Energy-Efficiency Investment Analysis

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Meet Your Panelists

- Mike Carter
- Mark Farrell
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- Compressed Air Systems
  - Conveyance Systems Energy Management

- Data Centers
  - Data Centers Data Center Energy Efficiency

- Energy Management
  - Introduction to Energy Data Analysis and KPIs
  - Energy Management: Introduction to Best Practices

- Fans
  - Fan System Assessment Tool (FSAT)
Upcoming NEEA Industrial In-Class Trainings

- **Motor Systems**
  - Adjustable Speed Drive Applications and Energy Efficiency

- **Pump Systems**
  - Pump System Optimization
    - PSAT Specialist Qualification

- **Refrigeration**
  - Industrial Refrigeration Energy Management
Upcoming NEEA Industrial Webinars

- **Advances in Lamps and Ballasts**

- **Adjustable Speed Drives**
  - June 8, 2012 - 1pm until 2pm (PST) [http://www.neea.org/participate/calendar.aspx?eventID=3411](http://www.neea.org/participate/calendar.aspx?eventID=3411)

- **Developing an Energy Plan**

- **Energy Auditing and Troubleshooting**
  - November 6, 2012 - 1pm until 2pm (PST) [http://www.neea.org/participate/calendar.aspx?eventID=3415](http://www.neea.org/participate/calendar.aspx?eventID=3415)

- **Energy Efficiency in Data Center**

- **Energy Management Opportunities for Industrial Customers**

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Contents

- Financial Decisions
- Simple Payback
- Time Value of Money
- Net Present Value
- Internal Rate of Return
- Life-Cycle Cost Analysis
- Combining Projects
- Resources

Source: Svilen Milev at www.sxc.hu
Financial Decisions

- Risk Tolerance

ANNUAL ENERGY CONSUMPTION

- Annual energy use, current application in place
- Annual energy use, efficient alternative

Committed Energy Volume: Buy and use as intended

Source: Christopher Russell, Energy PathFINDER
Financial Decisions

- Risk Tolerance

**Annual Energy Consumption**

- Annual energy use, current application in place
- Annual energy use, efficient alternative

**Volume at Risk:**
Buy and waste or pay to avoid buying—Pay for it either way!

**Committed Energy Volume:**
Buy and use as intended

Source: Christopher Russell, Energy PathFINDER
Financial Decisions

- Risk Tolerance
  - Price Volatility
    - Energy
    - Equipment
    - Labor
  - Lost Opportunity

Source: www.sxc.hu
Simple Payback

- $\text{SP} = \frac{\text{Initial Investment Cost}}{\text{Annual Savings}} = \text{Payback Period}$

- How long until I get my money back?
- Is this an investment I should make?
Simple Payback

\[ SP = \frac{\text{Initial Investment Cost}}{\text{Annual Savings}} = \text{Payback Period} \]

- How long until I get my money back?
- Is this an investment I should make?

<table>
<thead>
<tr>
<th>Year</th>
<th>Initial Investment</th>
<th>Annual Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>$12,000</td>
<td>$4,000</td>
</tr>
<tr>
<td>02</td>
<td>$12,000</td>
<td>$4,000</td>
</tr>
<tr>
<td>03</td>
<td>$12,000</td>
<td>$4,000</td>
</tr>
<tr>
<td>04</td>
<td>$12,000</td>
<td>$4,000</td>
</tr>
</tbody>
</table>

\[ SP = \frac{12,000}{4,000} = 3 \text{ yrs} \]
Simple Payback

- So why do we rely on simple payback?
  - Our operating goals, budgets, bonuses, and rewards are fixed in an annual (time) format*
  - Simple payback seems to fit naturally in our calendar-driven world*
  - Quick and easy to use
  - Easy to understand
  - Investment questions are reduced to *yes or no* decisions

- What are the limitations of simple payback?
  - Does not account for other energy savings or monetary net benefits that occur *after* the payback period
  - Does not account for the time value of money

---

*Christopher Russell, Energy PathFINDER*
Simple Payback

Which is the better investment?

A

$12,000

\[ SP = \frac{12,000}{4,000} = 3 \text{ yrs} \]

B

$10,000

\[ SP = \frac{10,000}{2,500} = 4 \text{ yrs} \]
Simple Payback

- When is simple payback best applied?
  - Capital cost is relatively small for your budget
  - Only one significant life-cycle operating cost (for example, electricity)
  - Steady annual cash flow
  - Simple equipment comparison (high-efficiency, roof-top AC unit vs. code-minimum unit)
  - Equipment is stock, not custom

- Equipment examples
  - Linear fluorescent lamps
  - Compact fluorescent lamps
  - Electronic fluorescent ballasts
  - Exit signs
  - Lighting controls
  - Lighting fixtures

Source: www.sxc.hu
Simple Payback

- Payback Periods on Lighting Control Solutions from Electricity Savings Only (Years)
  - Assumes $0.12/kWh, 88 ft²/fixture, 12 hrs/day @ 100% else @35%, no incentives

<table>
<thead>
<tr>
<th>Electric Savings</th>
<th>Industry Range of Pricing for Lighting Controls (Per Sq. Ft. Installed)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$1.00</td>
</tr>
<tr>
<td>35%</td>
<td>4.3</td>
</tr>
<tr>
<td>40%</td>
<td>3.7</td>
</tr>
<tr>
<td>45%</td>
<td>3.3</td>
</tr>
<tr>
<td>50%</td>
<td>3.0</td>
</tr>
<tr>
<td>55%</td>
<td>2.7</td>
</tr>
</tbody>
</table>

Source: Cleantech Approach, Lighting Controls-Savings, Solutions, Payback, and Vendor Profiles
Simple Payback

- **Sensitivity: Payback Periods at $1.50 Per Sq. Ft. Installed**
  - Assumes 88 ft²/fixture, 12 hrs/day @ 100% else @35%, no incentives

<table>
<thead>
<tr>
<th>Electric Savings</th>
<th>Electricity Price per Kilowatt-Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$0.06</td>
</tr>
<tr>
<td>35%</td>
<td>12.9</td>
</tr>
<tr>
<td>40%</td>
<td>11.2</td>
</tr>
<tr>
<td>45%</td>
<td>10.0</td>
</tr>
<tr>
<td>50%</td>
<td>9.0</td>
</tr>
<tr>
<td>55%</td>
<td>8.2</td>
</tr>
</tbody>
</table>

Source: Cleantech Approach, Lighting Controls-Savings, Solutions, Payback, and Vendor Profiles
Simple ROI

\[
\text{ROI} = \frac{\text{Annual Savings}}{\text{Initial Investment Cost}} = \frac{1}{SP}
\]

- **ROI (A)** = \(\frac{$4,000}{$12,000}\) = 33%
- **ROI (B)** = \(\frac{$2,500}{$10,000}\) = 25%

Source: www.sxc.hu
If we were to plan on purchasing something one year from now, how much should we set aside for that purchase today?

- Discount rate is 7%
  - Today’s value of $100 one year from now
    - $100/(1+discount rate)
    - $100/1.07
    - $93 today
  - Today’s value of $110 one year from now
    - $110/(1+discount rate)
    - $110/1.07
    - $103 today
Time Value of Money

- Present Value of Future Cash Flow
  - At a discount rate of 7%, the $100 received one year from now is worth $93 to us today.
    - Could invest the money in a financial instrument
    - Could invest in energy efficiency and decrease our costs
  - Since money has time value, the present value of a promised future amount is worth less the longer you wait to receive it.
Discount factor (DF)

\[ DF = \frac{1}{(1 + R)^N} \]

- \( R = DR = \) Discount rate
- \( N = \) Number of periods (years)

Example: \( \frac{1}{(1 + 0.07)^3} = 0.82 \)

<table>
<thead>
<tr>
<th>Year</th>
<th>DF (DR=7%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>1</td>
<td>0.93</td>
</tr>
<tr>
<td>2</td>
<td>0.87</td>
</tr>
<tr>
<td>3</td>
<td>0.82</td>
</tr>
<tr>
<td>4</td>
<td>0.76</td>
</tr>
</tbody>
</table>
Assume a 7% discount rate.

Net present value (NPV) is the sum of the present value and the initial (negative) investment.

\[
\text{NPV} = \$13,520 - \$12,000 = \$1,520
\]

Cash flow = \$16,000 - \$12,000 = \$4,000
Net Present Value

NPV = $14,900 - $10,000 = $4,900

Cash flow = $20,000 - $10,000 = $10,000
Net Present Value

- Which is the better investment?

A

\[ SP = \frac{12,000}{4,000} = 3 \text{ yrs} \]

NPV = $1,520

Cash flow = $4,000

B

\[ SP = \frac{10,000}{2,500} = 4 \text{ yrs} \]

NPV = $4,928

Cash flow = $10,000
Net Present Value

- **Advantages of NPV**
  - Incorporates all relevant information
  - Single NPV number allows for easy comparisons across project types
  - Allows for easy comparison of multiple financing alternatives (cash, loan, bond, lease)

- **Disadvantages of NPV**
  - Does not expressly account for differing useful lives between projects being compared
    - Residual value compensates for this
  - High information requirements
  - More complicated calculation
The internal rate of return (IRR) is the discount rate that makes the net present value of the project equal to zero.

- Assumes you will reinvest positive cash flows at the IRR rate

### Table: Internal Rate of Return

<table>
<thead>
<tr>
<th>Yr</th>
<th>DR</th>
<th>DF</th>
<th>Cash Flow</th>
<th>Present Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12.6%</td>
<td>0.89</td>
<td>$4,000</td>
<td>$3,558</td>
</tr>
<tr>
<td>2</td>
<td>12.6%</td>
<td>0.79</td>
<td>$4,000</td>
<td>$3,158</td>
</tr>
<tr>
<td>3</td>
<td>12.6%</td>
<td>0.70</td>
<td>$4,000</td>
<td>$2,800</td>
</tr>
<tr>
<td>4</td>
<td>12.6%</td>
<td>0.62</td>
<td>$4,000</td>
<td>$2,484</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td></td>
<td></td>
<td><strong>$16,000</strong></td>
<td><strong>$12,000</strong></td>
</tr>
</tbody>
</table>

**Example A:**

- Initial Investment: $12,000
- Cash Flows: $4,000 per year for 4 years
- IRR: 12.6% = DR [NPV=0]

**Example B:**

- Initial Investment: $10,000
- Cash Flows: $2,500 per year for 8 years
- IRR: 18.6% = DR [NPV=0]
Internal Rate of Return

- Advantages of IRR*
  - Easier to understand than NPV
  - Relates to the cost of borrowing
  - Easily compared to hurdle rate for decision making

- Disadvantages of IRR*
  - Removes the sensitivity of the analysis to alternative discount rates
  - Cannot be calculated when there is a loan or outsourcing agreement that does not involve any equity contribution at the beginning of the project (100% debt financing).
  - Does not account for the project’s magnitude or its impact on profits

*Guide to Optimizing Hospital Facility Investments, BetterBricks
**Internal Rate of Return**

- Impact of small variations in ratio of returns (DR=7%)

**A**
- Initial investment: $12,000
- Cash flows: $4,000 per year for 4 years
- IRR = 12.6% = DR [NPV=0]
- NPV = $1,520 (DR=7%)
- Cash flow = $4,000

**C**
- Initial investment: $100,000
- Cash flows: $30,000 per year for 4 years
- IRR = 7.7% = DR [NPV=0]
- NPV = $1,616 (DR=7%)
- Cash flow = $20,000
Life-Cycle Cost Analysis

- Life-Cycle Cost is the total cost of owning, operating, maintaining, and (eventually) disposing of the building system(s) over a given study period.
  - For energy efficiency projects, we compare project alternatives with a Baseline
    - Initial equipment investment cost
    - Finance costs
    - Equipment replacement costs
    - Disposal cost
    - Energy cost
    - Operation, maintenance, and repair costs

Source: www.sxc.hu
Life-Cycle Cost Analysis

- Water-cooled centrifugal chiller versus air-cooled screw chiller (20-year life) in office building
  - Energy simulation using DOE-2.2 Calculation Core Engine
  - NPV of total costs of ownership

<table>
<thead>
<tr>
<th></th>
<th>100-ton</th>
<th></th>
<th>500-ton</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Air</td>
<td>Water</td>
<td>Air</td>
<td>Water</td>
</tr>
<tr>
<td><strong>Cost Category</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miami</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial</td>
<td>43%</td>
<td>68%</td>
<td>24%</td>
<td>42%</td>
</tr>
<tr>
<td>Energy</td>
<td>50%</td>
<td>20%</td>
<td>65%</td>
<td>45%</td>
</tr>
<tr>
<td>Maintenance</td>
<td>7%</td>
<td>12%</td>
<td>11%</td>
<td>13%</td>
</tr>
<tr>
<td>Minneapolis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial</td>
<td>72%</td>
<td>78%</td>
<td>45%</td>
<td>60%</td>
</tr>
<tr>
<td>Energy</td>
<td>16%</td>
<td>10%</td>
<td>35%</td>
<td>20%</td>
</tr>
<tr>
<td>Maintenance</td>
<td>12%</td>
<td>12%</td>
<td>20%</td>
<td>20%</td>
</tr>
</tbody>
</table>

Source: Total Cost of Ownership For Air-Cooled and Water-Cooled Chiller Systems, Ramez Naguib
Life-Cycle Cost Analysis

- **Energy Efficiency Example**

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Equipment Cost</strong></td>
<td>$164,000*</td>
<td><strong>Loan Period (Yrs)</strong></td>
<td>10</td>
<td><strong>Discount Rate</strong></td>
<td>7%</td>
<td><strong>Baseline Energy</strong></td>
</tr>
<tr>
<td><strong>Cash %</strong></td>
<td>20%</td>
<td><strong>Study Period (Yrs)</strong></td>
<td>10</td>
<td><strong>Loan Rate</strong></td>
<td>7%</td>
<td><strong>Annual Savings</strong></td>
</tr>
<tr>
<td><strong>Financed Amount</strong></td>
<td>$131,200</td>
<td><strong>Useful Life (Yrs)</strong></td>
<td>15</td>
<td><strong>Inflation Rate</strong></td>
<td>0%</td>
<td><strong>Residual Value</strong></td>
</tr>
</tbody>
</table>

*Includes rebates and increased M&V costs
**At end of Study Period (Straight Line Depreciation)

- **SP** = \( \frac{164,000}{40,000} \) = 4.1 yrs
- **ROI** = \( \frac{40,000}{164,000} \) = 24%
Life-Cycle Cost Analysis

- **Energy Efficiency Example**

  - **Baseline**
    - *Do nothing*
    - Yearly cost: $80,000 for 10 years

  - **Energy Efficiency**
    - Yearly cost: $40,000 for 10 years

  - Equipment Cash: $32,800
  - Loan Cost: $80,000
  - Energy Cost: $40,000
  - Residual Value: $54,667
## Life-Cycle Cost Analysis

<table>
<thead>
<tr>
<th>Year</th>
<th>Baseline Energy Use</th>
<th>Energy Efficient Alternative Equipment</th>
<th>Energy Use</th>
<th>Loan</th>
<th>Net Annual Benefit (Cost)</th>
<th>PV Annual Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$32,800</td>
<td>$32,800</td>
<td></td>
<td></td>
<td>$(32,800)</td>
<td>$(32,800)</td>
</tr>
<tr>
<td>1</td>
<td>$80,000</td>
<td>$40,000</td>
<td>$18,280</td>
<td></td>
<td>$21,720</td>
<td>$20,299</td>
</tr>
<tr>
<td>2</td>
<td>$80,000</td>
<td>$40,000</td>
<td>$18,280</td>
<td></td>
<td>$21,720</td>
<td>$18,971</td>
</tr>
<tr>
<td>3</td>
<td>$80,000</td>
<td>$40,000</td>
<td>$18,280</td>
<td></td>
<td>$21,720</td>
<td>$17,730</td>
</tr>
<tr>
<td>4</td>
<td>$80,000</td>
<td>$40,000</td>
<td>$18,280</td>
<td></td>
<td>$21,720</td>
<td>$16,570</td>
</tr>
<tr>
<td>5</td>
<td>$80,000</td>
<td>$40,000</td>
<td>$18,280</td>
<td></td>
<td>$21,720</td>
<td>$15,486</td>
</tr>
<tr>
<td>6</td>
<td>$80,000</td>
<td>$40,000</td>
<td>$18,280</td>
<td></td>
<td>$21,720</td>
<td>$14,473</td>
</tr>
<tr>
<td>7</td>
<td>$80,000</td>
<td>$40,000</td>
<td>$18,280</td>
<td></td>
<td>$21,720</td>
<td>$13,526</td>
</tr>
<tr>
<td>8</td>
<td>$80,000</td>
<td>$40,000</td>
<td>$18,280</td>
<td></td>
<td>$21,720</td>
<td>$12,641</td>
</tr>
<tr>
<td>9</td>
<td>$80,000</td>
<td>$40,000</td>
<td>$18,280</td>
<td></td>
<td>$21,720</td>
<td>$11,814</td>
</tr>
<tr>
<td>10</td>
<td>$80,000</td>
<td>$(54,667)</td>
<td>$18,280</td>
<td></td>
<td>$76,387</td>
<td>$38,831</td>
</tr>
<tr>
<td>Total</td>
<td>$800,000</td>
<td>$400,000</td>
<td>$182,800</td>
<td></td>
<td>$239,067</td>
<td>$147,541</td>
</tr>
</tbody>
</table>

- Upgrade NPV (E) = $147,541
- IRR (E) = 66.4%
Modified IRR (MIRR)

- IRR assumes 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.

\[
\text{MIRR} = \sqrt[n]{\frac{-\text{FV (positive cash flows, reinvestment rate)}}{\text{PV (negative cash flows, finance rate)}}} - 1
\]
Modified IRR (MIRR)

- IRR assumes 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.
  - Example

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-$1,000</td>
</tr>
<tr>
<td>1</td>
<td>-$4,000</td>
</tr>
<tr>
<td>2</td>
<td>+$5,000</td>
</tr>
<tr>
<td>3</td>
<td>+$2,000</td>
</tr>
</tbody>
</table>

IRR = 25.5%

MIRR = 17.9%

- Assumes finance rate of 10% and reinvestment rate (cost of capital) of 12%

\[
MIRR = \sqrt[n]{\frac{-FV \text{ (positive cash flows, 12\%)}}{PV \text{ (negative cash flows, 10\%)}} - 1}
\]
## Life-Cycle Cost Analysis

<table>
<thead>
<tr>
<th>Financing Method</th>
<th>Total Cost</th>
<th>10 Yr. Total Savings</th>
<th>Simple Payback</th>
<th>ROI%</th>
<th>IRR%</th>
<th>MIRR %</th>
<th>LCC Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal (Cash)</td>
<td>$200,000</td>
<td>$400,000</td>
<td>5 Yr</td>
<td>20%</td>
<td>17%</td>
<td>12%</td>
<td>$114,833</td>
</tr>
<tr>
<td>Philanthropic</td>
<td>$0</td>
<td>$400,000</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>$314,833</td>
</tr>
<tr>
<td>Private Loan</td>
<td>$262,928</td>
<td>$400,000</td>
<td>5 Yr</td>
<td>20%</td>
<td>45%</td>
<td>22.8%</td>
<td>$118,358</td>
</tr>
<tr>
<td>Public Loan (state)</td>
<td>$243,646</td>
<td>$400,000</td>
<td>5 Yr</td>
<td>20%</td>
<td>49.7%</td>
<td>23.8%</td>
<td>$131,801</td>
</tr>
<tr>
<td>Tax-Exempt Bond</td>
<td>$280,000</td>
<td>$400,000</td>
<td>5 Yr</td>
<td>20%</td>
<td>79.2%</td>
<td>18.1%</td>
<td>$137,309</td>
</tr>
<tr>
<td>Self-Issued Bond</td>
<td>$312,000</td>
<td>$400,000</td>
<td>5 Yr</td>
<td>20%</td>
<td>70.9%</td>
<td>17.6%</td>
<td>$114,833</td>
</tr>
<tr>
<td>Municipal Bond</td>
<td>$280,000</td>
<td>$400,000</td>
<td>5 Yr</td>
<td>20%</td>
<td>79.2%</td>
<td>18.1%</td>
<td>$137,309</td>
</tr>
<tr>
<td>Capital Lease</td>
<td>$293,729</td>
<td>$400,000</td>
<td>N/A</td>
<td>N/A</td>
<td>23.7%</td>
<td>16.2%</td>
<td>$93,069</td>
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<tr>
<td>Lease w/Purchase</td>
<td>$267,991</td>
<td>$400,000</td>
<td>N/A</td>
<td>N/A</td>
<td>22.6%</td>
<td>14.3%</td>
<td>$92,327</td>
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<tr>
<td>Lease w/Renewal</td>
<td>$255,981</td>
<td>$400,000</td>
<td>N/A</td>
<td>N/A</td>
<td>25.8%</td>
<td>16.2%</td>
<td>$82,049</td>
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<tr>
<td>PC*-Guaranteed (Private)</td>
<td>$215,600</td>
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<td>4.1 Yr</td>
<td>24%</td>
<td>66.5%</td>
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<td>PC-Guaranteed (Public)</td>
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<td>24%</td>
<td>71.3%</td>
<td>27.6%</td>
<td>$158,647</td>
</tr>
<tr>
<td>PC-Shared Savings</td>
<td>$240,858</td>
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<td>24%</td>
<td>36.5%</td>
<td>20.3%</td>
<td>$119,573</td>
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*Source: Guide to Optimizing Hospital Facility Investments, BetterBricks*
## Combining Projects

### Lighting Retrofit

<table>
<thead>
<tr>
<th>Equipment Cost</th>
<th>$200,000*</th>
<th>Loan Period (Yrs)</th>
<th>5</th>
<th>Discount Rate</th>
<th>7%</th>
<th>Baseline Energy</th>
<th>$250,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash %</td>
<td>100%</td>
<td>Study Period (Yrs)</td>
<td>10</td>
<td>Loan Rate</td>
<td>7%</td>
<td>Annual Savings</td>
<td>$100,000</td>
</tr>
<tr>
<td>Financed Amount</td>
<td>0</td>
<td>Useful Life (Yrs)</td>
<td>5</td>
<td>Inflation Rate</td>
<td>0%</td>
<td>Residual Value**</td>
<td>0</td>
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SP = 2 years; ROI = 50%

### Chiller Replacement

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<tr>
<th>Equipment Cost</th>
<th>$500,000*</th>
<th>Loan Period (Yrs)</th>
<th>10</th>
<th>Discount Rate</th>
<th>7%</th>
<th>Baseline Energy</th>
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<tr>
<td>Cash %</td>
<td>100%</td>
<td>Study Period (Yrs)</td>
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<td>Loan Rate</td>
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<td>Financed Amount</td>
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<td>Useful Life (Yrs)</td>
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SP = 6 years; ROI = 17%
## Combining Projects

### Lighting Retrofit

<table>
<thead>
<tr>
<th>Year</th>
<th>Baseline Energy Use</th>
<th>Equipment</th>
<th>Energy Efficient Alternative Energy Use</th>
<th>Loan</th>
<th>Net Annual Benefit (Cost)</th>
<th>PV Annual Benefit</th>
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<tbody>
<tr>
<td>0</td>
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<td>0</td>
<td>$200,000</td>
<td>$(200,000)</td>
<td>$(200,000)</td>
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<td>$150,000</td>
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<td>$600,000</td>
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**IRR = 41%  MIRR = 16.4%**
## Combining Projects

### Chiller Replacement

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<th>Year</th>
<th>Baseline Energy Use</th>
<th>Energy Efficient Alternative Equipment</th>
<th>Energy Use</th>
<th>Loan</th>
<th>LCC Calculation</th>
<th>Net Annual Benefit (Cost)</th>
<th>PV Annual Benefit</th>
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</thead>
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<td>$500,000</td>
<td>$500,000</td>
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<td>$(500,000)</td>
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<td>$78,505</td>
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<td>$68,569</td>
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</table>

**IRR = 14.2%**  **MIRR = 10.9%**
## Combining Projects

### Lighting Retrofit Plus Chiller Replacement

<table>
<thead>
<tr>
<th>Year</th>
<th>Baseline</th>
<th>Energy Efficient Alternative</th>
<th>LCC Calculation</th>
</tr>
</thead>
<tbody>
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<td></td>
<td>Energy Use</td>
<td>Equipment</td>
<td>Energy Use</td>
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<td>$346,000</td>
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<tr>
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<td>$346,000</td>
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<td>$530,000</td>
<td>$346,000</td>
<td>$346,000</td>
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<tr>
<td>10</td>
<td>$530,000</td>
<td>$(250,000)</td>
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</tr>
<tr>
<td>Total</td>
<td>$5,300,000</td>
<td>$3,460,000</td>
<td>$3,460,000</td>
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</tbody>
</table>

- **SP**: 3.8 yrs
- **ROI**: 26%
- **IRR**: 21.2%
- **MIRR**: 13.5%
## Combining Projects

### Comprehensive Project (80% financed at 7% rate)

<table>
<thead>
<tr>
<th>Year</th>
<th>Baseline</th>
<th>Energy Efficient Alternative</th>
<th>LCC Calculation</th>
</tr>
</thead>
<tbody>
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<td>Equipment</td>
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<td>$530,000</td>
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<td>$78,025</td>
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<td>$530,000</td>
<td>$346,000</td>
<td>$78,025</td>
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<td>$530,000</td>
<td>$346,000</td>
<td>$78,025</td>
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<td>$40,000</td>
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<td>$(250,000)</td>
<td>$346,000</td>
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<tr>
<td>Total</td>
<td>$5,300,000</td>
<td>$3,460,000</td>
<td>$970,340</td>
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</tbody>
</table>

SP = 3.8 yrs  ROI = 26%  IRR = 98%  MIRR = 26%
Resources

- **Excel Spreadsheet**
  - `IRR(range, estimated_irr)`
    \[ f_x = \text{IRR(A1:A5)} \]
  - `MIRR(range, finance_rate, reinvestment_rate)`
    \[ f_x = \text{MIRR(A1:A5, 5\%, 8\%)} \]

- **Building Life-Cycle Cost (BLCC5) from NIST**
  - Building Life-Cycle Cost Program (Java with an XML file format)
  - Energy Escalation Rate Calculator
  - Handbook 135 (Life-Cycle Costing Manual for FEMP)
  - Annual Supplement to Handbook 135 (Energy Price Indices and Discount Factors)
Resources

- **Energy eVALUator 4.0** from Energy Design Resources
  - Considers the major factors (financing costs, inflation, discount rates) over the life of a project
  - Considers productivity impacts
  - Produces a set of *bottom-line* economic parameters as well as a year-by-year cash flow analysis
  - Expresses bottom-line numbers with an associated *uncertainty band*.

- **Energy Life-Cycle Cost Analysis** (ELCCA) from the Washington State Department of General Administration
  - Excel spreadsheet
  - Easily handles detailed energy rate information
  - Accounts for the initial cost of construction or renovating a facility
  - Accounts for the cost of owning and operating a facility over its useful life
Upcoming NEEA Industrial In-Class Trainings

Go to the NEEA calendar at www.neea.org/industrial-events for other trainings and events scheduled around the Northwest region.

- **Compressed Air Systems**
  - Conveyance Systems Energy Management

- **Data Centers**
  - Data Centers Data Center Energy Efficiency

- **Energy Management**
  - Introduction to Energy Data Analysis and KPIs
  - Energy Management: Introduction to Best Practices

- **Fans**
  - Fan System Assessment Tool (FSAT)
Upcoming NEEA Industrial In-Class Trainings

- **Motor Systems**
  - Adjustable Speed Drive Applications and Energy Efficiency

- **Pump Systems**
  - Pump System Optimization
  - PSAT Specialist Qualification

- **Refrigeration**
  - Industrial Refrigeration Energy Management
Upcoming NEEA Industrial Webinars

- **Advances in Lamps and Ballasts**

- **Adjustable Speed Drives**
  - June 8, 2012 - 1pm until 2pm (PST) [http://www.neea.org/participate/calendar.aspx?eventID=3411](http://www.neea.org/participate/calendar.aspx?eventID=3411)

- **Developing an Energy Plan**

- **Energy Auditing and Troubleshooting**
  - November 6, 2012 - 1pm until 2pm (PST) [http://www.neea.org/participate/calendar.aspx?eventID=3415](http://www.neea.org/participate/calendar.aspx?eventID=3415)

- **Energy Efficiency in Data Center**

- **Energy Management Opportunities for Industrial Customers**

- To register for multiple webinars at once, use landing page [https://mywebinars.webex.com/mywebinars/onstage/g.php?p=2&t=m](https://mywebinars.webex.com/mywebinars/onstage/g.php?p=2&t=m)
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  800-824-0488
  mcarter@questline.com
  mfarrell@questline.com
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