Money Talks:

Energy-Efficiency

Financial Analysis

March 28, 2017

Meet Your Presenters:

Mike Carter

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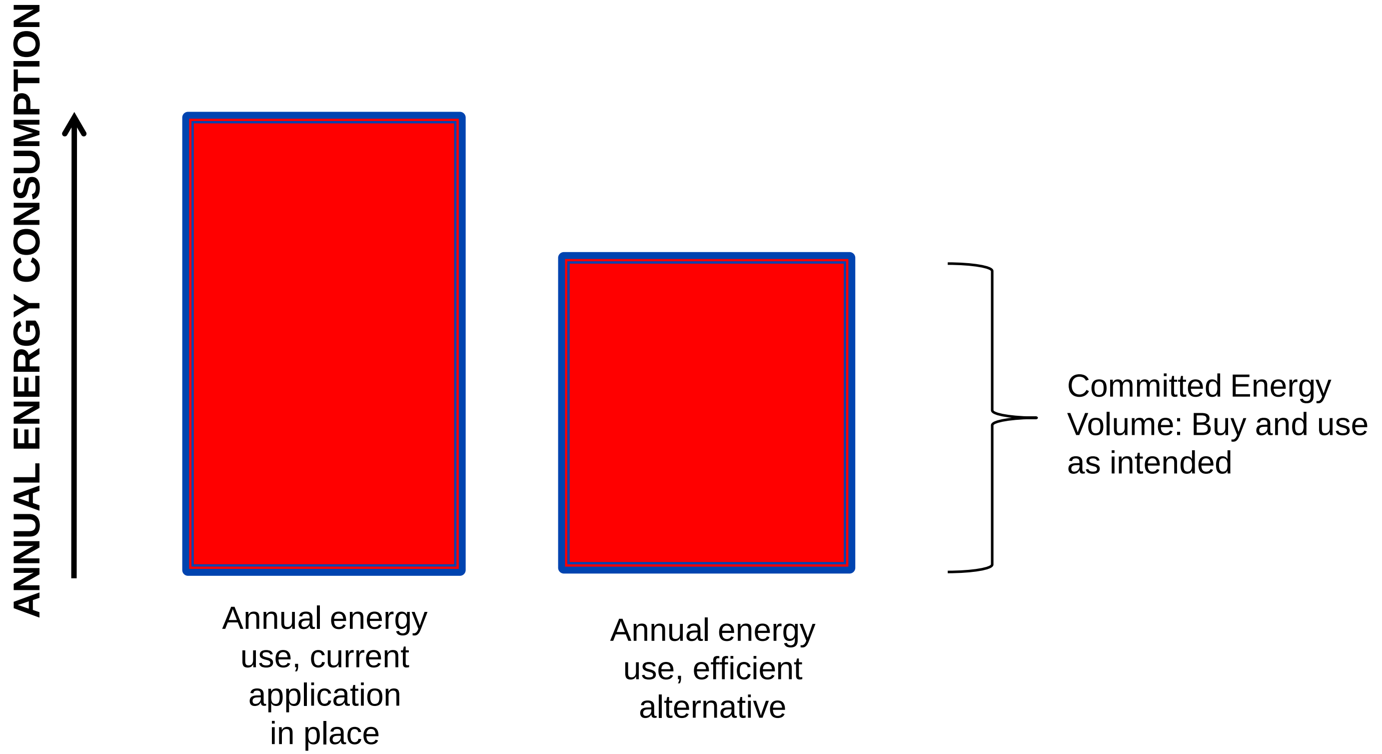
Source: Svilen Milev at www.sxc.hu

Financial Decisions

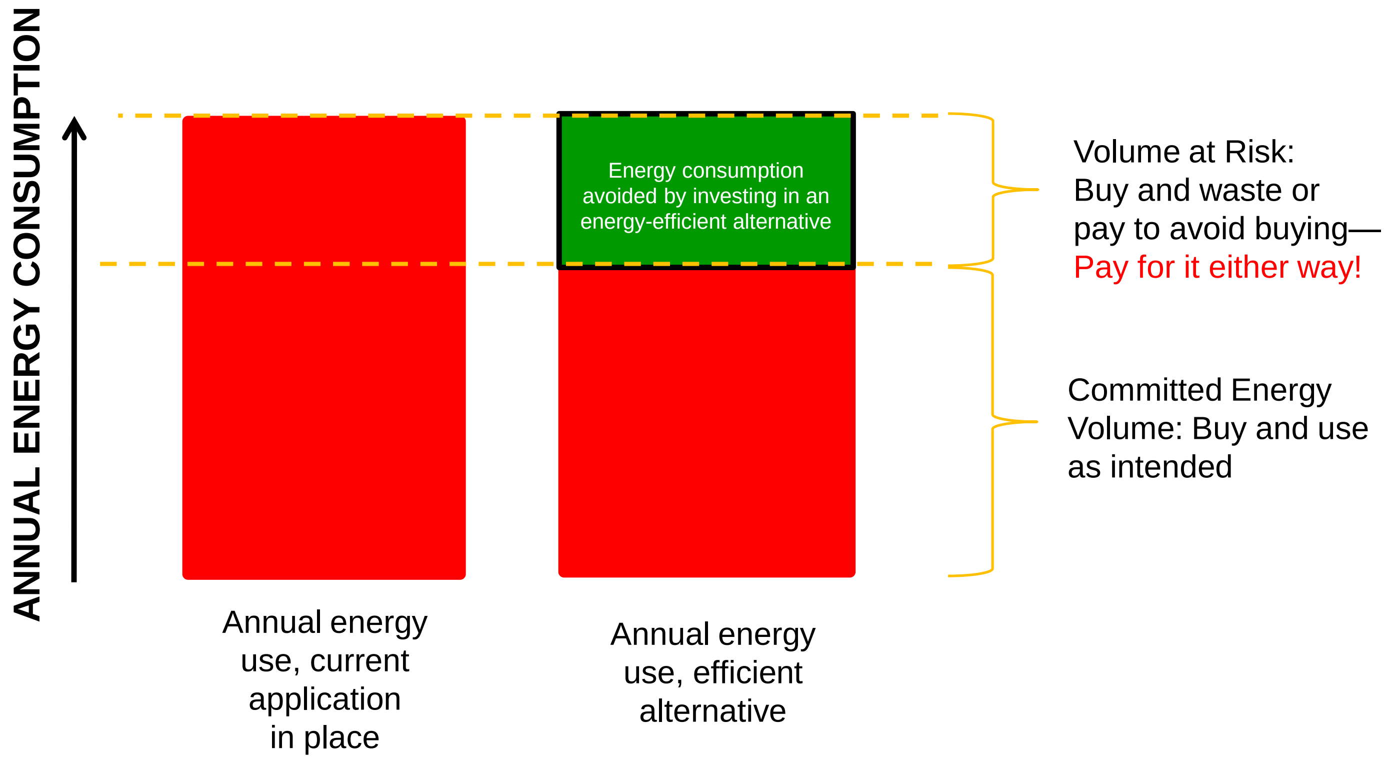
- Risk Tolerance



Source: Christopher Russell, Energy PathFINDER

Financial Decisions

- Risk Tolerance



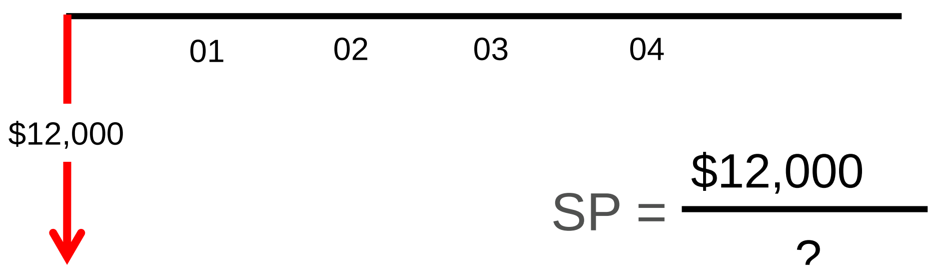
Source: Christopher Russell, Energy PathFINDER

Financial Decisions

- Risk Tolerance
  - Price Volatility
    - Energy
    - Equipment
    - Labor
  - Lost Opportunity
    - Incentive programs
    - Available capital

Simple Payback

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



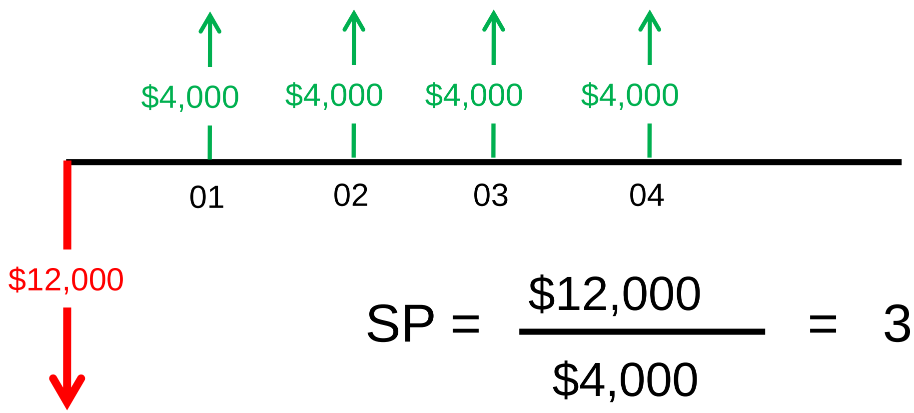
$$SP = \frac{\$12{,}000}{?} = \ ?\ \text{yrs}$$

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

Simple Payback

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

A



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

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

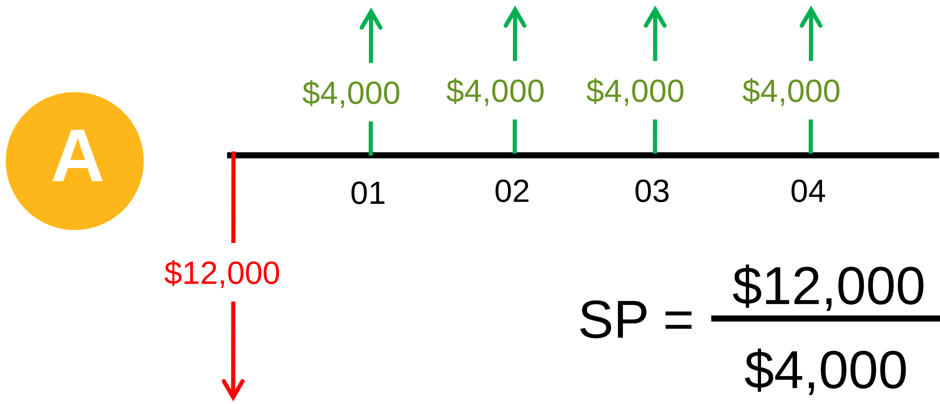
Simple Payback

- 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

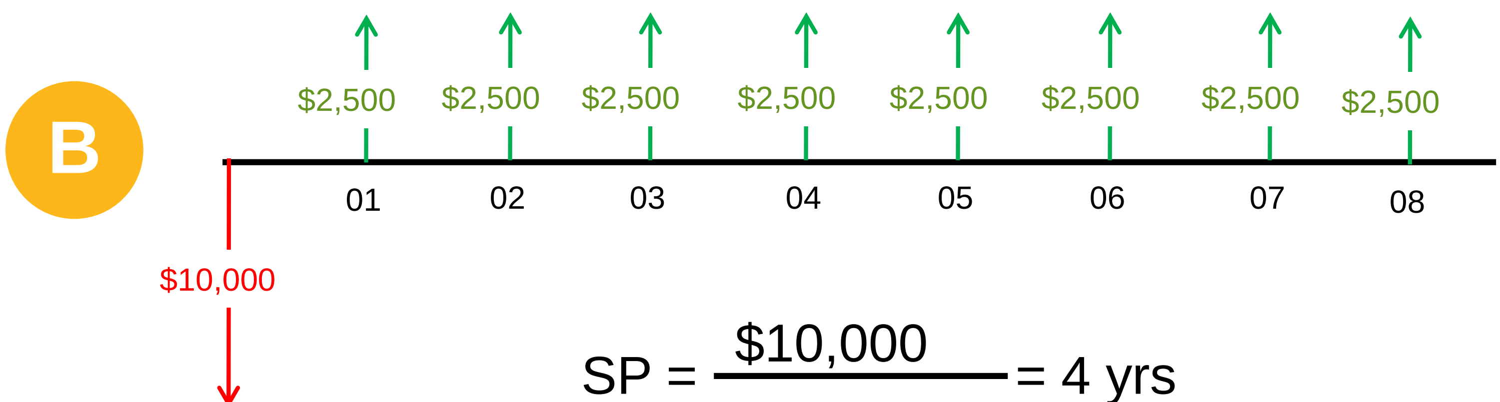
*Christopher Russell, Energy PathFINDER

Simple Payback

- Which is the better investment?



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



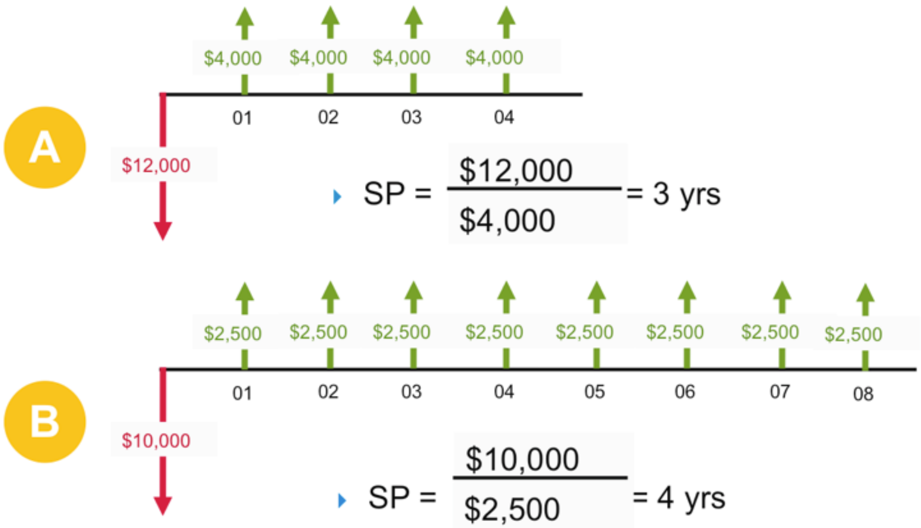
$$SP = \frac{\$10{,}000}{\$2{,}500} = 4 \text{ yrs}$$

Poll Question

Which is the better financial investment?

a) Project A with a 3 year simple payback

b) Project B with a 4 year simple payback



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
  - LED lamps
  - Electronic fluorescent ballasts
  - Exit signs
  - Lighting controls
  - Lighting fixtures

Simple Payback

- Payback Periods on Lighting Control Solutions from Electricity Savings Only (Years)
  - Assumes \$0.12/kWh, 88 ft^2/fixture, 12 hrs/day @ 100% else @35%, no incentives

Payback Periods on Lighting Control Solutions, Years							
Electric Savings	Industry Range of Pricing for Lighting Controls (Per Sq. Ft. Installed)						
	\$1.00	\$1.25	\$1.50	\$1.75	\$2.00	\$2.25	\$2.50
35%	4.3	5.4	6.4	7.5	8.6	9.6	10.7
40%	3.7	4.7	5.6	6.6	7.5	8.4	9.4
45%	3.3	4.2	5.0	5.8	6.7	7.5	8.3
50%	3.0	3.7	4.5	5.2	6.0	6.7	7.5
55%	2.7	3.4	4.1	4.8	5.5	6.1	6.8

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

PSEG

Simple Payback

- Sensitivity: Payback Periods at $1.50 Per Sq. Ft. Installed
  - Assumes 88 ft^2/fixture, 12 hrs/day @ 100% else @35%, no incentives

Payback Periods on Lighting Control Solutions, Years					
Electric Savings	Electricity Price per Kilowatt-Hour				
	$0.06	$0.09	$0.12	$0.15	$0.18
35%	12.9	8.6	6.4	5.1	4.3
40%	11.2	7.5	5.6	4.5	3.7
45%	10.0	6.7	5.0	4.0	3.3
50%	9.0	6.0	4.5	3.6	3.0
55%	8.2	5.5	4.1	3.3	2.7

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

Simple ROI

- $$\text{ROI} = \frac{\text{Annual Savings}}{\text{Initial Investment Cost}} = \frac{1}{\text{SP}}$$

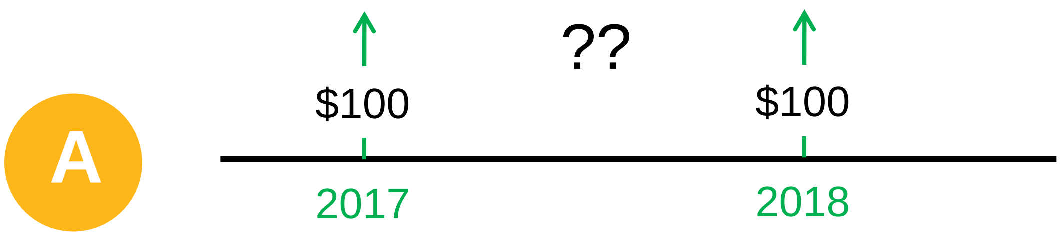
- $$\text{ROI (A)} = \frac{\$4{,}000}{\$12{,}000} = 33\%$$

- $$\text{ROI (B)} = \frac{\$2{,}500}{\$10{,}000} = 25\%$$

Source: www.sxc.hu

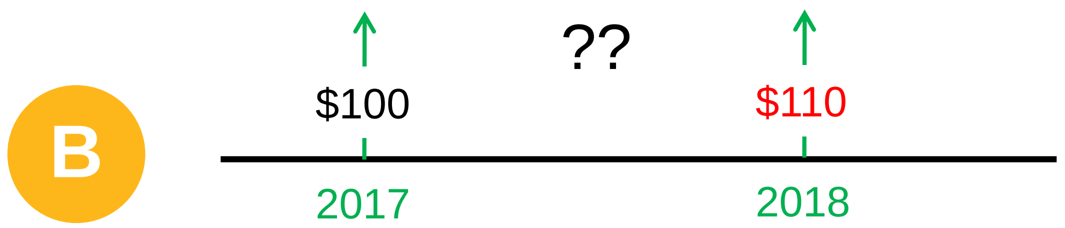
Time Value of Money

- Which would you prefer?



Time Value of Money

- Which would you prefer?



Time Value of Money

- Discount factor (DF)

$DF = 1/(1+R)^N$

R= Discount rate

N = Number of periods (years)

Example: $1/(1+0.07)^3 = 0.82$

Year	DF (DR=7%)
0	1.00
1	0.93
2	0.87
3	0.82
4	0.76

Time Value of Money

- Which would you prefer?
  - 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

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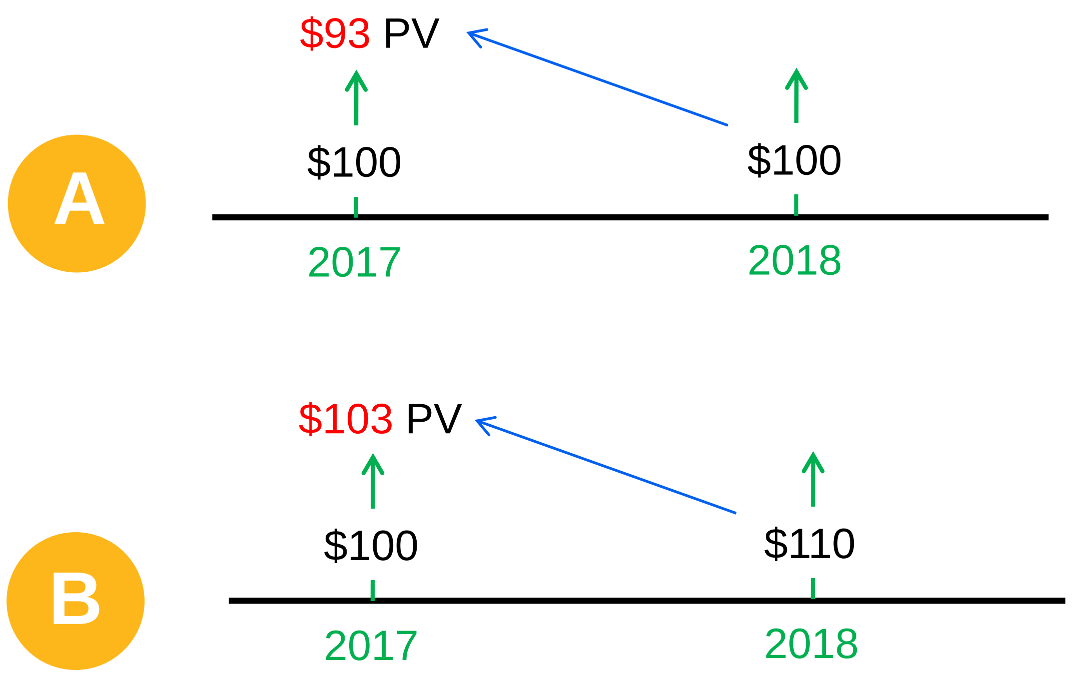
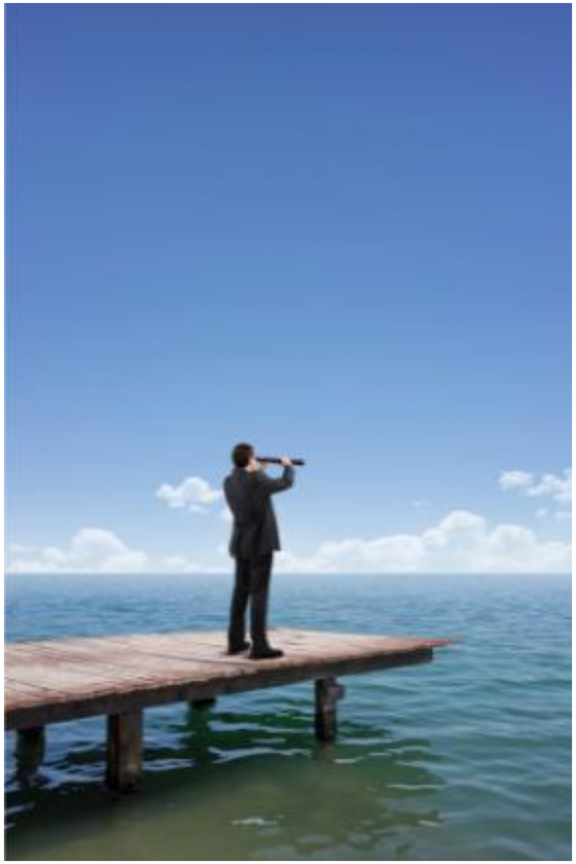
Time Value of Money

- Which would you prefer?
  - Discount rate is 7%



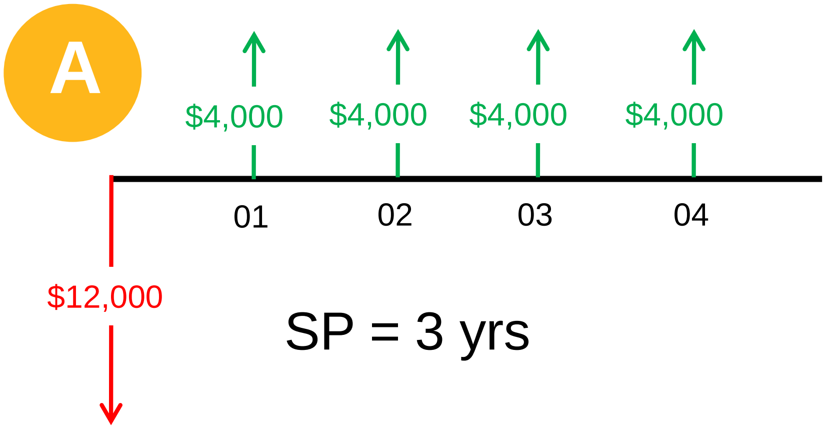
Time Value of Money

- 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.



Net Present Value

- Assume a 7% discount rate.



SP = 3 yrs

Year (N)	Discount Rate	DF $1/(1+R)^N$	Cash Flow	Present Value
1	7%	0.93	**$4,000**	$3,720
2	7%	0.87	**$4,000**	$3,480
3	7%	0.82	**$4,000**	$3,280
4	7%	0.76	**$4,000**	$3,040
Totals			**$16,000**	$13,520

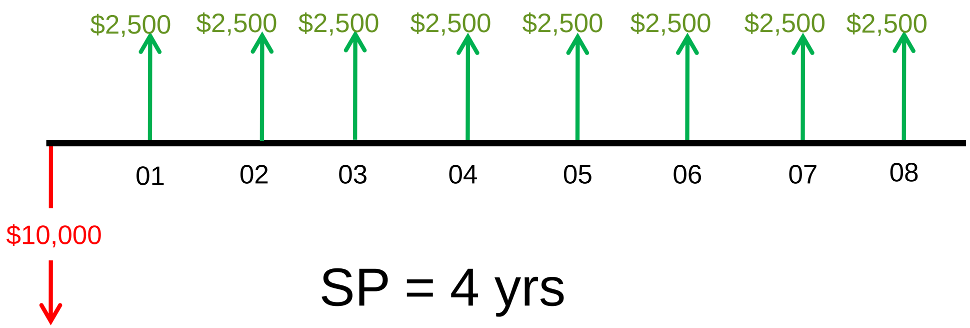
- **Net** present value (NPV) is the sum of the present value and the initial (negative) investment.

  NPV = $13,520 - **$12,000** = $1,520

- Cash flow = **$16,000** - **$12,000** = $4,000

Net Present Value

B



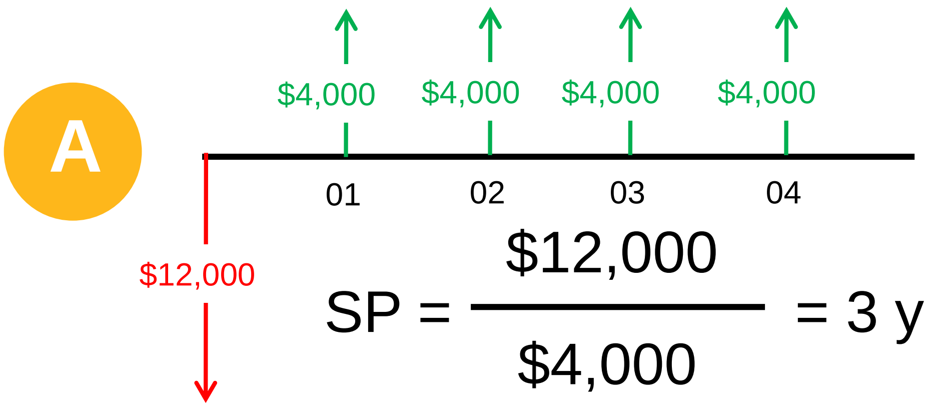
SP = 4 yrs

Year (N)	Discount Rate	DF $1/(1+R)^N$	Cash Flow	Present Value
1	7%	0.93	**$2,500**	$2,325
2	7%	0.87	**$2,500**	$2,175
3	7%	0.82	**$2,500**	$2,050
4	7%	0.76	**$2,500**	$1,900
5	7%	0.71	**$2,500**	$1,775
6	7%	0.67	**$2,500**	$1,675
7	7%	0.62	**$2,500**	$1,550
8	7%	0.58	**$2,500**	$1,450
Totals			**$20,000**	$14,900

- NPV = $14,900 - **$10,000** = $4,900
- Cash flow = **$20,000** - **$10,000** = $10,000

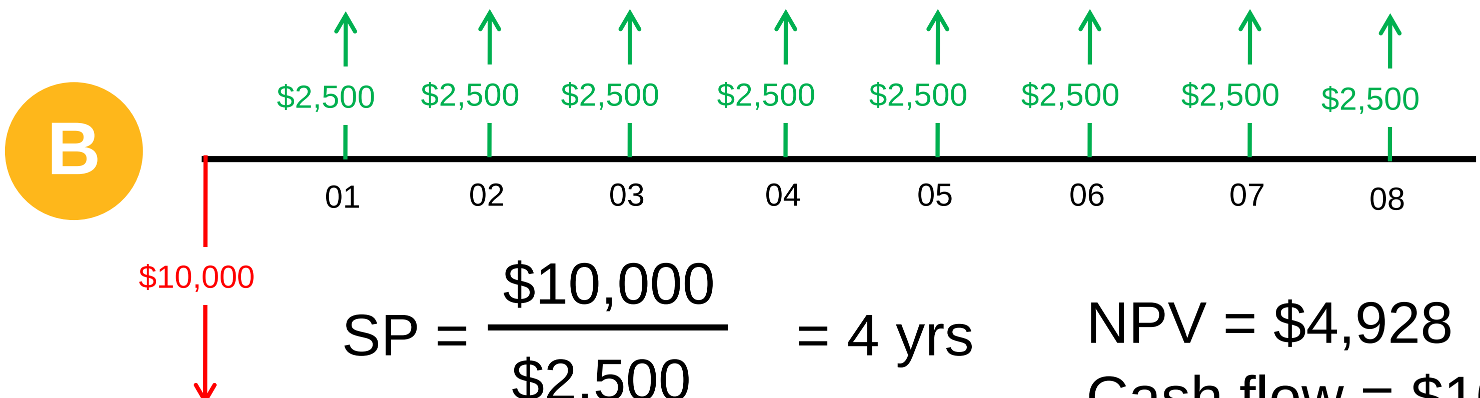
Net Present Value

- Which is the better investment?



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

NPV = $1,520
Cash flow = $4,000



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

NPV = $4,928
Cash flow = $10,000

PSEG

Poll Question

Which is the better financial investment?

a) Project A

b) Project B

A $SP = \frac{\$12{,}000}{\$4{,}000} = 3 \text{ yrs}$

NPV = $1,520
Cash flow = $4,000

B $SP = \frac{\$10{,}000}{\$2{,}500} = 4 \text{ yrs}$

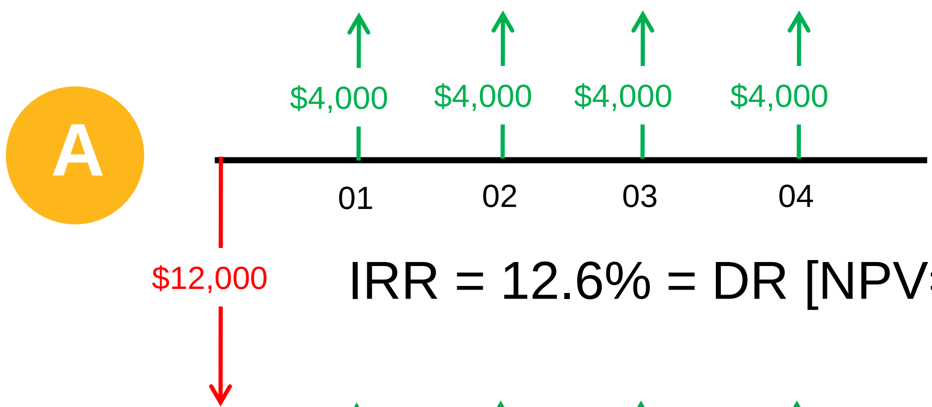
NPV = $4,928
Cash flow = $10,000

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

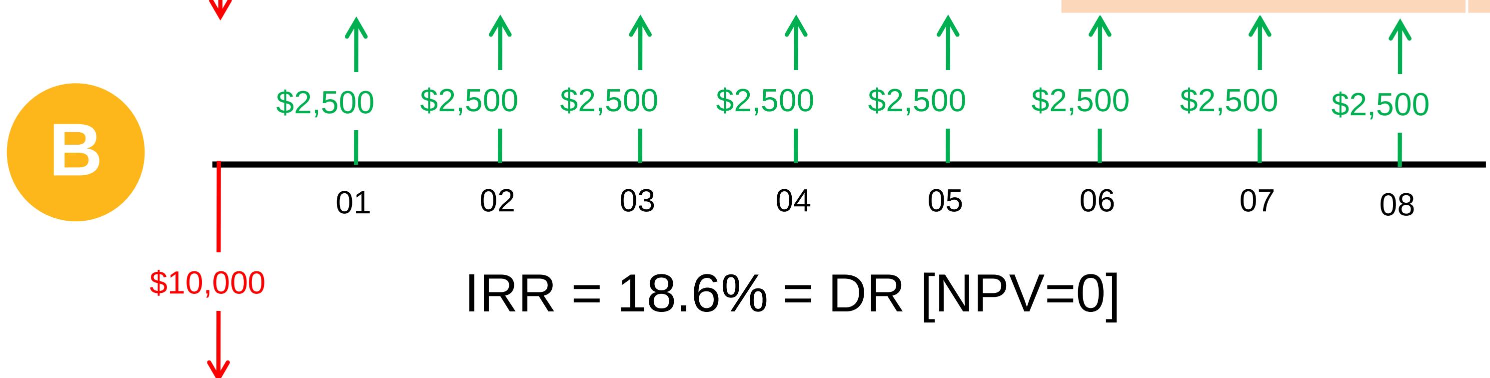
Internal Rate of Return

- 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



IRR = 12.6% = DR [NPV=0]

Yr	DR	DF	Cash Flow	Present Value
1	12.6%	0.89	**$4,000**	$3,558
2	12.6%	0.79	**$4,000**	$3,158
3	12.6%	0.70	**$4,000**	$2,800
4	12.6%	0.62	**$4,000**	$2,484
Totals			**$16,000**	$12,000



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 for 100% debt financing
  - Does not account for the project's magnitude or its impact on profits

*Guide to Optimizing Hospital Facility Investments, BetterBricks

Life-Cycle Cost Analysis

- Life-Cycle Cost
  - 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

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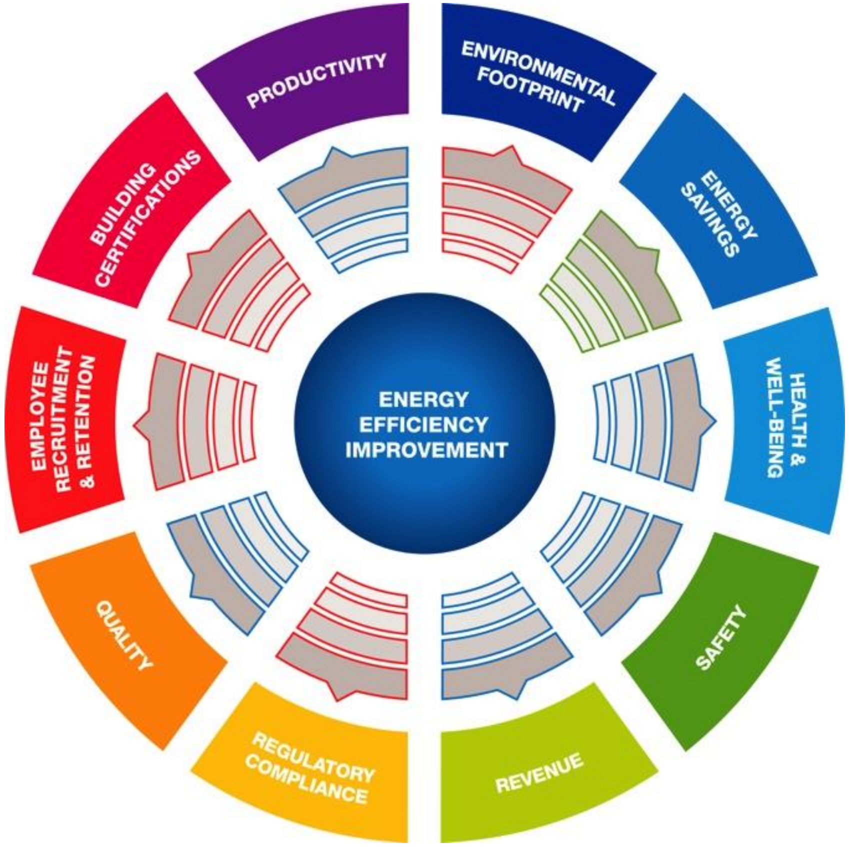
Life-Cycle Cost Analysis

- Non-Energy Benefits



Utility cost savings

Non-utility cost savings

Non-financial benefits

Life-Cycle Cost Analysis

- Energy Efficiency Example

Equipment Cost	$164,000*	Loan Period (Yrs)	10	Discount Rate	7%	Baseline Energy	$80,000
Cash %	20%	Study Period (Yrs)	10	Loan Rate	7%	Annual Savings	$40,000
Financed Amount	$131,200	Useful Life (Yrs)	15	Inflation Rate	0%	Residual Value**	$54,667

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

- $$SP = \frac{\$164,000}{\$40,000} = 4.1 \text{ yrs}$$

- $$ROI = \frac{\$40,000}{\$164,000} = 24\%$$

Life-Cycle Cost Analysis

- Energy Efficiency Example

Life-Cycle Cost Analysis

Year	Baseline	Energy Efficient Alternative			LCC Calculation	
	Energy Use	Equipment	Energy Use	Loan	Net Annual Benefit (Cost)	PV Annual Benefit
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
Total	$800,000		$400,000	$182,800	$239,067	$147,541

- Total cost = $32,800 + $182,800 = $215,600
- Upgrade NPV = $147,541
- IRR = 66.4%

Life-Cycle Cost Analysis

- 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.

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

Life-Cycle Cost Analysis

- Modified IRR (MIRR)
  - Example

Year	Cash Flow
0	-$1,000
1	-$4,000
2	+$5,000
3	+$2,000

IRR = 25.5%

MIRR = 17.9%

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

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

Life-Cycle Cost Analysis

Financing Method	Total Cost	10 Yr. Total Savings	Simple Payback	ROI%	IRR%	MIRR %	LCC Savings
Internal (Cash)	$200,000	$400,000	5 Yr	20%	17%	12%	$114,833
Philanthropic	$0	$400,000	N/A	N/A	N/A	N/A	$314,833
Private Loan	$262,928	$400,000	5 Yr	20%	45%	22.8%	$118,258
Public Loan (state)	$243,646	$400,000	5 Yr	20%	49.7%	23.8%	$131,801
Tax-Exempt Bond	$280,000	$400,000	5 Yr	20%	79.2%	18.1%	$137,309
Self-Issued Bond	$312,000	$400,000	5 Yr	20%	70.9%	17.6%	$114,833
Municipal Bond	$280,000	$400,000	5 Yr	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	$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)	$215,600	$400,000	4.1 Yr	24%	66.5%	26.9%	$147,541
PC-Guaranteed (Public)	$199,790	$400,000	4.1 Yr	24%	71.3%	27.6%	$158,647
PC-Shared Savings	$240,858	$400,000	4.1 Yr	24%	36.5%	20.3%	$119,573

*Performance Contacting

Source: Guide to Optimizing Hospital Facility Investments, BetterBricks

Combining Projects

- Lighting Retrofit

Equipment Cost	$200,000*	Loan Period (Yrs)	5	Discount Rate	7%	Baseline Energy	$250,000
Cash %	100%	Study Period (Yrs)	10	Loan Rate	7%	Annual Savings	$100,000
Financed Amount	0	Useful Life (Yrs)	5	Inflation Rate	0%	Residual Value**	0

$150,000 annual cost

SP = 2 years | ROI = 50%

- Chiller Replacement

Equipment Cost	$500,000*	Loan Period (Yrs)	10	Discount Rate	7%	Baseline Energy	$280,000
Cash %	100%	Study Period (Yrs)	10	Loan Rate	7%	Annual Savings	$84,000
Financed Amount	0	Useful Life (Yrs)	20	Inflation Rate	0%	Residual Value**	$250,000

SP = 6 years | ROI = 17%

$196,000 annual cost

PSE&G

Combining Projects

- Lighting Retrofit

Year	Baseline	Energy Efficient Alternative			LCC Calculation	
	Energy Use	Equipment	Energy Use	Loan	Net Annual Benefit (Cost)	PV Annual Benefit
0		$200,000			$(200,000)	$(200,000)
1	$250,000		$150,000	0	$100,000	$93,458
2	$250,000		$150,000	0	$100,000	$87,344
3	$250,000		$150,000	0	$100,000	$81,630
4	$250,000		$150,000	0	$100,000	$76,290
5	$250,000	$200,000	$150,000	0	$(100,000)	$(71,299)
6	$250,000		$150,000	0	$100,000	$66,634
7	$250,000		$150,000	0	$100,000	$62,275
8	$250,000		$150,000	0	$100,000	$58,201
9	$250,000		$150,000	0	$100,000	$54,393
10	$250,000		$150,000	0	$100,000	$50.835
Total	$2,500,000		$1,500,000	0	$600,000	$359,761

IRR = 41% | MIRR = 16.4%

Combining Projects

- Chiller Replacement

Year	Baseline	Energy Efficient Alternative			LCC Calculation	
	Energy Use	Equipment	Energy Use	Loan	Net Annual Benefit (Cost)	PV Annual Benefit
0		$500,000			$(500,000)	$(500,000)
1	$280,000		$196,000	0	$84,000	$78,505
2	$280,000		$196,000	0	$84,000	$73,369
3	$280,000		$196,000	0	$84,000	$68,569
4	$280,000		$196,000	0	$84,000	$64,083
5	$280,000		$196,000	0	$84,000	$59,891
6	$280,000		$196,000	0	$84,000	$55,973
7	$280,000		$196,000	0	$84,000	$52,311
8	$280,000		$196,000	0	$84,000	$48,889
9	$280,000		$196,000	0	$84,000	$45,690
10	$280,000	$(250,000)	$196,000	0	$334,000	$169,789
Total	$2,800,000		$1,960,000	0	$590,000	$217,068

IRR = 14.2% | MIRR = 10.9%

Combining Projects

- Lighting Retrofit Plus Chiller Replacement

Year	Baseline	Energy Efficient Alternative			LCC Calculation	
	Energy Use	Equipment	Energy Use	Loan	Net Annual Benefit (Cost)	PV Annual Benefit
0		$700,000			$(700,000)	$(700,000)
1	$530,000		$346,000	0	$184,000	$171,963
2	$530,000		$346,000	0	$184,000	$160,713
3	$530,000		$346,000	0	$184,000	$150,199
4	$530,000		$346,000	0	$184,000	$140,373
5	$530,000	$200,000	$346,000	0	$(16,000)	$(11,408)
6	$530,000		$346,000	0	$184,000	$122,607
7	$530,000		$346,000	0	$184,000	$114,586
8	$530,000		$346,000	0	$184,000	$107,090
9	$530,000		$346,000	0	$184,000	$100,084
10	$530,000	$(250,000)	$346,000	0	$434,000	$220,624
Total	$5,300,000		$3,460,000	0	$1,190,000	$576,829

SP= 3.8 yrs | ROI = 26% | IRR = 21.2% | MIRR = 13.5%

Combining Projects

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

Year	Baseline	Energy Efficient Alternative			LCC Calculation	
	Energy Use	Equipment	Energy Use	Loan	Net Annual Benefit (Cost)	PV Annual Benefit
0		$140,000			$(140,000)	$(140,000)
1	$530,000		$346,000	$78,025	$105,975	$99,042
2	$530,000		$346,000	$78,025	$105,975	$92,563
3	$530,000		$346,000	$78,025	$105,975	$86,507
4	$530,000		$346,000	$78,025	$105,975	$80,848
5	$530,000	$40,000	$346,000	$78,025	$65,975	$47,039
6	$530,000		$346,000	$116,043	$67,957	$63,511
7	$530,000		$346,000	$116,043	$67,957	$45,283
8	$530,000		$346,000	$116,043	$67,957	$42,320
9	$530,000		$346,000	$116,043	$67,957	$39,552
10	$530,000	$(250,000)	$346,000	$116,043	$317,957	$172,948
Total	$5,300,000		$3,460,000	$970,340	$939,660	$629,612

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

Poll Question

- Would you like someone from PSE&G to contact you?
  a) Yes
  b) No

- How valuable has this Webinar been to you?
  a) Not valuable at all.
  b) Slightly valuable.
  c) Moderately valuable.
  d) Very valuable.
  e) Extremely valuable.

Resources

- Excel Spreadsheet
  - IRR(range, estimated_irr)
    f_x =IRR(A1:A5)
  - MIRR(range, finance_rate, reinvestment_rate)
    f_x =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 PSE&G Webinars:

- From Symptoms to Solutions: Managing Power Quality Issues

  Tuesday, April 25, 2017 2:00 pm

  REGISTER HERE

- The Best in Energy-Efficient Commercial Lighting

  Tuesday, May 23, 2017 2:00 pm

  REGISTER HERE

PSEG

Q&A Session

Questions?

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