Energy Cost Control: How the Money Works

(Copies of these slides to be provided by DOE-ITP)

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"Spare no expense to save money on this one."

Samuel Goldwyn
(1879-1974)

OUTLINE

- A “money” perspective on energy
- Projects, payback
- Make-or-buy
- Annualized cost analysis
- Cost of doing nothing
- Break-even analysis
- Budget for additional analysis

About Christopher Russell

- Independent consulting since 2006
- Director of Industrial Programs, Alliance to Save Energy, 1999-2006
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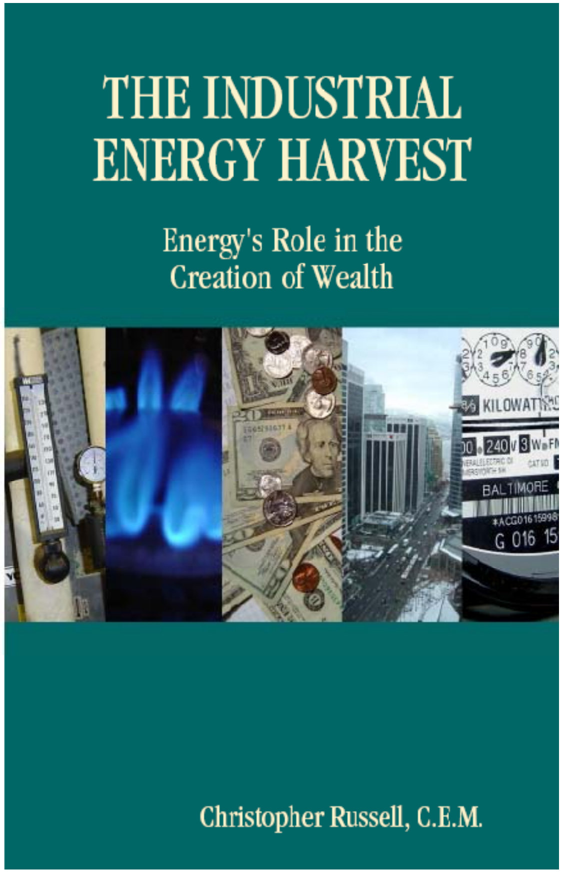

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INDUSTRIAL ENERGY LOSSES*

	As Percent of PRIMARY ENERGY SUPPLY	As Percent of DELIVERED ENERGY
PRIMARY ENERGY SUPPLY:	100%	
- GENERATION/TRANS/DIST LOSSES:	28%	
DELIVERED ENERGY:	72%	100%
- CENTRAL PLANT LOSSES:	5%	7%
- ONSITE DISTRIBUTION LOSSES:	5%	7%
- ENERGY CONVERSION LOSSES:	12%	17%
NET APPLIED TO WORK:	49%	68%

*Totals may not add due to rounding.

SOURCE: http://www1.eere.energy.gov/industry/energy_systems

Waste Raises the "Price" of Fuel

Example:

Purchase 100,000 MMBtu
@ $8.00 per MMBtu

SEQUENCE OF ACTIVITY	*QUANTITY (MMBtu)*	*INCREMENTAL VALUE*	*EXPENDITURE PER MMBtu "AVAILABLE"*
Fuel delivered "to the fence"	**100,000**	**$800,000**	**$8.00**
*Losses from combustion = 7 percent**	*-7,000*	*-$56,000*	
Heat available for distribution	**93,000**	**$744,000**	**$8.60**
*Losses from distribution = 7 percent**	*-7,000*	*-$56,000*	
Heat available for conversion to work	**86,000**	**$688,000**	**$9.30**
*Losses from heat-to-work conversion = 17 percent**	*-17,000*	*-$136,000*	
Energy available to perform process work	**68,000**	**$552,000**	**$11.76**
*Total energy losses = 32 percent**	*-32,000*	*-$248,000*	

When natural gas costs $8/MMBTU, the average U.S. industrial facility experiences waste that leads to **an expenditure of $11.76 per "available" MMBtu!**

*SOURCE: http://www.eere.energy.gov/industry/energy_systems/pdfs/energy_use_loss_opportunities_analysis.pdf

Thoughts About Project Payback

$$\text{Simple Payback} = \frac{\text{Total cost to install}}{\text{Annual operating savings}} = \frac{\left\{\begin{array}{l}\text{Search/acquisition costs}\\ \text{Consultant fees}\\ \text{Equipment cost}\\ \text{Sales commissions}\\ \text{Installation fees}\\ \text{Removal/scrap of old equipment}\\ \text{Finance transaction costs}\\ \text{Less projected salvage value}\\ \text{Cost of downtime, forfeited income}\\ \text{Cost of delay}\end{array}\right.}{\left\{\begin{array}{l}\text{Annual savings in energy costs}\\ \text{Less costs of upkeep}\\ \text{Less change in other O\&M expense}\\ \text{Less monthly finance charges}\\ \text{Plus any non-energy improvements}\end{array}\right.}$$

What's the Payback?

Spend Today:	Return 1yr out:	Return 2yrs out:	Return 3yrs out:	Return 4yrs out:
-$100	**$50.00**	**$50.00**	**$50.00**	**$50.00**

The range of answers to this question my surprise you.

Problems with Payback

- **Payback criteria rarely change, if ever** (e.g. "two years or less") Meanwhile, interest rates and our profitability measures change daily. "Cost of money" is cost to *waste* as well as cost to borrow

- **Payback calculations remain fixed in our minds.** Boiler replacement example:
  - 4-year payback in 2002 with gas @ $2.50/MMBtu
  - 0.83-year payback in 2008 with gas @ $12/MMBtu

- **So why do we rely on 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

Problems with Payback

- It is a risk assessment tool
- It is NOT a profitability metric
- It does NOT reflect cost of money (interest rates)

- If a 12-month payback is better than 24 months…
- Then a 6-month payback is better than 12 months…
- So a zero-month payback must be best!
- Because there's no wait to get the money back!

If getting the money back is a concern, then there's no reason to make the investment.

Simple Payback:
The Wrong Tool for Energy Project Analysis?

- Payback poses a two-step question in reaching one conclusion:
  - **How long until I get my money back?**

    And depending on my risk aversion…
  - **Is this an investment I should make?**
- **Investment questions are reduced to a Y/N decision**
- Energy management becomes a stop-and-go experience, stalling with each project rejection…
- …while interest rates, energy prices, and budget-to-actual performance change constantly.

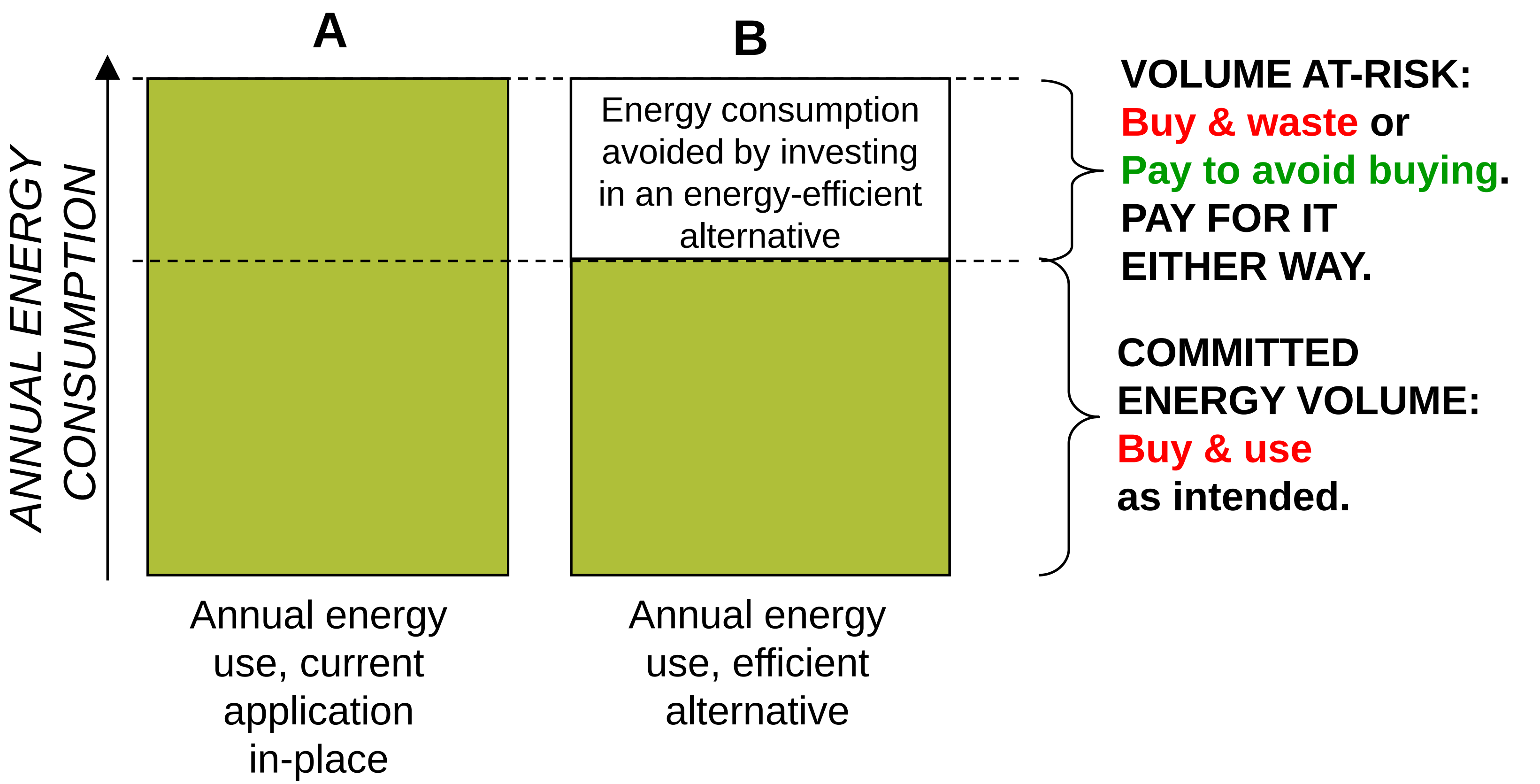
Making the case for energy improvements: *What do business leaders want to know?*

- What's the benefit?
  - How many dollars?
  - How quickly do the dollars accrue?
  - What's the risk of investing?
  - What's the risk of NOT investing?
- What's the most that I should pay for it? …per current investment criteria
- How does this compare to other ways to use money?

Simple Payback:
A 1950s Financial Analysis Tool

Is there a better way?

Energy At-Risk



SAVE or BUY?

- Continue to **BUY** energy at-risk from the market?
  - Remain exposed to constant price volatility

- **SAVE** energy by reducing the volume at-risk?
  - Do projects when cost to save a unit of energy is less than the price to buy it
  - Annualized cost stays fixed over the economic life of the project

Example: Boiler Replacement

REFERENCE DATA

Current price per therm:	$1.611
Economic life of new boiler (n):	25 yrs
Discount rate/cost of capital (i):	8%
Capital recovery factor (CRF):	.0937 = [i(1+i)^n]/[((1+i)^n)-1]

	OLD	NEW	SAVINGS
Therms consumed/year:	390,780	298,998	91,782
Annual fuel cost:	$629,547	$481,686	$147,861

Construction cost:	$239,305
Engineering fees:	$ 29,900
Total installed cost:	$269,205

Annualized Project Cost

$$\text{ANNUALIZED PROJECT COST} = \left(\text{UP-FRONT PROJECT COST}\right) \times \left(\text{CAPITAL RECOVERY FACTOR}\right)$$

AND

$$\frac{\text{ANNUALIZED PROJECT COST}}{\text{CRF}} = \text{UP-FRONT PROJECT COST}$$

$$\text{CAPITAL RECOVERY FACTOR (CRF)} = \frac{i(1+i)^n}{[(1+i)^n]-1}$$

Where:
i = cost of capital or discount rate on future cash flows
n = economic life (years) of remedy (energy improvement project)

WHY?

- **Operating budgets are ANNUAL**
- **Energy savings are accounted ANNUALLY**
- **Compare ANNUAL cost to ANNUAL benefit**
- **Compare 3-yr project to 10-year or 5-year projects….**

CAPITAL RECOVERY FACTORS

ECONOMIC LIFE (YRS)	ANNUAL DISCOUNT RATE or COST OF CAPITAL 4%	5%	6%	7%	8%	9%
0.5	2.0598	2.0747	2.0896	2.1044	2.1192	2.1340
1	1.0400	1.0500	1.0600	1.0700	1.0800	1.0900
2	0.5302	0.5378	0.5454	0.5531	0.5608	0.5685
3	0.3603	0.3672	0.3741	0.3811	0.3880	0.3951
5	0.2246	0.2310	0.2374	0.2439	0.2505	0.2571
7	0.1666	0.1728	0.1791	0.1856	0.1921	0.1987
10	0.1233	0.1295	0.1359	0.1424	0.1490	0.1558
15	0.0899	0.0963	0.1030	0.1098	0.1168	0.1241
20	0.0736	0.0802	0.0872	0.0944	0.1019	0.1095
30	0.0578	0.0651	0.0726	0.0806	0.0888	0.0973

What happens to the CRF as interest rates go up?

As the economic life increases?

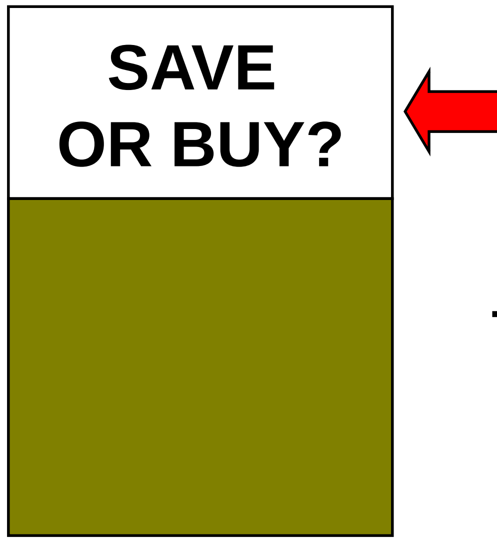
BOILER EXAMPLE:
Annualized Project Cost Per Therm Saved

$$\text{ANNUALIZED PROJECT COST} = \left(\text{UP-FRONT PROJECT COST}\right) \times \left(\text{CAPITAL RECOVERY FACTOR}\right)$$

$$\$25{,}225 = \left(\$269{,}205\right) \times \left(.0937\right)$$

$$\text{ANNUALIZED PROJECT COST PER ANNUAL THERM SAVINGS} = \frac{\$25{,}225}{91{,}782} = \$0.2748$$

Boiler Example: Save or Buy Choice



ENERGY AT-RISK

You will pay for it either way

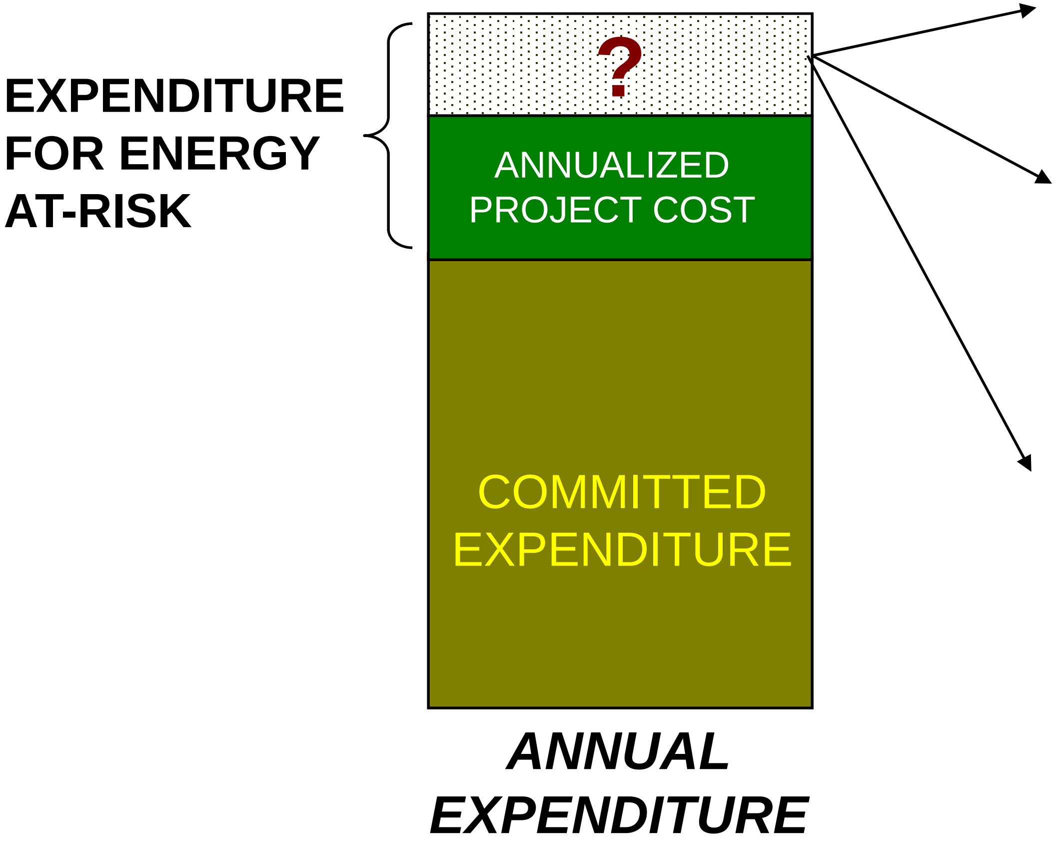
SAVE @ $0.2748 or BUY @ $1.611?

COST-BENEFIT RATIO

$$\frac{\text{COST TO SAVE A THERM}}{\text{PRICE TO BUY A THERM}} = \frac{\$0.2748}{\$1.611} = 0.17$$

This project allows the investor to pay $0.17 to avoid buying $1.00's worth of energy

INTERPRETING ANNUALIZED COST ANALYSIS

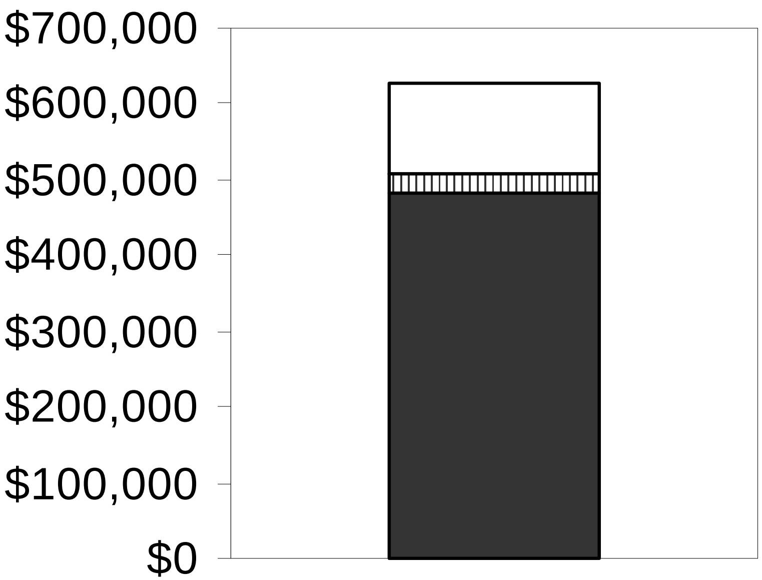


Annualized net savings

Annualized penalty for ***DOING NOTHING***

Theoretical maximum annualized budget for additional design, analysis, or reconfiguration

Boiler Example



Annualized Expenditure For this Activity

$629,547

= ANNUALIZED NET SAVINGS or ANNUAL **COST OF DOING NOTHING**
$122,642

= ANNUALIZED PROJECT COST*
$25,219

+ = GROSS ANNUAL SAVINGS
$147,861

= COMMITTED ENERGY
$481,686

*Assuming $269,205 up-front cost

ECONOMIC PENALTY FOR DOING NOTHING

(Price per unit to buy energy - Annualized cost to avoid purchasing a unit of energy) X Volume of avoidable energy purchases = Annualized Penalty for *Doing Nothing*

USING THE BOILER REPLACEMENT EXAMPLE:

($1.611 per therm - $0.2748 per therm) X 91,782 therms = $122,639

$122,639 = annual premium paid over the
25-year economic life of the proposed improvement

- Assumes energy prices and cost of money stay constant
- Penalty for doing *nothing* goes up:
  as energy prices rise and as interest rates fall

BREAK-EVEN POINT

ANNUALIZED PROJECT COST = TOTAL VALUE OF ANNUAL ENERGY SAVINGS

What's the MOST that should be paid for the project, given certain investment criteria?

Calculating the Financial Break-Even Cost

MAXIMUM ACCEPTABLE ANNUALIZED PROJECT COST *SHOULD BE NO MORE THAN* ANNUAL VALUE OF AVOIDED ENERGY PURCHASES

MAXIMUM ACCEPTABLE ANNUALIZED PROJECT COST = (DELIVERED PRICE PER UNIT OF ENERGY) X (UNITS OF AVOIDED ENERGY CONSUMPTION) = ANNUAL VALUE OF AVOIDED ENERGY PURCHASES

AND BECAUSE:

$$\frac{\text{ANNUALIZED PROJECT COST}}{\text{CRF}} = \text{UP-FRONT PROJECT COST}$$

THEREFORE:

$$\frac{\text{MAXIMUM ACCEPTIBLE ANNUALIZED PROJECT COST}}{\text{CRF}} = \text{MAXIMUM ACCEPTIBLE UP-FRONT PROJECT COST}$$

MORE...

Break-Even Calculation

$$\text{MAXIMUM ACCEPTABLE UP-FRONT PROJECT COST} = \frac{\left(\text{DELIVERED PRICE PER UNIT OF ENERGY}\right) \times \left(\text{UNITS OF AVOIDED ENERGY CONSUMPTION}\right)}{\text{CRF}} = \textbf{BREAK-EVEN PROJECT COST}$$

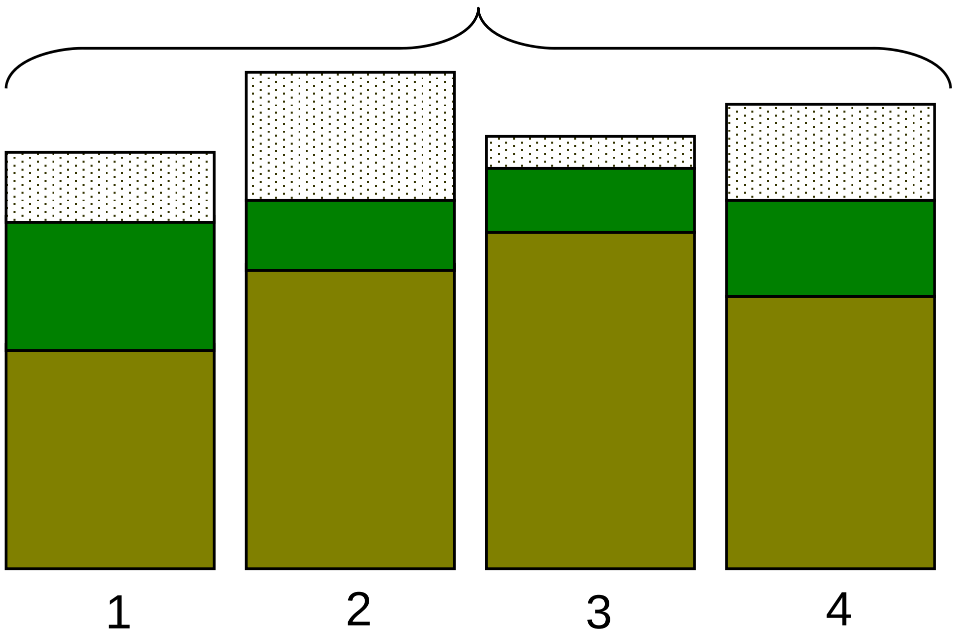
$$\text{MAXIMUM ACCEPTABLE UP-FRONT PROJECT COST} = \frac{\left(\$1.611\right) \times \left(91{,}782\right)}{0.0937} = \mathbf{\$1{,}578{,}383}$$

NOTE: CRF = 0.0937 when n=25 and i=8%

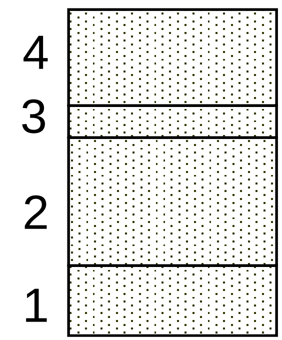
Actual cost is only $269,205... definitely worth it.

BUDGET:
For Additional Design, Analysis, Reconfiguration

ANNUALIZED ENERGY EXPENDITURES
FOR DISTINCT APPLICATIONS



SUM OF ANNUALIZED
NET SAVINGS



___% Cash Flow?

___% Design Work?

___% Analysis?

___% Reconfiguration?

= ANNUALIZED NET SAVINGS (dotted)

= ANNUALIZED PROJECT COST (green)

= COMMITTED EXPENDITURE (olive)

PAYBACK vs. ANNUALIZED COST

FEATURE	PAYBACK	ANNUALIZED COST ANALYSIS
Account for cash flows over the life of the improvement?	NO	YES
Incorporate the time-value of money?	NO	YES
Provide basis for break-even cost evaluation?	SORT OF	YES
Compare value of projects with different economic lives?	NO	YES
Permit real-time evaluation of the cost of waste?	NO	YES
Measure the penalty for NOT taking action?	NO	YES

Annualized Cost Analysis:
Apples-to-Apples Comparison

- Projects with different economic lives
- Projects with different fuel types
- Can easily adjust as variables change:
  - Cost of capital
  - Price of energy
  - Vendor quotes

Organizing Capital Budgets

NEW INITIATIVES:

- Option to invest in new commitments
- Alternative to investing is to keep the money
- Investment is a Yes/No choice
- Example: new product line, new plant addition
- **Simple payback** is the appropriate criterion

COMMITTED EXPENDITURES

- Make change to existing commitments
- More expensive vs. less expensive commitment
- Example: energy efficiency improvement
- **Save-or-buy** is the right criterion.

IF YOU MUST USE SIMPLE PAYBACK…

- …and if your capital budget competition blends COMMITTED expenditures with NEW INITIATIVES,
- …and if you refuse perfectly good energy-saving investments (they save money, but the payback is “too long”), then:
- You should add the capitalized value of energy waste to the investment cost of the new initiative, THEN calculate its simple payback.
- You are assured of investing in REALLY good new initiatives if they can pay for themselves PLUS cover the value of the energy waste that you decide to live with.

IF YOU MUST USE SIMPLE PAYBACK…

- When you DO accept energy-saving projects…
- Tabulate the value of energy saved over the economic life of the energy project…
- And count this as a subsidy to investment in any new initiative.
- Note that energy savings– as a subsidy to new initiatives– help to ensure that any new initiatives are more likely to meet their investment performance target!

Thank you…

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