# Energy Efficiency's Role in Business Investment

*Christopher Russell, Energy Pathfinder Management Consulting*

**ABSTRACT**

Rates of return are used to measure the investment performance of most assets, including stocks, bonds, and mutual funds, as well as the cost of borrowing money. The exception is investment in energy efficiency proposals, where simple payback is too often used to support recommendations that involve thousands or even millions of dollars. In any competition for capital investment funding, proposals that rely on simple payback measures may be at a disadvantage because their performance is not measured by the same yardstick used for other investment opportunities. Think of it this way: Who evaluates a mutual fund's performance by its simple payback?

Part 1 of this discussion presents a realistic energy improvement proposal. We discuss its investment performance in general terms. Part 2 offers a series of technical explanatory notes to support the Part 1 discussion. Overall, we seek clarity on a few points. What's wrong with simple payback? And if rates of return are a better tool, can that be proven? What's the difference between economic and financial performance, and how are these demonstrated for an energy efficiency investment? What exactly are the financial consequences of ignoring energy improvements? The findings from these questions should assist anyone who attempts to demonstrate the investment value of energy improvements, therefore convincing more business leaders to accept energy solutions of all description.

## Part 1: A Scenario for Discussion

The goal of industrial investors is to create new wealth by investing their capital in a business enterprise. When doing this, investors strike a balance between the speed and magnitude of investment returns. Annual capital investment programs seek optimized returns through investments that grow the firm's capacity to create wealth. For example, consider a proposed industrial energy efficiency project and its simple payback analysis as presented to the hypothetical XYZ Company:

| | |
|---|---|
| Project cost: | $1,000,000 |
| Annual energy savings: | $250,000 |
| Economic life: | 10 years |
| Simple payback: | 4 years |
| Investor's payback criterion: | 2 years or less |
| **Investor's conclusion:** | **Reject the proposal** |

Most of the variables needed for a robust financial analysis are omitted from simple payback calculations. Keep in mind that investors have other investment opportunities, both internal and external to the firm. So how does this proposal compare to all others? Investors need to know the following:

- **Both the speed and magnitude of returns**, using metrics that allow comparison to other ways to use the same investment capital. *Will this investment provide returns superior to other investment alternatives?*
- **Impact on the overall rate of return** of the business enterprise. *Will this investment improve the current overall rate of return realized by the firm's existing capital base?*
- **The cost of doing nothing.** Refusing an energy efficiency investment means committing to energy waste and a negative cash flow. *What are the implications of failing to invest?*

These questions describe an investment's potential to create wealth. In the case of "doing nothing," we want to determine the potential to destroy wealth through energy waste. "Capital recovery" describes wealth creation through new cash flow as the result of capital investment. Specifically, a business venture is obligated to achieve superior rates of capital recovery relative to other investment alternatives. While capital recovery is illustrated by a *rate* of return, the *magnitude* of returns are measured by cash flow. Simple payback fails to provide this insight (See NOTE 1: Why is Simple Payback Not Sufficient?).

Simple payback analysis (project cost divided by its annual energy savings) is entirely rooted in operating results, that is, before the impact of taxes and finance (See NOTE 2: Relevant Cash Flows). The analysis and outcome described above makes sense in light of the firm's organizational politics, if not its financial goals. Energy investments are perceived as "operations" issues that most corporate leaders will gladly delegate down to engineers and facility managers. These are middle managers that track budget dollars prior to tax and finance considerations, and therefore prior to profits. Profitability, which is measured by rates of return, is virtually irrelevant to these managers. Because it is developed from operating cash flows prior to taxes and finance, simple payback is the natural, if ill-chosen, investment metric of choice for the middle managers who are responsible for energy project choices.

Assuming XYZ Company's commitment to sustained business growth, capital investments should then be evaluated for two sequential criteria: economic and financial.

1. **Economic:** Will the proposal grow (or at least sustain) the business? If so, the proposed investment must generate wealth at a rate equal to or better than the capital recovery rate of the firm's existing capital.
2. **Financial:** Are the terms of project finance beneficial? The relevant measure for financial performance is free cash flow. Because it is a post-finance measure, free cash flow is the benefit that remains after any investment down-payment, operating expenses, and debt service paid to lenders.

The energy improvement project proposed to XYZ Company has a 10-year economic life, so the cash flow analysis is therefore a 10-year time frame (see NOTE 2: Relevant Cash Flows). A project with sufficient economic returns may not provide adequate financial performance if project financing terms are not favorable.

Keep in mind that the investor has other investment opportunities, both internal and external to the firm. How does the energy improvement proposal compare to all others? To answer this, we need a benchmark that compares this proposal's rate of return to other options. This analysis requires more data as shown in NOTE 3: Investment Parameters. The capital already invested in the hypothetical XYZ Company provides an 8.7 percent return on investment. This measure is derived from the financial statement and calculations shown in

NOTE 4: Calculating Capital Recovery. The firm's investors should want any additional investments to provide returns in excess of that 8.7 percent benchmark.

**Economic performance.** The relative profitability of an investment is given by the profitability index, which is the ratio of the present value of investment returns to the present value of investment outlays (see NOTE 5: Profitability Index). The profitability index for the energy improvement proposed to XYZ Company, compiled over the project's 10-year economic life, is as follows:

$$\text{Profitability Index} = \frac{\sum \text{Discounted Value of Investment Returns}}{\sum \text{Discounted Value of Investment Outlays}} = \frac{\$1{,}228{,}153}{\$1{,}000{,}000} = 1.2 \text{ in year 10}$$

Specifically, by the end of year 10, the cash flow from this investment not only returns the original $1 million investment, it creates new wealth that's equal to $228,153 in today's dollars.

**The economic cost of doing nothing.** The investors also have the option of refusing the energy improvement. This choice is also subject to investment analysis. By failing to invest $1 million in a specific energy improvement, the investors allow energy waste to continue and commit to 10 years' worth of avoidable cash flow. Because there is a negative cash flow to compare to a specified investment amount, this scenario describes capital recovery in reverse. But instead of measuring the profitability benefits, we measure the "unprofitability" of losses due to energy waste. For proof of this loss, look no further than the monthly checks written to the energy supplier.

By rejecting the proposed energy efficiency improvement, the investor has created $1 million in deferred expenses over a ten-year period. Energy expense—even the portion that's wasted—is tax deductible, so after-tax cash flow is relevant to this analysis. Also, remember that this example is a ten-year investment. The negative cash flow will deplete retained earnings. Depletion over the ten-year time frame will accrue to match, and then surpass, the $1 million value of the refused investment (See NOTE 6: Unprofitability Index).

An unprofitability analysis will determine (1) how long it takes for the $1 million investment value to be depleted through negative cash flow, and (2) how much additional capital is destroyed over the course of the deferred investment's economic life. The unprofitability index (UPI) is a ratio that describes the present value of after-tax cash outflow for energy waste (numerator) to the present value of the deferred investment amount:

$$\text{Unprofitability Index} = \frac{\sum \text{Discounted Value of After-Tax Economic Waste}}{\sum \text{Discounted Value of Nominal Investment Outlays}} = \frac{-\$1{,}056{,}783}{\$1{,}000{,}000} = -1.1 \text{ in year 10}$$

The unprofitability index (UPI) is negative, since the cash flow (after-tax economic waste) is negative. We also see that by the end of year ten, the failure to invest destroys not only the $1 million investment value, but also an additional $56,783 (in today's dollars). To avoid capital destruction, the firm needs to invest in this energy improvement.

**Financial performance.** A "good" investment should offer a rate of return superior to other alternatives. Financial performance is indicated by the bottom line cash flow after adjusting investment returns for depreciation, taxes, and third-party finance. The bottom line is free cash flow, which provides a specific internal rate of return (IRR). IRR describes the annualized effective compound rate of return realized by an investment over its lifetime. Stated differently,

IRR measures "how hard" an investment works at creating wealth. IRR allows the investor to critically evaluate the investment performance of dissimilar alternatives, such as stocks, bonds, mutual funds, and capital investment proposals.

NOTE 7 shows the derivation of internal rate of return for this investment after project finance. Over 10 years, IRR is 29 percent. We saw in NOTE 3 that one alternative was to put the money in an S&P 500 index mutual fund—which returns a mere 2.9 percent per annum over the last 10 years.

If XYZ Company rejects the proposed energy efficiency improvement, the $1 million capital is invested *somewhere*, even if it is a bank savings account. However, XYZ Company should seek a rate of return high enough to match the firm's overall rate of capital recovery PLUS compensate for the capital destruction due to this proposal's rejection. To compensate for energy waste, the firm needs to commit its $1 million to an investment that provides an internal rate of return of 10 percent or better. Why? Because the IRR is 10 percent on an investment of $1 million that returns an undiscounted $162,500 annually for ten years (See NOTE 6, Table 4). By rejecting the energy efficiency proposal, the firm must live with the consequences. Specifically, it will suffer negative cash flow that accrues over time, surpassing the value of the deferred $1 million investment in year nine and destroying an additional $56,783 by the end of year ten. In order to "remain whole," the alternative investment's rate of return must account for the additional capital destroyed. Such an investment must exceed a 10 percent rate of return. Any investment opportunities with a rate of return between 8.7 and 10 percent are now unsuitable. With higher rates of return comes the volatility of higher investment risk. By purposely sustaining its energy waste, the firm narrows its range of capital investment alternatives to opportunities with higher risk and volatility of performance.

## Conclusion: Putting It All Together

Recall that the hypothetical investment proposal presented here provided a four-year simple payback. If the investor required a payback of two years or less, they would dismiss this proposal. But at what cost? The findings from this discussion answer the questions of the astute investor, as posed at the beginning:

**What's wrong with simple payback?** It fails to describe the total value of returns over the economic life of the investment. It offers no way to compare investment performance of other options. It reveals nothing about the cost associated with rejecting the proposed investment.

**Why are rates of return a better indicator of investment performance?** In sum, these measures provide the investor with better decision-making insight. When used with the appropriate cash flow measure, the investor will understand how an energy efficiency proposal's performance compares to:

- The rate at which wealth is generated by existing invested capital
- The rate of return on other investment alternatives
- The rate (cost) of borrowing third-party capital
- The rate at which wealth is destroyed by failing to invest in the energy improvement

**How are the economic and financial performance demonstrated?** We saw economic returns demonstrated by the profitability index. Free cash flow (post finance) is the basis for internal

rate of return. Per economic analysis (the profitability index), investment capital is fully recovered in year nine, when evaluated by the firm's own rate of capital recovery. Note, however, that third-party finance accelerates the returns. Under the current lender's terms (80 percent of value financed at five percent compounded monthly for seven years), the IRR on free cash flow exceeds the firm's overall capital recovery rate in year six. The terms of finance allow the project to be fully amortized by the end of year seven; all free cash flow from that point on is new wealth.

**What's the risk of making this investment?** Investment risk is embodied in the timing of cash flows. If the investor in committed to the business for the long term (certainly more than the seven-year finance term), this investment is imperative. But if the owners intend to abandon the business (writing off the assets) at any time within the next seven years, then they should not make this investment. In that scenario, the owners commit to running the assets into the ground without improvement—"killing the goose" to get all the golden eggs now, at the expense of long-run returns. However, a more likely plan for divestiture is to sell the assets to a new owner/management team. If so, the current owners will have improved the income-producing capacity of their facility by adding this project to their asset base. The buyers are likely to offer a price based on capitalized income. Because of the greater net income made possible by efficient energy use, the capitalized enterprise value will be that much higher.

**What's the risk of NOT making this investment?** The "unprofitability index" (NOTE 6, Table 4) shows that rejecting this proposal results in destruction of the firm's capital, beginning immediately. The original $1 million investment value is depleted by year nine. By the end of year 10, $56,783 of additional existing capital is destroyed. "Destroyed" means income spent on avoidable energy waste instead of accruing to retained earnings.

**How does this investment compare to other ways to use the investment capital?** We saw above that the owner's best alternative investment would be to purchase shares in a mutual fund that has returned a 2.9 percent compound annual return over the past decade (NOTE 3). The internal rate of return on the free cash flow is 29 percent over ten years (NOTE 7, Table 5).

**How does this investment contribute to the competitiveness of the firm?** Recall from NOTE 3 that this firm competes in an industry with 10 percent overall growth rates. The financial IRR calculation shows that this investment, if leveraged with the third-party finance terms described here, will exceed 10 percent in year seven (see NOTE 7, Table 5). Once again, if the owners intend to remain invested in this firm through 10 years, they will increase the firm's capacity to create wealth by accepting the proposed energy efficiency improvement.

**Observations about simple payback.** Recall that this $1 million proposal yielded $250,000 in annual operating savings, a four-year payback. After adjusting for depreciation and taxes, the payback is 5.8 years. Then, after discounting future cash flows at the weighted average cost of capital, the initial investment is not entirely recovered until year eight, when the profitability index achieves parity (see NOTE 5, Table 3). Despite the discussion presented in this paper, simple payback will continue in widespread use. Care should be taken to communicate which cash flow is the basis for calculating payback. Avoid the temptation to calculate payback on the free cash flow remaining after project finance, because finance amortization has imposed an

artificial capital recovery structure that is relevant to the lender, not the investor. To understand this, see Table 5, Column H. A naïve calculation shows "simple payback" of the free cash flow occurring in year five, but in fact the investment capital is amortized over seven years and by definition is fully recovered over seven years.

A final note: all the results described above assume that energy prices will remain flat over the 10-year economic life of this investment. Each of these investment metrics will improve as energy prices rise (and/or as interest rates fall).

## Part 2: Supporting Analysis

---

**NOTE 1: Why is Simple Payback Not Sufficient?**

"Simple payback" is almost universally recognized and understood, but that doesn't mean that it is truly informative. Simple payback almost completely fails to answer the questions that an astute business investor would ask:

- **What's the magnitude of benefits offered by the investment?** Simple payback ignores benefits that accrue after the investment has paid for itself. Knowing the payback of a certain project tells you nothing about the cost of obtaining investment capital. It does not compare the project's returns to the profitability of the overall business. Nor does it compare the project returns to those provided by alternative investment opportunities such as stocks, bonds, or mutual funds. Payback is useful, to some extent, as a relative measure of investment risk. The quicker the payback, the less the risk.
- **What's the risk associated with this investment?** Simple payback helps the investor to decide whether or not to "walk away" from the proposed investment. In other words, if the calculated payback does not meet a prescribed threshold, the project is rejected. Unfortunately, in the case of energy efficiency improvements, walking away is not an option. The investor will outlay cash in either case: to pay for the energy efficiency upgrade, or to pay for excess energy that will be wasted. Simple payback provides no information about the cost of "doing nothing."
- **How does this investment compare to other ways to use the investment capital?** The investor always has alternatives to investing in energy efficiency projects. Whether it is a stock, bond, mutual fund, or an investment in the investor's own core business, each alternative delivers some rate of return. Because it does not measure rates of return, simple payback fails to allow comparisons with other investment opportunities.

---

**NOTE 2: Relevant Cash Flows**

The stages of a business process have incremental impacts on cash flow. In an industrial organization, cash flow is shaped first by operations that convert inputs into final products, then by the impact of depreciation and taxes, and finally by the payment and receipt of debt financing. Each stage of cash flows has a specific audience and purpose. These stages are relevant both to overall business performance and to individual investment evaluation.

**Table 1: Cash Flow Summary**

| | OPERATING PERFORMANCE | | | | ECONOMIC PERFORMANCE | | | | |
|---|---|---|---|---|---|---|---|---|---|
| A | B | C | D | E=C+D | F | G | H=E-F | I=(H-G)*tax | J=H-I+F |
| YEAR | NOMINAL INVESTMENT | NOMINAL ENERGY SAVINGS | NOMINAL O&M COST CHANGE | OPERATING INCOME & SALVAGE | DEPRECIATION CHARGE | BOOK LOSS See 1/ | TAXABLE INCOME | INCOME TAX 35.00% | NET INCOME |
| 0 | -$1,000,000 | | | | $0 | | | | |
| 1 | $0 | $250,000 | $0 | $250,000 | $25,641 | $0 | $224,359 | $78,526 | $171,474 |
| 2 | $0 | $250,000 | $0 | $250,000 | $25,641 | $0 | $224,359 | $78,526 | $171,474 |
| 3 | $0 | $250,000 | $0 | $250,000 | $25,641 | $0 | $224,359 | $78,526 | $171,474 |
| 4 | $0 | $250,000 | $0 | $250,000 | $25,641 | $0 | $224,359 | $78,526 | $171,474 |
| 5 | $0 | $250,000 | $0 | $250,000 | $25,641 | $0 | $224,359 | $78,526 | $171,474 |
| 6 | $0 | $250,000 | $0 | $250,000 | $25,641 | $0 | $224,359 | $78,526 | $171,474 |
| 7 | $0 | $250,000 | $0 | $250,000 | $25,641 | $0 | $224,359 | $78,526 | $171,474 |
| 8 | $0 | $250,000 | $0 | $250,000 | $25,641 | $0 | $224,359 | $78,526 | $171,474 |
| 9 | $0 | $250,000 | $0 | $250,000 | $25,641 | $0 | $224,359 | $78,526 | $171,474 |
| 10 | $0 | $250,000 | $0 | $250,000 | $25,641 | $743,590 | $224,359 | -$181,731 | $431,731 |

1/ "Book loss" is the balance of value that is not yet depreciated by the end of the economic life of the asset. This value is tax deductible. See NOTE 3.

- **Operating income is the measure of operating performance.** Operating performance measures how well inputs are being managed for revenue creation in any specific time period. These are "internal" activities which therefore exclude the impact of "external" influences such as taxes and debt service. Operating income is the result of subtracting operating expenses (typically including labor, materials, general & administrative costs, depreciation, and energy and other utilities) from revenue. Operating income is measured by current year activity, as reflected in the current year's operating budget.
- **Net income is a measure of economic performance.** Net income is operating cash flow adjusted for the impact of income tax, which is in turn derived from income adjustments due to depreciation charges. Net income is the relevant measure of new wealth to be evaluated for capital recovery performance. When future income values are discounted (reduced) by the WACC, the amount of the reduction represents the cost of capital while the remainder is equal to the initial investment plus any newly-created value. This is the essence of economic analysis: identifying investments that will create new value, thus raising the firm's overall capital recovery performance.
- **Free cash flow indicates financial performance.** Free cash flow is the value that remains after any debt service that may be issued to repay borrowed capital. Therefore, financial performance reflects the outcome of business leverage, or in effect, the ability to "use other people's money." If the business experiences no debt service, free cash flow is equal to net income.

These metrics describe the big picture investment performance of the firm. Economic investment analysis evaluates proposed asset performance relative to this big picture. While the worthiness of investment proposals is an economic question, the firm's actual commitment to any one proposal depends on the terms of project finance. What may be a "good" investment per

its economic performance may not be "good" (that is, have adequate profitability) if the lender's financing terms are not suitable.

**NOTE 3: Investment Parameters**

| | | |
|---|---|---|
| TOTAL CONSTRUCTION BUDGET: | $1,000,000 | In addition to equipment costs, the construction budget may include engineering and consulting fees, the net salvage value of old equipment being replaced, and various rebates or incentives. |
| ANNUAL ENERGY SAVINGS: | $250,000 | A four-year payback! |
| ECONOMIC LIFE OF THE PROPOSED ASSET: | 10 years | Economic life usually reflects the physical service life of the asset. |
| PERCENT OF TOTAL CONSTRUCTION BUDGET TO BE FINANCED: | 80% | This percentage is unique to every project, and reflects management discretion. |
| PROJECT FINANCE AMORTIZATION: | 7 YEARS | This is the length of time established by the lending agreement that finances the project. |
| ANNUAL PERCENTAGE RATE FOR FINANCE: | 5% | This is the rate of return required by the lender. |
| DEPRECIATION PROPERTY CLASS: | 39 YEARS | This is the number of years over which an asset value is relegated to operating expense. In the U.S., energy-consuming stationary mechanical systems powered by non-renewable energy sources are depreciated over 39 years. Since this asset has a 10-year economic life, there will be a balance of un-applied depreciation which manifests as a book loss (and a large tax benefit) in year 10. |
| MARGINAL TAX RATE APPLIED TO INCOME: | 35% | Taxes are applied to annual operating income MINUS the annual depreciation and book loss charges. |
| ECONOMIC RATE OF CAPITAL RECOVERY: | 8.7% | This is the rate of return needed to at least sustain current business performance. At a minimum, this is the average rate of return earned on the business' assets in recent years. See NOTE 4. |
| BEST ALTERNATIVE INVESTMENT RATE OF RETURN: | 2.9% | Let's say the owner's best alternative to investing in the business is to purchase shares in a Vanguard S&P 500 mutual fund, which has returned 2.9% per annum over the last decade. |
| INDUSTRY ANNUAL GROWTH RATE: | 10% | Firms should grow at this rate to remain competitive in the industry. |

**NOTE 4: Calculating Capital Recovery.**

Capital recovery is a rate of return on capital currently invested in a firm. In simple terms, capital recovery measures "how hard the firm works as an investment." Invested capital is usually a combination of debt and equity, so the firm provides returns measured by the weighted average of the cost of these capital sources. These costs are (1) returns provided to equity investors and (2) interest paid to lenders. The firm's current capital recovery rate is a benchmark for assessing the viability of additional investments, such as energy efficiency improvements. A "good" investment proposal is one that offers a rate of return superior to the current capital recovery benchmark.

Measures of capital recovery are derived from a firm's periodic financial statements. A sample consolidated financial statement for the hypothetical XYZ Company is in Table 2.

**Table 2: Consolidated Financial Statement, XYZ Company**

| | | |
|---|---|---|
| **BALANCE SHEET, December 31, 20XX** | | |
| CURRENT ASSETS…… | | $10,000,000 |
| LONG-TERM (L-T) ASSETS……. | | $80,000,000 |
| **TOTAL ASSETS……** | | **$90,000,000** |
| CURRENT LIABILITIES…….. | | $10,000,000 |
| LONG-TERM LIABILITIES……. | | $20,000,000 |
| **TOTAL LIABILITIES…….** | | **$30,000,000** |
| **EQUITY…….** | | **$60,000,000** |
| **TOTAL CAPITALIZATION……...** | | **$90,000,000** |
| **INCOME STATEMENT, Jan. 1, 20XX – Dec. 31 20XX** | | |
| | REVENUES……... | $100,000,000 |
| *Less* | OPERATING EXPENSES | $92,000,000 |
| | **OPERATING INCOME..** | **$8,000,000** |
| | DEPRECIATION……... | $3,000,000 |
| | **TAXABLE INCOME…..** | **$5,000,000** |
| *Adjust for* | TAXES @ 35%..... | $1,750,000 |
| | **NET INCOME…….** | **$6,250,000** |
| *Subtract* | INTEREST EXPENSE..… | ($1,600,000) |
| | **FREE CASH FLOW……** | **$4,650,000** |

The investment benchmark for XYZ Company is the rate at which it currently achieves capital recovery. That rate is the weighted average cost of capital, which is derived from return on equity (ROE) and the long term cost of debt:

**Return on Equity (ROE).** Equity describes the wealth that investors commit to a business firm. For capital investment analysis, ROE is an intermediate measure that contributes to the rate of capital recovery. ROE is after-tax net income divided by total equity:

$$\text{ROE} = \frac{\text{Net Income}}{\text{Total Equity}} = \frac{\$6{,}250{,}000}{\$60{,}000{,}000} = 10.4\%$$

**Long term cost of debt.** Another intermediate component of the capital recovery rate is the cost of long-term debt financing. Debt represents capital loaned to the business to grow its asset base. The cost of this debt is measured by the annual interest expense divided by the value of long term liabilities (debt):

$$\text{Cost of Long-Term Debt} = \frac{\text{Interest Expense}}{\text{Long-Term Liabilities}} = \frac{\$1{,}600{,}000}{\$20{,}000{,}000} = 8.0\%$$

**Weighted Average Cost of Capital (WACC).** This measure blends the interest cost on long-term debt with the cost of equity (ROE). The balance sheet shows that liabilities represent 33.3 percent of total capitalization; equity represents the remaining 67.7 percent. Note that interest paid on borrowed capital is tax deductible. For that reason, the interest rate on borrowed capital is modified by a tax correction factor (1-marginal tax rate). WACC becomes the discount rate at which future investment returns are adjusted for capital recovery. The WACC for XYZ Company is as follows:

$$\text{WACC} = (.677 \times 10.4\%) + [(.333 \times 8.0\%) \times (1\text{-}35\%)] = 8.7\%$$

## NOTE 5: Profitability Index

The profitability index (PI) is a ratio that compares the magnitude of investment returns (numerator) to investment outlays (denominator):

$$\text{Profitability Index} = \frac{\sum \text{Discounted Value of Project Benefits}}{\sum \text{Discounted Value of All Project Investments}}$$

A "good" investment is one with a PI of 1.0 or better. The profitability index is dynamic over a range of years—as the economic life of the project expands, more annual benefits are realized, and the compounded rate of return grows accordingly. So how well does the subject proposal perform as an investment? A profitability index, shown in the table that follows, is based on cumulative discounted cash flow results summarized in NOTE 2, Table 2.

**Table 3: Profitability Index**

| | A | B | C | D |
|---|---|---|---|---|
| $YEAR_t$ | ANNUAL INVESTMENT | NET INCOME | NET INCOME ADJUSTED FOR CAPITAL RECOVERY @ 8.7% | PI |
| 0 | $1,000,000 | | | |
| 1 | $0 | $171,474 | $157,750 | 0.2 |
| 2 | $0 | $171,474 | $145,124 | 0.3 |
| 3 | $0 | $171,474 | $133,509 | 0.4 |
| 4 | $0 | $171,474 | $122,823 | 0.6 |
| 5 | $0 | $171,474 | $112,993 | 0.7 |
| 6 | $0 | $171,474 | $103,949 | 0.8 |
| 7 | $0 | $171,474 | $95,630 | 0.9 |
| 8 | $0 | $171,474 | $87,976 | 1.0 |
| 9 | $0 | $171,474 | $80,934 | 1.0 |
| 10 | $0 | $431,731 | $187,464 | 1.2 |

The profitability of this investment ramps up with each additional year of net income derived from energy savings. This proposal describes an asset that recovers its investment value, properly adjusted for taxes and the cost of capital, by year eight (when PI achieves unity). After that, the investment creates new wealth. The PI metric in Table 3 (Column D) would derive its numerator from the present value of the cash flow shown in Column B. The denominator is derived from Column A. Both cash flows are discounted using the firm's WACC, or 8.7 percent.

## NOTE 6: Unprofitability Index

The unprofitability index (UPI) is a ratio that compares the capital amount *that would have been invested* (denominator) to the present value of waste that it could have eliminated (numerator). Again, this index is based on cumulative discounted cash flow results through year (t). The numerator of the unprofitability index is the present value (PV) of Table 4's Column D. The denominator is the PV of Column A. Discounting is achieved using the firm's current rate of capital recovery (8.7 percent; see NOTE 3):

$$\text{Unprofitability Index} = \frac{\sum \text{Discounted Value of After-Tax Economic Waste}}{\sum \text{Discounted Value of Total Rejected Investment Value}} = \frac{-\$1{,}056{,}783}{\$1{,}000{,}000} = -1.1$$

**Table 4: Unprofitability Index (UPI)**

| | UNDISCOUNTED | | | | DISCOUNTED | |
|---|---|---|---|---|---|---|
| | A | B | C | D | E | F |
| YEAR | REJECTED NOMINAL INVSTMNT OUTLAYS | OUTLAY FOR ENERGY WASTE (BEFORE TAX) | 35.00% TAX IMPACT | AFTER-TAX NET INCOME WASTE | NET INCOME ADJUSTED FOR CAPITAL RECOVERY @ 8.7% | UPI |
| 0 | $1,000,000 | | | | | |
| 1 | $0 | -$250,000 | $87,500 | -$162,500 | -$149,494 | -0.1 |
| 2 | $0 | -$250,000 | $87,500 | -$162,500 | -$137,529 | -0.3 |
| 3 | $0 | -$250,000 | $87,500 | -$162,500 | -$126,522 | -0.4 |
| 4 | $0 | -$250,000 | $87,500 | -$162,500 | -$116,395 | -0.5 |
| 5 | $0 | -$250,000 | $87,500 | -$162,500 | -$107,079 | -0.6 |
| 6 | $0 | -$250,000 | $87,500 | -$162,500 | -$98,509 | -0.7 |
| 7 | $0 | -$250,000 | $87,500 | -$162,500 | -$90,625 | -0.8 |
| 8 | $0 | -$250,000 | $87,500 | -$162,500 | -$83,371 | -0.9 |
| 9 | $0 | -$250,000 | $87,500 | -$162,500 | -$76,699 | -1.0 |
| 10 | $0 | -$250,000 | $87,500 | -$162,500 | -$70,560 | -1.1 |

When the UPI is below parity (years 1-8 in Table 4), the $1 million investment value is being drawn down by the energy waste. Once the UPI exceeds parity in year nine, the $1 million investment value has been totally expended, and the waste is now begins to destroy the firm's remaining assets.

## NOTE 7: Internal Rate of Return

The post-finance results for the energy improvement proposed to XYZ Company are shown Table 5. Column A, "net income," is the after-tax value of energy savings:

**Table 5: Internal Rate of Return on Free Cash Flow**

| | | LENDER'S FINANCE SCHEDULE END-OF-YEAR TOTALS, MONTHLY AMORTIZATION | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | NET INCOME | PAYMENT | INTEREST | PRINCIPAL | BALANCE | TAX SAVINGS ON INTEREST | AFTER-TAX CASH OUTLAY | FREE CASH FLOW | IRR |
| YEAR | A | B | C | D | E | F | G | H | I |
| 0 | | -$200,000 | | | $800,000 | | -$200,000 | -$200,000 | |
| 1 | $171,474 | -$135,686 | $37,776 | $97,909 | $702,091 | $13,222 | -$122,464 | $49,011 | NA |
| 2 | $171,474 | -$135,686 | $32,767 | $102,918 | $599,173 | $11,469 | -$124,217 | $47,257 | -38% |
| 3 | $171,474 | -$135,686 | $27,502 | $108,184 | $490,989 | $9,626 | -$126,060 | $45,414 | -16% |
| 4 | $171,474 | -$135,686 | $21,967 | $113,719 | $377,270 | $7,688 | -$127,997 | $43,477 | -3% |
| 5 | $171,474 | -$135,686 | $16,149 | $119,537 | $257,734 | $5,652 | -$130,033 | $41,441 | 4% |
| 6 | $171,474 | -$135,686 | $10,033 | $125,652 | $132,081 | $3,512 | -$132,174 | $39,300 | 9% |
| 7 | $171,474 | -$135,686 | $3,604 | $132,081 | $0 | $1,262 | -$134,424 | $37,050 | 12% |
| 8 | $171,474 | $0 | $0 | $0 | $0 | $0 | $0 | $171,474 | 20% |
| 9 | $171,474 | $0 | $0 | $0 | $0 | $0 | $0 | $171,474 | 24% |
| 10 | $431,731 | $0 | $0 | $0 | $0 | $0 | $0 | $431,731 | 29% |

Internal rate of return is dynamic: it grows with each additional year's returns. Because of finance, the investor's initial outlay is only 20 percent of the total project cost. And after paying debt service, the returns are still sufficient to yield a positive free cash flow (Column H). Note that the use of this debt finance accelerates the rate of return. The profitability index (see Table 3) reached parity in year 8. Here, IRR on free cash flow becomes positive in year five, surpasses the firm's weighted average cost of capital (8.7 percent) in year six, and returns 29 percent overall through 10 years.

## BIBLIOGRAPHY


Higgins, R. C. 2009. **Analysis for Financial Management,** Ninth Edition. New York, N.Y.: McGraw-Hill Irwin.

Boehlje, M. and Ehmke, C. 20??. **Capital Investment Analysis and Project Assessment**. http://www.extension.purdue.edu/extmedia/EC/EC-731.pdf. West Lafayette, Ind.: Purdue University.

Droms, W. G. 1990. **Finance and Accounting for Nonfinancial Managers**. Reading, Mass.: Addison-Wesley.