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TH01 - How to Evaluate Financial and Energy Use Impacts of Energy Efficiency, Green and Sustainability Construction Options

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CONSTRUCT2009
Conference: June 16-19, 2009
Indiana Convention Center
Indianapolis, IN



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Learning Objectives:

Upon completing this program, the participant should know how to:

1. **Identify sources of risk associated with alternative energy efficiency investment options**
2. **Evaluate financial and energy savings associated with alternative energy efficiency investment options**
3. **Develop financial and performance requirements of energy efficiency investments consistent with budget flexibility and risk tolerance**

Presentation Outline

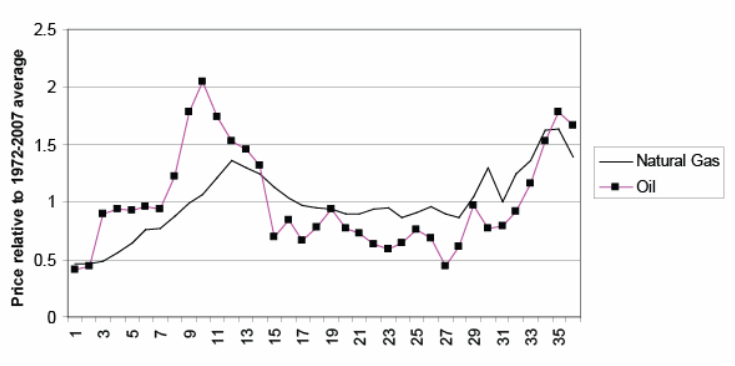
- The Issues
- Energy Prices: Down, Holding or Up?
- Efficiency Investment Analysis: Theory and Reality
- Risk Management Framework
- Energy Efficiency Risk Management
- Energy Budgets at Risk (EBaR) Case Study
- Summary

Issue for Commercial Building Industry

- Are energy-efficiency, green, sustainability a fad?
- Green costs
- Is there a green financial return?
- How to make the green sale
  - Owners are concerned about construction cost
  - Life-cycle costs, etc. are non-starters for most owners
  - Translating green investments into terms that make sense to financial people

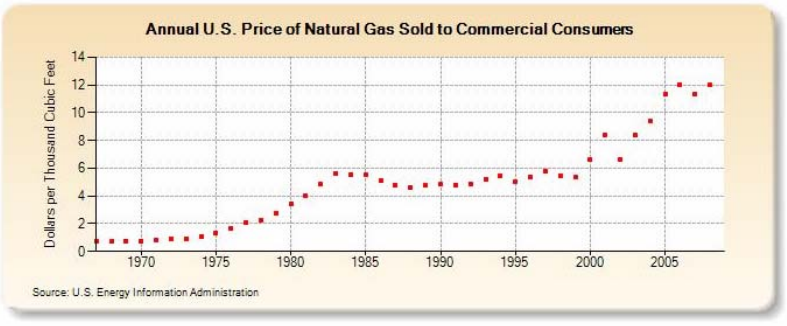
Energy Price History: Oil

World Oil Prices Pull US Natural Gas Prices in the Same Direction



Natural gas prices determine marginal electricity prices in Texas

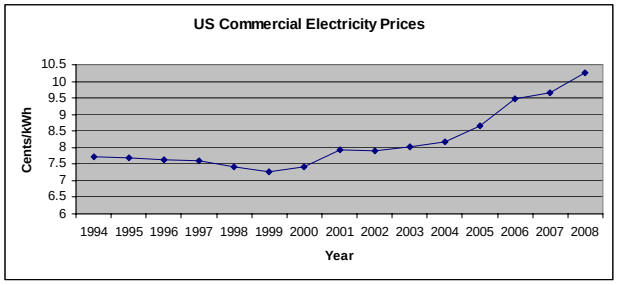
Energy Price History: Natural Gas



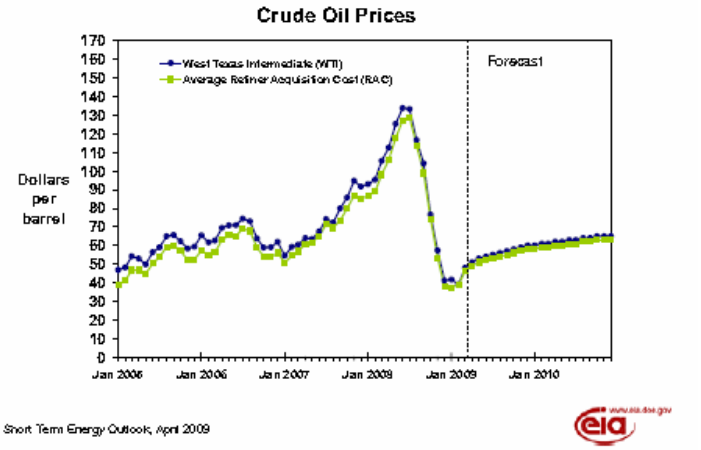
Higher Fossil Fuel Prices and Other Factors Have Increased Electricity Prices

- Natural gas is ~20 % of generation; however it is the marginal fuel driving electricity prices
- Coal prices have increased significantly in the last decade

Energy Prices History: Electricity



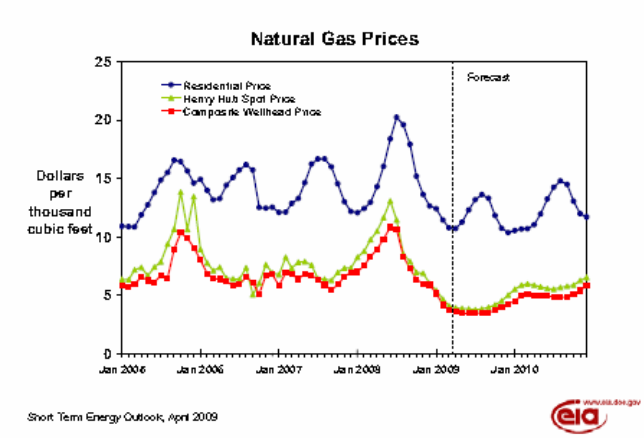
Likely Energy Price Future: Oil



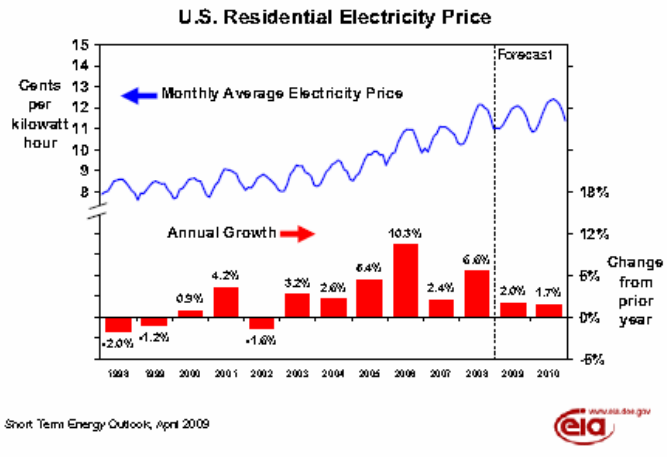
Why Oil Prices Are Not Likely to Return to Low 1990's Levels

- High cost of new fossil fuel exploration/production
  - marginal oil requires ~ $70/barrel
- Declining production from existing oil fields
- New production technologies are expensive
- OPEC reaction

Likely Energy Price Future: Natural Gas



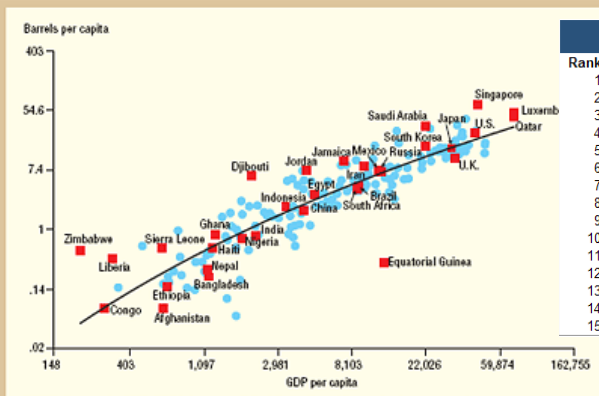
Likely Energy Price Future: Electricity



What Will Recover Bring?

Chart 2

Oil Consumption Rises with Income



NOTES: Data are for 2005. GDP is in current U.S. dollars adjusted for purchasing power parity.

SOURCES: International Monetary Fund; World Bank; Energy Information Administration.

GDP per capita
US: $45,845
China: $5,292
India: $2,659

Top World Oil Consumers, 2006
(thousand barrels per day)

Rank	Country	Consumption
1	United States	20,687
2	China	7,201
3	Japan	5,159
4	Russia	2,811
5	Germany	2,665
6	India	2,572
7	Canada	2,264
8	Brazil	2,217
9	Korea, South	2,174
10	Saudi Arabia	2,139
11	Mexico	1,997
12	France	1,961
13	United Kingdom	1,825
14	Italy	1,732
15	Iran	1,679

Source: Dallas Federal Reserve Bank, EIA, IMF

Developing Country Oil Demand Will Grow Rapidly

Table 1. World Marketed Energy Consumption by Country Grouping, 2005-2030
(Quadrillion Btu)

Region	2005	2010	2015	2020	2025	2030	Average Annual Percent Change, 2005-2030
OECD	240.9	249.7	260.5	269.0	277.6	285.9	0.7
North America	121.3	126.4	132.3	137.8	143.4	148.9	0.8
Europe	81.4	83.9	86.8	88.5	90.4	92.0	0.5
Asia	38.2	39.3	41.4	42.7	43.7	44.9	0.7
Non-OECD	221.3	262.8	302.5	339.4	374.2	408.8	2.5
Europe and Eurasia	50.7	55.1	59.5	63.3	66.0	69.1	1.2
Asia	109.9	137.1	164.2	189.4	215.3	240.8	3.2
Middle East	22.9	26.4	29.5	32.6	34.7	36.8	1.9
Africa	14.4	16.5	18.9	20.9	22.5	23.9	2.0
Central and South America	23.4	27.7	30.5	33.2	35.7	38.3	2.0
Total World	462.2	512.5	563.0	608.4	651.8	694.7	1.6

Note: Totals may not equal sum of components due to independent rounding.
Sources: 2005: Energy Information Administration (EIA), *International Energy Annual 2005* (June-October 2007), web site www.eia.doe.gov/iea. Projections: EIA, World Energy Projections Plus (2008).

Renewables to the Rescue?

Table 1.1 U.S. Energy consumption by energy source, 200-2004 (Quadrillion Btu).

ENERGY SOURCE	2001	2002	2003	2004	2005
Total	96.563	98.101	98.450	100.586	100.942
Fossil Fuels	83.138	83.994	84.386	86.191	86.451
Coal	21.914	21.904	22.321	22.466	22.785
Coal Coke Net Imports	0.029	0.061	0.051	0.138	0.044
Natural Gas	22.861	23.628	22.967	22.993	22.886
Petroleum	38.333	38.401	39.047	40.594	40.735
Electricity Net Imports	0.075	0.072	0.022	0.039	0.084
Nuclear Electric Power	8.033	8.143	7.959	8.222	8.160
Renewable Energy	**5.465**	**6.067**	**6.321**	**6.433**	**6.588**
Conventional Hydroelectric	2.242	2.689	2.825	2.690	2.703
Geothermal Energy	0.311	0.328	0.331	0.341	0.343
Biomass	2.777	2.880	2.988	3.196	3.298
Solar Energy	0.065	0.064	0.064	0.064	0.066
Wind Energy	0.070	0.105	0.115	0.142	0.178

Source: Energy Information Administration, August 2005,
http://www.eia.doe.gov/cneaf/solar.renewables/page/trends/table1.html

Energy Market/Green Prognosis

- Economic slowdown has not significantly reduced natural gas or electricity prices
- Economic recovery will eventually restore tight markets and upward price pressure
- Limits on oil production rate (~ 95 – 105 mbpd) likely to drive future oil prices considerably higher in future years
- Most likely outcome – oil prices head back towards $100/barrel, natural gas and electricity prices continue on upward trend
- Energy efficiency, green and sustainability are here to stay

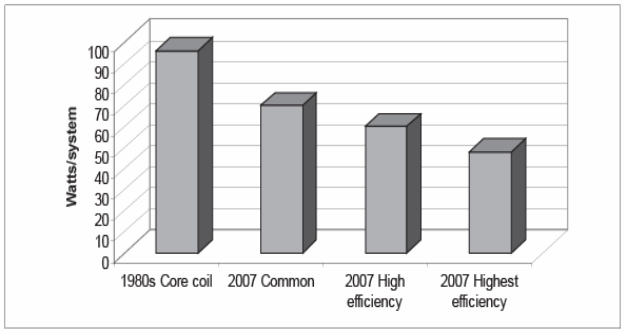
Green Costs and Returns on Green Investments

- Current financial evidence
  - Rent premiums
  - Occupancy premiums
  - Absorption
  - Building value
- Other benefits?
  - Carbon emissions
  - Productivity

Significant Energy-Efficiency Opportunities Exist in Most Commercial, Institutional and Government Buildings

- Most buildings can reduce energy use by 20 – 40 percent with cost-effective efficiency investment opportunities
- Recent tax incentives improve economics even more
- Recent data indicates that rent and occupancy premiums for Energy Star Buildings more than pay for upgrade costs
- Recommissioning costs of about $0.60/square foot often pay for themselves in less than a year and save an average of 15 percent in energy use.
- Existing efficiency technologies provide substantial savings.

Example Fluorescent Lamp Technology Options



However, Profitable Efficiency Recommendations Are Often Rejected

- A recent study of 9,000 manufacturing firms found an average payback requirement of 15 months to qualify an energy efficiency investment, even after detailed engineering project energy savings and cost analysis had been performed by an outside organization
- The internal rate of return (return on the investment over its lifetime) of a 15 month payback is about 70 percent.
- If a firm can borrow money at 10 percent and make a return of 70 percent, it can make a profit on the investment increasing its cash flow.
- Energy engineers and facility managers are often frustrated with their inability to sell good projects that benefit their organizations.
- How can traditional energy efficiency investments analysis be improved to compete with other organization investments?

Traditional Financial Investment Analysis

- Net present value calculation is universally recommended to evaluate capital budgeting decisions (i.e. efficiency investments)

$$NPV = \sum_{t=1}^{T} S/(1+i)^t - I$$

Where NPV = net present value, i= interest rate, T = life of equipment, I = initial investment cost, S = annual savings

Future savings must be "discounted" with an interest rate to reflect the fact that a future amount is worth less than a present amount.

Rule: Invest if NPV>0, that is, if investment is paid for by annual savings

Internal Rate of Return (IRR) Analysis is Equivalent to NPV Analysis

- Back to the NPV formula:

$$E(NPV) = \sum_{t=1}^{T} E(S)/(1+i)^t - I$$

Setting NPV = 0 and solving for i yields the internal rate of return (IRR) associated with the investment. The IRR equals the minimum interest that must be earned on alternative investments to match the returns provided by the efficiency investment.

The IRR can be compared to the cost of capital (e.g., interest rate), to identify profitable investments. Invest if the IRR is greater than the cost of capital.

Problem With NPV & IRR: Savings, S are uncertain

Finance Textbooks Recommend Adding a Risk Factor to Reflect Annual Savings Uncertainty

- New NPV formula:

$$E(NPV)= \sum_{t=1}^{T} E(S)/(1+r+i)^t - I$$

Where NPV = net present value, i= interest rate, T = life of equipment, I = initial investment cost, S = annual savings and E(.) reflect average or expected values

r is a risk premium that must be included to make this uncertain stream of cash flows equivalent to a stream without any uncertainty

Problem: How do we develop a value for r?

Scenario Analysis Represents a Step in the Right Direction

- Alternative price assumptions can be conducted using the interest rate without a risk premium to discount future cash flows

$$NPV= \sum_{t=1}^{T} S/(1+i)^t - I$$

Where NPV = net present value, i= interest rate, T = life of equipment, I = initial investment cost, S = annual savings

- Use various worst case assumptions
- Assign probabilities to assumptions
- Not widely used
  - Difficulty in applying multiple sources of uncertainty
  - Difficulty in translating analysis results into decisions

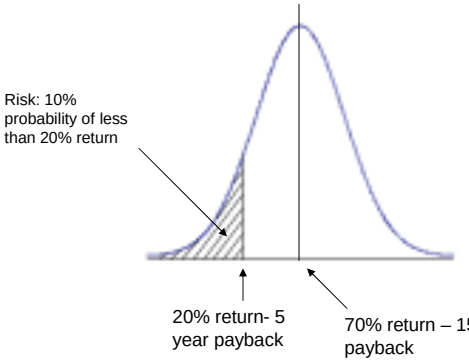
What Do Most Decision-Makers Do When Evaluating Uncertain Investments?

- Simple payback is used to screen investment for risk

Pay Back = I/S = initial cost/expected annual savings
= # years for savings to pay for investment

Payback is an Intuitive Approach to Avoiding Risk

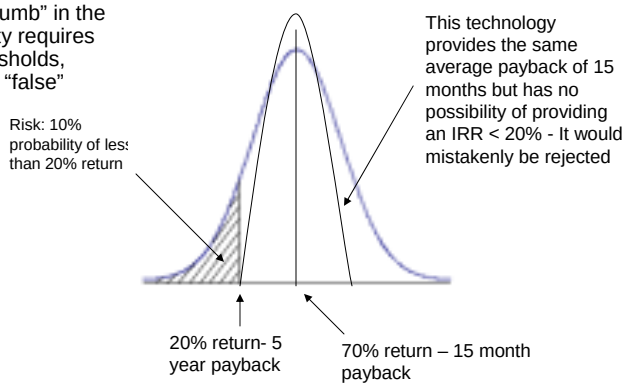
- Risk: Probability of an adverse outcome
- Energy investment and risk



Decision-makers use a 15 month payback threshold to make sure that the odds of receiving a return of less than 20% internal rate of return are smaller than 10 %

Problem With Payback Is It Bypasses Profitable Investments

- Using "rules of thumb" in the face of uncertainty requires "worst-case" thresholds, resulting in many "false" rejections



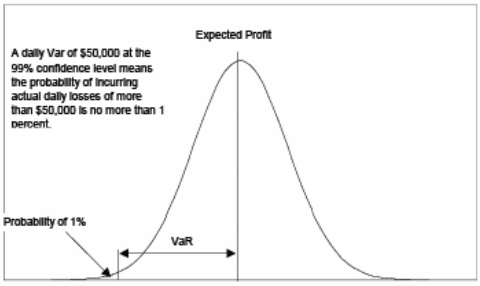
- Other payback problems
  - Consider only near-term expected benefits
  - Ignores "good" investment rewards
    - Increased cash flows - Reduced budget risk - Increased capitalized business/facility value

Risk Management Analysis of Energy Efficiency Investments Is More Appropriate Than Attempting to Avoid Risk With Rules-of-Thumb

- Managing risk is more profitable than avoiding risk
- Risk management provides greater benefits in volatile markets
- Risk management considers both risks and rewards
- Quantitative methodologies have been developed and are widely applied in financial analysis
- **Question: Can risk management analysis can be applied to develop a useful "real world" energy efficiency risk management analysis that provides simple, intuitive decision rules and quantitative determination of investment risks and rewards ?**

A Widely-Used Financial Risk Management Tool Meets These Analysis Requirements

- "Value at Risk" (VaR) measures risks and rewards associated with a financial portfolio over a specified period.
- VaR statistics are quantitative, simple, easy to understand
- VaR is used throughout the financial industry
  - Investment risk assessment by financial organizations
  - Regulatory requirements
- CFOs and financial administrators at most organizations are familiar with VaR

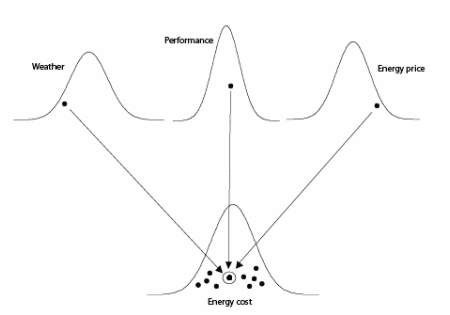


VaR Can Be Extended to Quantify Energy Budget, Investment and Purchase Risk

- Determinants of budget risk can be quantified
  - Natural gas prices
  - Electricity prices
  - Weather and facility weather responsiveness
  - Random factors
- Additional risk factors are included in evaluating energy-efficiency investment risks
  - Operating hours
  - Equipment performance

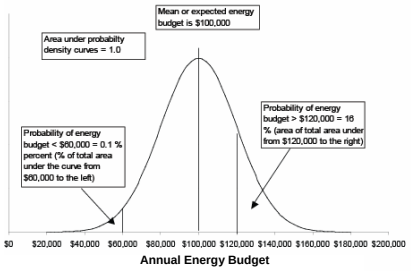
Monte Carlo Analysis Translates Variations in All Inputs into a Distribution of Energy Cost Savings

- Monte Carlo is an analysis technique widely used in finance, economics, statistics, transportation, engineering, …
- Any input distribution can be applied to reflect alternative scenarios

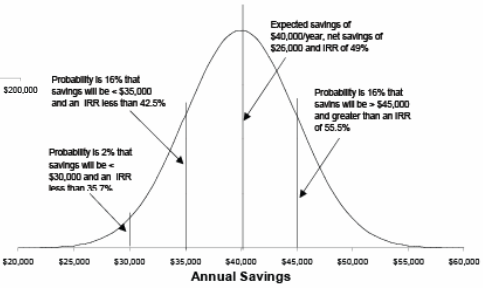


Extending VaR to Energy Budget and Investment Analysis

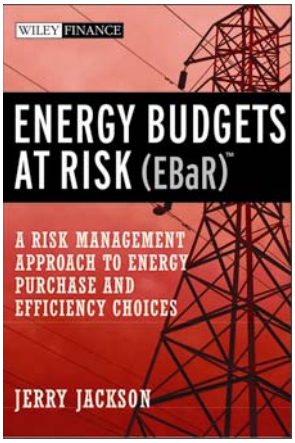
Budget Risk Analysis



Investment Risk Analysis



This Risk Management Approach is Described in More Detail in *Energy Budgets at Risk (EBAR)*® and on energybudgetsatrisk.com



The case study application described in the remainder of this presentation is described in step-by-step detail in the book including Excel instructions.

EBaR Casts Facility Managers as Efficiency Investment Advisors

- Energy costs should be managed differently than other facility costs
  - Efficiency investments:
    - Reduce energy use
    - Increases cash flow == new revenue source
  - Addresses competitive energy purchasing risk/rewards
- Energy is often the most volatile component of operating costs
  - Risk management is an essential analysis tool
- Energy use reductions help achieve green goals
  - Carbon emissions/trading/taxes

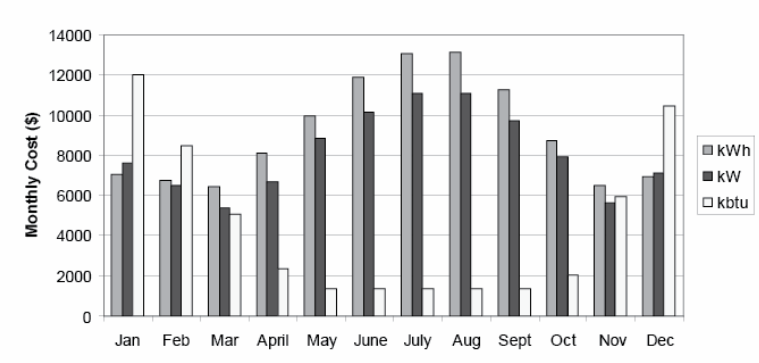
An EBaR Case Study

Office building in Austin, Texas

- Five-story, 120,000 square foot office building, constructed in 1988.
- Operating hours are 8:00 am to 6:00 pm Monday through Friday.
- Natural gas for space heating, some water heating, electricity for other end uses.
- Variable air volume HVAC system with setbacks at 6:00 pm - 7:30 am. Janitorial from approximately 6:00 to 9:00 pm each weekday. The building is open and is periodically used by staff during off hours.

- The HVAC system in the building has not been recommissioned.
- Typical 1980s lighting system with average connected load of 2.0 W/square feet. Standard high efficiency ballasts with T12 lamps.
- Annual electricity use is 16.42 kWh/square foot and natural gas use is 35.1 kBtu/square foot.
- Electric bills ~ $200,000 per year, natural gas bills ~ $50,000 per year

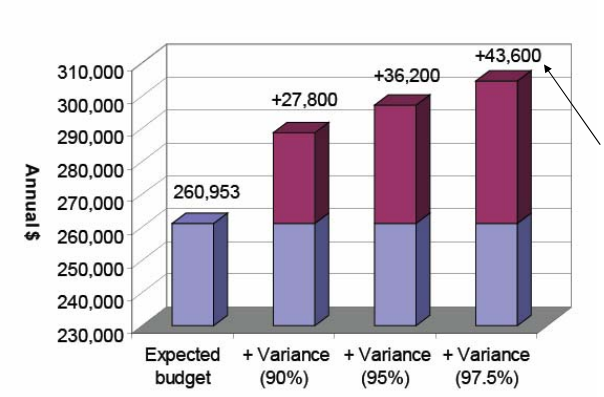
Austin Office Energy Costs



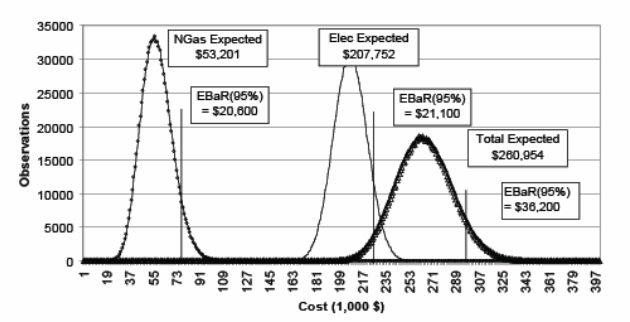
Monte Carlo Analysis Input Variable Distributions

- Weather-related HVAC summer and winter variations
  - Estimated HVAC-weather relationship
  - 30 year historical weather data means and standard deviations
- Random monthly energy use variations
  - Historical variation
- Natural gas price variations
  - +- $2.00/1000 cubic feet
  - Electricity price variations as a function of natural gas prices
    - Estimated from historical electric and natural gas prices

Facility Budget EBaR Analysis Results



Budget Distributions

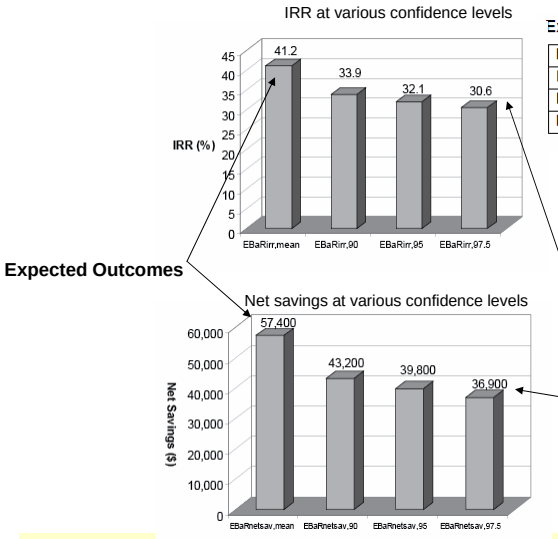


	BUDGET AND VARIANCES			BUDGETS		
	Electricity	Natural Gas	Total	Electricity	Natural Gas	Total
Expected	207,752	53,201	260,953	207,752	53,201	260,953
EBaR 90%	16,300	15,500	27,800	224,052	68,701	288,753
EBaR 95%	21,100	20,600	36,200	228,852	73,801	297,153
EBaR 97.5%	25,100	25,200	43,600	232,852	78,401	304,553

Two Efficiency Options Considered

- Lighting: replaceT12 lamp/ballast systems with super T8 lamp/electronic ballasts, delampling (removing some lighting fixtures), installation of occupancy and day lighting controls in selected areas and replacement of selected incandescent lamps with compact fluorescent lamps.
  - Estimated savings: 483,000 kWh per year, 145 kW peak electricity use
  - Cost: $100,000 (fixed)
  - Estimated savings variation: +- 15 %
  - Payback of 2.1 years
- Recommissioning oversized and poorly designed HVAC system including a building energy management control system.
  - Estimated savings: 30 % for AC (after lighting changes), 65 % for natural gas heating use.
  - Cost: $125,000 (fixed)
  - Estimated savings variation: +- 20%
  - Payback of 3+ years

Investment IRR and Net Cash Flow Bar Charts



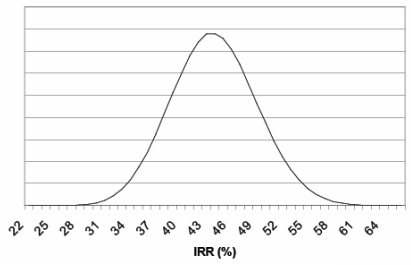
Expected investment analysis summary

Investment Cost	$225,000
Energy cost savings	$98,153
Net cash flow	$57,400
Internal rate of return	41.2 %

Expected Outcomes

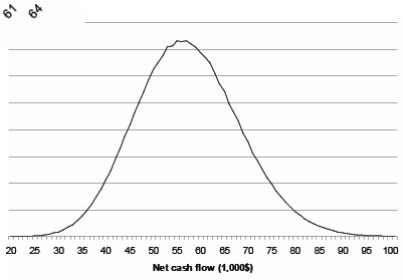
Worst Case Outcomes

Investment IRR and Net Cash Flow Outcome Distributions

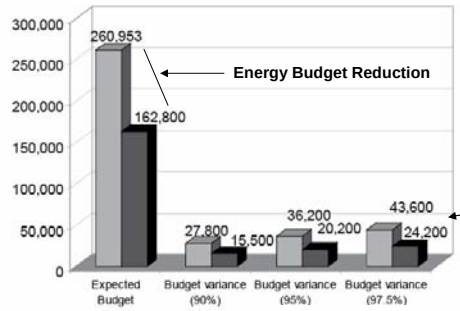


Efficiency program returns

	IRR (%)	NET CASH FLOW
Expected	41.2	$57,400
EBaR 90%	33.9	$43,200
EBaR 95%	32.1	$39,800
EBaR 97.5%	30.6	$36,900

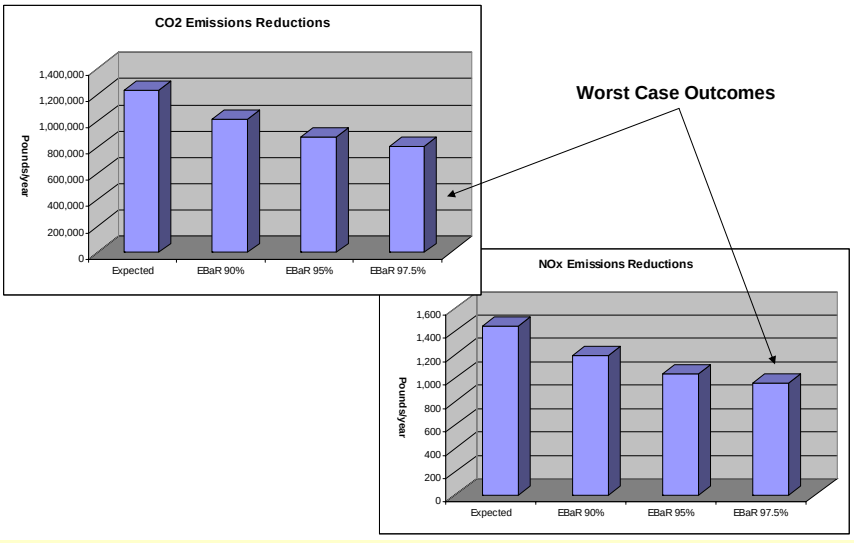


Investment Impacts on The Energy Budget

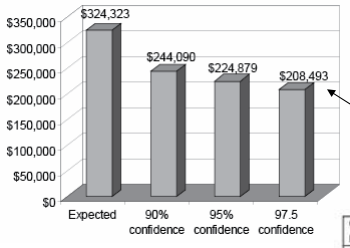


	HVAC AND LIGHTING EFFICIENCY MEASURES ANALYSIS			BASELINE ANALYSIS		
	Electricity	Natural gas	Total	Electricity	Natural gas	Total
Expected	143,300	19,500	162,800	207,752	53,201	260,953
EBaR 90%	12,200	5,100	15,500	16,300	15,500	27,800
EBaR 95%	15,900	6,900	20,200	21,100	20,600	36,200
EBaR 97.5%	19,000	8,500	24,200	25,100	25,200	43,600

Investment Impacts on Facility Emissions



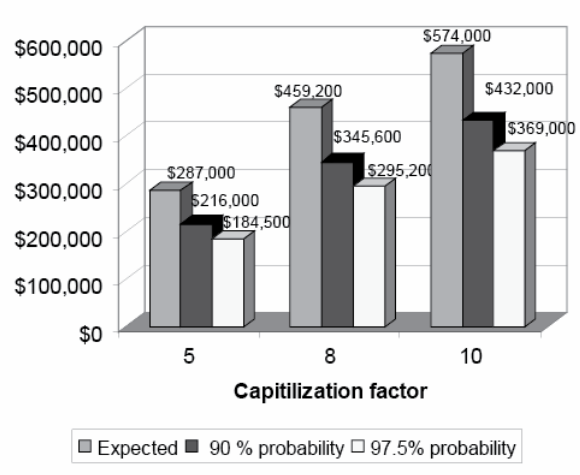
Opportunity Costs of Bypassing Investment



Worst Case Outcome

Confidence Level	Annual Savings	Total Discounted Savings	IRR (%)	Definition
Expected	$57,400	$324,323	41.2	Expected opportunity costs
90%	$43,200	$244,090	33.9	Probability is 90% that values will be at least as large as these
95%	$39,800	$224,879	32.1	Probability is 95% that values will be at least as large as these
97.5%	$36,900	$208,493	30.6	Probability is 97.5% that values will be at least as large as these

Impacts on Facility Capital Value



EBaR Software

- Excel based
- Monte Carlo subroutine is called to conduct analysis
- Many of the case study parameters can be changed to become familiar with the process
- Examples

In Conclusion: The EBaR Value Proposition

- Based on widely used financial risk management tool
- Provides intuitive results and more information than traditional payback and IRR analysis
- Quantifies both investment risks and rewards
  - Risks Assessment
    - Potential budget variances
    - Investment outcomes and their probabilities
  - Rewards
    - Increased cash flow ~ new revenue source
    - Reduced budget volatility and risk
    - Integrated efficiency investment/purchasing decisions
    - Increased capital asset values
- Consistent with trends toward greater use of quantitative management tools like Six Sigma
- Straight-forward application
  - Excel and commercially available Monte Carlo analysis software
  - Energybudgetsatrisk.com



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Thank You for Attending!

Any Questions?

This concludes the American Institute of Architects Continuing Education Systems Program.