid:

1. During planning/construction period

   a. Cash flow, T(1,4):

   $$T(1,4)=\sum_{I=1}^{P1} F(I,11).$$

   b. Discounted to start of study period, T(2,3):

   $$T(2,3)=\sum_{I=1}^{P1} F(I,11)/(1+I1)**(I-1).$$

2. At occupancy, T(1,8),T(2,7):

   $$T(1,8)=T(2,7)=\sum_{I=P1+1}^{P1+F1} F(I,11).$$

E. Investor's initial cash requirements for components:

1. During each year of planning/construction period, N(2,I):

   For I=1 to P1

   $$N(2,I)=N(1,I)-F(I,10).$$

2. Total for planning/construction period, T(1,2):

   a. Cash flow, T(1,2):

   $$T(1,2)=\sum_{I=1}^{P1} N(2,I).$$

   b. Discounted to start of study period, T(2,2):

   $$T(2,2)=\sum_{I=1}^{P1} N(2,I)/(1+I1)^{**}(I-1).$$

3. At occupancy, T(1,6),T(2,6):

   $$T(1,6)=T(2,6)=[1-\sum_{I=P1+1}^{P1+F1} F(I,1)]^{*}T(1,1)-T(1,2).$$

F. Interest and principal calculations:

NOTE: I=1 to P1 for temporary financing; I=P1+1 to P1+F1 for permanent financing.

1. Loan type 1, amortized (permanent financing at occupancy only).

   For loans I=P1+1 to P1+F1:

   a. Calculate loan payment per time period, F(I,7):

   $$F(I,7)=\frac{(F(I,3)/F(I,4))^{*}(1+F(I,3)/F(I,4))^{**}(F(I,2)^{*}F(I,4))}{(1+F(I,3)/F(I,4))^{**}(F(I,2)^{*}F(I,4))-1}$$

   b. Calculate equivalent "nominal" discount rate, D9, which, when compounded F(I,4) times, equals the effective annual discount rate:

   $$D9=F(I,4)^{*}(1+I1)^{**}(1/F(I,4))-F(I,4).$$

c. Total interest paid from start of occupancy to end of study period, discounted from end of year, F(I,12):

i. If $F(I,3)=0$ then $F(I,12)=0$;

ii. If $F(I,3)<>0$ then calculate intermediate variables DC, D1, D2, D3, D4:

$DC=F(I,8)$ if $I1=0$, or

$$DC=\frac{[(1+I1)**F(I,8)]-1}{I1*(1+I1)**F(I,8)} \quad \text{if } I1<>0;$$

$D2=F(I,4)*F(I,7)*DC$;

$$D3=\left[\frac{F(I,7)}{F(I,3)/F(I,4)}-1\right]*\left[1-\frac{1}{[1+F(I,3)/F(I,4)]**F(I,4)}\right]; \text{ and}$$

$D4=D3*F(I,8)$ if $F(I,4)=1$ and $I1=F(I,3)$, or

if $F(I,4)>1$ or $F(I,4)=1$ and $I1<>F(I,3)$ then

$$D1=\frac{1+I1}{[1+F(I,3)/F(I,4)]**F(I,4)}-1, \text{ and}$$

$$D4=\frac{D3*(1+D1)**F(I,8)-1}{D1*(1+D1)**F(I,8)}. \text{ Then}$$

$F(I,12)=(D2-D4)*F(I,10)$.

d. Total interest paid from start of loan to end of study period, discounted from time of payment, F(I,13):

i. If $F(I,4)=1$ then $F(I,13) = F(I,12)$.

ii. If $F(I,4)>1$ and $F(I,3)=0$ then $F(I,13)=0$.

iii. If $F(I,4)>i$ and $F(I,3)<>0$ then first compute UPW for loan payments, F(I,9):

$F(I,9)=F(I,8)*F(I,4)$ if $I1=0$, or

$$F(I,9)=\frac{[1+D9/F(I,4)]**(F(I,8)*F(I,4))-1}{(D9/F(I,4))*[1+D9/F(I,4)]**(F(I,8)*F(I,4))} \text{ if } I1 <> 0;$$

If F(I,4) <> 1 then compute intermediate variables D5–D8:

$$D5=\frac{1+D9/F(I,4)}{1+F(I,3)/F(I,4)}-1,$$

where D9 is calculated in F.1.b.;

$$D6= F(I,7)*F(I,9);$$

$$D7=\frac{F(I,7)-F(I,3)/F(I,4)}{1+F(I,3)/F(I,4)};$$

$$D8=D7*\frac{(1+D5)**(F(I,8)*F(I,4))-1}{D5*(1+D5)**(F(I,8)*F(I,4))}; \text{ and}$$

$$F(I,13)=(D6-D8)*F(I,10).$$

e. Total principal payments discounted from time of payment, F(1,14):

 i. If F(I,3)=0 then first compute the UPW of all loan payments, F(I,9):

$$F(I,9)=F(I,4)*F(I,8) \text{ if } I1=0, \text{ or}$$

$$F(I,9)=\frac{(1+D9/F(I,4)**(F(I,8)*F(I,4))-1}{(D9/F(I,4))*(1+D9/F(I,4))**(F(I,8)*F(I,4))} \text{ if } I1 <> 0. \text{ Then}$$

$$F(I,14)=F(I,9)*F(I,7)*F(I,10).$$

 ii. If F(I,3) <> 0 then

$$F(I,14)= D4*F(I,10) \quad \text{if} \quad F(I,4)=1, \text{ or}$$
$$F(I,14)= D8*F(I,10) \quad \text{if} \quad F(I,4)>1.$$

f. Compute present value of remaining principal at end of study period, F(I,15):

 i. If F(I,3)=0 then

$$F(I,15)=0 \text{ if } F(I,2) <= P2, \text{ or}$$

$$F(I,15)=\frac{(F(I,2)-F(I,8))*F(I,10)}{F(I,2)*(1+I1)**F(I,8)} \text{ if } F(I,2)>P2.$$

ii. If $F(I,3)<>0$ then

$F(I,15)=0$ if $F(I,2)<=P2$, or

If $F(I,2)>P2$, then compute intermediate variables D0, DA, DB:

$D0= 1/[1+F(I,3)/F(I,4)]-1;$

$DB=D3$ if $F(I,4)=1$, or
$DB=D7$ if $F(I,4)>1$;

$$DA=DB * \frac{(1+D0)**(F(I,8)*F(I,4))-1}{D0*(1+D0)**(F(I,8)*F(I,4))}; \text{ and}$$

$$F(I,15)=\frac{F(I,10)-DA}{(1+I1)**F(I,8)}.$$

2. Loan Type 2, interest only.

a. Temporary financing during each planning/construction year, $I=1$ to P1.

NOTE: Percent of year I construction costs financed, interest rate, number of payments per year, “points” paid, and loan type are assumed to be the same in each year during planning/construction period.

$DD=P1\text{-}I+1$, years remaining before occupancy at the beginning of year I.

i. Compute present value (PV) of interest payments discounted from end of year, F(I,12):

$$\text{If } I1 <> 0 \text{ then } DC=\frac{(1+I1)**DD-1}{I1*(1+I1)**DD}, \text{ or}$$

If $I1=0$ then $DC=DD$. Then

$$F(I,12)=\frac{F(I,10)*F(1,3)*DC}{(1+I1)**(I-1)}.$$

ii. Compute PV of interest payments discounted from time of payment, F(I,13), and sum of interest payments discounted from time of payment, T(2,4):

If F(1,4)=1 then F(I,13)=F(I,12);

if F(1,4) > 1 then

$$\text{if I1} <> 0,\ F(I,9)=\frac{(1+D9/F(1,4))**(F(1,4)*DD)-1}{(D9/F(1,4))*(1+D9/F(1,4))**(F(1,4)*DD)},\ \text{or}$$

if I1=0, F(I,9)=F(1,4)*DD,

where D9=F(1,4)*(1+I1)**(1/F(1,4))−F(1,4); and

$$F(I,13)=\frac{F(I,9)*(F(1,3)/F(1,4))*F(I,10)}{(1+I1)\ **\ (I-1)}$$

$$T(2,4)=\sum_{I=1}^{P1} F(I,13)$$

iii. Compute actual interest paid in planning/construction year I, F(I,15):

For I=1 to P1,

$$F(I,15)=F(1,3)*\sum_{J=1}^{I} F(J,10).$$

iv. Compute total of all interest actually paid on temporary financing, T(1,5):

$$T(1,5)=\sum_{I=1}^{P1} F(I,15).$$

b. Permanent financing at occupancy, loans I=P1+1 to P1+F1:

i. Compute PV of interest payments discounted from end of year, F(I,12):

$$\text{If I1} <> 0 \text{ then } DC=\frac{(1+I1)**F(I,8)-1}{I1*(1+I1)**F(I,8)};$$

If I1=0 then DC=F(I,8). Then

F(I,12)=F(I,3)*F(I,10)*DC.

ii. Compute PV of interest payments discounted from time of payment, F(I,13), and sum of interest payments discounted from time of payment, T(2,4):

If F(I,4)=1 then F(I,13)=F(I,12);

if F(I,4)>1 then

$$\text{if I1} <> 0,\ F(I,9)=\frac{(1+D9/F(I,4))**(F(I,4)*F(I,8))-1}{(D9/F(I,4))*(1+D9/F(I,4))**(F(I,4)*F(I,8))},$$

where D9=F(I,4)*(1+I1)**(1/F(I,4))−F(I,4), or

if I1=0, F(I,9)=F(I,4)*F(I,8). Then

F(I,13)=F(I,9)*F(I,10)*F(I,3)/F(I,4).

$$T(2,4)=\sum_{I=1}^{P1} F(I,13)$$

iii. Compute PV of principal repayment, discounted from end of loan life or end of study period, whichever comes first, F(I,15):

$$F(I,15)=\frac{F(I,10)}{(1+I1)**F(I,8)}$$

3. Loan type 3, interest and principal deferred.

a. Temporary financing during each planning/construction year, I=1 to P1. (See note under III.F.2.a., loan type 2.)

i. Compute PV of interest payment at end of planning/construction period for loan amount borrowed in year I, F(I,12):

F(I,9)=F(I,10)*[((1+F(1,3))**DD)−1], and

$$F(I,12)=\frac{F(I,9)}{(1+I1)**P1}.$$

NOTE: PV of interest payments discounted from time of payment, F(I,13), is equivalent to F(I,12) in this case. Also, total interest paid on temporary financing discounted from time of payment, T(2,4), is equivalent to F(I,12).

ii. Compute total amount of interest paid at end of planning/construction period, F(P1,15), T(1,5):

$$F(P1,15)=T(1,5)=\sum_{I=1}^{P1} F(I,9).$$

b. Permanent financing at occupancy, I=P1+1 to P1+F1.

i. Compute PV of interest payments made at end of loan life or end of study period, whichever comes first, F(I,12):

$$F(I,12)=\frac{F(I,10)*[((1+F(I,3))**F(I,8))-1]}{(1+I1)**F(I,8)}.$$

ii. Compute PV of principal repayment, discounted from end of loan life or end of study period, whichever comes first, F(I,15):

$$F(I,15)=\frac{F(I,10)}{(1+I1)**F(I,8)}.$$

G. Compute summation variables for all permanent loans, I=P1+1 to P1+F1, T(2,8), T(2,9), T(2,10):

$$T(2,8)\ =\ \sum_{I=P1+1}^{P1+F} F(I,13),$$

$$T(2,9)\ =\ \sum_{I=P1+1}^{P1+F1} F(I,12),\ \text{and}$$

$$T(2,10)=\ \sum_{I=P1+1}^{P1+F1} F(I,14).$$

H. Set-up of "points" payments and construction interest payments for income tax deduction purposes.

NOTE: See discussion in Appendix I on IRS rules related to tax deductions for "points" and construction interest.

1. Temporary financing during planning/construction period ("points" and interest):

Add "points" paid for construction financing to interest paid for construction financing in each year of planning/construction period (I=1 to P1), F(I,16):

$F(I,16)=F(I,11)+F(I,15)$

a. If $F4=1$ (for-profit tax status), compute present value (PV) of construction "points" and interest ($F(I,16)$, $I=1$ to $P1$) amortized over period specified by IRS ($P4$, currently 10 years) in three parts:

i. Compute PV of that portion of $F(I,16)$, $I=1$ to $P1$, that is tax deductible in the year incurred, $T(3,22)$:

$$T(3,22)=\sum_{I=1}^{P1} \frac{F(I,16)}{P4*(1+I1)**I}.$$

ii. If $P4>1$, compute PV of that portion of $F(I,16)$, $I=1$ to $P1$, that must be amortized over the remaining $(P4-1)$ years, beginning with the first year of occupancy, $T(3,23)$:

$P5=MIN(P4-1,P2)$

$$T(3,23)=\sum_{I=1}^{P1} \frac{F(I,16)}{P4} * \frac{(1+I1)**P5-1}{I1*(1+I1)**P5} * \frac{1}{(1+I1)**P1}$$

iii. If $P4-1>P2$, then compute PV of unamortized portion of $F(I,16)$, $I=1$ to $P1$, at end of study period, $T(3,24)$:

$$T(3,24)=\sum_{I=1}^{P1} \frac{P4-1-P2}{P4} * \frac{F(I,16)}{(1+I1)**P3}.$$

b. If $T4=2$ (owner-occupied residence) then compute PV of $T(I,18)$, $I=1$ to $P1$, discounted from end of year, $T(3,22)$:

$$T(3,22)=\sum_{I=1}^{P1} \frac{F(I,16)}{(1+I1)**I},$$

and set $T(3,23)=0$ and $T(3,24)=0$.

c. If $T4=3$ (non-profit tax status) then set $T(3,22)=0$, $T(3,23)=0$, and $T(3,24)=0$.

2. Permanent financing at occupancy ("points" only):

a. If $T4=1$ (for-profit tax status) then

i. Calculate PV of "points" payments amortized over life of each permanent loan (I=P1+1 to P1+F1), T(3,20):

$$T(3,20)=\sum_{I=P1+1}^{P1+F1} \frac{F(I,I1)}{F(I,2)} * \frac{(1+I1)**F(I,8)-1}{I1*(1+I1)**F(I,8)} * \frac{1}{(1+I1)**P1}.$$

ii. Calculate PV of any unamortized "points" at end of study period for any loan that extends beyond study period, T(3,21):

$$T(3,21)=\sum_{I=P1+1}^{P1+F1} \frac{F(I,2)-P2}{F(I,2)} * \frac{F(I,11)}{(1+I1)**P3}, \quad \text{only for those I where } F(I,2)>P2.$$

b. If T4=2 (owner-occupied residence tax status) then

i. Calculate PV of "points" payments at occupancy, discounted from end of first year of occupancy, T(3,20):

$$T(3,20)=\frac{T(2,7)}{(1+I1)**(P1+1)}.$$

ii. Set T(3,21)=0.

c. If T4=3 (non-profit tax status) set:

T(3,20)=0 and T(3,21)=0.

IV. Depreciation calculations

NOTE: Depreciation calculations can be based on one of four different methods, as specified below. Straight-line depreciation allowances are always calculated for each component and replacement, regardless of the method actually used. The straight-line calculations are used later in calculating depreciation recapture taxes. Depreciation calculations are made for building components (except land) and for replacements to components, as requested by the user. The calculation procedures used in NBSLCC are purposely made flexible in order to allow changes in computational procedures made periodically by IRS. For this reason the user must be acquainted with the IRS rules before using these procedures.

Depreciation variables for both capital cost components and replacements are converted to the following temporary variables used in the depreciation calculations:

D1 = total nominal cost of component (i.e., adjusted for inflation up to time of installation), but not including sales tax, if any. This is the original basis for depreciation.
D2 = depreciation life.
D4 = acceleration rate (for declining balance method only).
D5 = salvage value factor (unadjusted for inflation).*
D6 = additional first year depreciation factor.
D7 = the remaining basis for depreciation after reducing original basis by additional first year depreciation and designated portion of tax credit, D1*(1 – D6)*(1 – C(I,9)*T0).

D2(1,J) = annual depreciation allowance in year J, based on the straight-line method.
D2(2,J) = annual depreciation allowance in year J, based on the depreciation method actually specified.

A. Reduce original depreciation basis by designated portion of investment tax credit and additional first year depreciation, D7:

   D7 = D1*(1 – C(I,9)*T0)*(1 – D6).

B. Compute depreciation allowances for each year (J = 1 to D2), D2(1,J) and D2(2,J):
   1. Straight-line method.
      a. For year 1:
         D2(1,1) = D1*(1 – C(I,9)*T0)*D6 + (D7 – D5*D1)/D2.
      b. For years 2 to D2:
         D2(1,J) = (D7 – D5*D1)/D2.
   2. Declining balance method.
      a. For year 1:
         D2(2,1) = D1*(1 – C(I,9)*T0)*D6 + D9,
         where D9 = (D4/D2)*D7.
      b. For year 2:
         D2(2,J) = (D4/D2)*(D7 – D9).
      c. For years 3 to D2:
         D2(2,J) = D4/D2*(D7 – D9),
         where D9 = D2(2,J – 1) + previous value of D9, unless:
         i. The remaining basis falls below salvage value
            (i.e., D7 – D9 – D2(2,J) < D1*D5). Then
            D2(2,J) is recalculated as
            D2(2,J) = (D7 – D1*D5) – D9,
            and all subsequent D2(2,J) = 0; or

*Note that the salvage value used in income tax calculations is based on the IRS definition rather than on the actual resale value of the component at the end of its useful life.

ii. Switching to the straight line method would result in a larger depreciation allowance in year J,

$$\left(\text{i.e., } D2(2,J) < \frac{(D7-D1*D5)-D9}{D2\text{-}J+1}\right). \text{ Then}$$

$$D2(2,J) = \frac{(D7-D1*D5)-D9}{D2-J+1}$$

for year J and all subsequent years to D2.

3. Sum of digits method.

First define sum of digits, D8:

$$D8 = \sum_{J=1}^{D2} J \text{ . Then}$$

a. For year 1:

$$D2(2,1) = D1*(1-C(I,9)*T0)*D6 + \frac{(D7-D1*D5)*D2}{D8}.$$

b. For years J=2 to D2:

$$D2(2,J) = \frac{(D7-D1*D5)*(D2-J+1)}{D8}.$$

4. Standard table method

D2(2,J) is specified by user for each year, J=1 to D2.

C. Calculate cumulative depreciation allowance for components and replacements[1].

1. For components I=1 to C1:

$$D1(1,I) = \sum_{J=1}^{D2} D2(1,J), \text{ and}$$

$$D1(2,I) = \sum_{J=1}^{D2} D2(2,J).$$

2. For replacements K=1 to C(I,12) to component I,I=1 to C1:

[1] If the depreciation life extends beyond the study period for any component or replacement, the cumulative depreciation allowed is as of the end of the study period.

$$D3(I,K)= \sum_{J=1}^{D2} D2(1,J), \text{ and}$$

$$D4(I,K)= \sum_{J=1}^{D2} D2(2,J).$$

D. Calculate present value of depreciation allowances.[1]

1. For all components, T(2,13):

$$T(2,13)= \sum_{I=1}^{C1} \sum_{J=1}^{C(I,2)} \frac{D2(2,J)}{(1+I1)**J},$$

where D2(2,J) is the actual depreciation allowance in year J for the Ith component.

2. For all replacements, T(2,14):

$$T(2,14)= \sum_{I=1}^{C1} \sum_{K=1}^{C(I,12)} \sum_{J=1}^{R4(I,K)} \frac{D2(2,J)}{(1+I1)**(R1(I,K)-1+J)},$$

where D2(2,J) is the actual depreciation allowance in year J for the Kth replacement to the Ith component.

V. Replacement cost calculations

NOTE: Replacements are considered to be capital expenditures and are therefore assumed to be incurred at the beginning of the assigned year.

Calculate cost for each replacement K=1 to C(I,12) of each component I=1 to C1.

A. Actual cost of the replacement at time of installation, R9(I,K):

$$R9(I,K)=[R2(I,K)*(1+C(I,15))**P1]*[(1+C(I,7))**(R1(I,K)-1)].$$

B. Present value (PV) of total sales tax on all replacements discounted from end of year (for income tax purposes), T(2,12):

[1] See footnote on previous page.

$$T(2,12)=\sum_{I=1}^{C1}\sum_{K=1}^{C(I,12)}\frac{R9(I,K)*R3(I,K)*T5}{(1+I1)**R1(I,K)}.$$

C. PV of all replacement expenditures, including sales tax, discounted from beginning of year of replacement, T(2,27):

$$T(2,27)=\sum_{I=1}^{C1}\sum_{K=1}^{C(I,12)}\frac{R9(I,K)*(1+R3(I,K)*T5)}{(1+I1)**(R1(I,K)-1)}.$$

VI. Resale value, capital gains and depreciation recapture taxes for capital components and replacements

A. Compute resale value of all components and replacements.

1. Compute resale value of components (I=1 to C1) remaining at end of study period, DA(I), and disposed of before end of study period, DB(I):

   a. DA(I)=C(I,14)*C(I,11)*(1+C(I,7))**P2 for all I from 1 to C1 where C(I,10)$\geqslant$P2

   b. DB(I)=C(I,14)*C(I,11)*(1+C(I,7))**C(I,10) for all I from 1 to C1 where C(I,10)$<$P2

2. Compute resale value of replacements remaining at end of study period, RA(I,K), and disposed of before end of study period, RB(I,K):

   a. RA(I,K)=R9(I,K)*R7(I,K)*(1+C(I,7))**(P2−R1(I,K+1))
   for all I,K (I=1 to C1, K=1 to C(I,12))
   where R1(I,K)+R6(I,K)−1$\geqslant$P2.

   b. RB(I,K)=R9(I,K)*R7(I,K)*(1+C(I,7))**R6(I,K)
   for all I,K (I=1 to C1, K=1 to C(I,12))
   where R1(I,K)+R6(I,K)−1$<$P2.

B. Compute PV of total resale value of all components and replacements:

1. PV of resale value of components and replacements remaining at end of study period, T(2,17):

$$T(2,17)=\frac{\sum_{I=1}^{C1} DA(I) + \sum_{I=1}^{C1} \sum_{K=1}^{C(I,12)} RA(I,K)}{(1+I1)^{**}P2}$$

2. PV of resale value of components and replacements disposed of before end of study period, T(2,18):

$$T(2,18)=\sum_{I=1}^{C1} \frac{DB(I)}{(1+I1)^{**}C(I,10)} + \sum_{I=1}^{C1} \sum_{K=1}^{C(I,12)} \frac{RB(I,K)}{(1+I1)^{**}(R1(I,K)+R6(I,K)-1)}.$$

C. Compute PV of any capital gains and recapture taxes on components and replacements remaining at end of study period, T(2,19):

1. Compute total resale value of all components and replacements remaining at end of study period, D1:

$$D1=\sum_{I=1}^{C1} DA(I) + \sum_{I=1}^{C1} \sum_{K=1}^{C(I,12)} RA(I,K).$$

2. Compute total original cost of all components and replacements remaining at end of study period, D2:

$$D2=\sum_{I=1}^{C1} C(I,14) \text{ for all I where } C(I,10) \geqslant P2$$

$$+\sum_{I=1}^{C1} \sum_{K=1}^{C(I,12)} R9(I,K) \text{ for all I,K where } R1(I,K)+R6(I,K)-1 \geqslant P2.$$

3. If T4=1 (for-profit tax status), add any unamortized "points" and construction interest remaining at end of study period to D2:

$$D2=D2+T(3,21)+T(3,24)$$

4. Compute sum of cumulative straight-line depreciation allowable as of end of study period, D3:

$$D3 = \sum_{I=1}^{C1} D1(1,I) \qquad \text{for all I where } C(3,10) \geqslant P2$$

$$+ \sum_{I=1}^{C1} \sum_{K=1}^{C(I,12)} D3(I,K) \qquad \text{for all I,K where } R1(I,K)+R6(I,K)-1 \geqslant P2.$$

5. Compute sum of depreciation allowances actually used as of end of study period, D4:

$$D4 = \sum_{I=1}^{C1} D1(2,I) \qquad \text{for all I where } C(I,10) \geqslant P2$$

$$+ \sum_{I=1}^{C1} \sum_{K=1}^{C(I,12)} D4(I,K) \qquad \text{for all I,K where } R1(I,K)+R6(I,K)-1 \geqslant P2$$

6. Use subroutine DRT (see D. below) to calculate total capital gains and depreciation recapture tax for components and replacements remaining at end of study period, D6.

7. Compute PV of capital gains and recapture tax, T(2,19)

$$T(2,19) = \frac{D6}{(1+I1)^{**}P2}.$$

D. Subroutine DRT to compute capital gains and depreciation recapture taxes, D6:

D1 = resale value of components and/or replacements
D2 = original cost of components and/or replacements
D3 = cumulative straight-line depreciation allowable
D4 = cumulative depreciation actually claimed

T1 = marginal tax rate
T3 = percent of capital gains subject to taxation
T6 = recapture code (see Appendix G for codes)

1. Assign depreciation recapture method to variables TY and TZ.

   a. If T6=1 then TY=T1 and TZ=T1.
   b. If T6=2 then TY=T1*T3 and TZ=T1*T3.
   c. If T6=3 then TY=T1 and TZ=T1*T3.

2. If D1>(D2−D3) and D1⩽D2 then
   D6=(D1−D2+D3)*TZ+(D4−D3)*TY.

3. If D1⩾(D2−D3) and D1>D2 then
   D6=(D1−D2)*T1*T3+D3*TZ+(D4−D3)*TY.

4. If (D2−D3) >D1⩾(D2−D4) then
   D6=(D1−D2+D4)*TY.

5. If D1<(D2−D4) then D6=0

E. Compute PV of total capital gains and depreciation recapture tax due on components and replacements disposed of before end of study period, T(2,20):

1. For each component I (I=1 to C1) for which C(I,10)<P2

   a. Set D1=DB(I)
      D2=C(I,14)
      D3=D1(1,I)
      D4=D1(2,I)

   b. Compute capital gains and recapture tax using subroutine DRT (D., above), D6.

   c. Compute PV of tax and add to T(2,20):

$$T(2,20)=T(2,20)+\frac{D6}{(1+I1)^{**}C(I,10)}$$

2. For each replacement I,K (I=1 to C1, K=1 to C(I,12)) for which R1(I,K)+R6(I,K)−1<P2:

   a. Set D1=RB(I,K)
      D2=R9(I,K)

D3=D3(I,K)
D4=D4(I,K)

b. Compute capital gains and recapture tax using subroutine DRT (D., above), D6.

c. Compute PV of tax and add to T(2,20):

$$T(2,20)=T(2,20)+\frac{D6}{(1+I1)^{**}(R1(I,K)+R6(I,K)-1)}$$

VII. Present value of recurring and non-recurring O&M expenditures

A. Present value (PV) of all annually recurring O&M costs (ARC), discounted from end of year incurred, T(2,21):

1. Compute PV factor for ARC, M3:

a. If M2 <> I1 then

$$M3=\left(\frac{1+M2}{I1-M2}\right) * \left[1-\left(\frac{1+M2}{1+I1}\right)^{**}P2\right] * (1+M2)^{**}P1.$$

b. if M2=I1 then
M3=P2*(1+M2)**P1.

2. T(2,21)=M1*M3.

B. Present value of all non-annually recurring O&M costs (NARC), discounted from end of year incurred, T(2,22):

$$T(2,22)=\sum_{J=1}^{M4} \frac{M(2,J)^*(1+M5)^{**}(P1+M(1,J))}{(1+I1)^{**}M(1,J)}.$$

VIII. Present value (PV) of property tax payments for components and replacements, discounted from end of year paid

NOTE: All property taxes are assumed to be paid at beginning of year, based on assessed value at beginning of year.

A. Compute PV of property taxes for components, discounted from beginning of year incurred, T(2,23):

1. For each component, calculate property tax in year J, PT(I,J):

a. If $C(I,10)<999$ then

$$PT(I,J)=[C(I,14)-D8]*C(I,8)*T2*(1+C(I,7))**(J-1),$$

$$\text{where } D8=\frac{C(I,14)*(1-C(I,11))*(J-1)}{C(I,13)}.$$

b. If $C(I,10)=999$ then

$$PT(I,J)=C(I,14)*C(I,8)*T2*(1+C(I,7))**(J-1).$$

2. $$T(2,23)=\sum_{I=1}^{C1}\sum_{J=1}^{C(I,13)}\frac{PT(I,J)}{(1+I1)**(J-1)}.$$

B. Compute PV of property taxes for replacements discounted from beginning of year incurred, T(2,24):

$$T(2,24)=\sum_{I=1}^{C1}\sum_{K=1}^{C(I,12)}\sum_{J=1}^{C(K,13)}\frac{[R9(I,K)-D8]*R8(I,K)*T2*[(1+C(I,7))**(J-1)]}{(1+I1)**(R1(I,K)+J-2)},$$

where $C(K,13)=MIN\ [R6(I,K),P2-R1(I,K)+1]$, and

$$D8=\frac{R9(I,K)*[(1-R7(I,K))*(J-1)]}{C(K,13)}.$$

IX. Present value PV of all energy costs, discounted from end of year incurred, T(2,25):

A. Compute PV of total cost for each energy type ($I=1$ to E1), E1(4,I):

1. Compute modified uniform present worth factor for each energy type in time interval K, D8:

a. If I1 <> E3(I,K) then

$$D8=\frac{1+E3(I,K)}{I1-E3(I,K)} * \left[1-\left(\frac{1+E3(I,K)}{1+I1}\right)**E2(I,K)\right].$$

b. If I1=E3(I,K) then

$$D8=E2(I,K).$$

2. Compute modified uniform present worth factor for each energy type I over the entire study period, E1(3,I):

$$E1(3,I)=\sum_{K=1}^{E1(2,I)} \prod_{J=0}^{K-1} \frac{1+E3(I,J)}{(1+I1)**E2(I,J)} * D8.$$

3. Compute PV cost for energy type I over the study period, E1(4,I):

$$E1(4,I)=[E1(1,I)*(E4(I)+E5(I))]*[(1+E1(5,I))**P1]*E1(3,I).$$

B. $T(2,25)=\sum_{I=1}^{E1} E1(4,I).$

X. Discount T(2,I), I=5 to 10 and I=12 to 27, from beginning of occupancy to beginning of study period if P1>0:

T(2,I) is replaced by $\frac{T(2,I)}{(1*I1)**P1}$ for I=5 to 10 and I=12 to 27.

XI. Aggregate all costs in present value terms at beginning of study period and compute tax deductions and credits

A. Define tax-related variables:

1. If T4=3 then

a. T(2,1) = 0
b. T(2,11) = 0
c. T(2,12) = 0
d. T(2,13) = 0
e. T(2,14) = 0
f. T(2,15) = 0
g. T(2,16) = 0
h. T(2,19) = 0
i. T(2,20) = 0
j. T(2,23) = 0
k. T(2,24) = 0

2. If T4=2 then

a. $T(2,13) = 0$
b. $T(2,14) = 0$
c. $T(2,19) = 0$
d. $T(2,20) = 0$

B. Aggregate cost variables:

1. $T(3,1) = T(2,17) + T(2,18)$
2. $T(3,2) = T(2,19) + T(2,20)$
3. $T(3,3) = T(3,1) - T(3,2)$
4. $T(3,4) = T(2,23) + T(2,24)$
5. $T(3,5) = T(2,21) + T(2,22)$
6. $T(3,6) = T(2,11) + T(2,12)$
7. $T(3,7) = T(2,2) + T(2,3)+T(2,4)+T(2,5)+T(2,6)+T(2,7)$
8. $T(3,8) = T(2,9)$
9. $T(3,9) = T(2,8) + T(2,10)$
10. $T(3,11) = [T(2,1) + T(3,22)]*T1$

C. Aggregate tax-related O&M items, T(3,16):

1. If T4=1 then

$$T(3,16)=\frac{T(3,4)}{1+I1}+T(2,21)+T(2,22)+T(2,25).$$

2. If T4=2 then

$$T(3,16)=\frac{T(3,4)}{1+I1}.$$

3. If T4=3 then $T(3,16)=0$.

D. Calculate total income tax deductions during occupancy, T(3,10):

1. If T4=1 (for profit), then
$T(3,10)=T(2,9)+T(2,13)+T(2,14)+T(3,6)+T(3,16)+T(3,20)+T(3,23)$.

2. If T4=2 (homeowner occupied), then
$T(3,10)=T(2,9)+T(3,6)+T(3,16)+T(3,20)$.

3. If T4=3 (tax-exempt), then $T(3,10)=0$.

E. Aggregate cost variables

1. T(3,12) = T(3,7)+T(3,9)+T(3,4)+T(3,5)+T(2,25)+T2,27)−T(3,3).
2. T(3,17) = T(3,10)*T1+T(2,15)+T(2,16).
3. T(3,15) = T(3,12)−T(3,17)−T(3,11).
4. T(3,18) = T(2,27).
5. T(3,19) = T(2,25).

XII. Find annualized value of all T(2,I) and T(3,I) costs

A. Compute capital recovery factor, D9:

1. If I1<0 then

$$D9 = \frac{I1 * (1+I1)**P3}{I(1+I1)**P3-1}.$$

2. If I1=0 then D9=1/P3

B. T(4,I)=T(2,I)*D9 for I=1 to 27.

C. T(5,I)=T(3,I)*D9 for I=1 to 19.

NOTE: The following variables are used in the COMPARE program:

XIII. Calculation of cost differentials (base case costs—alternative case costs), NB(I):

A. Define new variables

CC(1,I)=T(3,I) for base case, I=1 to 19.
CC(2,I)=T(3,I) for alternative case, I=1 to 19.

B. Adjust credit items:

CC(K,3)=CC(K,3)*−1 for K=1 to 2.
CC(K,17)=CC(K,17)*−1 for K=1 to 2.
CC(K,11)=CC(K,11)*−1 for K=1 to 2.

C. Determine net cash requirements before and at occupancy, CC(K,20):

CC(K,20)=CC(K,7)+CC(K,11)+CC(K,21) for K=1 to 2.
CC(K,4)=CC(K,4)−CC(K,21)

D. Calculate differential costs between base case and alternative, NB(I):

NB(I)=CC(1,I)−CC(2,I) for I=1 to 20.

XIV. Calculation of Savings-to-Investment Ratio and Adjusted Internal Rate of Return

A. Savings-to-Investment Ratio (SIR):

$$SIR = \frac{NB(20)-NB(15)}{NB(20)},$$

where NB(20)=reductions in future costs due to alternative case, and
NB(15)=additional investor cash at or before occupancy required by alternative case.

B. Adjusted Internal Rate of Return (AIRR) at reinvestment rate I1:

AIRR=(1+I1)*[1+NB(15)/(NB(20)*−1)]**(1/P3)−1,

where NB(15) and NB(20) have been calculated using I1 as the discount rate.

APPENDIX I

METHODOLOGY AND ASSUMPTIONS USED TO CALCULATE INCOME TAX ADJUSTMENTS IN THE NBSLCC PROGRAM

The LCCMAIN subprogram can estimate income tax savings relating to owning and operating a building. To do so requires the user to specify the values of the tax-related parameters used in the calculations. These values are specified in the building characteristics file set up for each project analysis. It is important to note that the validity of the tax-related adjustments made by the NBSLCC program is largely dependent on the user's knowledge of Internal Revenue Service (IRS) rules as reflected in the specification of parameters. These rules may change from year to year; however, the computational methods themselves are sufficiently flexible to accommodate such changes.[1] Many IRS rules are subject to interpretation; the methods used in the NBSLCC program are general in nature and may not represent the actual decision that either the IRS or an experienced tax consultant would make in every case.

There are six types of income tax adjustments in the NBSLCC program:

(1) Tax savings from sales tax on capital components and replacements.

(2) Tax savings from occupancy-related costs, including operating and maintenance costs, energy costs, and property taxes.

(3) Tax savings from depreciation of capital components and capital replacements.

(4) Capital gains and depreciation recapture tax liabilities at the end of the study period or at the end of the life of a component or replacement.

(5) Tax savings from interest and "points" on construction and permanent mortgage loans.

(6) Tax savings from investment (and related) tax credits.

The computational algorithms used to calculate these income tax adjustments are outlined in some detail in Appendix H. In this section, the general methodology for computing each of these adjustments is discussed.

All tax-related computations in the LCCMAIN subprogram are based on the assumption that tax savings and tax credits earned at any time during the calendar year are not realized (i.e., do not generate cash flow) until the end of that year. As a consequence, all tax savings and tax credits are discounted from the end of the year in which they are earned.

A composite marginal income tax rate is used in all of the tax-related computations described below. This composite rate is based on the assumption that State income taxes (including local income taxes, if any) are deductible expenses in the calculation of Federal income taxes. The composite rate is less than the simple sum of the Federal and State tax rate. That is, the composite Federal and State tax rate is equal to the marginal Federal tax rate x(1 − marginal State tax rate) + the marginal State tax rate.

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[1]The computation of income tax savings by NBSLCC assumes that the tax rules do not change during the study period. Thus the phasing-in of new tax provisions cannot be handled. The tax provisions expected to dominate the income tax computations during the study period should be used in such a case.

Sales Taxes

If sales taxes are itemized separately in deriving the cost of components and replacements to components, they are assumed to be tax deductible in the year they are incurred in the for-profit tax status. The tax savings in each year is calculated as the product of the composite income tax rate and the sales tax paid in that year. If sales taxes are itemized separately, they are not included in the original cost basis used for depreciation calculations and/or for the determination of resale value. (Sales tax can be made deductible for residences (tax status=2) by respecifying variable P6=1 in the LCCMAIN program code.)

Separate itemization of sales taxes is most likely to occur when an owner of a building makes purchases of materials directly rather than through a contractor. When a contractor makes these purchases, any sales tax paid by the contractor is generally considered by the IRS to be part of the original cost basis of the component or replacement and is therefore not itemized separately.

Occupancy-related costs

For buildings in the "for-profit" tax status, all occupancy-related costs paid by the owner (e.g., maintenance and repairs, insurance, energy, water, and property taxes) are assumed to be tax deductible in the year they are incurred. For owner-occupied dwelling units, property taxes are the only occupancy-related cost that is tax deductible. The tax savings in each year is calculated as the product of the composite Federal and State income tax rate and the sum of tax-deductible occupancy-related costs for that year. (Property taxes can be made non-deductible for residences (tax status=2) by respecifying variable P7=0 in the LCCMAIN program code.)

Depreciation of Capital Components and Replacements

Tax savings due to depreciation are allowed only for buildings in the "for-profit" tax status, e.g., commercial buildings and rental residential units. Four types of depreciation can be calculated by the NBSLCC program:

- straight line
- declining balance (accelerated)
- sum of years digit
- depreciation table

The NBSLCC program allows depreciation schedules to be set up separately for each capital component. Land itself cannot be depreciated, but land development costs can be designated as a capital component and depreciated, if appropriate. The procedure for specifying the depreciation type for each capital component and the variables needed to compute the depreciation allowance in each year are discussed in Chapter 6 as part of the Capital and Replacement Cost Data.

If the Accelerated Cost Recovery System (ACRS) is to be used to calculate depreciation, identical depreciation schedules should be set up for each capital component in the project (except for land). ACRS does not allow individual building components to be depreciated separately (unless

they are new or replacement components added during the life of the project); however, if identical schedules are specified for each component, the computational results will be the same as if all components were depreciated together. The depreciation table method is generally used for ACRS depreciation calculations.

Tax savings from depreciation in each year are calculated as the product of the marginal income tax rate and the sum of all depreciation allowances claimed in that year.

Capital Gains and Depreciation Recapture Taxes

Capital gains and depreciation recapture tax liabilities are only calculated for buildings in the "for-profit" tax status. For owner-occupied residences, any tax liabilities due to capital gains at resale are assumed to be postponed indefinitely through rollovers and are therefore ignored. The following discussion is therefore limited to buildings in the "for-profit" tax status.

If the resale value computed for the overall project at the end of the study period is greater than the original cost basis of the components and replacements remaining at that time, capital gains tax liabilities will be calculated. Capital gains are calculated as the difference between the resale value of the project and the original cost basis of those remaining components and replacements. The capital gains tax liability is calculated as the product of the marginal composite tax rate, the "Percent of Capital Gains Subject to Taxation," and the capital gains. Capital gains are calculated individually for any component or replacement which is sold before the end of the study period at a price greater than its original cost basis.

If the resale value computed for the overall project at the end of the study period is greater than the original cost basis of the remaining components and replacements, less the cumulative depreciation claimed for those components and replacements, depreciation recapture taxes will also be calculated. There are a number of different methods that can be used to compute depreciation recapture; the appropriate method depends on the type of property that has been depreciated. Three methods that can be specified in NBSLCC are described in Chapter 6 under "Depreciation Recapture Method." The IRS provides specific guidelines for computing depreciation recapture taxes that should be consulted before specifying the method to be used in a NBSLCC analysis. Depreciation recapture taxes are calculated individually for any component or replacement which is sold before the end of the study period.

Capital gains tax can be ignored by specifying 0 for the "Percent of Capital Gains Subject to Income Tax" when setting up the building characteristics file for a building. Depreciation recapture can be ignored by specifying 0 for the "Depreciation Recapture Method" at the same time.

Interest and "Points"

For owner-occupied residences, interest and "points" paid on both construction loans and permanent mortgage loans are assumed to be tax deductible in the year they are paid. For "for-profit" buildings, the computation of deductions is considerably more complicated. In this latter case, the method used to determine the tax deduction for "points" and interest is different for construction loans and mortgage loans. These methods are based on current IRS provisions.

Tax deductions for "points" and interest paid on construction loans are amortized on a straight-line basis over a 10 year period. One-tenth of those costs are deducted in the year that they are actually incurred; the remaining nine-tenths are spread evenly over the first nine years of occupancy. If the study period ends before the ninth year, the unamortized portion of these costs is added to the original cost basis of the building when calculating capital gains tax liabilities. (This 10 year factor can be changed in the LCCMAIN program to any other length of time by respecifying variable P4.)

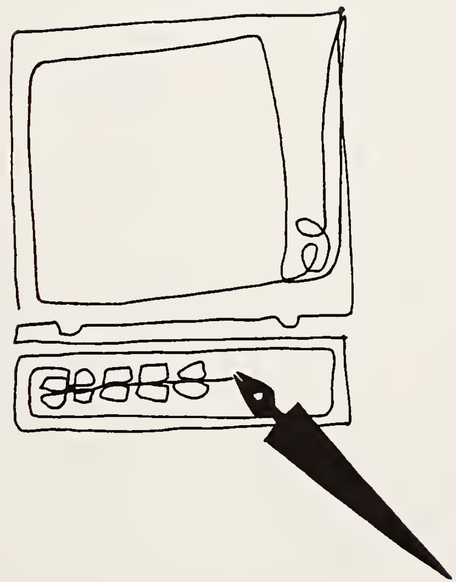
Interest paid on permanent mortgage loans is deductible in the year that payment is made. However, "points" paid for permanent mortgages are considered to be prepaid interest and are amortized over the life of the loan on a straight-line basis. If the study period ends before the life of the loan, any unamortized "points" are added to the original cost basis for purposes of calculating capital gains.

Tax savings from interest and "points" in each year are calculated as the product of the marginal income tax rate and the sum of all deductions for interest and "points" that can be claimed in that year. (Interest and "points" can be made non-deductible for residences (tax status=2) by respecifying variable P8=0 in the LCCMAIN program code.)

Investment Tax Credits

Investment tax credits are calculated as a percent of the original cost of a component or replacement. (Energy conservation tax credits, if any, should be set up as investment tax credits.) Investment tax credits for capital components are assumed to be claimed in the first year of occupancy, even if they are related to investments made during construction.

If an investment tax credit is claimed for a component or replacement, the original cost basis for depreciating that item may need to be reduced by some percentage of the tax credit. The IRS has specific guidelines for this adjustment. The "Depreciation Basis Adjustment Factor" is used to make this adjustment to the original cost basis of all components and replacements. (See Chapter 6.)



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The NBSLCC program and related files (described in Chapter 6) are contained on a single 5-1/4 inch diskette in MS-DOS format. If you would like to have a copy of the NBSLCC diskette, it can be ordered from:

National Technical Information Service
U.S. Department of Commerce
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