Guide to Optimizing Hospital Facility Investments

Purpose

This guide is intended to help hospital facility managers, construction project managers and other decision makers more effectively evaluate the economic viability of energy-related investments in existing facilities, major renovations and new construction. It also presents a range of project financing options.

The purposes of this guide are to help hospital decision makers:

- Better understand economic analysis methods and available tools. The particular focus of this guide is on the merits of a life-cycle cost analysis approach.
- Develop a common language and methodology for economic analysis that can be used throughout a hospital organization to discuss and assess the financial merits of both energy-related and non-energy-related investments.
- Expand decision makers' understanding of the range of financing options available to them for energy-related projects.

Ultimately this guide should be used by hospitals looking to improve their economic position by reducing operating costs through energy savings. This will increase access to capital and help hospital operating margins. "Access to capital is a reflection of one thing: operating efficiency," says Michael Williams, CEO of Community Health Corp.[1] By using the tools presented here, hospitals should be able to improve their bottom line.

1. Financing the Future Report 4: How Are Hospitals Financing the Future? The Future of Capital Access. Healthcare Financial Management Association (HFMA), page 14 (2004).

One thing this guide does not address is quantifying the full range of non-energy benefits that accompany many energy-saving projects. When it is possible to quantify additional savings such as water, sewer or maintenance expenses, these can be included in the equations presented in this guide. On the other hand, improved system reliability, staff and patient comfort, increased indoor air quality and other benefits are harder to quantify but are nonetheless important. As such, the results derived using the tools presented in this guide will be conservative, as they do not include the value of these other non-energy benefits.

A downloadable version of this guide is available on the BetterBricks website **(www.betterbricks.com/healthcare)**, and copies can also be obtained directly from NEEA.

Guidebook Organization

This guide is divided into six sections:

- **Section I** (Basic Concepts) provides a brief introduction to the concept of the Time Value of Money (TVM).
- **Section II** (Economic Evaluation Tools) provides a discussion of the basic approaches used to evaluate the benefits of a particular energy efficiency project or activity, and is targeted to those who are unfamiliar with standard economic analysis methods. These methods include net present value, simple payback, internal rate of return and return on investment, with sample calculations provided for each.
- **Section III** (Life-Cycle Cost Analysis) presents an overview of the life-cycle cost analysis method. This method utilizes the net present value calculation discussed in Section II to evaluate different energy efficiency project options. The method examines all of the costs that accrue during the life of the project for each project alternative being considered. The Life-Cycle Cost Analysis method is a powerful tool that allows the relative costs of different projects to be compared using a single discounted cost number.
- **Section IV** (Financing Options) describes commonly used financing options, including loans, bond issues, internal capital and philanthropic donations. The Guide discusses the potential advantages and disadvantages of each financing option and provides simple examples of each method. The Appendix to the guide also describes less common options, including operating leases where equipment payments are kept off the balance sheet (and therefore not reported as balance sheet debt), and provides more detail on the financing options discussed in Section IV.
- **Section V** (Performance Contracting) provides an overview of performance contracting and discusses its relationship to project management, completion and financing.
- **Section VI** (Project Examples) discusses the effects of project delay, how to compare multiple projects and the advantages of combining multiple energy-efficiency projects into a larger and more comprehensive project. A general project approach discussion emphasizes the advantages of employing more sophisticated financial analysis tools in helping facility and construction managers evaluate their investment options. A flowchart is presented, detailing a proposed process for financial analysis of projects.

The Appendices, in addition to providing further detail on the methods discussed, provide tools and lists of some of the resources available to assist hospitals and other commercial customers considering energy efficiency improvements. The list includes state loan programs designed for hospital construction or energy projects, utilities and government agencies that offer commercial energy efficiency programs, and resources and services available through BetterBricks. Utility programs often include loans, direct financial incentives and tax credits, including tax credits that can be used to the benefit of non-profit organizations. Many of these utilities and government agencies also offer technical assistance for system design and equipment selection.

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Section I: Basic Concepts

Time Value of Money

Time Value of Money (TVM) is an important concept in financial management. It can be used to compare investment alternatives and to solve problems involving loans, mortgages, leases, savings and annuities.

TVM is based on the concept that a dollar that you have today is worth more than the promise or expectation that you will receive a dollar in the future. Money that you hold today is worth more because you can invest it and earn interest. After all, you should receive some compensation for forgoing spending. For instance, you can invest your dollar for one year at a 6 percent annual interest rate and accumulate $1.06, at the end of the year. You can say that the future value of the dollar is $1.06 given a 6percent interest rate and a one-year period. It follows that the present value of the $1.06 you expect to receive in one year is only $1.

A key concept of TVM is that a single sum of money or a series of equal, evenly spaced payments or receipts promised in the future can be converted to an equivalent value today. Conversely, you can determine the value to which a single sum or a series of future payments will grow at some future date.

There are five key variables used in the TVM calculations: interest rate, number of periods, payments, present value and future value. Knowing the value of any four enables you to calculate the fifth. Each of these factors is very briefly defined below:

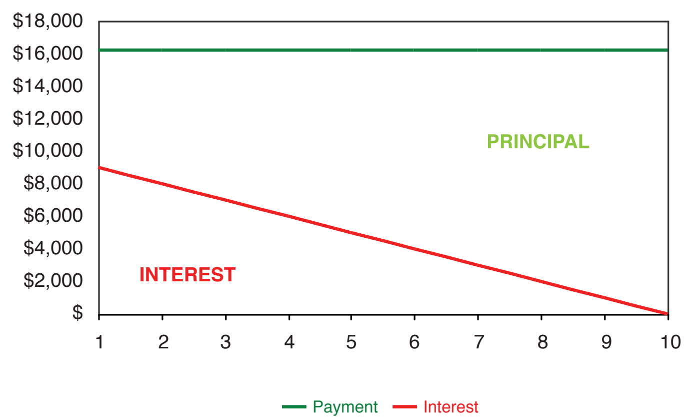
- Interest is a charge for borrowing money, usually stated as a percentage of the amount borrowed over a specific period of time. Simple interest is computed only on the original amount borrowed. It is the return on that principal for one time period. In contrast, compound interest is calculated each period on the original amount borrowed plus all unpaid interest accumulated to date. Compound interest is always assumed in TVM problems.

- Periods are evenly spaced intervals of time. They are intentionally not stated in years, since each interval must correspond to a compounding period for a single amount or a payment period for an annuity.

- Future value is the amount of money that an investment with a fixed, compounded interest rate will grow to by some future date. The investment can be a single sum deposited at the beginning of the first period, a series of equally spaced payments (an annuity) or both. Since money has time value, we naturally expect the future value to be greater than the present value. The difference between the two depends on the number of compounding periods involved and the going interest rate.

FIGURE 1: LOAN AMORTIZATION

$100,000 @ 10% for 10 Years



- Payments are a series of equal, evenly spaced cash flows. In TVM applications, payments must represent all outflows (negative amount) or all inflows (positive amount).

- Present value is an amount today that is equivalent to a future payment, or series of payments, that has been discounted by an appropriate interest rate. The future amount can be a single sum that will be received at the end of the last period, as a series of equally spaced payments (an annuity)h or both. Since money has time value, the present value of a promised future amount is worth less the longer you have to wait to receive it.

The present value must be escalated to its future value.

- Two additional concepts are important in TVM analysis:

- Inflation (or deflation) is a special case of the future value of money. When inflation occurs, the value of a dollar in the future is reduced as compared to a dollar today. Often this works counter to the interest that can be earned by investing a dollar for a period of time. For example, if we invest a dollar at a nominal interest rate of 5 percent, but the inflation rate is 3 percent our investment escalates at a real interest rate of only 2 percent. To simplify calculations involving inflation, escalation and discounting, often real rates are used instead of nominal rates. This allows the use of constant dollars for many future values instead of having to adjust all future values for inflation. Thus, only those future values that vary at a rate different than the normal inflation rate have to be adjusted for inflation, instead of all future values. The alternative to this method is to consider all values to be in current dollars for their time period and to adjust them all for inflation.

- Loan amortization is a method for repaying a loan in equal installments. Part of each payment goes toward interest, and any remainder is used to reduce the principal. As the balance of the loan is gradually reduced, a progressively larger portion of each payment goes toward reducing principal.

Cash Flow Diagram

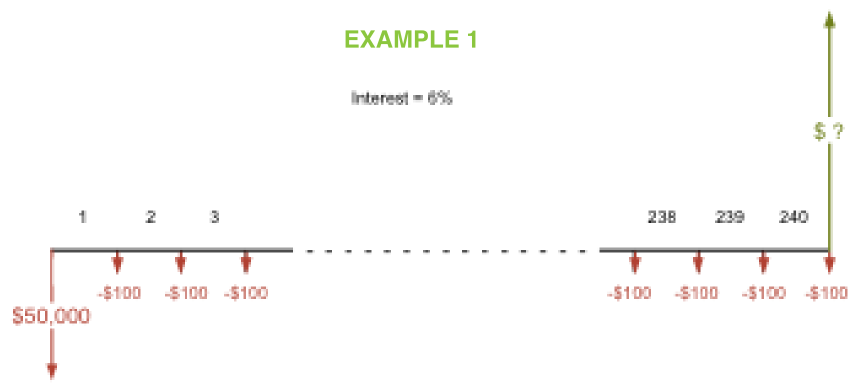
A cash flow diagram is a picture of a financial problem that shows all cash inflows and outflows along a time line. It can help you to visualize a problem and to determine how it can be solved by TVM methods.

Constructing a Cash Flow Diagram

The time line is a horizontal line divided into equal periods such as days, months, or years. Each cash flow, such as a payment or receipt, is plotted along this line at the beginning or end of the period in which it occurs. Funds that you pay out, such as savings deposits or lease payments, are negative cash flows that are represented by arrows that extend downward from the time line with their bases at the appropriate positions along the line. Funds that you receive, such as proceeds from a mortgage or withdrawals from a savings account, are positive cash flows represented by arrows extending upward from the line.

Example 1: You are 40 years old and have accumulated $50,000 in your savings account. You can add $100 at the end of each month to your account, which pays an annual interest rate of 6 percent compounded monthly. Will you be able to retire in 20 years?

The time line is divided into 240 monthly periods (20 years times 12 payments per year), since the payments are made monthly and the interest is also compounded monthly. The $50,000 that you have now (present value) is a negative cash outflow, since you will treat it as though you were just now depositing it into the account. It is represented with a downward pointing arrow with its base at the beginning of the first period. The 240 monthly $100 deposits are also negative outflows represented with downward pointing arrows placed at the end of each period. Finally you will withdraw some unknown amount (the future value) after 20 years. Represent this positive inflow with an upward pointing arrow with its base at the very end of the last period.



This diagram was drawn from your point of view. From the bank's point of view, the flows of cash would be opposite, with the present value and the series of deposits as positive cash inflows, and the final withdrawal of the future value as a negative outflow.

Economic Conventions

In the following sections we will be talking about the time value of money and economic evaluation tools used to compare various energy efficiency investments. Several investment examples will be used during this discussion. In order to simplify these examples, a cash flow diagram will be included in each case.

In order to be as consistent as possible in all economic evaluations related to energy efficiency projects, the standards developed by ASTM International will be used throughout this guide.

ASTM E 833-04, "Standard Terminology of Building Economics," ASTM International.
ASTM E 917-05, "Standard Practice for Measuring Life-Cycle Costs of Buildings and Building Systems," ASTM International.
ASTM E 964-02, "Standard Practice for Measuring Benefit-to-Cost and Savings-to-Investment Ratios for Buildings and Building Systems," ASTM International.
ASTM E 1057-04, "Standard Practice for Measuring Internal Rate of Return and Adjusted Internal Rate of Return for Investments in Buildings and Building Systems," ASTM International.
ASTM E 1074-04, "Standard Practice for Measuring Net Benefits and Net Savings for Investments in Buildings and Building Systems," ASTM International.
ASTM E 1121-02, "Standard Practice for Measuring Payback for Investments in Buildings and Building Systems," ASTM International.
ASTM E 1185-02, "Standard Guide for Selecting Economic Methods for Evaluating Investments in Buildings and Building Systems," ASTM International.
For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

Section II: Economic Evaluation Tools

This section reviews the most common methods used to evaluate investment opportunities and demonstrates each method with simple calculations. Following this introductory discussion, the methods are used to evaluate a variety of different financing options available to hospitals considering efficiency investments. The simplest methods are presented first, followed by descriptions of more sophisticated evaluation techniques.

Simple payback analysis

The Simple Payback approach is the simplest and most straightforward — and hence the most commonly used — method for evaluating a project's economic feasibility. However, it is also the method that leaves many economic variables unaccounted for in analyzing potential benefits of a project. This approach approximates the time it takes for an energy efficiency project to pay for itself, also known as the project's break-even point or the point at which it begins to turn a profit. More precisely, simple payback measures the length of time — or payback period — needed for cumulative energy savings to equal the initial investment. Essentially, this approach answers the very basic question that many facility engineers confront: How quickly will the cost savings from lower energy consumption recover the initial costs of the energy-efficient measure?

Simple payback considers the initial investment costs and the resulting annual energy savings. If the annual energy savings are equal, the payback period is calculated using the following equation:

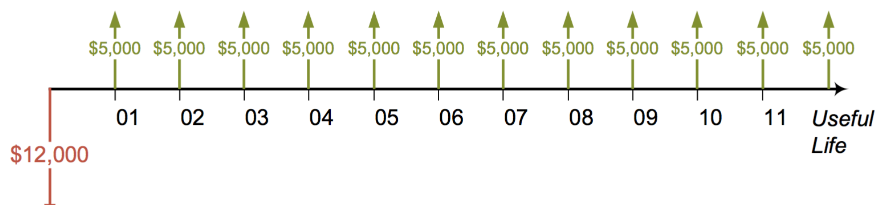
$$\frac{\text{INITIAL INVESTMENT COST}}{\text{ANNUAL SAVINGS}} = \text{PAYBACK PERIOD (Years)}$$

Suppose, as in Example 2, that a hospital installed an efficiency measure with an initial investment cost of $12,000. The measure is expected to yield energy cost savings totaling $5,000 per year. As shown below, the simple payback period for this project is 2.4 years.

As can be seen above, the simple payback method does not account for savings after the payback period. It is a quick and easy way to estimate an efficiency project's viability when assess the viability of a specific energy efficiency project. From this perspective, the simple payback approach can influence the decision to expend further resources to research and implement an efficiency project or activity.

- Easy to understand. From a marketing perspective, simple payback easily communicates a project's potential benefit to a non-technical audience that has limited understanding of financial analysis methods.

EXAMPLE 2



$$\text{PAYBACK PERIOD (YEARS)} = \frac{\text{INITIAL INVESTMENT COST}}{\text{ANNUAL SAVINGS}} = \frac{\$12,000}{\$5,000} = 2.4 \text{ YEARS}$$

savings are constant over time. However, the method becomes more cumbersome when energy and other cost savings do not occur at a constant rate; if annual energy savings are not constant or equal, the payback period is the time taken for the sum of annual energy savings to equal initial investment cost. Beyond the savings associated with lower energy consumption, annual savings can also include those derived from lower maintenance costs and/or reduced labor expenses. These additional cost savings factors may complicate the payback calculation.

Generally speaking, the simple payback approach is:

- Quick and easy to use. The method generates a point estimate that allows building engineers to quickly

For more complicated projects, however, the simple payback technique has significant limitations:

- Simple payback does not account for energy savings or other monetary net benefits that occur after the payback period. This limitation proves particularly troublesome for energy efficiency measures with long effective useful lives (EULs): once the energy savings just cover the initial investment costs, further profits or additional net benefits are ignored. Suppose, for example, that an energy efficiency measure has an EUL of five years and a payback period of two years. Under this scenario (assuming the measure operates to the full extent of its estimated EUL) the net benefits for three additional years of energy savings are ignored in the simple payback calculation.

- Simple payback does not account for the time value of money. Given inflation and investment opportunities, a dollar today is worth more than a dollar next year; the simple payback approach ignores this fundamental fact. This significant shortcoming makes the simple payback method less applicable for energy efficiency projects with long payback periods. Depending on the choice of discount rate (implicitly, the estimated rate of inflation, opportunity cost of capital and risk), the future value of net benefits 10 years from now could be significantly less than today's value.
- Simple payback has limited application outside of energy efficiency projects. Many financial analysts are more familiar with simple return on investment (ROI) rather than payback (discussed below).

Simple Return on Investment (ROI)

The simple return on investment (ROI) method is another commonly used approach that is likely more familiar to financial analysts outside of energy efficiency applications. Calculation of the ROI is straightforward; assuming that the annual energy savings is constant, the ROI is simply the inverse of the simple payback:

Continuing with the same example used for simple payback (see Example 2), consider the case where a hospital installs an efficiency measure with an initial

$$\text{RETURN ON INVESTMENT (ROI)} = \frac{\text{ANNUAL SAVINGS}}{\text{INITIAL INVESTMENT COST}} = \frac{1}{\text{SIMPLE PAYBACK}}$$

investment cost of \$12,000 that will deliver energy cost savings of \$5,000 per year. As shown below, the ROI is 41.67 percent, which is the inverse of the simple payback of 2.4 shown earlier:

The advantages of the ROI method are basically the same as the simple payback

$$\text{RETURN ON INVESTMENT (ROI)} = \frac{\text{ANNUAL SAVINGS}}{\text{INITIAL INVESTMENT COST}} = \frac{\$5{,}000}{\$12{,}000} = 41.67\ \%$$

$$\text{RETURN ON INVESTMENT (ROI)} = \frac{1}{\text{SIMPLE PAYBACK}} = \frac{1}{2.4\ \text{YEARS}} = 41.67\ \%$$

method:

- Quick and easy to use. The ROI calculation is simple and requires only the most basic information on the proposed project. The method generates a single value that allows the return of a project to be easily compared against some threshold return rate.
- Easy to understand. The ROI method is easy to understand and should be familiar to most financial analysts — and likely more familiar than simple payback.

The ROI method does not address more complicated aspects of energy efficiency

Sacred Heart Medical Center Motor Replacement Project

Sacred Heart Medical Center recently teamed with the Eugene Water and Electric Board to install new premium efficiency motors at its facilities. "We had no doubt there would be energy savings," says Greg Kelleher, an EWEB Energy Management Services engineer. "The real question was: where would motor replacements be cost-effective?" A few adjustments were needed along the way, but energy savings have been better than anticipated. The premium efficiency motors are saving more than 5 percent in energy and demand, resulting in savings of almost \$2,500 per year. With the incentives provided by EWEB, the simple payback for the project is about six months (equal to a 200 percent simple return on investment).

Source: "Sacred Heart Pilots Motor Replacement Program," Efficiency by Design, Fall 2002.

investments, and therefore has the following limitations:

- The ROI method does not incorporate the length of time that energy savings are expected to occur. For example, consider two projects with identical initial costs and annual savings: one with savings over five years and the other with savings spanning 10 years. From an ROI perspective, the value of these investments is the same, even though the one with the longer period of savings would be clearly preferred.
- ROI does not account for the time value of money. With the ROI method, energy savings achieved in future years are valued the same as energy savings today. Given inflation and investment opportunities, however, the time value of money means that energy savings in future years are valued less than if they were achieved today. ROI does not include any adjustments to reflect the time value of money.

Net Present Value Analysis

The net present value method significantly improves upon the simple payback and ROI methods because it:

- Considers the time value of money, and
- Evaluates cash flows (cash inflows and outflows or, alternatively, benefits and costs) over the lifetime of the efficiency measure.

Although this technique's data demands are somewhat greater than those of the simple payback and ROI approaches, this method produces a dollar figure that explicitly recognizes the project's value. Consequently, it is the method that we recommend for evaluating all potential energy efficiency investments, as it is flexible enough to incorporate all the potential costs and benefits of a project.

Because of risk, inflation and foregone investment opportunities, individuals generally prefer a dollar now to a dollar 10 years from now. An energy efficiency project will have an initial investment cost (negative cash flow now) that is expected to yield energy and other savings (positive cash flows) in the future. To find the present value of this series of future annual cash flows, one must reduce or discount future amounts to the present using a discount rate. After the initial investment costs are subtracted, the technique yields the project's net present value. The NPV calculation is adapted for use in the life-cycle cost analysis method discussed in the next chapter.

The discounting process uses the following two components: 1) the expected future cash flows or earnings stream, and 2) the discount rate. (The initial investment costs mark the time period to which future cash flows will be discounted and, accordingly, are themselves not discounted.) The expected future cash flow is simply the savings (or lower costs) obtained as a result of the energy efficiency measure. The discount rate represents the opportunity cost of capital, i.e., the forgone interest or rate of return that could have been earned by investing these funds elsewhere. As such, many businesses describe the discount rate as their "hurdle rate," the minimum required rate of return on a project.

The following equation calculates net present value (NPV) of a project:

$$NPV = \sum_{n=0}^{n} \frac{CF_n}{(1+r)^n} = CF_0 + \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \ldots + \frac{CF_n}{(1+r)^n}$$

Where:

CF = Cash Flow (Note: CF0 represents the initial investment costs and is negative)

r = discount rate

n = number of periods (years)

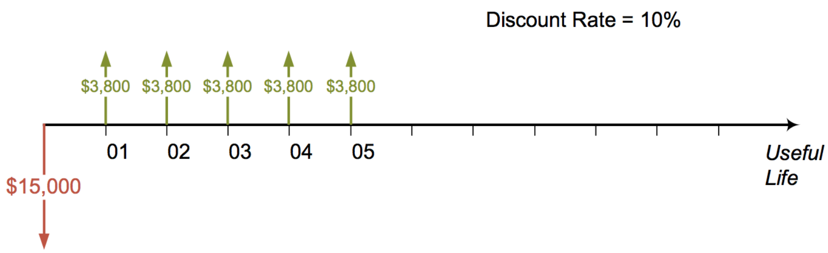
For a project under review, the net present value approach can be used to determine whether or not the project is economically feasible and if it should be accepted or rejected. This “absolute choice” considers the following:

If NPV > 0, the project is economically feasible and should be accepted

If NPV = 0, outcomes are neutral

If NPV < 0, the project is not economically feasible and should be rejected

EXAMPLE 3



Suppose, as in Example 3, that the initial investment cost for an energy efficiency measure is $15,000 and that this project will reduce energy costs by $3,800 each year for five years. Also, suppose the firm could invest this money elsewhere and earn a 10 percent rate of return. The table below demonstrates all the components of the net present value method and how it can guide the investment decision for this project.

TABLE 1: NPV (EXAMPLE 3)

YEAR (T)	DISCOUNT RATE (R)	DISCOUNT FACTOR 1/(1+R)T	CASH FLOW	PRESENT VALUE OF ANNUAL CASH FLOWS
0	10%	1.00	-$15,000	-$15,000
1	10%	0.91	$3,800	$3,455
2	10%	0.83	$3,800	$3,140
3	10%	0.75	$3,800	$2,855
4	10%	0.68	$3,800	$2,595
5	10%	0.62	$3,800	$2,360
		TOTAL NOMINAL CASH FLOW	$4,000	NET PRESENT VALUE (NPV) OF CASH FLOW -$595

As can be seen in Table 1, the cumulative value of the nominal — or unadjusted — cash flows is $4,000. Using these unadjusted cash flows, one could (incorrectly) conclude that the project is financially feasible. However, as discussed previously, inflation, risk, and foregone interest earning possibilities render dollars in the future less valuable than dollars now. Adjusting the nominal cash flows to convert them into present value terms using the discount rate gives us the net present value (NPV) of the investment. As shown at the bottom of the table, the sum of the present value of cash flows — including the initial investment cost of $15,000 — yields a net present value for the project of –$595. Based on this evaluation, this project is not economically feasible and should be rejected, as the present value of the benefits is less than the present value of the costs.

Oftentimes plant managers and facility engineers need to consider multiple projects. In other words, a given amount of funding capital may be available for investment in multiple projects. In this case, then, the decision maker can use the net present value approach to compare the economic feasibility of several alternative projects. Suppose, as in Example 4, that two energy efficiency projects (A and B) have effective useful lives of two years each.

Investment A costs $15,000 and yields $9,000 in energy savings each year for the next two years. Investment B costs $10,000 today and reduces energy costs by $7,500 each year for the next two years. Using a 10 percent discount rate, which is the better option?

As demonstrated in the previous example, the net present value of Alternative B ($3,016) is greater than the net present value of Alternative A ($620), and Alternative B is the preferred choice. The net present value approach measures cash flow over the entire life of the energy efficiency project and discounts future values to accommodate a positive time preference for money. As such, this evaluation method is often preferable to the simple payback approach.

In this guide, we vary the NPV calculation slightly in cases where the project is being financed through a borrowing arrangement, such that payments on the loan occur each period. In this case, we calculate the present value of the net cash flow over the life of the project. To prevent double-counting the cost of the loan, we include only the monthly (or yearly) loan payments in the calculation and do not include the initial equipment cost in the present value calculation. To avoid confusion, we include this method with our NPV discussion rather than creating a separate category.

To demonstrate this further, consider Example 4, with the two energy efficiency projects (Alternatives A and B) and assume that these projects are paid for by borrowing, with the price paid off evenly over the two-year period (see Example 5 below). For simplicity, we assume that there are no interest payments in this example. Recall that Alternative A has a cost of $15,000 and results in $9,000 a year in energy savings. If the loan is paid off evenly over the two years, the cost is $7,500 a year. When the loan cost is subtracted from the energy savings, the project yields an annual net benefit of $1,500 ($9,000 minus $7,500). Similarly, Alternative B has a cost of $10,000 with annual energy savings of $7,500. If the loan is paid over the two-year period, the cost of borrowing is $5,000 per year, and when this is subtracted from the annual savings, the project results in an annual net benefit of $2,500.

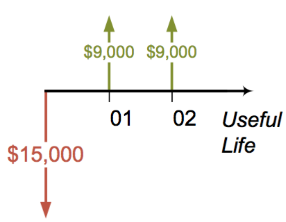
As in the earlier example, the annual benefits need to be discounted into present value terms in order to evaluate the relative merits of each investment alternative. As shown in Example 5, Alternative A has an NPV of $2,603, while Alternative B has an NPV of $4,339. (Note also how much the NPV increases when payment is spread out over time rather than incurred immediately in the first period.) Since the NPV for Alternative B is greater than for Alternative A, it is the preferred investment, although both investments would be considered beneficial since the NPVs are both greater than zero.

In general, NPV has the following important advantages:

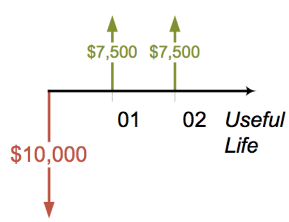
- **Incorporates all relevant information.** The NPV takes into account all costs and benefits, as well as the time period over which they are expected to occur. The NPV method also

EXAMPLE 4

Discount Rate = 10%



Alternative A



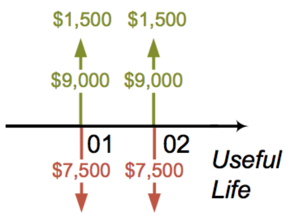
Alternative B

$$\text{NPV ALTERNATIVE A} = -\$15{,}000 + \frac{\$9{,}000}{(1.10)} + \frac{\$9{,}000}{(1.10)^2} = \$620$$

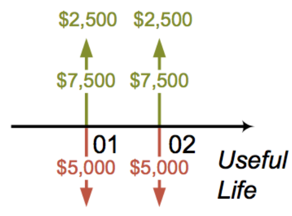
$$\text{NPV ALTERNATIVE B} = -\$10{,}000 + \frac{\$7{,}500}{(1.10)} + \frac{\$7{,}500}{(1.10)^2} = \$3{,}016$$

EXAMPLE 5

Discount Rate = 10%



Alternative A



Alternative B

$$\text{NPV ALTERNATIVE A} = \frac{\$1{,}500}{(1.10)} + \frac{\$1{,}500}{(1.10)^2} = \$2{,}603$$

$$\text{NPV ALTERNATIVE B} = \frac{\$2{,}500}{(1.10)} + \frac{\$2{,}500}{(1.10)^2} = \$4{,}339$$

adjusts for the time value of money, as energy savings achieved in future years are appropriately discounted into present value terms.

- **Single NPV number allows for easy comparisons across project types**. Once calculated, the NPV value provides an easy way to compare various projects, even when projects have very different values for annual savings, initial costs, or equipment life.
- **Allows for easy comparison of multiple financing alternatives.** As with the project comparisons, the NPV method can be used to easily compare different financing options for the same project. The single NPV number provides a straightforward way to evaluate different financing options even when these options, may vary substantially over the project life and annual payments. (This is discussed in much greater detail in the following section.)

Although the NPV is the preferred option for evaluating energy efficiency projects, there are some disadvantages to this method:

- **Does not expressly account for differing useful lives between projects being compared.** This is one of the strengths of the life-cycle cost analysis method discussed in a later section.
- **High information requirements**. Relative to the simple payback and ROI methods, NPV has a somewhat higher information requirement. The NPV calculation requires information on the effective useful life of the equipment considered and information on the costs and energy savings expected for each year. The analyst must also choose an appropriate discount rate to complete the present value calculation.
- **More complicated calculation.** Although the NPV calculation is familiar and straightforward, it is more complicated than the simple payback or ROI calculations. For this reason, many have used the simple payback or ROI methods that are easier to calculate.

Internal Rate of Return Analysis

The net present value approach requires an audience somewhat familiar with financial analysis methods. When an audience does not grasp the "present value" concept, many financial analysts use the internal rate of return (IRR) method to evaluate projects.

The internal rate of return method is closely related to the net present value method. Internal rate of return is essentially the discount rate that equates future net benefits to initial investment cost; in other words, the internal rate of return is the discount rate that makes the net present value of the project equal to zero. Expressed as a percentage, the internal rate of return for a given project can then be compared to the business's costs of borrowing. Indeed, many companies will set a minimum rate of return — or "hurdle rate" — that projects must satisfy to be considered financially viable. Suppose, for example, that a business requires a project to earn at least a 15 percent return on investment, and the internal rate of return on a given project is 25 percent. In this case, then, the internal rate of return exceeds the minimum or threshold rate of return, and the project should be approved.

As shown below, the internal rate of return is the discount rate (r*) that makes the net present value of a project equal to zero.

$$NPV = CF^0 + \frac{CF_1}{(1 + r^*)^1} + \frac{CF_2}{(1 + r^*)^2} + \dots + \frac{CF_n}{(1 + r^*)^n} = 0$$

Using the same alternative energy investment discussed in Example 5, the internal rate of return method can also be used to compare projects. As seen below, the internal rate of return for Alternative B is 31.9 percent, and the rate for Alternative A is 13.1 percent. Given limited funds and the ability to select one project only, the internal rate of return analysis tool can help the plant manager or facility engineer choose the project that will provide the greatest benefit.

$$\text{NPV ALTERNATIVE A} = -\$15{,}000 + \frac{\$9{,}000}{(1 + r^{*})} + \frac{\$9{,}000}{(1 + r^{*})^{2}} = \$0 \quad \text{WHEN } r^{*} = 13.1\%$$

$$\text{NPV ALTERNATIVE B} = -\$10{,}000 + \frac{\$7{,}500}{(1 + r^{*})} + \frac{\$7{,}500}{(1 + r^{*})^{2}} = \$0 \quad \text{WHEN } r^{*} = 31.9\%$$

As with the net present value method, the internal rate of return method incorporates discounted cash flows over the life of an energy efficiency measure or project. It does not, however, account for the project's magnitude or its impact on profits. More importantly, this method solves for a discount rate that makes the NPV of a project equal to zero, and thereby removes the sensitivity of the analysis to alternative discount rates.

One significant issue with the IRR method is that it assumes all interim cash flows are re-invested at the IRR percentage for the remaining period. If the IRR percentage varies significantly from the discount rate, this is usually not a valid assumption. In these cases the modified (or adjusted) internal rate of return (MIRR) is normally a better indicator of true economic performance (see the section on MIRR on p. 15).

The IRR method has similar advantages to the NPV method:

- **Easy comparisons of different project types.** Once calculated, the IRR provides a simple way to compare the relative benefits of different projects, even when projects have very different values for annual savings, initial costs or equipment life.
- **Easy comparison with other investment alternatives.** Unlike the NPV, the IRR method provides the most straightforward metric for comparing an energy efficiency project with all other investment opportunities and with the costs of borrowing. This allows the energy efficiency project to be compared with other non-energy investments that the hospital may be considering. This comparison is more difficult if the net benefit of the energy efficiency investment is expressed as a dollar value. Because most investment opportunities are expressed as a rate of return on investment, the IRR method may be more appealing for financial analysts, and it maintains the advantage of incorporating all of the relevant project information used in the NPV calculation.

Although the IRR is similar to the NPV calculation, the IRR method has several important limitations:

- **High information requirements.** The IRR calculation requires all of the same information as NPV, including effective useful life of the equipment, expected annual equipment costs and energy savings, and a discount rate for converting future costs and benefits into present value terms.
- **More complicated calculation.** The IRR calculation is a more elaborate extension of the NPV calculation and consequently is the most complicated of all the methods addressed in this guide. Nevertheless, the calculation is very manageable once all the required information has been collected.
- **Limited applicability.** The IRR method presented here requires some sort of initial investment by the hospital in order to complete the calculation. Consequently, the IRR can be calculated where internal financing is used, but cannot be calculated when there is a loan or outsourcing agreement that does not involve any equity contribution by the hospital at the beginning of the project (i.e., 100 percent debt financing).
- **Does not expressly account for differing useful lives between projects being compared.** This is one of the strengths of the life-cycle cost analysis method discussed in a later section.
- **Assumes that interim positive cash flows (savings) are re-invested at the IRR percentage for the remaining period.** If the IRR percentage is more than 10 percentage points above the discount rate, this is probably not a valid assumption.

3. Internal Rate of Return: A Cautionary Tale, CFO Magazine, October 2004 (republished from the McKinsey Quarterly, August 2004).

Modified (Adjusted) Internal Rate of Return

The modified internal rate of return (MIRR) method is closely related to the IRR method. However, the MIRR does not assume that interim positive cash flows are re-invested at the IRR percentage rate.

Briefly, the MIRR is calculated as follows:

1. Find the present value of negative cash flows incurred in any year during the course of the investment, discounting them at the loan (finance) rate.

2. Find the future value of positive cash flows incurred in any year during the course of the investment, growing them at the discount rate.

3. Find the average interest rate that grows your adjusted investment (step 1) into your adjusted return (step 2).

To begin to give the reader some sense of the difference between these methods in actual practice, wherever the IRR is stated for an investment in the remainder of this Guide, the MIRR will also be stated.

FIGURE 2: IRR VS. MIRR

SUMMARY

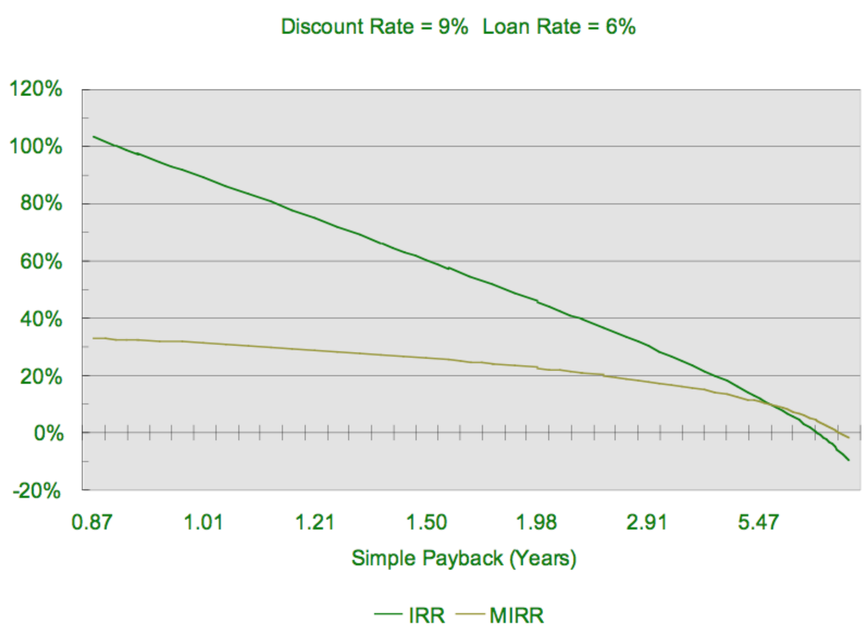


Table 2 provides a summary of the advantages and disadvantages of each of the financial evaluation methods discussed. Many of the commonly used methods for evaluating energy efficiency investments do not incorporate all of the relevant information on costs and benefits. In particular, the simple payback and ROI methods do not provide any information on the duration of the energy savings one can expect from the project. The IRR method is a straightforward metric for comparing investment opportunities, but may not evaluate the relative advantages of different financing options. The NPV calculation captures all the costs and benefits of the project and adjusts according to the financing method used.

The following section provides additional examples of each of these methods. Each of the techniques discussed is calculated for a hypothetical energy project under a range of different financing options.

TABLE 2: ECONOMIC ANALYSIS TOOLS

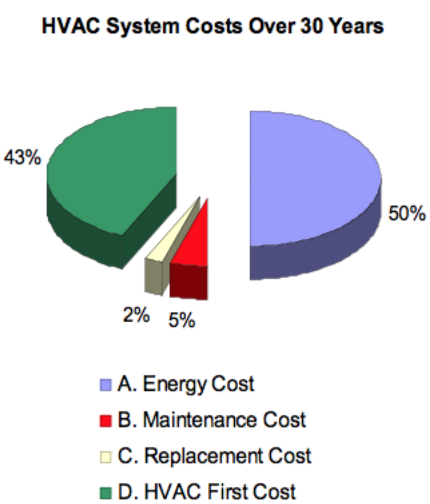
Evaluation Method	Calculation Difficulty	Advantages	Disadvantages
Simple Payback (SP)	Low	• Simple to calculate • Easy to understand • Can be used in early project screening to assess a project's economic viability	• Ignores savings after payback period • Less familiar method to financial analysts • Does not account for time value of money (discounting)
Return on Investment (ROI)	Low	• Simple to calculate • Easy to understand • Use is similar to SP, but ROI is more familiar to financial analysts	• Ignores savings after payback period • Does not account for time value of money
Net Present Value (NPV)	Moderate	• Accounts for time value of money • Allows for simple comparisons across project types • Incorporates most relevant cost and savings information • Allows for simple comparisons across financing methods	• More complex calculation than simple payback and ROI • Higher information requirements • Does not expressly account for differing useful lives
Internal Rate of Return (IRR)	Moderate	• Accounts for time value of money • Allows for simple comparisons across project types • Incorporates most relevant cost and savings information	• More complex calculation than simple payback and ROI • Higher information requirements • Limited applications • Assumes that positive cash flows are re-invested at IRR percentage • Does not expressly account for differing useful lives
Modified Internal Rate of Return (MIRR)	Moderate	• Positive cash flows re-invested at discount rate instead of at IRR percentage; negative cash flows considered at loan (finance) rate • Better reflects real world benefits	• More complex calculation than IRR, and not as well known as the IRR to management professionals • Does not expressly account for differing useful lives

See Table 4 for similar information on life-cycle cost analysis.

Section III: Life-Cycle Cost Analysis

One method that utilizes the net present value calculation discussed in the previous chapter is life-cycle cost analysis (LCCA). LCCA is a method for assessing capital investment decisions where initial and future costs differ among project alternatives. The Federal Energy Management Agency defines life-cycle cost as "the total cost of owning, operating, maintaining and (eventually) disposing of the building system(s) over a given study period." In other words, LCCA is a way of assessing a facility's true cost of ownership throughout its lifetime. The pie chart shows the types and share of costs that might accrue over 30 years with an HVAC system, for example.[5]

FIGURE 3: LIFE-CYCLE COST



The value of the LCCA method is that it provides a simple method to assess two or more different project alternatives where the costs among projects vary in both magnitude and timing. For example, with energy projects, there may be higher initial costs for high-efficiency equipment choices that will reduce energy costs in future years relative to standard efficiency options. The LCCA method allows these differences in costs to be taken into account when evaluating different project options. The end result of the LCCA calculation is a discounted cost value that allows decision makers to choose between alternatives based on a single life-cycle cost number for each option considered.

The LCCA method is limited when alternative building designs or systems result in different revenue streams (for example, they generate different rental income) or result in other benefits related to overall performance of the building (for example, more useable space). To illustrate, if a hospital needs to replace an HVAC system, then LCCA can be used to measure the least-cost option among different HVAC possibilities. However, additional non-cost benefits, such as increased useable space, must be considered separately.

Project alternatives must be compared over the same study period. If the expected lives are different, adjustments are required. One common approach is to select the relevant time horizon of the investor as the study period. Then use replacements and residual values to evaluate each alternative within the common study period.

LCCA also requires that project alternatives be mutually exclusive, meaning that only one of the options will be chosen. With the HVAC example, options that may be considered include renovating the existing system, installing a new standard efficiency system, and installing a new high-efficiency system. In this case, the LCCA method provides a method for assessing the tradeoff between higher initial costs with the standard and high-efficiency choices versus the costs of energy and maintenance in future years if the existing system is maintained.

In some cases, a series of non-exclusive alternatives can be evaluated separately with the LCCA method, and then compared as combined exclusive alternatives with a single overall LCCA measure. An example would be to compare HVAC systems with LCCA and then use the best HVAC choice in a model to select the best building envelope system.

LCCA Calculation

LCCA calculation follows eight basic steps:

1. **Identify project alternatives.** The first stage of the LCCA is to identify the various project alternatives that will be considered. As discussed, appropriate alternatives include projects that are all designed to fill a common need. For energy projects, this may include projects designed to address a particular end use (e.g., HVAC system, lighting, etc.) or projects that address whole building energy use (and therefore might cover multiple measures and end uses).

2. **Identify the baseline.** For most facility projects, but specifically for energy efficiency projects, it is important to establish what the baseline alternative is. In many refurbishment projects this will be the "do-nothing" alternative, such as continuing to repair the existing system. For new construction projects, it is often the minimum

4. Life-Cycle Costing Manual for the Federal Energy Management Agency, NIST Handbook 135, U.S. Department of Commerce, Washington, D.C., 1995.
5. Data from the Washington State Department of Administration as reported on the Whole Building Design Guide website, www.wbdg.org/design/lcca.php.

standards of the local energy code. Sometimes a separate baseline is used for utility company rebate calculation and overall project economic evaluation.

3. **Determine activity timing.** The relevant time frame of the project costs needs to be set for each alternative considered, and is usually equal to the equipment life for each option. This step includes establishing the start of the project (base date) and the timing when costs such as project management, design, construction, energy use, maintenance, equipment disposal and finance costs will occur.

4. **Determine the study period.** Where project alternatives have different useful lives, a relevant study period must be determined that allows for equitable comparison. Replacements and residual values can be used to make appropriate adjustments.

5. **Estimate costs.** Dollar values need to be calculated for each of the costs included in the LCCA calculation for each of the alternatives considered. This includes the initial equipment installation costs, as well as costs that occur throughout the project life.

6. **Compute life-cycle costs.** Once all of the cost values and the time frame for each alternative are identified, the LCCA calculation is conducted, which involves taking the discounted present value of the project costs for each alternative over the project life.

7. **Consider non-monetary benefits and costs.** Non-monetary benefits and costs are project-related effects for which you have no objective way of assigning a dollar value. Examples of non-monetary effects may be the benefit derived from a particularly quiet HVAC system or from an expected, but hard-to-quantify, productivity gain due to improved lighting. These items, by their nature, are external to the LCCA, and thus do not directly affect the calculation of a project's cost effectiveness. Nevertheless, you should consider significant non-monetary effects in your final decision, and they should be included in the project documentation.

8. **Compare results across projects.** Once the calculation is completed, the LCCA values for each alternative are compared. The alternative with the lowest LCCA value would be the preferred project.

The key to conducting a meaningful LCCA is to identify and quantify the costs associated with each project alternative. The costs fall into two distinct categories: initial costs and future costs.

Initial costs refer to all costs associated with a project that occur before the project is put into service. These costs are usually the easiest to estimate because they can be obtained from quotes for purchase and installation from local suppliers, designers and contractors. Initial costs may include design, project management and in-house costs as well. Further, on some projects, an "investment grade" energy audit may be required as part of a project's initial cost. If financing is involved, and a portion of the project cost is paid for as a down payment, that would be considered as an initial cost as well.

Future costs refer to all costs associated with a project that occur after the project is put into service. They include costs such as maintenance and energy costs that accrue throughout the life of the equipment. Loan or lease payments fall into this category as well. These costs can be more difficult to estimate, since they represent costs that have not yet occurred and can be influenced by a variety of factors.

In addition to identifying the types of costs to include in the LCCA, the timing of each cost must also be specified. Costs that occur in the future may be annual, occur at regular intervals, or be single costs that are expected to occur at some point during a project's lifetime. In some cases one can assume that supply and demand conditions will remain relatively stable, in which case the costs at the start of the project can be used to estimate future costs simply by adjusting for inflation over time.

Below is a description of the more common costs associated with energy efficiency projects. It is important to note that not all projects will have the same relevant cost categories, and it is not required that each alternative utilize the same set of costs in order to complete the LCCA calculation.

Common costs for energy projects include the following:

Initial Costs

- **Initial purchase costs.** This refers to all costs associated with the initial implementation of the project. These include the cost of the equipment plus the labor costs from the installation. Any design, audit or engineering studies conducted prior to installation should also be included in the initial purchase cost. Project management costs, both external and in-house, must be considered as well. If financing is involved, a down payment related to a loan may replace some of these costs.

Future Costs

- **Energy costs.** This refers to the costs of electricity, gas or other fuel used by the building for each project alternative. The cost of each fuel should be estimated separately based on the equipment installed, energy consumption and the local price of the fuel.

- **Water usage costs.** Costs of water usage are analogous to energy costs, although these may not be impacted by the energy projects being considered. If water use will be affected by the equipment options being considered, then the water costs should be included in the LCCA and will be influenced by the various equipment options being considered.
- **Finance costs.** Finance costs include loan payments or similar costs needed to finance the project. Different types of finance methods and their associated costs are discussed in detail later in this guidebook.
- **Operation, maintenance and repair (OM&R) costs.** OM&R includes all of the costs associated with operating and maintaining the facility or system. These may include annual costs, costs that occur at various time periods or single costs that are expected at some point during the project life.
- **Replacement costs.** These are the costs associated with the expected replacement of parts of a facility or system. This is sometimes referred to as major maintenance or capitalized maintenance. If one project alternative has a significantly longer expected life than another, then the entire shorter-lived system may need to be replaced during the study period. In this case the replacement cost would be included in the LCCA calculation.
- **Disposal costs and residual value.** These are the costs of removal and disposal of a system after its useful life is over. In some cases the system may have a positive disposal value, which reflects the resale, salvage or residual value of the system at the end of the project period. When project alternatives with different useful lives are compared, the residual value at the end of the study period may be used to equitably compare the alternatives.

In addition to the costs listed above, some systems may offer benefits over other systems that are difficult to quantify. These are often referred to as non-monetary benefits, or non-energy benefits and include benefits like improved occupancy comfort and air quality. Because these benefits are often difficult to quantify reliably, they are usually left out of the LCCA calculation. Nevertheless, these benefits can be significant and may help inform the ultimate project selection if appropriate values on these benefits are available.

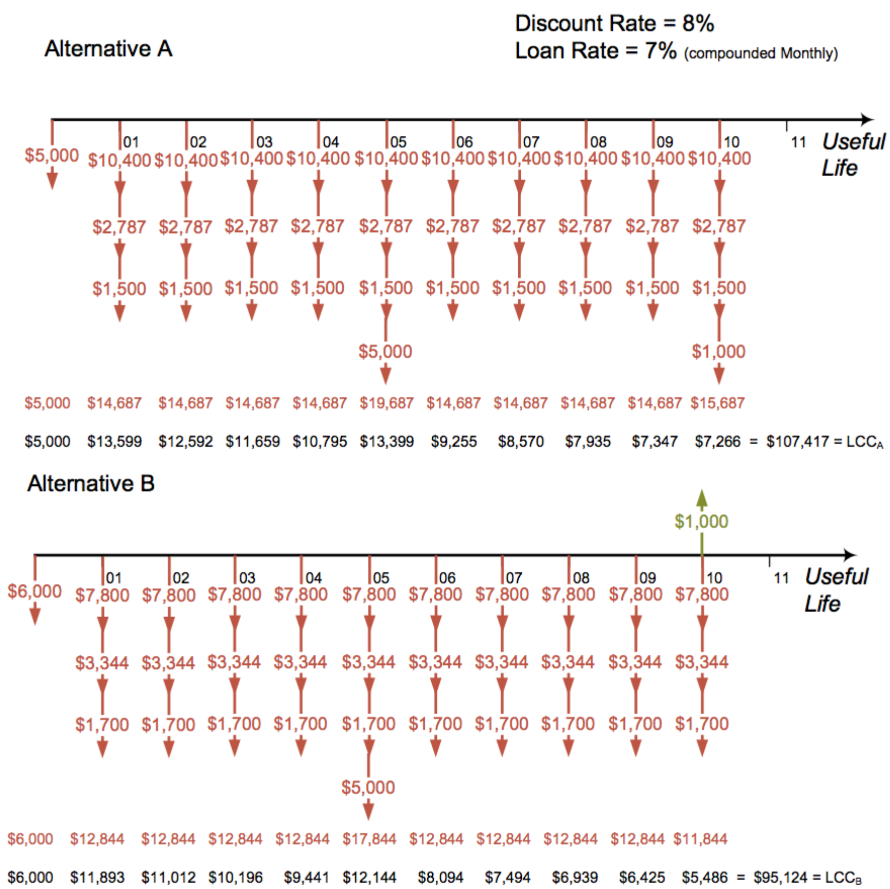
Simple LCCA Example

A simple example will help illustrate the basic LCCA calculation. Consider the case of two hypothetical projects, where Alternative A has standard efficiency equipment and Alternative B has high-efficiency equipment. Both have an expected equipment life of 10 years, and it is expected that part of the equipment will need to be replaced halfway through the equipment life. Both projects involve borrowing funds to pay for the project and therefore have annual financing costs. In addition, other significant costs considered for each include energy costs, disposal costs and OM&R.

To add some measure of reality to the example, it is assumed that approximately 20 percent of the cost of each project is not financed. This will represent the initial audit expense, in-house management fees and design review costs.

For the purposes of this simple example, the effect of inflation has been ignored, and monthly loan payments

EXAMPLE 6



have been “lumped” together into an annual amount before discounting to a present value. In addition, initial costs are assumed to occur at the beginning of year 1, instead of in a separate year.

Table 3 shows the costs associated with each cost category for Alternative A and Alternative B. With the standard efficiency equipment (Alternative A), the initial cost is lower, but the expected energy costs are higher relative to Alternative B throughout the life of the project. Expected OM&R costs are also lower with Alternative A. Since the initial cost is higher with Alternative B, the financing costs are also higher (both loans assume a 7 percent interest rate). Both projects have an expected replacement cost for equipment of $5,000 in year 5. Finally, the disposal cost of Alternative B is –$1,000, and since this is a negative cost, it indicates that there is some salvage value at the end of the project period. Alternative A has a disposal cost of $1,000, which indicates that there is a cost for removing and disposing of the equipment at the end of the project.

The far right column of Table 3 shows the costs of each alternative, converted to present value terms using an 8 percent discount rate. Note that for electricity and the other annual costs, the present value is the sum of the annual costs over the

TABLE 3: LCCA CALCULATION EXAMPLE

Equipment Option	Cost Category	Amount	Year of Occurrence	Total Present Value (10 years)
Alternative A (Total Cost $25,000)	Initial Equipment Cost	$5,000	Base Date	$5,000
	Finance Cost	$2,787	Annual	$18,701
	Replacement Cost	$5,000	5	$3,403
	Disposal	$1,000	10	$463
	Electricity Cost	$10,400	Annual	$69,785
	OM&R	$1,500	Annual	$10,065
Alternative B (Total Cost $30,000)	Initial Equipment Cost	$6,000	Base Date	$6,000
	Finance Cost	$3,344	Annual	$22,438
	Replacement Cost	$5,000	5	$3,403
	Disposal	–$1,000	10	–$463
	Electricity Cost	$7,800	Annual	$52,339
	OM&R	$1,700	Annual	$11,407

10-year life of the project. The present value calculation is performed for the total annual cost for each option, using the same calculation method discussed in the previous section.

Once the costs have been quantified and converted into present value terms, they are simply added up to determine the life-cycle cost for each option, based on the data from Table 3. This calculation is as follows:

$$LCC = I + F + R + D + E + OMR$$

Where:

LCC = life-cycle cost
I = initial equipment investment cost
F = finance costs
R = replacement costs
D = disposal cost
E = energy cost
OM&R = operation, maintenance and repair costs

Applying this formula for Alternative A to the present values from the far right column of Table 3, the life-cycle cost is given by:

$$LCC_A = \$5{,}000 + \$18{,}701 + \$3{,}403 + \$463 + \$69{,}785 + \$10{,}065$$

$$LCC_A = \$107{,}417$$

Similarly, for Alternative B the life-cycle cost is:

$$LCC_B = \$6{,}000 + \$22{,}438 + \$3{,}403 - \$463 + \$52{,}339 + \$11{,}407$$

$$LCC_B = \$95{,}124$$

Since the life-cycle cost of the energy efficient project (Alternative B) is less than the life-cycle cost of the standard efficiency alternative (Alternative A), the energy efficient option would be preferred. Using the cost information from the example above, the net cost savings from Alternative A is simply the difference in life-cycle costs relative to the next best alternative (Alternative B):

$$\text{Net LCC Savings} = LCC_A - LCC_B$$

$$\text{Net LCC Savings} = \$107{,}417 - \$95{,}124 = \$12{,}293$$

LCCA Resources

The Appendix of this Guide provides information on four different software tools designed to conduct the LCCA calculations. While there are more than four tools available in the market, these tools were selected for several key reasons: they are available at no cost but have good associated documentation; they represent a range of complexity and therefore offer options to users in selecting a tool appropriate to their analytical objectives and capabilities.

The four tools covered are:

- BLCC5 (National Institute of Standards and Technology (NIST))
- Energy eVALUator (Southern California Edison)
- Energy Life-Cycle Cost Analysis spreadsheet (Washington State Department of General Administration)

- Life-Cycle Cost Calculator (Rebuild America)

Rates — Discount, Escalation, Inflation, & Interest

In the simple life-cycle example (above) it was assumed that the discount rate was 8 percent, that the interest rate was 7 percent and that inflation was non-existent. This allowed for a simple demonstration of the calculation principles involved, yet it varied significantly from real-world conditions. Additional discussion is necessary on the interaction of these various rates.

First, a brief recap of their meanings:

- Discount rate: the rate of interest that balances an investor's time value of money, since a dollar in the future is of less value to the investor then a dollar today that could be invested.
- Escalation rate: the same as the discount rate. Simply put, we either escalate a present value to find its future value, or we discount a future value to find its present value.
- Inflation rate: the rate by which the value of a dollar in the future is reduced as compared to a dollar today, due to a reduction in its actual purchasing power.
- Interest rate: usually refers to the rate charged for the loan of money in the context of life-cycle cost analysis. The escalation rate (discount) would normally apply to an investment as compared to a loan.

In application, the discount rate usually works in concert with the inflation rate. For example, if we were to plan on purchasing something a year from now that would cost $1 today, how much should we set aside today for that purchase? If inflation was thought to be 3 percent and the discount rate was 7 percent we would make the following calculations:

The cost of the item a year from now = $1 x (1 + inflation rate) = $1 x (1.03) = $1.03

The value of that $1.03 today = $1.03 / (1 + discount rate) = $1.03/1.07 = $0.96

Thus, if we were to invest $0.96 today at 7 percent we would have the $1.03 we would need in one year in order to purchase an item that would cost $1 today.

While this is a very simple example, it still establishes the concepts of analysis based on the time value of money. Almost all real-world transactions involve this same basic relationship between inflation and discounting.

In the above discussion, we have been using the nominal inflation rate and discount rates in order to accurately portray the financial transaction.

In some life-cycle analysis programs, real inflation and discount rates are used in an effort to simplify the transactions. It is felt by many that inflation affects most expenses in such a uniform manner that it would be better to eliminate it as a component of the calculations by reducing the discount rate a corresponding amount. In so doing it becomes necessary to adjust only such fixed items as loan payments negatively for inflation, instead of all normal costs. In concept, this seems a rational approach.

For example, if we took our same $1 purchase and considered it using a real inflation rate of 0 percent and a real discount rate of 4 percent we would have the same calculation result as before, but with only one step necessary, since a dollar would still buy the same amount a year from now:

$1 / (1 + discount rate) = $1/ 1.04 = $0.96

While this seems to simplify transactions, it works only where all expenses are affected by inflation equally. This is rarely the case. For example, natural gas does not usually increase in cost at exactly the same rate as electricity. Consequently, while the adjustment amount is smaller when real rates are used instead of nominal rates, often just as many calculations must be made as before. The only exception would be if we were willing to accept the approximation of one combined inflation rate for all expenses.

While most of the examples in this Guide ignore the effects of inflation, in actual practice it must be carefully considered in all calculations.

A further consideration is interest rates. We have often stated them in this Guide as an annual sum of the monthly payments. We have accounted for them as if they occurred at the end of the year. In the real world this is not the case, and could adversely bias life-cycle calculations unless they are addressed in the same manner in all considered alternatives, both for energy efficiency measures and for more general revenue-producing investments.

End-of-the-year conventions, or mid-year conventions, or any other similar standard must be used uniformly for all calculations with all alternatives.

Summary

TABLE 4: LIFE-CYCLE ANALYSIS SUMMARY

Evaluation Method	Calculation Difficulty	Advantages	Disadvantages
Life-Cycle Cost Analysis (LCCA)	High	• The LCCA method is comprehensive and takes into account all relevant costs over the lifetime of the system, as well as the time period in which they are expected to occur. • Once the life-cycle cost has been calculated for each project alternative, the total costs of each project can be easily compared, as the final life-cycle cost is expressed as a single number. • As with the project comparisons, the LCCA can be used to easily compare different financing options for the same project. The single life-cycle cost given to each alternative provides a straightforward way to evaluate different financing options, even when these options may involve costs that vary substantially over the project life.	• Project benefits are not explicitly considered in the LCCA calculation. Only costs are considered directly in the life-cycle cost calculation, which implies that the potential benefits (other than cost reductions) are similar across project types. If benefits vary significantly across options, then LCCA may not be appropriate. • The LCCA method has relatively high information requirements, as all of the relevant costs need to be known (or estimated) throughout the life of the project for each alternative being considered. If costs are expected to change over time (e.g., rising fuel costs, inflation, maintenance costs increasing with equipment age), then the rate of change for these costs also needs to be determined and factored into the LCCA calculation.

Section IV: Financing Options

This section applies the evaluation methods discussed in Sections II and III to different financing options. Figure 4 shows the most common sources of capital for hospitals for financing projects, and we have tailored our guidebook to match these sources. As shown in the graph, capital expenditures decreased from 2001 to 2002. For-profit debt/equity issues and bank loans saw the largest declines — over 50 percent. Philanthropic donations declined by 20 percent to $4 billion in 2002. Public financing in the form of municipal bonds remained steady at $20 billion in 2001 and 2002.

FIGURE 4: SOURCES OF CAPITAL FOR HOSPITALS

Source: Financing the Future Report 1, HFMA, page 4

To facilitate comparisons across different sources of financing and different financial evaluation methods, we use a project example with a $200,000 equipment cost, $40,000 in annual savings, a 15-year equipment life, a 10-year loan duration (where applicable), a 7 percent discount rate, and a 10-year study period. Table 5 shows a comparison of the benefits of this project when financed with different sources of capital.

To add some measure of reality to the example, it is assumed that approximately 20 percent of the project cost is not financed. This will represent the initial audit expense, in-house management fees, design review costs, etc. Rarely are all project-related costs covered completely by financing arrangements.

The comparison of a single project using different financial evaluation methods shows the various strengths and limitations of each technique relative to the others. The project's five-year simple payback might seem to be too long for some facility managers to promote — especially if there are other potential projects with faster payback periods. However, when this project is assessed using the other financial evaluation methods, it proves to be a very good investment.

As shown in Table 5, both the payback and the ROI method remain unchanged across the various financing mechanisms, as the investment cost ($200,000) and annual benefit ($40,000) remain unchanged across financing options. This makes it difficult to differentiate among the various financing options. Also, there are some financing options where it is not possible to calculate values for payback and ROI. In contrast, the IRR and MIRR vary significantly for these projects because of their differing treatments of interim cash flows. Similarly, the LCC savings method varies in each application to reflect the different financing methods and costs of capital. It is also possible to calculate the LCC savings for virtually all of the financing methods included in this guide.

Table 5 lists the various financing options. Each is discussed in more detail later. It is important to remember that while optimizing the total LCC benefit is the goal, it must be balanced against project risks and finding the best way to mitigate them. For instance, if the healthcare organization lacks certain technical expertise related to installing energy-efficiency technologies, it may be wiser to place operational risks on a third party through an alternate project financing option. To provide some guidance on how the costs involved in use of a third party would relate to the more traditional project delivery and financing options, three examples on Performance Contracting (PC) are included, which are discussed in more detail in the following sections.

Currently, hospitals depend extensively on cash from operating budgets to finance capital investments. According to recent surveys conducted for the Healthcare Financial Management Association (HFMA), 81 percent of hospital chief financial officers rely on cash from operating budgets to

TABLE 5: FINANCING OPTIONS SUMMARY TABLE

Financing Method	Total Cost Calculation Difficulty	10-Yr. Total Savings	Payback	ROI%	IRR%	MIRR%	LCC Savings
Internal Financing (Cash)	$200,000	$400,000	5 years	20%	17.0	12.0	$114,833
Philanthropic	$0	$400,000	N/A	N/A	N/A	N/A	$314,833
Private Loan	$262,928	$400,000	5 years	20%	45.0	22.8	$118,258
Public Loan	$243,646	$400,000	5 years	20%	49.7	23.8	$131,801
Tax-Exempt Bond	$280,000	$400,000	5 years	20%	79.2	18.1	$137,309
Self-Issued Bond Financing	$312,000	$400,000	5 years	20%	70.9	17.6	$114,833
Municipal Bond	$280,000	$400,000	5 years	20%	79.2	18.1	$137,309
Capital Lease	$293,729	$400,000	N/A	N/A	23.7	16.2	$93,062
Lease w/ Purchase Option	$267,991	$400,000	N/A	N/A	22.6	14.3	$92,327
Lease w/ Renewal	$255,981	$400,000	N/A	N/A	25.8	16.2	$82,049
PC — Guaranteed (Private Loan)	$215,601	$400,000	4.1 years	24%	66.5	26.9	$147,541
PC — Guaranteed (Public Loan)	$199,790	$400,000	4.1 years	24%	71.3	27.6	$158,647
PC — Shared Savings	$240,858	$400,000	4.1 years	24%	36.5	20.3	$119,573

finance at least 25 percent of their capital expenditures.[6] The survey also reports that most hospital CFOs anticipate increasing difficulties with capital investment finance and, as a result, are increasing dependence on cash from operating budgets. Compared to infrastructure or other facility renovations, however, energy efficiency investments generate positive cash flows that can be used to decrease operating expenses in the future or to finance additional capital investments.

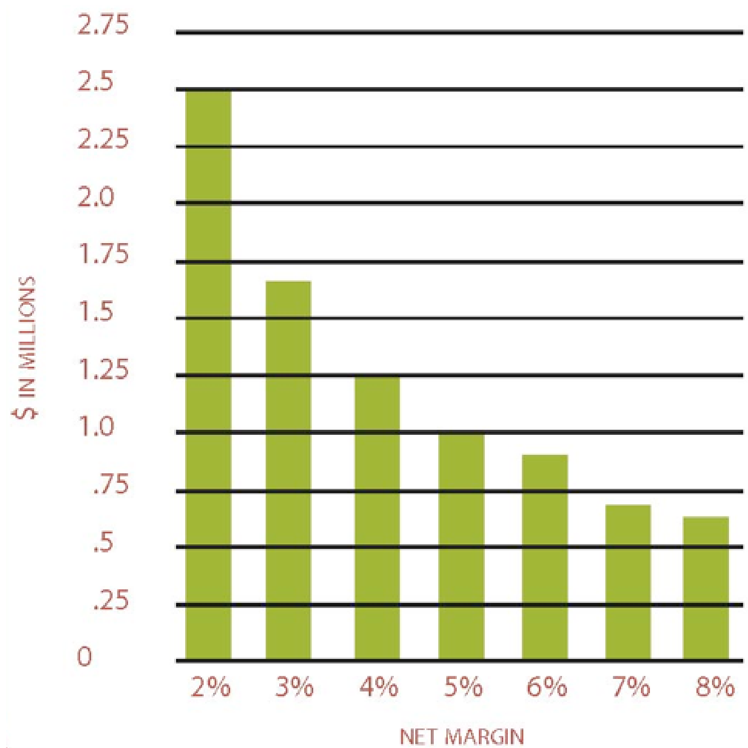
Hospitals can also finance energy efficiency projects with funds from their capital budgets. These projects, however, can face intense competition with other capital investment projects: productivity enhancements, medical equipment upgrades, etc., whose priority ranking may be higher. Important distinctions between cost-saving and revenue-producing investments can be unclear, and should be taken into account.

Hospitals are continuously facing enormous pressure to operate more efficiently, and many are looking to innovative ways to reduce costs. Improving operating margins is also needed in order to free up capital for investing in new equipment and technologies. "We estimate that 80 percent of our capital will have to be generated internally, so we need to focus on the things we can control," says John Wiest, CFO of Lee Memorial Health System in Ft. Myers, Florida. "Revenue increases are being outpaced by cost increases, and our only remaining option is to increase productivity. It comes down to process redesign, and eliminating those activities that do not ultimately enhance patient outcomes. Through these types of initiatives, we've enhanced our turnover time by 30 percent. Based on our 10-year financial plan, we have to become 2.2 percent more productive each year to fund our capital needs. Productivity is the key."[7]

One method for raising capital has been the sale or "monetization" of assets, where non-key holdings are sold to third parties to raise cash. "Except in strategic situations, many medical office buildings no longer need to be owned by the hospitals, so we're seeing more third-party models," says Pierre Bogacz, vice president at Ziegler. "There are a lot of untapped opportunities out there if the CFO is willing to go through the balance sheet item by item and review all assets and liabilities based on the institution's strategic plan." [8]

Figure 5 helps show how a project resulting in net operating cost savings can compete with a capital project — say, a new MRI machine — that is projected to produce a certain amount of gross revenue. The idea is to convert net operating cost savings to equivalent gross revenues using the hospital's net margin. For example, suppose you are proposing a project projected to reduce annual energy costs by $50,000. If your hospital has an operating margin of 4 percent, it would have to generate gross revenues of $1.65 million ($50,000 / 0.04) to achieve the same bottom line results. Thus it is a useful tool for comparisons between capital investments that are characterized by gross revenues and those that produce net savings from reduced operating revenues.

FIGURE 5: REVENUE EQUIVALENT OF A $50,000 ANNUAL ENERGY SAVINGS



6. See HFMA's Financing the Future Report 4 for more information.
7. Financing the Future Report 4, HFMA, page 14 (2004).
8. Financing the Future Report 1: How Are Hospitals Financing the Future? Access to Capital in Health Care Today. HFMA, pages 18 – 19 (2004).

Another consideration in is that operating savings have a positive impact on cash flow. They are avoided expense, so dollars don't go out, as opposed to revenue-generating projects where the dollars eventually come in. Since most revenues significantly lag the expenses that generate them, there is a significant impact.

Without this kind of comparative analysis, any remaining capital funds are typically allocated to projects that yield the highest rates of return, e.g., internal rates of return ranging from 20 percent to 30 percent with payback periods less than three years. Depending on the capital allocation process, expenditure priorities and strength of the balance sheet, larger energy efficiency projects (with payback periods in excess of five years and annual rates of return less than 20 percent) may be disadvantaged in the competition to win funding. As a result, this particular vein of internal financing may induce "cream skimming" behavior and prevent more comprehensive energy efficiency projects (see Section VI for project examples). In these cases,

TABLE 6: INTERNALLY FINANCED CASH PURCHASE EXAMPLE

Equipment Cost	$200,000	Loan Period (yrs)	10	Discount Rate	7%	Annual Savings	$40,000
Cash %	100%	Study Period (yrs)	10	Loan Rate	7%		
Financed Amount	$—	Useful Life (yrs)	15	Inflation Rate	0%	Residual Value*	$66,667

	Baseline		Energy Efficient Alternate			Life-Cycle Cost Calculation	
Year**	Equipment	Energy Usage	Equipment	Energy Usage	Loan (or Lease) Expense	Net Annual Benefit (Cost)	PV Annual Benefit
Start	0		$200,000			($200,000)	($200,000)
1		$80,000		$40,000	$—	$40,000	$37,383
2		$80,000		$40,000	$—	$40,000	$34,938
3		$80,000		$40,000	$—	$40,000	$32,652
4		$80,000		$40,000	$—	$40,000	$30,516
5		$80,000		$40,000	$—	$40,000	$28,519
6		$80,000		$40,000	$—	$40,000	$26,654
7		$80,000		$40,000	$—	$40,000	$24,910
8		$80,000		$40,000	$—	$40,000	$23,280
9		$80,000		$40,000	$—	$40,000	$21,757
10		$80,000		$40,000	$—	$106,667	$54,224
	$200,000	$400,000	5	20%	17.0%	12.0%	**$114,833**
	Total Cost	**Total Savings**	**SPB (yrs)*** **	**ROI**	**IRR**	**MIRR**	**Net LCC Savings**

* = At end of study period (straight line depreciated)
** = End of year convention for all expenses, except initial construction expenses are at start of Year 1
*** = Simple payback does not consider benefits or costs beyond the initial payback period, or the time value of money

hospitals should explore other financing options to fully exploit the energy and cost savings available with more comprehensive efficiency projects. Hospitals should also consider the fact that investments in energy projects typically have a lower risk of performance over time relative to other investments. Compared to other investments, savings from energy projects are easier to forecast reliably than savings or revenue increases expected from more variable investments, such as IT system upgrades and new clinical equipment.

TABLE 7: PROJECT FINANCING THROUGH PHILANTHROPIC DONATION

Equipment Cost	$—	Loan Period (yrs)	10	Discount Rate	7%	Annual Savings	$40,000
Cash %	100%	Study Period (yrs)	10	Loan Rate	7%		
Financed Amount	$—	Useful Life (yrs)	15	Inflation Rate	0%	Residual Value*	$66,667

	Baseline		Energy Efficient Alternate			Life-Cycle Cost Calculation	
Year**	Equipment	Energy Usage	Equipment	Energy Usage	Loan (or Lease) Expense	Net Annual Benefit (Cost)	PV Annual Benefit
Start	0		$—			$—	$—
1		$80,000		$40,000	$—	$40,000	$37,383
2		$80,000		$40,000	$—	$40,000	$34,938
3		$80,000		$40,000	$—	$40,000	$32,652
4		$80,000		$40,000	$—	$40,000	$30,516
5		$80,000		$40,000	$—	$40,000	$28,519
6		$80,000		$40,000	$—	$40,000	$26,654
7		$80,000		$40,000	$—	$40,000	$24,910
8		$80,000		$40,000	$—	$40,000	$23,280
9		$80,000		$40,000	$—	$40,000	$21,757
10		$80,000	($66,667)	$40,000	$—	$106,667	$54,224
	$0	$400,000	N/A	N/A	N/A	N/A	**$314,833**
	Total Cost	**Total Savings**	**SPB (yrs)***	**ROI**	**IRR**	**MIRR**	**Net LCC Savings**

* = At end of study period (straight line depreciated)
** = End of year convention for all expenses, except initial construction expenses are at start of year 1
*** = Simple payback does not consider benefits or costs beyond the initial payback period, or the time value of money

Internal Financing (Cash)

Table 6 shows the impact on cash flows from an internally financed energy efficiency project with an initial investment cost of $200,000. The project is expected to produce energy cost savings of $40,000 per year over its 10-year effective useful life.[9] Assuming a 7.0 percent discount rate, the net present value of the project is $80,943. The project is, therefore, financially feasible and offers a net benefit to the hospital. As shown, the project has an IRR of 17 percent, which is above most hurdle rates for private investment. The payback for this project is five years.

By internally financing the energy efficiency project now, the hospital starts benefiting immediately from the higher cash flows associated with lower energy costs. In this case, positive cash flows enable the energy efficiency investment to pay for itself in five years. The remaining five years of the investment's operation produce an additional $200,000 in positive cash flows for the hospital.

Internal Financing Advantages

- Delays associated with other, more complex financial arrangements are avoided and the energy efficiency project can be undertaken quickly.
- Hospital retains all of the benefits of the energy savings.
- Depreciation of energy efficiency investment is tax deductible.
- No financing costs (interest and transactions fees).

Internal Financing Disadvantages

- Initial capital outlay represents 100 percent of the investment costs and internal financing may not be possible.
- The decision to use cash to finance energy efficiency investment(s) precludes its use for alternative projects. Most hospitals confront intense budgetary constraints, so the cash for energy efficiency projects competes with alternative projects.
- The hospital assumes risks associated with the energy efficiency investment.

Philanthropic Donations

Many hospital projects are financed through philanthropic donations, and energy efficiency projects are legitimate candidates for this type of funding. Through a philanthropic donation provided by a charitable organization or individual, a project's capital cost is paid for by a third party. This has great advantages for the hospital, as the energy efficiency equipment is essentially a gift with no capital costs or costs associated with repaying a loan. The number of projects that can be funded in this manner is limited, however, and energy efficiency investments will need to compete with other capital investments for those donations. In addition, healthcare donations are declining, falling from $4.89 billion in 2001 to $3.64 billion in 2002 even through philanthropic donations as a source of capital increased from 1997 to 2001.[10]

Table 7 shows the same project example funded through philanthropic donations. Although the equipment cost is still $200,000, from the hospital's standpoint the cost is zero, as the hospital is not paying for the equipment. The hospital does reap the benefits of the annual energy savings of $40,000. The combination of these two produces a very attractive LCC savings of $314,833 for this project.

Philanthropic Financing Advantages

- Equipment cost is essentially free to the hospital through the philanthropic donation.
- No debt appears on the hospital's balance sheet for this type of funding, and there are no annual loan payments.

Philanthropic Financing Disadvantages

- Energy efficiency investments must compete with other potential uses for donated funds. Charitable gifts oftentimes are directed toward more tangible improvements, such as a new hospital wing or medical equipment. Consequently it may be more difficult to raise money for energy efficiency improvements from donations than for other, high-profile improvements.

Third-Party Financing, Borrowing

As an alternative to internal funds, hospitals can borrow to finance energy efficiency investments. Generally, loans are used for a larger, more complex and more expensive energy efficiency investment whose cost exceeds available internal capital. There are two general types of loans: 1) unsecured loans and 2) secured loans. Unsecured loans, such as business lines of credit, have shorter terms (one to three years) and higher interest rates, and are seldom used to finance energy efficiency projects. While secured loans generally have longer terms and relatively lower interest rates, the exact loan terms depend on the borrower's creditworthiness, the amount financed and the project risk. Banks and other private lenders may require a large down payment — up to 30 or 40 percent — and collateral. While governmental funding sources such as the Oregon Department of Energy and Idaho Department of Water Resources may not require down payment, they still require appropriate collateral for their loans or a publicly backed finance authority.

9. In all the examples provided in this guidebook, for simplicity we assume that the project is completed in year 0 and savings begin accruing immediately so that a full year's savings are achieved at the end of year 1. In reality, project timelines will vary and the net benefits eventually realized will depend on when the project becomes fully operational. Savings will also accrue on a continuous basis (not as a lump sum at the end of the year as shown in the examples used in this guidebook) and loan payments are usually made monthly rather than annually. Those interested in capturing more fully the timing of project costs and savings may want to consider a monthly rather than an annual model. Despite the simplifying assumptions used for this guidebook, the annual model still allows for a comprehensive benefit assessment of the various investment opportunities.
10. Financing the Future Report 1. HFMA, page 22 (2004).

Two types of borrowing are discussed in Appendix I. Private loan financing refers to obtaining a loan from a bank or other private lender. Public loan financing refers to getting the loan from a government agency such as a state energy loan program.

Bond Financing

Bond financing is another alternative by which hospitals — particularly large, urban hospitals — can obtain capital funds for energy efficiency investments. According to a recent HFMA survey, tax-exempt bonds are the second largest funding source for capital projects.[11] Bond financing reached an all-time high ($19.9 billion in new financing) in 2003. However, as the economy improves and interest rates rise, the cost of capital will increase and the demand for this type of financing will likely decline.

There are two types of bond financing that are most relevant for hospitals. Self-issued bond financing involves the hospital itself issuing the bonds to raise money. These bonds can be either taxable or tax exempt-depending on the nonprofit status of the hospital. Municipal bond financing involves a state or local government agency issuing the bonds and then providing the money to the hospital for the capital improvement. These types of bonds are tax-exempt. Both types of bond financing are discussed in Appendix I.[12]

Lease Agreements

The preceding options address capital improvements where hospitals are purchasing new energy efficiency equipment. As an alternative to purchasing equipment, there are a variety of leasing options that may provide an attractive means for hospitals to achieve energy savings. These types of agreements can involve the renting of energy efficiency equipment or the leasing of services to help improve operations and maintenance of new or existing equipment. Each of these types of lease agreements (and their potential benefits and drawbacks) is discussed in this section.

Hospitals are increasingly turning to leasing to help improve overall financial performance, and the Equipment Leasing Association predicts that healthcare equipment leasing will increase from $6.3 billion in 2003 to $7.4 billion in 2005.[13] “Historically, what we’ve done is buy everything,” says Kenneth Johnson of Scott and White, an AA-rated hospital in Temple, Texas. Lately, hospitals have increasingly relied on operating leases on clinical technologies that change every few years. This allows them the flexibility needed to switch to newer technologies when they become available and transfers the risk of equipment obsolescence to the lessor.[14]

In general, lease agreements allow hospitals to pay for the use of efficiency equipment in fixed monthly installments. Depending on the lease, the agreement may allow the hospital to purchase the equipment at the end of the lease period for a nominal fee. A lease can also be structured with a purchase option that is not counted as debt in the hospital books, an attractive prospect for hospitals with significant levels of existing debt.

In Appendix I, two basic types of lease agreements are discussed. An operating lease is a more traditional leasing arrangement where equipment is rented for a certain period of time and the lessor retains ownership. Various options for renewal or purchase may apply. A capital lease is a leasing arrangement where ownership of the equipment is effectively transferred to the hospital, but the debt is kept off the hospital’s balance sheet during the leasing period.

11. Financing the Future Report 4. HFMA, 2004.
12. Both public and private bond issues will have minimums of several million dollars, and bond issues totaling in the tens or hundreds of millions of dollars are not uncommon. Given the size needed to make issuing bonds cost effective, energy efficiency investments that are funded by bonds are likely to be part of large construction or retrofit projects.
13. Financing the Future Report 4. HFMA, page 12 (2004).
14. Ibid.

Bond Insurance

Like many of its counterparts nationwide, two years ago Memorial Hermann Baptist Beaumont Hospital had a deteriorating physical plant, a desperate need for capital and an inability to access long-term financing at affordable prices.

The 251-bed nonprofit hospital in Beaumont, Texas — which is managed but not owned by the Houston-based Memorial Hermann Healthcare System — tried in late 2000 to float a bond issue to fund a much-needed addition to its East Campus facility, renovate other portions of the hospital and repay bank loans, capital leases and loans from the Memorial Hermann system. But given its shaky financial state at the time, officials say, Baptist Beaumont was unable to secure bond insurance and its balance sheet doomed it to a non-investment-grade bond rating, all of which made it an extremely difficult sell in the debt markets.

Many facilities in similar circumstances have thrown in the towel and turned to an acquisition by a for-profit hospital chain as their only hope for long-term survival.

But Baptist Beaumont chose a different path.

With guidance from investment bank Bear, Stearns & Co. Inc., it became the first hospital in Texas in recent years to take advantage of the Federal Housing Administration's Section 242 mortgage insurance program. With FHA backing, it was able to secure nearly $117 million in bonds in August 2001 with a strong AA rating and insurance from Ambac Assurance Corp, which boosted its bond rating even higher, to AAA. That translated into an affordable 5.45 percent interest rate and gave the hospital the funds needed to pay off debt and to finance construction of the hospital's new addition. That addition, which includes a 26-bed intensive-care unit, eight new operating rooms, an imaging center and a new emergency department, will open this summer.

Reprinted from "Courting Capital," HealthLeaders March 2003 Cover Story

Summary

TABLE 8: FINANCING METHODS SUMMARY

Financial Method	Advantages	Disadvantages
Internal Financing	• Energy efficiency project can be undertaken quickly. • Hospital retains all of the benefits of the energy savings. • Depreciation of energy efficient investment is tax deductible. • No financing costs.	• Hospital needs to provide funds for the entire investment at the start of the project. • Project prevents cash from being used for other projects. • Hospital assumes all investment risk.
Philanthropic Financing	• Equipment cost is essentially free to the hospital. • No debt appears on the hospital's balance sheet and there are no annual loan payments.	• Energy efficiency investments must compete with other potential uses for donated funds.

TABLE 8: FINANCING METHODS SUMMARY (Cont.)

Financial Method	Advantages	Disadvantages
Private Loan Financing	• Enables funding for large, comprehensive energy efficiency projects that are beyond the financial resources available in operating and capital budgets. • Energy efficiency investments can be undertaken now rather than waiting for cash to become available. • Depreciation and interest expenses are tax deductible to for-profit hospitals. • Loan terms can be structured to minimize initial negative cash flows or return some designated cash flow.	• Loan financing requires cooperation with a lending institution, which may delay implementation of the project. • The hospital assumes all of the project risk. Should the performance of the energy efficiency investment be less than anticipated, the hospital may incur cash flows that make repaying the loan difficult. • The loan is accounted for on the hospital's balance sheet.
Public Loan Financing	• Interest costs will generally be lower. • Loans can be used to finance large, comprehensive energy efficiency projects that are beyond internal resources. • Energy efficiency investments can be undertaken now rather than later when cash becomes available. • Depreciation and interest expenses are tax deductible for for-profit hospitals. • Loan terms can be structured to minimize initial negative cash flows or return some designated cash flow.	• Loan financing requires applying to a particular government loan program, which may delay implementation of the project if there is an extensive application process. • The hospital assumes all of the project risk. Should the performance of the energy efficiency investment be less than anticipated, the hospital may incur cash flows that make repaying the loan difficult. • Access to some public financing sources is limited to public or no-profit institutions. • The loan is accounted for on the hospital's balance sheet.
Self-Issued Bond Financing	• The hospital retains all positive cash flows due to energy savings. • Bonds allow hospitals to amortize capital costs over the effective useful life of the energy project. • Bonds impose interest and other costs on hospitals, but an energy efficiency project that begins quickly can more effectively offset these costs. • Bond issues can generate a large amount of financial capital and allow hospitals to undertake large energy efficiency projects on a more cost-effective basis.	• The capital investment is reported on the hospital's balance sheet. • The hospital assumes all of the risk of the energy efficiency project should the performance of the energy efficiency investment be less than anticipated. • Bond deals are complex financial arrangements; bond issuance can take several months or even years and involve issuance fees and legal and financial advice.

TABLE 8: FINANCING METHODS SUMMARY (Cont.)

Financial Method	Advantages	Disadvantages
Municipal Bond Financing	• Interest payments are tax-exempt, making these bonds attractive for certain investors. • Bonds allow hospitals to amortize capital costs over the effective useful life of the energy project. • Bonds impose interest and other costs on hospitals, but an energy efficiency project that begins quickly can more effectively offset these costs through the energy savings created by the project. • Bond issues can generate a large amount of financial capital and allow hospitals to undertake large energy efficiency projects.	• The capital investment is reported on the hospital's balance sheet. • The hospital assumes all of the risk of the energy efficiency project should the performance of the energy efficiency investment be less than anticipated. • Issuing public bonds is subject to political pressures and consequently may be a longer process than self-issued bonds or private loan financing.
Operating Lease	• Kept off balance sheet, lease payments considered an operating expense. • Since not counted as debt, does not limit ability to borrow. • Lower investment risk, as hospital does not own equipment. • Lower monthly payments than capital lease.	• No depreciation tax benefit to for-profit hospitals. • Complicated contracting and tax implications — get an accountant involved early in the process.
Lease-Option	• Kept off balance sheet; lease payments considered an operating expense. • Since not counted as debt, does not limit ability to borrow. • Lower investment risk, as hospital does not own equipment. • Lower monthly payments then Capital Lease.	• No depreciation tax benefit to for-profit hospitals. • Complicated contracting and tax implications — get an accountant involved early in the process.
Capital Lease	• Ownership of equipment is assured. • Can claim depreciation expenses on taxes.	• Considered as debt on balance sheet; limits ability to borrow for other projects. • Hospital assumes risk of investment. • Higher monthly payment relative to an operating lease. • Complicated contracting and tax implications — get an accountant involved early in the process.

Section V: Performance Contracting

Performance contracts are a general class of agreements where the annual payment obligation is related to the expected energy savings or service value. Performance contracts can be limited in scope, such as a contract related to specific equipment, or large in scope, such as a comprehensive energy efficiency upgrade to an entire facility. Capital project financing associated with performance contracting can be structured as any of the financing alternatives discussed in this Guide. Performance contracts for specific equipment are often similar to the lease agreements discussed above, with energy savings made an explicit part of the agreement by linking payments for the equipment to the expected savings.

Two general types of performance contracts can be described as follows:

- Performance-based or shared savings contracts refer to an agreement where the compensation to the energy service company (ESCO) providing the equipment is based on the actual savings achieved from a project. Because compensation is tied to realized savings, these contracts usually involve monitoring and verification (M&V) work to measure energy usage before and after equipment installation. These agreements sometimes require that the ESCO have an equity stake in the project. They may be financially structured similar to a capital lease.
- A guaranteed savings contract is an arrangement where an ESCO will guarantee a minimum savings amount as part of the agreement with the hospital. Under this type of arrangement, the primary goal is to have the ESCO guarantee that the loan payment obligation can be paid for from the achieved savings in energy, utility and/or operational costs. M&V is usually required for one to three years after installation and is included in the purchase cost. Typically the loan term is seven to twelve years. The hospital is free to choose whatever means of financing it feels is appropriate. There is no required financing arrangement with the ESCO.

Design-Build vs. Design-Bid-Build

One of the advantages of working with an ESCO is that they are usually structured so as to be capable of using a design-build project completion format on energy efficiency installations. This can allow the hospital to reap significant economic benefits from a streamlined approach to project completion. In some cases as much as 40 percent savings can be realized from the reduction in design effort, mobilization time and tiered overheads from subcontractors.

The typical advantages associated with design-build are:[15]

- **Singular responsibility.** With both design and construction in the hands of a single entity, there is a single point of responsibility for quality, cost and schedule adherence.
- **Quality.** The singularized responsibility inherent in design-build serves as a motivation for quality and proper project performance.
- **Cost savings.** Design and construction personnel, working and communicating as a team, evaluate alternative materials and methods efficiently and accurately.
- **Time savings.** Because design and construction are overlapped, and because bidding periods and redesign are eliminated, total design and construction time can be significantly reduced.
- **Potential for reduced administrative burden.** During procurement, the potential exists for design-build to reduce the owner's administrative burden; however, preparing RFPs and conducting evaluations can be resource intensive during the early learning curve.
- **Early knowledge of firm costs.** Guaranteed construction costs are known far earlier than in other delivery systems.
- **Improved risk management.** Performance aspects of cost, schedule and quality are clearly defined and responsibilities/risks are appropriately balanced (individual risks are managed by the party best positioned to manage that risk).

Recapture of Grants, Rebates, & Incentives

Often in traditional capital construction projects, the recapture of grants, rebates and incentives is not consistently carried out. In many cases they cannot be recaptured without significant effort on the part of designers and contractors, whose compensation is fixed by a lowbid and who have little incentive to make extra effort to recover these funds on behalf of the owner. In

15. An Introduction to Design-Build, Design-Build Institute of America, 1994.

fact, there may be additional charges from design professionals for the additional studies necessary to define baselines related to grants, rebates and incentives.

Performance contracting includes full services for recovery of all grants, rebates and incentives as part of its normal design and construction commitment. Performance contracting is specialized around this type of effort.

Measurement & Verification

Savings guarantees should be expressed in simple terms that are easily and fairly verifiable. Most often they should be expressed in terms that reflect metering on specific pieces of equipment instead of a percentage reduction in a utility bill. In the normal course of a performance contract these savings must be verified. A usual term for M&V is from one to three years after project completion.

Costs directly associated with M&V are usually minimal, perhaps 1 percent of total project cost.

M&V should be stated in a form that can be technically verified by a third party and leaves little or no room for interpretation.

Additional Services Contracts

Additional services are quite often offered by ESCOs that go well beyond the scope of an energy efficiency project. These services can be as simple as an extended warranty on the equipment installed, or be as complex as management of the entire facility, where an outside firm manages energy services and several other O&M components.

In general, these services are usually classed as outsourcing or out-tasking:

- Outsourcing refers to an agreement where an outside firm is hired to provide a service formerly done in-house, such as complete energy management at a facility. An outsourcing agreement could involve either a guaranteed savings or performance-based contract to achieve energy and cost savings from no- and low-cost operations improvements when capital is not an issue.
- Out-tasking refers to a more limited relationship, where individual and specialized tasks or equipment — rather than full-service operations — are managed by outside contractors.

The decision to outsource or out-task is not limited to a specific project completion method such as performance contracting. Further, such a decision should be based on factors that go well beyond the scope of an individual energy efficiency project, and should be validated independently by life-cycle cost analysis. Consequently, they will not be considered within this scope.

Fee Structure, Pricing & Accountability

RFP/RFQ is a common selection method. Specifications are often the more simple "performance-based" type instead of the more effort-intensive method of specifying certain products.

Fee structure is usually some variation of "open-book." Remember that total fees involve direct ESCO expenses, markup on subcontractors' work, audit fees, design fees, project management fees, equipment markups and material markups. Expect to be provided documentation for all cost items.

Asking about the ESCO's expectation regarding gross margin is a reasonable question. Fee structure and margin expectations can vary significantly between ESCOs. It is in part dependent on the firm's business model and fixed overheads relating not just to the ESCO business unit but to the overall company as well. Efficiency, productivity and fixed costs can vary significantly from one ESCO to another.

Performance Contracting Examples

The following tables show general examples of the effect of using a performance contract to complete the same standard project as outlined previously. Because of the added efficiencies of the performance contracting method (discussed above) as compared to traditional project completion, we have adjusted the installation price down by 20 percent. On balance, we have added back 2 percent to cover the additional costs of measurement and verification for three years.

Table description:

- Table 9 — Guaranteed savings performance contract with 80 percent of the construction cost financed with a private loan at 7 percent.
- Table 10 — Guaranteed savings performance contract with 80 percent of the construction cost financed with a public loan at 5 percent.
- Table 11 — Shared savings performance contract with 80 percent of the construction cost financed by the ESCO (essentially a capital lease).

TABLE 9: PC — GUARANTEED SAVINGS — PRIVATE LOAN

Equipment Cost****	$164,000	Loan Period (yrs)	10	Discount Rate	7%	Annual Savings	$40,000
Cash %	20%	Study Period (yrs)	10	Loan Rate	7%		
Financed Amount	$131,200	Useful Life (yrs)	15	Inflation Rate	0%	Residual Value*	$54,667

	Baseline		Energy Efficient Alternate			Life-Cycle Cost Calculation	
Year**	Equipment	Energy Usage	Equipment	Energy Usage	Loan (or Lease) Expense	Net Annual Benefit (Cost)	PV Annual Benefit
Start	0		$32,800			$(32,800)	$(32,800)
1		$80,000		$40,000	$18,280	$21,720	$20,299
2		$80,000		$40,000	$18,280	$21,720	$18,971
3		$80,000		$40,000	$18,280	$21,720	$17,730
4		$80,000		$40,000	$18,280	$21,720	$16,570
5		$80,000		$40,000	$18,280	$21,720	$15,486
6		$80,000		$40,000	$18,280	$21,720	$14,473
7		$80,000		$40,000	$18,280	$21,720	$13,526
8		$80,000		$40,000	$18,280	$21,720	$12,641
9		$80,000		$40,000	$18,280	$21,720	$11,814
10		$80,000	$(54,667)	$40,000	$18,280	$76,387	$38,831
	$215,601	$400,000	4.1	24%	66.5%	26.9%	**$147,541**
	Total Cost	**Total Savings**	**SPB (yrs)*** **	**ROI**	**IRR**	**MIRR**	**Net LCC Savings**

* = At end of study period (straight line depreciated)
** = End of year convention for all expenses, except initial construction expenses are at start of year 1
*** = Simple payback does not consider benefits or costs beyond the initial payback period, or the time value of money
**** = Equipment cost reduced by design-build efficiencies, reduced project overhead and 100 percent receipt of rebates; increased by M&V costs

TABLE 10: PC — GUARANTEED SAVINGS — PUBLIC LOAN

Equipment Cost****	$164,000	Loan Period (yrs)	10	Discount Rate	7%	Annual Savings	$40,000
Cash %	20%	Study Period (yrs)	10	Loan Rate	5%		
Financed Amount	$131,200	Useful Life (yrs)	15	Inflation Rate	0%	Residual Value*	$54,667

	Baseline		Energy Efficient Alternate			Life-Cycle Cost Calculation	
Year**	Equipment	Energy Usage	Equipment	Energy Usage	Loan (or Lease) Expense	Net Annual Benefit (Cost)	PV Annual Benefit
Start	0		$32,800			($32,800)	($32,800)
1		$80,000		$40,000	$16,699	$23,301	$21,777
2		$80,000		$40,000	$16,699	$23,301	$20,352
3		$80,000		$40,000	$16,699	$23,301	$19,021
4		$80,000		$40,000	$16,699	$23,301	$17,776
5		$80,000		$40,000	$16,699	$23,301	$16,613
6		$80,000		$40,000	$16,699	$23,301	$15,526
7		$80,000		$40,000	$16,699	$23,301	$14,511
8		$80,000		$40,000	$16,699	$23,301	$13,561
9		$80,000		$40,000	$16,699	$23,301	$12,674
10		$80,000	($54,667)	$40,000	$16,699	$77,968	$39,635
	$199,790	$400,000	4.1	24%	71.3%	27.6%	**$158,647**
	Total Cost	**Total Savings**	**SPB (yrs)*** **	**ROI**	**IRR**	**MIRR**	**Net LCC Savings**

* = At end of study period (straight line depreciated)
** = End of year convention for all expenses, except initial construction expenses are at start of year 1
*** = Simple payback does not consider benefits or costs beyond the initial payback period, or the time value of money
**** = Equipment cost reduced by design-build efficiencies, reduced project overhead and 100 percent receipt of rebates; increased by M&V costs

TABLE 11: PC — SHARED SAVINGS — ESCO FINANCED

Equipment Cost****	$164,000	Lease Period (yrs)	10	Discount Rate	7%	Annual Savings	$40,000
Cash %	20%	Study Period (yrs)	10	Loan Rate	10%		
Lease Amount	$131,200	Useful Life (yrs)	15	Inflation Rate	0%	Residual Value*	$54,667

	Baseline		Energy Efficient Alternate			Life-Cycle Cost Calculation	
Year**	Equipment	Energy Usage	Equipment	Energy Usage	Lease Payments	Net Annual Benefit (Cost)	PV Annual Benefit
Start	0		$32,800			($53,606)	($53,606)
1		$80,000		$40,000	$20,806	$19,194	$17,938
2		$80,000		$40,000	$20,806	$19,194	$16,765
3		$80,000		$40,000	$20,806	$19,194	$15,668
4		$80,000		$40,000	$20,806	$19,194	$14,643
5		$80,000		$40,000	$20,806	$19,194	$13,685
6		$80,000		$40,000	$20,806	$19,194	$12,790
7		$80,000		$40,000	$20,806	$19,194	$11,953
8		$80,000		$40,000	$20,806	$19,194	$11,171
9		$80,000		$40,000	$20,806	$19,194	$10,440
10		$80,000	($54,667)	$40,000	$—	$94,667	$48,124
	$240,858	$400,000	4.1	24%	36.5%	20.31%	**$119,573**
	Total Cost	**Total Savings**	**SPB (yrs)*** **	**ROI**	**IRR**	**MIRR**	**Net LCC Savings**

* = At end of study period (straight line depreciated)
** = End of year convention for all expenses, except initial construction expenses are at start of year 1
*** = Simple payback does not consider benefits or costs beyond the initial payback period, or the time value of money
**** = Equipment cost reduced by design-build efficiencies, reduced project overhead and 100 percent receipt of rebates; increased by M&V costs

Summary

Performance Contracting Advantages

- Payments tied directly to savings achieved, which provides an incentive to maximize savings.
- Allows energy cost savings (rather than debt from internal financing) to pay for the project.
- Project delivery is improved due to design-build efficiencies.
- Capture of grants, rebates and incentives is improved.

Performance Contracting Disadvantages

- Performance-based contracts usually require some M&V work to determine actual project savings.
- Performance-based contracts can be disruptive to existing facilities staff.
- Baselines used to calculate savings for performance contracts must be modified over time as hospitals expand, change their service mix, retire old equipment and purchase new devices. M&V standards must be designed so that they can be determined fairly in these situations.

Section VI: Project Examples

Project Approach

In general, a life-cycle cost analysis begins with the consideration of individual components, then proceeds to the consideration of system alternatives and finally considers whole facility alternatives. Each "building block" must be considered in turn before integrating into the next larger unit of the project.

After decisions have been evaluated as to component choice, size and best combination, an analysis is performed to validate that the proposed energy efficiency project meets the minimum financial "hurdle rates" of the hospital organization.

If the project is acceptable to the hospital, often it must then compete for available funds with other projects that may, or may not, be energy related. Again, a form of life-cycle analysis occurs as the various project investments are evaluated.

In any given project, the reader may be involved in all of these steps, or in only a few of them, or in only one of them. The basic steps necessary to perform an accurate life-cycle analysis are the same in each case.

This process is outlined in the flow chart included in Appendix II.

Time and space do not permit a full description of every step of this repeating process in this Guide. However, an example, showing how one phase of analysis relates to another, may help to illustrate.

Detailed Example

A construction manager has already completed the preliminary steps of deciding on components, sizes and system alternatives, and now needs to get approval for the funding for the project.

The project information is as follows:

Differential construction cost:	$356,883
Baseline electricity cost for first year:	$1,699,500/yr
Energy alternative electricity cost for first year:	$1,515,384/yr

O&M costs are the same for both the alternative and the baseline.

The financial information is as follows:

Inflation rate for all items:	3%
Discount rate:	9.3%
Loan interest rate:	6%
Loan term:	10 years
Study period (and useful life):	10 years
Loan to value:	0%

The hospital has established the following minimum criteria for project acceptance:

Five-year simple payback and an IRR > 20% based on a 100% cash purchase

Does this project qualify for acceptance by the hospital? What are the net LCC savings?

Using a spreadsheet analysis similar to that developed earlier, we get the following results:

TABLE 12: DETAILED LCC EXAMPLE (WITH INFLATION)

Equipment Cost	$356,883	Loan Period (yrs)	10	Discount Rate	9.3%	Annual Savings	$184,116
Cash %	100%	Study Period (yrs)	10	Loan Rate	6%		
Financed Amount	$—	Useful Life (yrs)	10	Inflation Rate	3%	Residual Value*	$—

	Baseline		Energy Efficient Alternate			Life-Cycle Cost Calculation	
Year**	Equipment	Energy Usage	Equipment	Energy Usage	Loan (or Lease) Expense	Net Annual Benefit (Cost)	PV Annual Benefit
Start	0		$356,883			($356,883)	($356,883)
1		$1,699,500		$1,515,384	$—	$184,116	$168,450
2		$1,750,485		$1,560,846	$—	$189,639	$165,638
3		$1,803,000		$1,607,671	$—	$195,328	$159,446
4		$1,857,090		$1,655,901	$—	$201,188	$153,485
5		$1,912,802		$1,705,579	$—	$207,224	$147,748
6		$1,970,186		$1,756,746	$—	$213,440	$142,224
7		$2,029,292		$1,809,448	$—	$219,844	$136,908
8		$2,090,171		$1,863,732	$—	$226,439	$131,790
9		$2,152,876		$1,919,644	$—	$233,232	$126,863
10		$2,217,462	$—	$1,977,233	$—	$240,229	$122,120
	$356,883	$2,110,679	1.94	52%	53.6%	24.5%	**$1,097,789**
	Total Cost	**Total Savings**	**SPB (yrs)*** **	**ROI**	**IRR**	**MIRR**	**Net LCC Savings**

* = At end of study period (straight line depreciated)
** = End of year convention for all expenses, except initial construction expenses are at start of year 1
*** = Simple payback does not consider benefits or costs beyond the initial payback period, or the time value of money

In this example we have had to consider the effect of inflation as well as that of escalation (the discount rate). Since the utility costs are actually considered to occur at year-end, we have to begin by inflating our Year 1 energy estimates by 3 percent, as well as each year thereafter.

Does this project meet the hospital's "hurdle rates"? Yes, it does. It has a simple payback of less than two years, and an IRR of over 53 percent. What are the net LCC savings? $1,097,789.

With over $1 million in savings, it is informative to think of this in terms of the revenue equivalent, as shown previously in Figure 5. With a 3 percent net operating margin, a hospital would be required to increase revenues by $32 million in order to have the same impact as the $1 million. With an 8 percent net operating margin, $12 million in new revenues is needed to have an equivalent impact on the bottom line. Comparing cost savings with revenue equivalents is valuable especially when comparing multiple projects, where some are cost-savings projects and others are designed to increase revenues. If you propose an energy-saving facility project to your CEO and s/he also receives some revenue-generation clinical projects, this approach can allow you to showcase the true value comparison between projects.

Effect of Project Delay

In general, delaying projects will decrease the overall benefits (although there are some situations where delay might be beneficial). Energy cost savings and positive cash flows can immediately improve a hospital's balance sheet and a project's overall net benefits if the project is done sooner rather than later. If self-financing were the only option, then delaying projects until funds are available may be inevitable. Since this is not the case and there are a variety of different financing options available, it is often in the best interest of the hospital to arrange financing so that projects can be undertaken sooner.

The following two tables illustrate the advantage of starting projects immediately. Both tables show a project costing $200,000 and providing energy savings of $40,000 per year over 10 years. However, in Table 13A, the project begins immediately, resulting in overall net LCC savings of $114,833. Table 13B shows the same project, but with a start delay of one year. With just one year of delay, the net LCC savings fall 27 percent to $84,228. The hospital has forgone the $40,000 in energy cost savings in Year 1 by waiting. These energy savings are gone forever and cannot be recouped. Naturally, the decrease in project benefits will be more pronounced the longer the project is delayed.

TABLE 13A: CASH FINANCE, START IMMEDIATELY

Equipment Cost	$200,000	Loan Period (yrs)	10	Discount Rate	7%	Annual Savings	$40,000
Cash %	100%	Study Period (yrs)	10	Loan Rate	7%		
Financed Amount	$—	Useful Life (yrs)	15	Inflation Rate	0%	Residual Value*	$66,667

	Baseline		Energy Efficient Alternate			Life-Cycle Cost Calculation	
Year**	Equipment	Energy Usage	Equipment	Energy Usage	Loan (or Lease) Expense	Net Annual Benefit (Cost)	PV Annual Benefit
Start	0		$ 200,000			($200,000)	($200,000)
1		$80,000		$40,000	$—	$40,000	$37,383
2		$80,000		$40,000	$—	$40,000	$34,938
3		$80,000		$40,000	$—	$40,000	$32,652
4		$80,000		$40,000	$—	$40,000	$30,516
5		$80,000		$40,000	$—	$40,000	$28,519
6		$80,000		$40,000	$—	$40,000	$26,654
7		$80,000		$40,000	$—	$40,000	$24,910
8		$80,000		$40,000	$—	$40,000	$23,280
9		$80,000		$40,000	$—	$40,000	$21,757
10		$80,000	($66,667)	$40,000	$—	$106,667	$54,224
	$200,000	$400,000	5	20%	17.0%	12.0%	**$114,833**
	Total Cost	**Total Savings**	**SPB (yrs)*** **	**ROI**	**IRR**	**MIRR**	**Net LCC Savings**

* = At end of study period (straight line depreciated)
** = End of year convention for all expenses, except initial construction expenses are at start of year 1
*** = Simple payback does not consider benefits or costs beyond the initial payback period, or the time value of money

TABLE 13B: CASH FINANCE, WAIT ONE YEAR

Equipment Cost	$200,000	Loan Period (yrs)	10	Discount Rate	7%	Annual Savings	$40,000
Cash %	100%	Study Period (yrs)	10	Loan Rate	7%		
Financed Amount	$—	Useful Life (yrs)	15	Inflation Rate	0%	Residual Value*	$80,000

	Baseline		Energy Efficient Alternate			Life-Cycle Cost Calculation	
Year**	Equipment	Energy Usage	Equipment	Energy Usage	Loan (or Lease) Expense	Net Annual Benefit (Cost)	PV Annual Benefit
Start	0					$—	$—
1		$80,000	$200,000	$80,000	$—	($200,000)	($200,000)
2		$80,000		$40,000	$—	$40,000	$34,938
3		$80,000		$40,000	$—	$40,000	$32,652
4		$80,000		$40,000	$—	$40,000	$30,516
5		$80,000		$40,000	$—	$40,000	$28,519
6		$80,000		$40,000	$—	$40,000	$26,654
7		$80,000		$40,000	$—	$40,000	$24,910
8		$80,000		$40,000	$—	$40,000	$23,280
9		$80,000		$40,000	$—	$40,000	$21,757
10		$80,000	($80,000)	$40,000	$—	$120,000	$61,002
	$200,000	$360,000	5	20%	16.7%	11.6%	**$84,228**
	Total Cost	**Total Savings**	**SPB (yrs)*** **	**ROI**	**IRR**	**MIRR**	**Net LCC Savings**

* = At end of study period (straight line depreciated)
** = End of year convention for all expenses, except initial construction expenses are at start of year 1
*** = Simple payback does not consider benefits or costs beyond the initial payback period, or the time value of money

Given the costs associated with delaying projects even one year, loans can be an attractive solution that enables the hospital to undertake the energy efficiency investment immediately, rather than waiting for cash to become available in future years. Over the life of the project, loan financing can also increase the overall project benefits relative to the case where the project is delayed.

If the project starts immediately and is financed with a loan (Table 14), the hospital will have annual loan payments of $22,293 and annual energy cost savings of $40,000 starting in the first year. The hospital, therefore, can immediately (i.e., at the end of Year 1) use the energy cost savings to finance the loan and improve the hospital's balance sheet. The net annual benefit to the hospital is $17,707 over the 10-year life of the project. The net LCC savings is $118,258. Again, in contrast, for the delayed project the net LCC savings are only $84,228 (Table 13B).

TABLE 14: LOAN FINANCE, START IMMEDIATELY

Equipment Cost	$200,000	Loan Period (yrs)	10	Discount Rate	7%	Annual Savings	$40,000
Cash %	20%	Study Period (yrs)	10	Loan Rate	7%		
Financed Amount	$160,000	Useful Life (yrs)	15	Inflation Rate	0%	Residual Value*	$66,667

	Baseline		Energy Efficient Alternate			Life-Cycle Cost Calculation	
Year**	Equipment	Energy Usage	Equipment	Energy Usage	Loan (or Lease) Expense	Net Annual Benefit (Cost)	PV Annual Benefit
Start	0		$40,000			$(40,000)	$(40,000)
1		$80,000		$40,000	$22,293	$17,707	$16,549
2		$80,000		$40,000	$22,293	$17,707	$15,466
3		$80,000		$40,000	$22,293	$17,707	$14,454
4		$80,000		$40,000	$22,293	$17,707	$13,509
5		$80,000		$40,000	$22,293	$17,707	$12,625
6		$80,000		$40,000	$22,293	$17,707	$11,799
7		$80,000		$40,000	$22,293	$17,707	$11,027
8		$80,000		$40,000	$22,293	$17,707	$10,306
9		$80,000		$40,000	$22,293	$17,707	$9,632
10		$80,000	$(66,667)	$40,000	$22,293	$84,374	$42,891
	$262,928	$400,000	5.00	20%	45.0%	22.8%	**$118,258**
	Total Cost	**Total Savings**	**SPB (yrs)*** **	**ROI**	**IRR**	**MIRR**	**Net LCC Savings**

* = At end of study period (straight line depreciated)
** = End of year convention for all expenses, except initial construction expenses are at start of year 1
*** = Simple payback does not consider benefits or costs beyond the initial payback period, or the time value of money

Comparing Multiple Projects

The preceding examples describe each financing option independently, but these methods can be used to evaluate multiple projects or to compare alternative financing methods for the same project. This section discusses the value or benefits of adopting a comprehensive strategic approach to energy efficiency investments, compared to a tactical measure-by-measure approach.

This section also relates to new construction projects, which often present a better opportunity than existing facilities for installing multiple equipment options simultaneously. In either the new construction or existing builder applications, the same financial evaluation methods and financing options apply.

Cream Skimming vs. Comprehensive Project

Oftentimes organizations choose to invest in simple energy efficiency projects that have low initial investment costs and short payback periods. Called "cream skimming," this approach seeks to capture higher rates of return while minimizing risk and preserving liquidity. In other words, the goal is to minimize initial investment costs rather than maximize energy savings. In terms of energy reduction and lower costs in the longer run, this is not the most cost-effective approach to energy efficiency. Indeed, this piecemeal approach likely precludes or crowds out additional energy savings opportunities associated with more comprehensive or capital-intensive energy efficiency investments.

Choosing only those projects that have a short payback period may also decrease the benefits to the hospital in the long run if there are better investments available. Recall that the ROI measure is simply the inverse of the simple payback. Figure 6 shows the tradeoff between ROI and simple payback. As discussed previously, financial staff are more likely to be familiar with ROI than with payback. If we consider a project with a 10-year payback, this translates to a 10 percent ROI. While a 10-year payback period might be considered too long for an energy efficiency investment, a 10 percent ROI would generally be considered a good investment — especially with hospitals that struggle to maintain operating margins of 3 – 4 percent annually.

FIGURE 6: TRADEOFF BETWEEN SIMPLE PAYBACK AND ROI

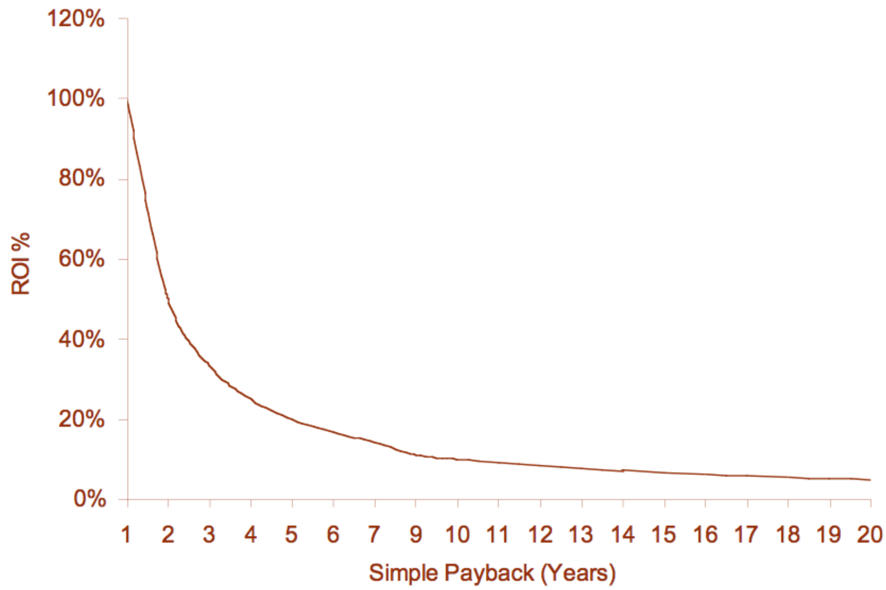
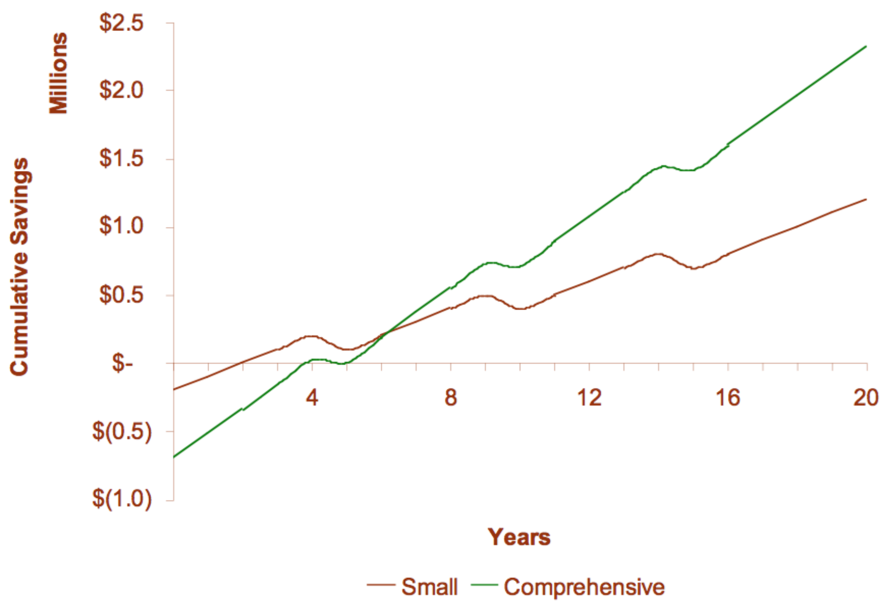


FIGURE 7: COMPARISON OF ENERGY SAVINGS FOR SMALL PROJECT & COMPREHENSIVE PROJECT



Analyzing Energy Project Returns

A comprehensive energy efficiency project is an investment that bundles multiple energy efficiency measures with varying rates of return. Although the project may produce an attractive average rate of return, such a comprehensive project will — relative to a more limited efficiency project — entail higher capital investment, a longer payback period and a lower overall rate of return on investment. Without a strategic energy financing approach, many organizations will choose to install the simple and inexpensive energy efficiency measures first. Rates of return on additional energy efficiency measures are then lower, and these projects are therefore less likely to be undertaken.

Figure 7 compares the energy cost savings for a small energy efficiency project to those of a large, comprehensive project. The small energy efficiency project has an initial investment cost of $200,000 and returns energy cost savings of $100,000 annually (50 percent ROI) for five years before an additional investment of $200,000 is needed. The initial investment cost of the large energy efficiency project is $700,000 and the project returns annual energy cost savings of $184,000 annually (26 percent ROI) for 20 years with replacement costs of $200,000 every five years. (For comparison purposes, we have assumed that both projects have identical 20-year effective useful lives.)

The small project has a two-year payback and an internal rate of return of 41 percent. The larger, comprehensive project has a 3.8-year payback period and a 21 percent internal rate of return. The low initial investment costs and quick payback period may seem to make the smaller project appear more attractive than the larger, comprehensive project. However, the comprehensive project is clearly cost-effective and over the 20-year project life generates energy cost savings that greatly exceed those of the smaller project. (Note the difference in height between the cumulative energy cost savings curves.)

The small project minimizes initial investment costs while the comprehensive project maximizes energy cost savings; the small project leaves most of the energy savings opportunities untapped. Indeed, at year 20, the cumulative energy cost savings are $1,200,000 for the small project and $2,325,000 for the comprehensive project, resulting in $1,125,000 in foregone energy cost savings as a result of cream skimming.

With over $1.1 million in foregone savings, it is informative to think of this in terms of the revenue equivalent, as shown previously in Figure 5. With a 3 percent net operating margin, a hospital would be required to increase revenues by nearly $35 million in order to have the same impact as the $1.1 million. With an 8 percent net operating margin, more than $13 million in new revenues is needed to have an equivalent impact on the bottom line. Comparing cost savings with revenue equivalents is valuable especially when comparing multiple projects, where some are cost-savings projects and others are designed to increase revenues. If you propose an energy-saving facility project to your CEO and s/he also receives some revenue-generation clinical projects, this approach can allow you to showcase the true value comparison between projects.

As discussed in Section III, the LCCA method is designed to evaluate the relative merits of multiple projects based on total costs. The LCCA method can be used with the previous example to evaluate two different energy projects where costs accrue at different points during the project life.

Oftentimes, one of the issues in considering a comprehensive project relates to the financial guidelines established for project approval within a hospital organization. For example, a very realistic guideline may require a five-year simple payback for initial project qualification and a 20 percent IRR as the minimum acceptable project approval standard, with financing not to exceed a 10-year loan term.

Trying to purchase major equipment with long useful lives within these guidelines is often difficult when considered as separate projects. Yet, when considered as part of a comprehensive project , the purchase of major equipment often becomes quite feasible.

This is shown in Table 15. The first project (Table 15, Option A) is small lighting retrofit and has a lower initial cost but also lower savings during the study period. After five years, the retrofit must

Saving Energy at Fred Hutchinson Cancer Research Center (FHCRC)

FHCRC has a continuing, long-term commitment to energy conservation. This commitment has resulted in nearly 30 energy projects completed in the past few years.

Besides saving more than $1 million per year, FHCRC has also earned some 20 awards at the national, state and local level for its efforts.

FHCRC has made a long-term commitment that led to this success. This commitment covers five areas:

- Build energy efficiency into new facilities
- Retrofit existing facilities
- Ensure energy-efficient operations
- Education of faculty, staff and the community
- Proper equipment operation and maintenance

They continue to find additional energy-saving opportunities, assess which ones are cost-effective investments and then implement them. The FHCRC policy-level commitment ensures ongoing success.

Source: FHCRC staff and Northwest Energy Efficiency Alliance.

be completely redone in order to continue the savings. The second project (Table 15, Option B) is a chiller replacement that has a higher initial cost, but would continue to generate savings for 20 years, well beyond the loan term and the end of the study period (10 years). The lighting retrofit project easily meets the "hurdle rates" for the hospital with a two-year simple payback and an IRR of 41 percent. However, the chiller replacement will not qualify by itself, since its simple payback is six years, and the IRR is only 14 percent. Yet we know that the chiller replacement will generate much more in energy savings over its 20-year useful life than the short-lived lighting retrofit project will. By combining both of these projects into a comprehensive project, we are able to maximize the energy savings and meet the financial guidelines for the hospital organization (Table 15, Option C).

The initial equipment costs and annual energy costs assuming a 10-year project life are shown in Table 15. Note that this simple example does not include other costs that may be relevant, such as operations, maintenance and repair or financing costs.

TABLE 15: EXAMPLE COMPARING TWO PROJECTS USING LCCA
OPTION A — LIGHTING RETROFIT PROJECT

Equipment Cost	$200,000	Loan Period (yrs)	5	Discount Rate	7%	Annual Savings	$100,000
Cash %	100%	Study Period (yrs)	10	Loan Rate	7%		
Financed Amount	$—	Useful Life (yrs)	5	Inflation Rate	0%	Residual Value*	$—

	Baseline		Energy Efficient Alternate			Life-Cycle Cost Calculation	
Year**	Equipment	Energy Usage	Equipment	Energy Usage	Loan (or Lease) Expense	Net Annual Benefit (Cost)	PV Annual Benefit
Start	0		$200,000			($200,000)	($200,000)
1		$250,000		$150,000	$—	$100,000	$93,458
2		$250,000		$150,000	$—	$100,000	$87,344
3		$250,000		$150,000	$—	$100,000	$81,630
4		$250,000		$150,000	$—	$100,000	$76,290
5		$250,000	$200,000	$150,000	$—	($100,000)	($71,299)
6		$250,000		$150,000	$—	$100,000	$66,634
7		$250,000		$150,000	$—	$100,000	$62,275
8		$250,000		$150,000	$—	$100,000	$58,201
9		$250,000		$150,000	$—	$100,000	$54,393
10		$250,000	$—	$150,000	$—	$100,000	$50,835
	$200,000	$1,000,000	2	50%	41%	16.4%	**$359,761**
	Total Cost	**Total Savings**	**SPB (yrs)*** **	**ROI**	**IRR**	**MIRR**	**Net LCC Savings**

* = At end of study period (straight line depreciated)
** = End of year convention for all expenses, except initial construction expenses are at start of year 1
*** = Simple payback does not consider benefits or costs beyond the initial payback period, or the time value of money

TABLE 15: EXAMPLE COMPARING TWO PROJECTS USING LCCA (Cont.)
OPTION B — CHILLER REPLACEMENT PROJECT

Equipment Cost	$500,000	Loan Period (yrs)	10	Discount Rate	7%	Annual Savings	$84,000
Cash %	100%	Study Period (yrs)	10	Loan Rate	7%		
Financed Amount	$—	Useful Life (yrs)	20	Inflation Rate	0%	Residual Value*	$250,000

	Baseline		Energy Efficient Alternate			Life-Cycle Cost Calculation	
Year**	Equipment	Energy Usage	Equipment	Energy Usage	Loan (or Lease) Expense	Net Annual Benefit (Cost)	PV Annual Benefit
Start	0		$500,000			($500,000)	($500,000)
1		$280,000		$196,000	$—	$84,000	$78,505
2		$280,000		$196,000	$—	$84,000	$73,369
3		$280,000		$196,000	$—	$84,000	$68,569
4		$280,000		$196,000	$—	$84,000	$64,083
5		$280,000		$196,000	$—	$84,000	$59,891
6		$280,000		$196,000	$—	$84,000	$55,973
7		$280,000		$196,000	$—	$84,000	$52,311
8		$280,000		$196,000	$—	$84,000	$48,889
9		$280,000		$196,000	$—	$84,000	$45,690
10		$280,000	($250,000)	$196,000	$—	$334,000	$169,789
	$500,000	$840,000	6	17%	14.2%	10.9%	**$217,068**
	Total Cost	**Total Savings**	**SPB (yrs)*** **	**ROI**	**IRR**	**MIRR**	**Net LCC Savings**

* = At end of study period (straight line depreciated)
** = End of year convention for all expenses, except initial construction expenses are at start of year 1
*** = Simple payback does not consider benefits or costs beyond the initial payback period, or the time value of money

With the lighting project, the total life-cycle savings are $359,761 over the 10-year study period, using a discount rate of 7 percent. The comprehensive project (lighting & chiller) has a life-cycle savings of $576,829 using the same discount rate. The result is a net savings in life-cycle costs of $217,068 ($576,829 minus $359,761) for the larger project compared to the smaller project, even though the larger project has a higher initial cost. In either case, the larger project option yields greater overall benefits in this example based on its lower life-cycle costs.

TABLE 15: EXAMPLE COMPARING TWO PROJECTS USING LCCA (Cont.)
OPTION C — REPLACEMENT

Equipment Cost	$700,000	Loan Period (yrs)	10	Discount Rate	7%	Annual Savings	$184,000
Cash %	100%	Study Period (yrs)	10	Loan Rate	7%		
Financed Amount	$—	Useful Life (yrs)	20	Inflation Rate	0%	Residual Value*	$250,000

	Baseline		Energy Efficient Alternate			Life-Cycle Cost Calculation	
Year**	Equipment	Energy Usage	Equipment	Energy Usage	Loan (or Lease) Expense	Net Annual Benefit (Cost)	PV Annual Benefit
Start	0		$700,000			($700,000)	($700,000)
1		$530,000		$346,000	$—	$184,000	$171,963
2		$530,000		$346,000	$—	$184,000	$160,713
3		$530,000		$346,000	$—	$184,000	$150,199
4		$530,000		$346,000	$—	$184,000	$140,373
5		$530,000	$200,000	$346,000	$—	($16,000)	($11,408)
6		$530,000		$346,000	$—	$184,000	$122,607
7		$530,000		$346,000	$—	$184,000	$114,586
8		$530,000		$346,000	$—	$184,000	$107,090
9		$530,000		$346,000	$—	$184,000	$100,084
10		$530,000	($250,000)	$346,000	$—	$434,000	$220,624
	$700,000	$1,840,000	3.8	26%	21.2%	13.5%	**$576,829**
	Total Cost	**Total Savings**	**SPB (yrs)*** **	**ROI**	**IRR**	**MIRR**	**Net LCC Savings**

Chiller saves an additional $84,000/yr for 10 years after the study period, $840,000

* = At end of study period (straight line depreciated)
** = End of year convention for all expenses, except initial construction expenses are at start of year 1
*** = Simple payback does not consider benefits or costs beyond the initial payback period, or the time value of money

In fact, by considering the leverage created by financing this project, as compared to funding it internally, we can increase the economic benefit to the hospital even more (Table 16). With financing at a 7 percent rate, the IRR on the comprehensive project increases from approximately 21 percent to over 62 percent.

TABLE 16: EFFECT OF FINANCING ON COMPREHENSIVE PROJECT
COMPREHENSIVE PROJECT — LIGHTING RETROFIT & CHILLER REPLACEMENT — FINANCED

Equipment Cost	$700,000	Loan Period (yrs)	10	Discount Rate	7%	Annual Savings	$170,000
Cash %	20%	Study Period (yrs)	10	Loan Rate	7%		
Financed Amount	$560,000	Useful Life (yrs)	20	Inflation Rate	0%	Residual Value*	$250,000

	Baseline		Energy Efficient Alternate			Life-Cycle Cost Calculation	
Year**	Equipment	Energy Usage	Equipment	Energy Usage	Loan (or Lease) Expense	Net Annual Benefit (Cost)	PV Annual Benefit
Start	0		$140,000			($140,000)	($140,000)
1		$530,000		$360,000	$78,025	$91,975	$85,958
2		$530,000		$360,000	$78,025	$91,975	$80,335
3		$530,000		$360,000	$78,025	$91,975	$75,079
4		$530,000		$360,000	$78,025	$91,975	$70,167
5		$530,000	$40,000	$360,000	$78,025	$51,975	$37,058
6		$530,000		$360,000	$116,043	$53,957	$35,954
7		$530,000		$360,000	$116,043	$53,957	$33,602
8		$530,000		$360,000	$116,043	$53,957	$31,403
9		$530,000		$360,000	$116,043	$53,957	$29,349
10		$530,000	($250,000)	$360,000	$116,043	$303,957	$154,516
	$1,110,340	$1,700,000	4.1	24%	62.3%	24.4%	**$493,420**
	Total Cost	**Total Savings**	**SPB (yrs)*** **	**ROI**	**IRR**	**MIRR**	**Net LCC Savings**

Chiller saves an additional $84,000/yr for 10 years after the study period, $840,000

* = At end of study period (straight line depreciated)
** = End of year convention for all expenses, except initial construction expenses are at start of year 1
*** = Simple payback does not consider benefits or costs beyond the initial payback period, or the time value of money

Appendix I: Financing Methods – Details

Private Loan Financing

Private borrowing involves obtaining a loan from a private lending institution such as a bank. When borrowing from a bank or other private entity, hospitals can also work with lending institutions to develop the loan package most suited to their investment strategy. For instance, a hospital can work with the lender to tailor a loan that avoids negative cash flows early, allows the efficiency project to just break even or returns some other pre-designated rate of return.

Table 17 provides an example of an energy efficiency investment financed through private borrowing. In this case, the energy efficiency investment costs $200,000 and returns energy cost savings of $40,000 annually. Most private loans have a shorter term and larger down payment; this example assumes a 20 percent down payment and a 7 percent interest rate over 120 months. That means the loan payments are $22,293 annually.[16] The annual energy cost savings are greater than the annual loan payments, so the investment returns a positive cash flow for the hospital ($17,707 annually). At the end of 10 years on a life-cycle savings basis, the investment returns $118,258 in profits to the hospital. Through borrowing from a private agency, the hospital was able to implement the energy efficiency investment and immediately benefit from lower energy costs; the hospital could also use the positive cash flows to cover financing costs. (Note that the LCC savings, IRR and MIRR have changed from the internal financing option, but the other measures are unchanged.)

Private Loan Financing Advantages

- Loans can be used to finance large, comprehensive energy efficiency projects that are beyond the financial resources available in operating and capital budgets.
- Energy efficiency investments can be undertaken now rather than later when cash becomes available. Loan financing, therefore, enables the hospital to immediately begin receiving the benefits of energy cost savings.
- Depreciation and interest expenses are tax deductible to for-profit hospitals.
- Loan terms can be structured to minimize initial negative cash flows or return some designated cash flow.

Private Loan Financing Disadvantages

- Loan financing requires cooperation with a lending institution, which may delay implementation of the project.
- The hospital assumes all of the project risk. Should the performance of the energy efficiency investment be less than anticipated, the hospital may incur cash flows that make repaying the loan difficult.
- The loan is accounted for on the hospital's balance sheet and may not be possible if the hospital has restrictive financial covenants as part of previous loan agreements. Energy efficiency investments, however, are often relatively small compared with other health care system balance sheet liabilities.

Public Loan Financing

Sometimes funding for an energy efficiency investment can be obtained through a loan from a state agency or state-formed authority rather than from a bank. Many states, including all four Northwest states, have funds available specifically for financing energy efficiency investments. From the hospital standpoint, borrowing from the state agency or authority is the same as borrowing from a bank, with the exception that the cost of borrowing (interest rate) is typically lower from the state. (When the state agency or authority pays for the loan by issuing bonds, then this option is similar to the municipal bond financing option described below.)

Table 18 provides an example of an energy efficiency investment financed with a loan from a state agency. In this case, since states can usually raise capital at a lower cost than private entities, the interest rate in this example is 5 percent as opposed to the 7 percent used in the private loan financing from a bank. As before, the energy efficiency investment costs $200,000 and returns energy cost savings of $40,000 annually. Assuming a 20 percent down payment and the 5 percent interest rate over 120 months, the loan payments are lower at $20,365 annually. When the loan cost is combined with the annual energy savings, the hospital realizes a net benefit of $19,635 per year. Over the 10-year life of the project, the total net present value of this project is $131,801. Because the hospital was able to finance the project at a lower rate from a government loan compared with a bank loan at 7 percent interest, the total project benefit for the

16. Again, for simplicity we assume that both energy savings and loan payments occur at the end of each year.

TABLE 17: PRIVATE LOAN FINANCING EXAMPLE

Equipment Cost	$200,000	Loan Period (yrs)	10	Discount Rate	7%	Annual Savings	$40,000
Cash %	20%	Study Period (yrs)	10	Loan Rate	7%		
Financed Amount	$160,000	Useful Life (yrs)	15	Inflation Rate	0%	Residual Value*	$66,667

	Baseline		Energy Efficient Alternate			Life-Cycle Cost Calculation	
Year**	Equipment	Energy Usage	Equipment	Energy Usage	Loan (or Lease) Expense	Net Annual Benefit (Cost)	PV Annual Benefit
Start	0		$40,000			($40,000)	($40,000)
1		$80,000		$40,000	$22,293	$17,707	$16,549
2		$80,000		$40,000	$22,293	$17,707	$15,466
3		$80,000		$40,000	$22,293	$17,707	$14,454
4		$80,000		$40,000	$22,293	$17,707	$13,509
5		$80,000		$40,000	$22,293	$17,707	$12,625
6		$80,000		$40,000	$22,293	$17,707	$11,799
7		$80,000		$40,000	$22,293	$17,707	$11,027
8		$80,000		$40,000	$22,293	$17,707	$10,306
9		$80,000		$40,000	$22,293	$17,707	$9,632
10		$80,000	($66,667)	$40,000	$22,293	$84,374	$42,891
	$262,928	$400,000	5	20%	45%	22.8%	**$118,258**
	Total Cost	**Total Savings**	**SPB (yrs)*** **	**ROI**	**IRR**	**MIRR**	**Net LCC Savings**

* = At end of study period (straight line depreciated)
** = End of year convention for all expenses, except initial construction expenses are at start of year 1
*** = Simple payback does not consider benefits or costs beyond the initial payback period, or the time value of money

TABLE 18: PUBLIC LOAN FINANCING EXAMPLE

Equipment Cost	$200,000	Loan Period (yrs)	10	Discount Rate	7%	Annual Savings	$40,000
Cash %	20%	Study Period (yrs)	10	Loan Rate	5%		
Financed Amount	$160,000	Useful Life (yrs)	15	Inflation Rate	0%	Residual Value*	$66,667

	Baseline		**Energy Efficient Alternate**			**Life-Cycle Cost Calculation**	
Year**	Equipment	Energy Usage	Equipment	Energy Usage	Loan (or Lease) Expense	Net Annual Benefit (Cost)	PV Annual Benefit
Start	0		$40,000			($40,000)	($40,000)
1		$80,000		$40,000	$20,365	$19,635	$18,351
2		$80,000		$40,000	$20,365	$19,635	$17,150
3		$80,000		$40,000	$20,365	$19,635	$16,028
4		$80,000		$40,000	$20,365	$19,635	$14,980
5		$80,000		$40,000	$20,365	$19,635	$14,000
6		$80,000		$40,000	$20,365	$19,635	$13,084
7		$80,000		$40,000	$20,365	$19,635	$12,228
8		$80,000		$40,000	$20,365	$19,635	$11,428
9		$80,000		$40,000	$20,365	$19,635	$10,680
10		$80,000	($66,667)	$40,000	$20,365	$86,302	$43,872

	$243,646	$400,000	5	20%	49.7%	23.8%	**$131,801**
	Total Cost	**Total Savings**	**SPB (yrs)*** **	**ROI**	**IRR**	**MIRR**	**Net LCC Savings**

* = At end of study period (straight line depreciated)
** = End of year convention for all expenses, except initial construction expenses are at start of year 1
*** = Simple payback does not consider benefits or costs beyond the initial payback period, or the time value of money

hospital is higher. Again, this benefit is reflected only in the LCC calculation, the IRR and the MIRR, as the other measures remain unchanged from the Private Loan option.

Public Loan Financing Advantages

- Interest costs will generally be lower, as public agencies have a lower cost of raising capital than do banks.
- Loans can be used to finance large, comprehensive energy efficiency projects that are beyond the financial resources available in operating and capital budgets.
- Energy efficiency investments can be undertaken now rather than later when cash becomes available. Loan financing, therefore, enables the hospital to immediately begin receiving energy cost savings rather than delaying the project until capital can be raised through other means.
- Depreciation and interest expenses are tax deductible for for-profit hospitals.
- Loan terms can be structured to minimize initial negative cash flows or return some designated cash flow.

Public Loan Financing Disadvantages

- Loan financing requires applying to a particular government loan program, which may delay implementation of the project if there is an extensive application process.
- The hospital assumes all of the project risk. Should the performance of the energy efficiency investment be less than anticipated, the hospital may incur cash flows that make repaying the loan difficult.
- Access to some public financing sources is limited to public or nonprofit institutions.
- The loan is accounted for on the hospital's balance sheet, and may not be possible if the hospital has restrictive financial covenants as part of previous loan agreements.

Revolving Loan Funds

Many public organizations have established "revolving funds" to finance energy efficiency investments. Future positive cash flows are returned to the fund to pay off the original investment and finance additional energy efficiency projects. Revolving funds make energy efficiency a line item in the budget instead of an expense item in the operating budget. As such, they give energy efficiency investments a stronger sense of permanency and facilitate long range planning. For example, in 1984 the city of Phoenix, Arizona, used $500,000 a year (the maximum annual contribution). The city estimated that the fund has financed retrofits that have resulted in $18 million of energy cost savings from 1978 to 1992. It is estimated that total energy cost savings from 1978 to 2002 will be approximately $42.6 million.

Source: "Best Practices — The Revolving Energy Funds," San Diego Regional Energy Office website, www.sdenergy.org.

Self-Issued Bond Financing

The economics of self-issued bond financing are straightforward. The hospital receives money by selling bonds to investors and agrees to pay back that money plus interest at a pre-determined time. Hospitals must conduct a thorough financial feasibility analysis to demonstrate the project's ability to generate cash flows sufficient to cover all interest and principal payments to bondholders. In general, self-issued bond financing is more suitable for large, more expensive energy efficiency investments. The term of the bond cannot exceed the effective useful life of the energy-efficient measures or project.

Table 19 gives an example of self-issued bond financing with a for-profit hospital so that the interest paid on the bond will be taxable. This assumes that the energy efficiency investment is financed with a $160,000 bond issue (20 percent upfront costs) that pays 7 percent interest annually for 10 years, at which time the bond principal is repaid. As noted earlier, since bonds are typically issued for larger amounts (a million dollars or more), a $200,000 equipment purchase utilizing bond financing would likely be only one part of a much larger bond sale.

TABLE 19: BOND FINANCING EXAMPLE

Equipment Cost	$200,000	Loan Period (yrs)	10	Discount Rate	7%	Annual Savings	$40,000
Cash %	20%	Study Period (yrs)	10	Loan Rate	5%		
Financed Amount	$160,000	Useful Life (yrs)	15	Inflation Rate	0%	Residual Value*	$66,667

	Baseline		Energy Efficient Alternate			Life-Cycle Cost Calculation	
Year**	Equipment	Energy Usage	Equipment	Energy Usage	Bond Payments	Net Annual Benefit (Cost)	PV Annual Benefit
Start	0		$40,000			($40,000)	($40,000)
1		$80,000		$40,000	$11,200	$28,800	$26,916
2		$80,000		$40,000	$11,200	$28,800	$25,155
3		$80,000		$40,000	$11,200	$28,800	$23,509
4		$80,000		$40,000	$11,200	$28,800	$21,971
5		$80,000		$40,000	$11,200	$28,800	$20,534
6		$80,000		$40,000	$11,200	$28,800	$19,191
7		$80,000		$40,000	$11,200	$28,800	$17,935
8		$80,000		$40,000	$11,200	$28,800	$16,762
9		$80,000		$40,000	$11,200	$28,800	$15,665
10		$80,000	($66,667)	$40,000	$171,200	($64,533)	($32,805)
	$312,000	$400,000	5.00	20%	70.9%	17.6%	**$114,833**
	Total Cost	**Total Savings**	**SPB (yrs)*** **	**ROI**	**IRR**	**MIRR**	**Net LCC Savings**

* = At end of study period (straight line depreciated)
** = End of year convention for all expenses, except initial construction expenses are at start of year 1
*** = Simple payback does not consider benefits or costs beyond the initial payback period, or the time value of money

Self-issued bonds can also be tax-exempt if issued by a not-for-profit hospital. Table 20 shows an example of how tax-exempt bonds affect future cash flows and the project's net present value. As shown, the interest rate on tax-exempt bonds is less (5 percent) than taxable bonds (7 percent) and the assumption of a 7 percent discount rate is maintained. As a result of the tax-exempt bond status, the life-cycle savings of a $200,000 energy efficiency investment (20 percent upfront costs) that yields energy cost savings of $40,000 annually for 10 years is $137,309, compared to $114,833 using taxable bonds.

TABLE 20: TAX-EXEMPT SELF-ISSUED BOND FINANCING EXAMPLE

Equipment Cost	$200,000	Loan Period (yrs)	10	Discount Rate	7%	Annual Savings	$40,000
Cash %	20%	Study Period (yrs)	10	Loan Rate	5%		
Financed Amount	$160,000	Useful Life (yrs)	15	Inflation Rate	0%	Residual Value*	$66,667

	Baseline		Energy Efficient Alternate			Life-Cycle Cost Calculation	
Year**	Equipment	Energy Usage	Equipment	Energy Usage	Bond Payments	Net Annual Benefit (Cost)	PV Annual Benefit
Start	0		$40,000			($40,000)	($40,000)
1		$80,000		$40,000	$8,000	$32,000	$29,907
2		$80,000		$40,000	$8,000	$32,000	$27,950
3		$80,000		$40,000	$8,000	$32,000	$26,122
4		$80,000		$40,000	$8,000	$32,000	$24,413
5		$80,000		$40,000	$8,000	$32,000	$22,816
6		$80,000		$40,000	$8,000	$32,000	$21,323
7		$80,000		$40,000	$8,000	$32,000	$19,928
8		$80,000		$40,000	$8,000	$32,000	$18,624
9		$80,000		$40,000	$8,000	$32,000	$17,406
10		$80,000	($66,667)	$40,000	$168,000	($61,333)	($31,179)
	$280,000	$400,000	5	20%	79.2%	18.1%	**$137,309**
	Total Cost	**Total Savings**	**SPB (yrs)*** **	**ROI**	**IRR**	**MIRR**	**Net LCC Savings**

* = At end of study period (straight line depreciated)
** = End of year convention for all expenses, except initial construction expenses are at start of year 1
*** = Simple payback does not consider benefits or costs beyond the initial payback period, or the time value of money

Self-Issued Bond Financing Advantages

- The hospital retains all positive cash flows.
- Bonds allow hospitals to amortize capital costs over the effective useful life of the energy efficiency project as opposed to a 100 percent cash transaction or loans with large down payments.
- Bonds impose interest and other costs on hospitals, but an energy efficiency project that begins quickly can more effectively offset these costs.
- Bond issues can generate a large amount of financial capital and allow hospitals to undertake large, comprehensive energy efficiency projects on a more cost-effective basis. Piecemeal energy efficiency retrofits and cream skimming are avoided.

Self-Issued Bond Financing Disadvantages

- The capital investment is reported on the hospital's balance sheet. This may pose problems for hospitals near their maximum debt capacity or hospitals that have financial arrangements with restrictive covenants.
- The hospital assumes all of the risk of the energy efficiency project. Should the performance of the energy efficiency investment be less than anticipated, the hospital may incur cash flows that make repaying the loan difficult.
- Bond deals are complex financial arrangements; bond issuance can take several months or even years. In addition, bonds are costly and involve issuance fees and often legal and financial advice.

Municipal Bond Financing

Municipal bonds are issued by state or local governments and generally are used to pay for projects that clearly contribute to the public good. While the most common applications are for roads and schools, these types of bonds can also be used to finance hospital improvements. A government agency would issue the bond to raise money for energy efficiency improvements, for example, and then the hospital would make payments to the issuing agency to cover the loan over the bond period. Since the government issues the bond, the interest payments are tax-exempt.

Table 21 shows an example of a project financed with a municipal bond and assumes that the hospital is responsible for repaying the loan. The resulting payments are identical to the tax-exempt self-issued bond example shown in Table 20. As a result of the tax-exempt bond status and resulting lower interest rate, the Life-cycle savings of a $200,000 energy efficiency investment with 20 percent upfront costs that yields energy cost savings of $40,000 annually for 10 years is $137,309.

Municipal Bond Financing Advantages

- Interest payments are tax-exempt, making these bonds attractive for certain investors.
- Bonds allow hospitals to amortize capital costs over the effective useful life of the energy efficiency project as opposed to a 100 percent cash transaction or loans with large down payments.
- Bonds impose interest and other costs on hospitals, but an energy efficiency project that begins quickly can more effectively offset these costs through the energy savings created by the project.
- Bond issues can generate a large amount of financial capital and allow hospitals to undertake large, comprehensive energy efficiency projects on a more cost effective basis.

Municipal Bond Financing Disadvantages

- The capital investment is reported on the hospital's balance sheet, which may be a disadvantage for hospitals near their maximum debt capacity.
- The hospital assumes all of the risk of the energy efficiency project. Should the performance of the energy efficiency investment be less than anticipated, the hospital may incur cash flows that make repaying the loan difficult.
- Issuing public bonds is subject to political pressures and consequently may be a longer process than self-issued bonds or private loan financing.

TABLE 21: MUNICIPAL BOND FINANCING EXAMPLE

Equipment Cost	$200,000	Loan Period (yrs)	10	Discount Rate	7%	Annual Savings	$40,000
Cash %	20%	Study Period (yrs)	10	Loan Rate	5%		
Financed Amount	$160,000	Useful Life (yrs)	15	Inflation Rate	0%	Residual Value*	$66,667

	Baseline		Energy Efficient Alternate			Life-Cycle Cost Calculation	
Year**	Equipment	Energy Usage	Equipment	Energy Usage	Bond Payments	Net Annual Benefit (Cost)	PV Annual Benefit
Start	0		$40,000			($40,000)	($40,000)
1		$80,000		$40,000	$8,000	$32,000	$29,907
2		$80,000		$40,000	$8,000	$32,000	$27,950
3		$80,000		$40,000	$8,000	$32,000	$26,122
4		$80,000		$40,000	$8,000	$32,000	$24,413
5		$80,000		$40,000	$8,000	$32,000	$22,816
6		$80,000		$40,000	$8,000	$32,000	$21,323
7		$80,000		$40,000	$8,000	$32,000	$19,928
8		$80,000		$40,000	$8,000	$32,000	$18,624
9		$80,000		$40,000	$8,000	$32,000	$17,406
10		$80,000	($66,667)	$40,000	$168,000	($61,333)	($31,179)
	$280,000	$400,000	5	20%	79.2%	18.1%	**$137,309**
	Total Cost	**Total Savings**	**SPB (yrs)*** **	**ROI**	**IRR**	**MIRR**	**Net LCC Savings**

* = At end of study period (straight line depreciated)
** = End of year convention for all expenses, except initial construction expenses are at start of year 1
*** = Simple payback does not consider benefits or costs beyond the initial payback period, or the time value of money

Operating Lease

Under an operating lease, the lessee rents the use of the equipment from the lessor. An operating lease must satisfy the following four conditions:[17]

1. Ownership of the equipment cannot transfer automatically to the lessee at the end of the lease period.
2. The lessee is not given the option of purchasing the equipment for a bargain price at the end of the agreement.
3. The lease term does not exceed 75 percent of the useful life of the equipment.
4. The net present value of the lease payments is less than 90 percent of the fair market value of the equipment.

17. From Statement of Financial Accounting Standards No. 13: Accounting For Leases, Financial Accounting Standards Board, p. 8, November 1976.

Under this agreement, the lessor retains ownership of the equipment at the end of the lease period but allows the lessee to renew the agreement or purchase the equipment at its residual value.

Since the lessee does not own the equipment, an operating lease is considered an off-balance, sheet financing mechanism, and lease payments are considered part of normal operating expenses rather than a debt obligation. If the equipment has a significant amount of value at the end of the lease period, then the lease agreement can likely be considered an operating lease (as opposed to a capital lease, discussed below) and in turn an off-balance-sheet expense. The lessee cannot claim depreciation expenses under this type of arrangement, however, since s/he does not have an equity stake in the equipment.

TABLE 22: OPERATING LEASE EXAMPLE

Equipment Cost	$40,000	Loan Period (yrs)	5	Discount Rate	7%	Annual Savings	$40,000
Cash %	20%	Study Period (yrs)	10	Loan Rate	10%	Lease NPV	$99,490
Financed Amount	$160,000	Useful Life (yrs)	15	Inflation Rate	0%	75% of Useful Life (yrs)	11.3
	Baseline		**Energy Efficient Alternate**			**Life-Cycle Cost Calculation**	
Year**	Equipment	Energy Usage	Equipment	Energy Usage	Lease Payments	Net Annual Benefit (Cost)	PV Annual Benefit
Start	0		$40,000		$24,265	($64,265)	($64,265)
1		$80,000		$40,000	$24,265	$15,735	$14,706
2		$80,000		$40,000	$24,265	$15,735	$13,744
3		$80,000		$40,000	$24,265	$15,735	$12,845
4		$80,000		$40,000	$24,265	$15,735	$12,004
5		$80,000	($26,667)	$40,000	$—	$66,667	$47,532
	$161,324	$200,000	N/A	N/A	21.8%	17.1%	**$36,566**
	Total Cost	**Total Savings**	**SPB (yrs)*** **	**ROI**	**IRR**	**MIRR**	**Net LCC Savings**

* = At end of study period (straight line depreciated)
** = End of year convention for all expenses, except initial construction expenses are at start of year 1
*** = Simple payback does not consider benefits or costs beyond the initial payback period, or the time value of money

Table 22 gives an example of an operating lease using the earlier example of equipment costing $200,000. Note that lease payments are paid at the beginning of each period while savings do not accrue until the end of each year. Over the course of the lease the net present value of the lease payments totals $99,490, which is about 62 percent of the initial equipment cost. Since this is less than the 90 percent threshold level, this example meets one of the four criteria for an operating — as opposed to a capital lease.

Operating Lease Advantages

- Kept off the balance sheet, lease payments considered an operating expense.
- Since not counted as debt, does not limit ability to borrow for other projects.
- Lower investment risk, as hospital does not own equipment.
- Lower monthly payments relative to a capital lease.

Operating Lease Disadvantages

- No depreciation tax benefit to for-profit hospitals.
- Complicated contracting and tax implications — get an accountant involved early in the process.

Lease Options

A common variation on the standard lease is a lease with a purchase option at the end of the lease period. With a lease option, the lease is in place for a fixed period and then the lessee has the option to purchase the equipment for the fair market value at the end of the lease period.

The basic advantages and disadvantages of a lease option are generally the same as those mentioned above. An important advantage of a lease option is the eligibility for tax credits that are not applicable to the other lease options. In particular, in Oregon the Business Energy Tax Credit (BETC) can be applied to a lease option agreement, with the tax credit going to the leasing company. This benefit provides some leverage to the hospital to negotiate a more favorable leasing arrangement with the company receiving the benefit. If a hospital is a nonprofit (and therefore cannot otherwise benefit from the tax credit), it avoids the time and effort needed to find a pass-through partner to take advantage of the BETC.

The following tables compare two different leasing agreements using our same example of equipment costing $200,000 with energy savings of $40,000 annually and an equipment useful life of 10 years. Table 23 shows a lease for a five-year period that is renewed for a second five years at the end of the first lease. Renewing the lease to cover the entire 10-year study period yields a life-cycle savings of $82,049. Table 24 shows the same equipment under a lease option, with the purchase option exercised at the end of the five-year lease period. In this example, the purchase price of $106,667 reflects the remaining market value of the equipment after five years. With the lease option, the life-cycle savings of this arrangement is $92,327. Comparing these two lease agreements, the lease option is the preferred choice due to the slightly higher net present value of the project net benefits.

Lease Option Advantages

- Eligible for some tax credits, particularly Oregon's Business Energy Tax Credit.
- Kept off balance sheet, lease payments considered an operating expense.
- Since not counted as debt, does not limit ability to borrow for other projects.
- Lower investment risk, as hospital does not own equipment (at least during leasing period). Keeps options flexible in terms of equipment purchase and/or lease renewal.
- Lower monthly payments relative to a capital lease.

Lease Option Disadvantages

- Limited depreciation tax benefit (depends on remaining equipment value if purchased).
- Complicated contracting and tax implications — get an accountant involved early in the process.

18. For simplicity, we have assumed a constant rate of depreciation so that the equipment value has declined to 67 percent after one-third of the useful life has expired. In reality, due to tax credits and accelerated depreciation options that may be available, the purchase price after 5-years may be significantly lower than what is used in this example, which would increase the benefit of the lease-option relative to a standard operating lease.

TABLE 23: OPERATING LEASE WITH RENEWAL

Equipment Cost	$40,000	Loan Period (yrs)	5	Discount Rate	7%	Annual Savings	$40,000
Cash %	20%	Study Period (yrs)	10	Loan Rate	10%	Lease NPV	$99,490
Financed Amount	$160,000	Useful Life (yrs)	15	Inflation Rate	0%	75% of Useful Life (yrs)	11.3

	Baseline		Energy Efficient Alternate			Life-Cycle Cost Calculation	
Year**	Equipment	Energy Usage	Equipment	Energy Usage	Lease Payments	Net Annual Benefit (Cost)	PV Annual Benefit
Start	0		$40,000		$24,265	($64,265)	($64,265)
1		$80,000		$40,000	$24,265	$15,735	$14,706
2		$80,000		$40,000	$24,265	$15,735	$13,744
3		$80,000		$40,000	$24,265	$15,735	$12,845
4		$80,000		$40,000	$24,265	$15,735	$12,004
5 (Renewal)		$80,000		$40,000	$18,931	$21,069	$15,022
6		$80,000		$40,000	$18,931	$21,069	$14,039
7		$80,000		$40,000	$18,931	$21,069	$13,120
8		$80,000		$40,000	$18,931	$21,069	$12,262
9		$80,000		$40,000	$18,931	$21,069	$11,460
10		$80,000	($13,333)	$40,000	$—	$53,333	$27,112
	$255,981	$400,000	N/A	N/A	25.8%	16.2%	**$82,049**
	Total Cost	**Total Savings**	**SPB (yrs)*** **	**ROI**	**IRR**	**MIRR**	**Net LCC Savings**

* = At end of study period (straight line depreciated)
** = End of year convention for all expenses, except initial construction expenses are at start of year 1
*** = Simple payback does not consider benefits or costs beyond the initial payback period, or the time value of money

TABLE 24: LEASE WITH PURCHASE OPTION

Equipment Cost	$40,000	Loan Period (yrs)	5	Discount Rate	7%	Annual Savings	$40,000
Cash %	20%	Study Period (yrs)	10	Lease Rate	10%	Lease NPV	$99,490
Financed Amount	$160,000	Useful Life (yrs)	15	Inflation Rate	0%	Value @ end of Yr 5	$106,667

	Baseline		Energy Efficient Alternate			Life-Cycle Cost Calculation	
Year**	Equipment	Energy Usage	Equipment	Energy Usage	Lease Payments	Net Annual Benefit (Cost)	PV Annual Benefit
Start	0		$40,000		$24,265	($64,265)	($64,265)
1		$80,000		$40,000	$24,265	$15,735	$14,706
2		$80,000		$40,000	$24,265	$15,735	$13,744
3		$80,000		$40,000	$24,265	$15,735	$12,845
4		$80,000		$40,000	$24,265	$15,735	$12,004
5		$80,000	$106,667	$40,000	$—	($66,667)	($47,532)
6		$80,000		$40,000	$—	$40,000	$26,654
7		$80,000		$40,000	$—	$40,000	$24,910
8		$80,000		$40,000	$—	$40,000	$23,280
9		$80,000		$40,000	$—	$40,000	$21,757
10		$80,000	($66,667)	$40,000	$—	$106,667	$54,224
	$267,991	$400,000	N/A	N/A	22.6%	14.3%	**$92,327**
	Total Cost	**Total Savings**	**SPB (yrs)*** **	**ROI**	**IRR**	**MIRR**	**Net LCC Savings**

* = At end of study period (straight line depreciated)
** = End of year convention for all expenses, except initial construction expenses are at start of year 1
*** = Simple payback does not consider benefits or costs beyond the initial payback period, or the time value of money

Capital Lease

Under a capital lease (sometimes referred to as a financing lease), the lessee pays to own the equipment on a monthly basis throughout the lease period, much in the same way that a hospital would pay on a standard capital improvement loan. At the end of the lease period, there is typically an agreement for a final payment (usually small) by which the lessee acquires ownership.

Since monthly payments by the lessee go toward interest and principal, a capital lease is usually considered debt. And because the monthly payments include some amount for principal, the payments are usually higher than payments under an operating lease. With a capital lease, the lessee owns the equipment and can therefore claim the tax benefit of depreciation.

Table 25 demonstrates a capital lease using the same example discussed earlier. Equipment costing $200,000 is leased on an annual basis at $25,373, and the expected energy savings is $40,000 per year over the 10-year life of the equipment. Note that the present discounted value of the lease payments equals $178,209, or 89 percent of the $160,000 financed equipment cost (assuming a discount rate of 7 percent). Given the size of the annual payments, the lessee effectively purchases the equipment over the lease term in an arrangement very similar to that of a standard loan. As shown in the far right column of Table 25, the Life-Cycle Savings of the net payments (energy savings minus lease payments) is greater than zero, which makes this arrangement a net benefit to the hospital.

Capital Lease Advantages

- Ownership of equipment is assured.
- Can claim depreciation expenses on taxes.

Capital Lease Disadvantages

- Considered as debt on balance sheet, limits ability to borrow for other projects.
- Hospital assumes risk of investment.
- Higher monthly payment relative to an operating lease.
- Complicated contracting and tax implications — get an accountant involved early in the process.

TABLE 25: CAPITAL LEASE EXAMPLE

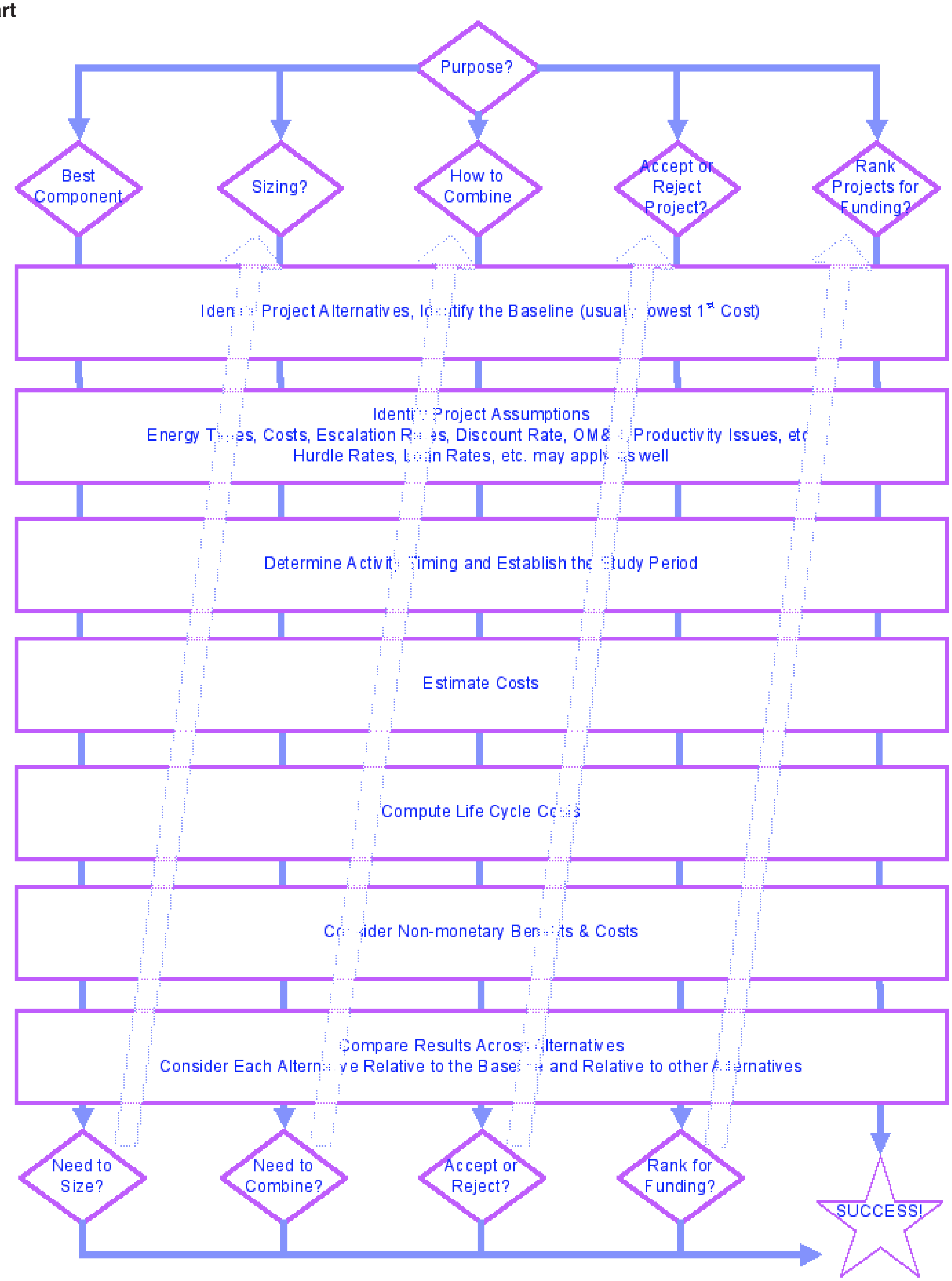
Equipment Cost	$200,000	Lease Period (yrs)	10	Discount Rate	7%	Annual Savings	$40,000
Cash %	20%	Study Period (yrs)	10	Capital Lease Rate	10%	Lease NPV	$178,209
Lease Amount	$160,000	Useful Life (yrs)	15	Inflation Rate	0%	75% of Useful Life (yrs)	11

	Baseline		Energy Efficient Alternate			Life-Cycle Cost Calculation	
Year**	Equipment	Energy Usage	Equipment	Energy Usage	Lease Payments	Net Annual Benefit (Cost)	PV Annual Benefit
Start	0		$40,000		$25,373	($65,373)	($65,373)
1		$80,000		$40,000	$25,373	$14,627	$13,670
2		$80,000		$40,000	$25,373	$14,627	$12,776
3		$80,000		$40,000	$25,373	$14,627	$11,940
4		$80,000		$40,000	$25,373	$14,627	$11,159
5		$80,000		$40,000	$25,373	$14,627	$10,429
6		$80,000		$40,000	$25,373	$14,627	$9,747
7		$80,000		$40,000	$25,373	$14,627	$9,109
8		$80,000		$40,000	$25,373	$14,627	$8,513
9		$80,000		$40,000	$25,373	$14,627	$7,956
10		$80,000	($66,667)	$40,000	$—	$106,667	$54,224
	$293,729	$400,000	5	20%	23.7%	16.2%	**$84,150**
	Total Cost	**Total Savings**	**SPB (yrs)*** **	**ROI**	**IRR**	**MIRR**	**Net LCC Savings**

* = At end of study period (straight line depreciated)
** = End of year convention for all expenses, except initial construction expenses are at start of year 1
*** = Simple payback does not consider benefits or costs beyond the initial payback period, or the time value of money

APPENDIX II:
LIFE-CYCLE ANALYSIS TOOLS

Flow Chart



Data Sheet

(1 for each Alternative)

Project Title: ______________________________

Location: ______________________________

Contact: ______________________________

Building Size: ______________________________

Case (Baseline or Alternative): ______________________________

Description: ______________________________

____

____

Capital Costs:

Initial Capital Costs | Replacements

Description	Amount	Description	Interval	Amount

Energy Costs:

Electricity: ____________ Natural Gas: ____________ Other: ____________

Non-Energy Costs:

Annual O&M | Non-Annual O&M

Description	Amount	Description	Yrs from Start	Amount

Other Expenses:

Annual | Non-Annual

Description	Amount	Description	Yrs from Start	Amount

Data Sheet

(1 for each Alternative)

Case (Baseline or Alternative): ______________________________

Financial Assumptions:

Period of Analysis	Yrs	General Inflation	%
Discount Rate	%	Electricity Inflation	%
Loan Interest Rate	%	Natural Gas Inflation	%
Loan Term	Yrs	O&M Inflation	%
Loan to Value	%	Capital Purchases Inflation	%
Capitalization Rate	%	Lease Income Inflation	%

Productivity Adjustments:

Space Description	Size	Salary/Sq.Ft./Yr	Productivity %	Impact Amount

Lease Income:

Tenant	Area Leased	Lease Rate

Notes:

GLOSSARY

Beginning of Year Convention:
In order to simplify the calculation of multi-year life-cycle cost estimates, transactions such as construction costs, energy savings, etc., are assumed to all occur at the same point in time for any given year. If the point in time selected for all such transactions is the beginning of the year, then a "Beginning of Year Convention" has been adopted for the calculations.

Constant Dollars:
Dollars that have uniform purchasing power over time and that are not affected by general price inflation or deflation.

Current Dollars:
Dollars that do not have uniform purchasing power over time and that are affected by general price inflation or deflation.

Discount Rate:
The rate of interest that balances an investor's time value of money.

End of Year Convention:
In order to simplify the calculation of multi-year life-cycle cost estimates, transactions such as construction costs, energy savings, etc., are assumed to all occur at the same point in time for any given year. If the point in time selected for all such transactions is the end of the year, then an "End of Year Convention" has been adopted for the calculations.

Future Value:
The amount of money that an investment with a fixed, compounded interest rate will grow to by some future date. The investment can be a single sum deposited at the beginning of the first period, a series of equally spaced payments (an annuity) or both. Since money has time value, we naturally expect the future value to be greater than the present value. The difference between the two depends on the number of compounding periods involved and the going interest rate. The present value must be escalated to its future value.

Hurdle Rate:
The required rate of return in a discounted cash flow analysis above which an investment makes sense and below which it does not. It should generally equal the organization's incremental cost of capital. Hurdle rates are set by each organization.

Inflation (or deflation):
A special case of the future value of money. When inflation occurs, the value of a dollar in the future is reduced as compared to a dollar today. Often this works counter to the interest that can be earned by investing a dollar for a period of time. For example, if we invest a dollar at a nominal interest rate of 5 percent, but the inflation rate is 3 percent our investment escalates at a real interest rate of only 2 percent. To simplify calculations involving inflation, escalation and discounting, often real rates are used instead of nominal rates. This allows the use of constant dollars for many future values instead of having to adjust all future values for inflation. Thus, only those future values that vary at a rate different than the normal inflation rate have to be adjusted for inflation, instead of all future values. The alternative to this method is to consider all values to be in current dollars for their time period and to adjust them all for inflation.

Initial Investment Cost:
Any cost of creation of a facility prior to its occupation.

Interest:
A charge for borrowing money, usually stated as a percentage of the amount borrowed over a specific period of time. Simple interest is computed only on the original amount borrowed. It is the return on that principal for one time period. In contrast, compound interest is calculated each period on the original amount borrowed plus all unpaid interest accumulated to date. Compound interest is always assumed in TVM problems.

Life-cycle Cost:
A sum of all costs of creation and operation of a facility over a period of time.

Life-cycle Cost Analysis:
A technique used to evaluate the economic consequences over a period of time of mutually exclusive project alternatives.

Loan Amortization:
A method for repaying a loan in equal installments. Part of each payment goes toward interest, and any remainder is used to reduce the principal. As the balance of the loan is gradually reduced, a progressively larger portion of each payment goes toward reducing principal.

Maintenance Cost:
Any cost of scheduled upkeep of a building, building system or building component.

Metric:
A calculated term or enumeration representing some aspect of a system, function or other measurable quality. A metric is a characteristic that changes in some predictable way with increased human influence.

Mid-year Convention:
In order to simplify the calculation of multi-year life-cycle cost estimates, transactions such as construction costs, energy savings, etc., are assumed to all occur at the same point in time for any given year. If the point in time selected for all such transactions is the middle of the year, then a "Mid-Year Convention" has been adopted for the calculations.

Nominal Discount Rate:
A discount rate that includes the rate of inflation.

Operating Cost:
Any cost of the daily function of a facility.

Payments:
A series of equal, evenly spaced cash flows. In TVM applications, payments must represent all outflows (negative amount) or all inflows (positive amount).

(Energy) Performance Contracting:
A construction method that allows a facility to complete energy-saving improvements within an existing budget by financing them with money saved through reduced utility expenditures. Facilities make no up-front investments and instead finance projects through guaranteed annual energy savings.

Periods:
Evenly spaced intervals of time. They are intentionally not stated in years, since each interval must correspond to a compounding period for a single amount or a payment period for an annuity.

Present Value:
An amount today that is equivalent to a future payment, or series of payments, that has been discounted by an appropriate interest rate. The future amount can be a single sum that will be received at the end of the last period, as a series of equally spaced payments (an annuity) or both. Since money has time value, the present value of a promised future amount is worth less the longer you have to wait to receive it.

Real Discount Rate:
A discount rate that excludes the rate of inflation.

Repair Cost:
Any cost of unscheduled upkeep of a building system that does not require replacement of the entire system.

Replacement Cost:
Any cost of scheduled replacement of a building system or component that has reached the end of its design life.

Residual Value:
The value of a building or building system at the end of the study period.

Study Period:
The time period over which a life-cycle cost analysis is performed.

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