Zell Scholarship Research Report

Green Real Estate: Hedging Risk of Sustainable Building Improvements

Louis Merlini

Kellogg School of Management

5/21/10

Table of Contents

Executive Summary

When investing in sustainable building features, a significant portion of investment risk is generated by the inherent volatility of utility pricing. For example, specific year-over-year changes in natural gas pricing over the past 35 years have been as high as +28% and as low as -22%[1]. Given the high correlation between utility price growth and sustainable project returns, such price movements are a key driver of investment risk.

As such, the goal of this paper is show that a real estate developer/owner investing in sustainable building features can minimize the risks associated with those investments by hedging against the volatility of utility pricing through either direct forward contracts with energy providers or indirect option trading on financial exchange markets.

To prove this hypothesis, the paper analyzes the potential chiller replacement of the Rohm and Haas Research Campus in Springfield, Pennsylvania. The investment scenario is as follows:

> *As part of a sustainable improvement initiative, Rohm and Haas is looking to replace their Springfield Research Campus's existing (and fully functioning) chiller system with one of the three high efficiency options listed above. Although their system still has substantial useful life remaining, they are willing to make the upfront capital expenditure now to realize future utility cost savings over the 10 year life of the project.*

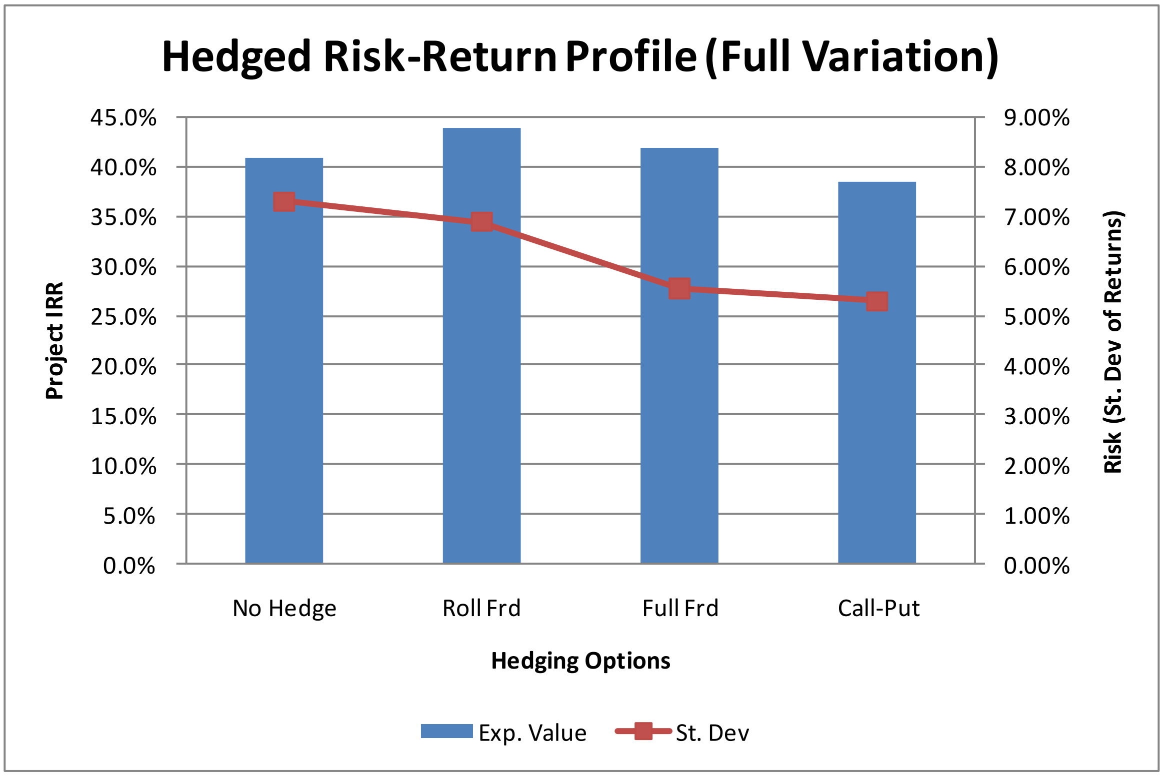
Using a combination of random generation functions tied to historical pricing movements and cumulative probability distributions related to installed cost and annual gas/electricity consumption expectations, the analysis simulates full project pro formas for the following 4 investment scenarios:

- No Hedging (Baseline)
- Direct Hedging – Rolling Forward Contracts
- Direct Hedging – Full Forward Contracts
- Indirect Hedging – Put & Call Option Positions

[1] Source: U.S. Department of Energy: http://www.eia.doe.gov/

As hypothesized, the analysis shows that engaging in any of the proposed hedging strategies significantly decreased the standard deviation of returns without substantially reducing their magnitude, thus creating alpha.

The following chart shows the comparison of expected returns to standard deviation for each of the various hedging strategies (the returns shown are for the most profitable of the proposed replacement system options). Under the Full Forward hedging strategy, the standard deviation of returns drops from 7.29% to 5.54% (a 24% reduction in risk) while the expected IRR actually increased from 40.9% to 41.9%.



The data presented in this paper clearly shows that there is an opportunity to generate alpha on sustainable real estate investments by reducing risk without significantly impacting expected returns using a variety of hedging methods. Based on the findings under this specific investment scenario, the Full Forward hedge produces the best overall risk adjust returns. Operationally, this is also the easiest hedge to construct as it is set up directly with the utility provider and requires less annual oversight than the rolling forward strategy.

Thesis

A real estate developer/owner investing in sustainable building features can minimize the risks associated with those investments by hedging against the volatility of utility pricing through either direct forward contracts with energy providers or indirect option trading on financial exchange markets.

Introduction

In light of the recent economic crisis, the overall landscape of the commercial real estate industry is shifting dramatically. The previously attractive build-and-flip strategy has now given way to a more long-term, operations focused mentality. As a result, sustainable technology is playing an increasingly important role in the overall profitability of real estate investments due to the fact that developers will now likely operate their properties long enough to fully realize the returns on their green investments. Additionally, most municipalities now require at least some minimal level of green design for all new developments. Going forward, industry experts predict that regulatory changes will continue to force green technology to become even more important in the zoning and entitlement process for years to come.

The topic of risk mitigation of sustainable investing is particularly relevant to the following real estate owner/operators:

1) Large institutions, specifically hospitals and universities
2) Corporations with significant real estate portfolios
3) Major development/acquisition firms with long term hold strategies

For the reasons noted above, all of these entities will likely be engaged in significant amounts of sustainable investment in the future. To fund these projects, these entities will need to sell investors on the risk adjusted returns that they can provide. Therefore, a strategy for minimizing this risk without significantly impacting returns will be particularly attractive. Additionally, this research could be useful to financial institutions that advise clients on various hedging products as it identifies a potential new, diverse group of clientele.

Risks of Sustainable Investing

Like any investment, there are financial risks associated with investing in green technology. Specifically, for green investments to generate positive returns, the incremental additional capital required to purchase and install sustainable systems must eventually be offset by future savings in utility costs. For example, when a developer or owner is faced with the decision of installing a high efficiency mechanical system, he/she must determine if the reduction in energy usage (in comparison to a "non-green" system) will provide the necessary utility cost savings to justify the additional up front capital expenditure.

At a high level, the variability (or risk of deviation from) expected returns associated with almost all investments in sustainable building projects can be broken down into three main types:

1) *Installation Cost:* Will the new system be installed per the anticipated budget?
2) *System Performance:* Will year-over-year climate changes and the variability of system operating hours lead to significant variability in resource (i.e. electricity or natural gas) consumption and thus increase volatility of returns?
3) *Utility Price Volatility:* Will utility prices rise or fall in-line with pro-forma expectations, impacting the net savings (returns) associated with the sustainable upgrade?

Risk Mitigation: Installation cost risk can be controlled though careful due diligence in the bidding process as well as careful contracting with the construction company, locking in a guaranteed maximum price and incentivizing the subcontractors to complete the project as cost effectively as possible. Year-over-year consumption needs will always have some degree of variability, however in many cases mechanical engineering consultants can confidently predict annual resource consumption within a reasonable range, limiting the effect on the variation of returns[2].

The focus of this research paper will mainly target the final risk category: Utility Price Volatility. Specifically, the paper looks at potential strategies to mitigate the utility price risk through either direct forward contracts with energy providers or indirect option trading on financial exchange markets.

[2] Source: Tom Bathgate, P.E. – Principal, PWI Engineering

Utility Price Risk

When analyzing the expected return of a potential green investment, the accuracy of this return analysis is highly dependent on the analyst's ability to predict utility price movements as far as 10 years into the future. Moreover, analysts evaluating sustainable investments often assume a constant growth rate for future utility prices. However, as the following table of historical electricity and natural gas prices highlights, future price growth will likely contain substantial volatility.

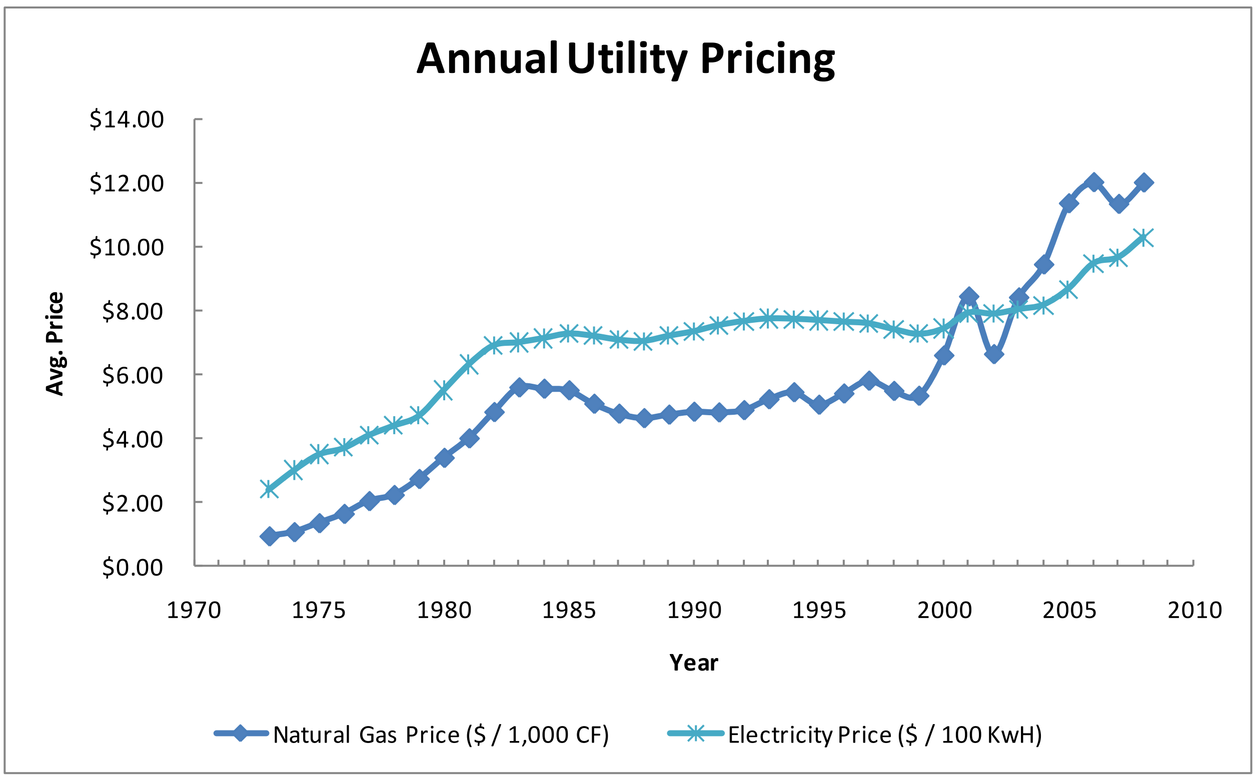


Figure 1: Historical Utility Pricing Data – National As-Delivered Commercial Retail Averages[3]

As stated above, the assumed utility price growth rate will play a significant role in the projection of a sustainable project's NPV and IRR. Specifically, a higher assumed price growth rate (of the resource being saved by the green system) will lead to more attractive expected return projections. The following

[3] Source: U.S. Department of Energy: http://www.eia.doe.gov/

chart highlights the danger of analyzing a potential sustainable investment without incorporating the potential variability of utility pricing (i.e. using a constant price growth assumption).

This graph illustrates the range of NPV and IRR returns of the sample project analyzed in this paper assuming a variety of constant utility price growth rates.

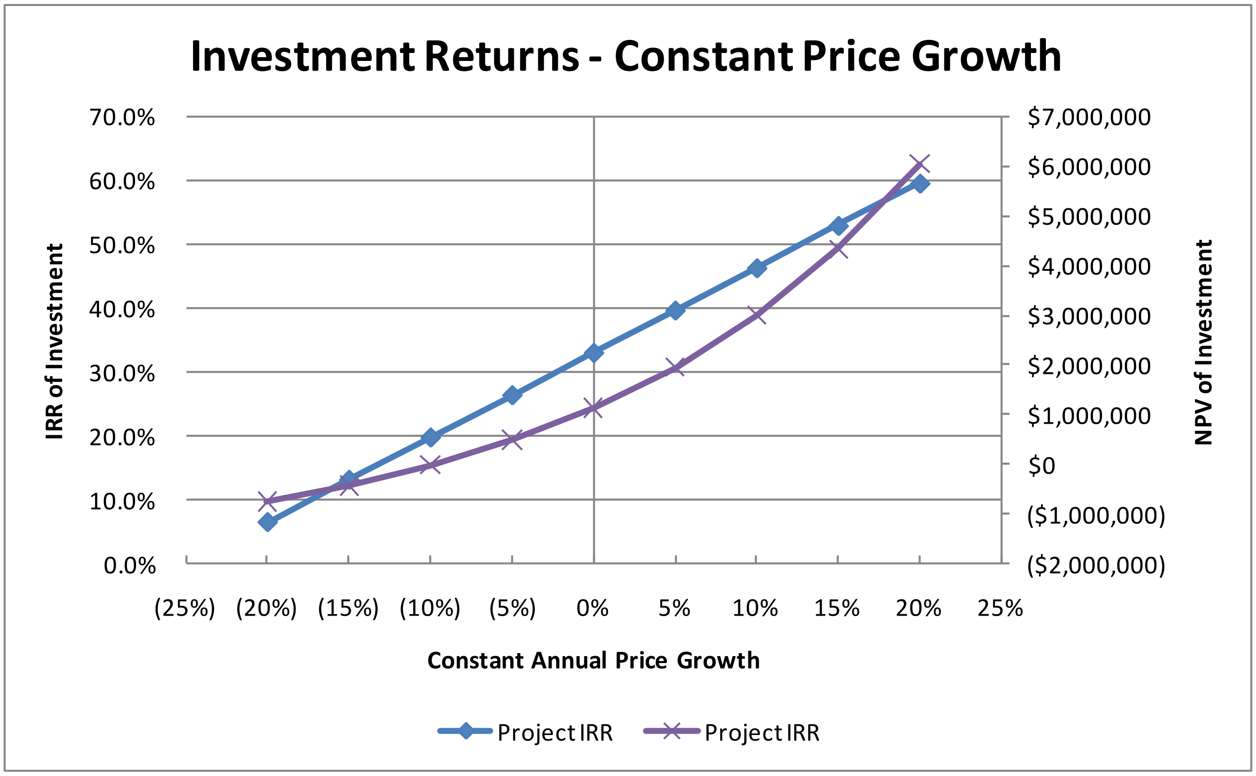
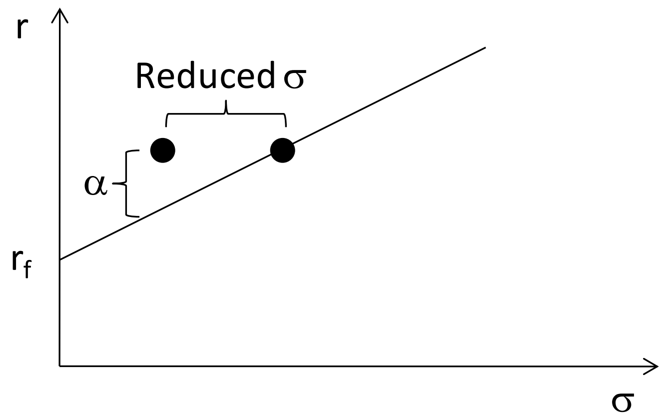


Figure 2: Projected Investment Returns of Rohm and Haas Research Campus Chiller Replacement Project Assuming Constant Price Growth (NPV Discount Rate = 20%)

Looking at the utility pricing trends in Figure 1, it is clear that historical price movements fluctuate significantly depending on the time period of the sample. More specifically, if an analyst were to use historical pricing to simply estimate an average growth rate, the sample period used would drastically impact the assumption. Furthermore, Figure 2 shows that the assumed growth rate has a major impact on expected returns. For example, shifting the assumption from 5% to 15% annual growth (both realistic assumptions) more than doubles the project's NPV. As such, the substantial volatility of utility pricing and the high correlation of price growth to expected return is the fundamental driver of the need to hedge out utility price risk.

Method of Utility Price Risk Mitigation

This goal of this paper is to show that by smoothing future cash flows (generated from utility savings), we can reduce the risk (standard deviation σ) of returns without significantly affecting the magnitude of returns (r), thus generating alpha (α).



To smooth future cash flows, this paper investigates three different strategies to hedge against movements in utility prices. The first two strategies (future contracts) can be employed directly with the utility provider, however the third strategy (option trading) would require a financial institution to shape and execute the trades. It is important to note that all of these strategies assume that the building operator is only hedging against the quantity of resources used in the specific green project under consideration, *not* their entire energy needs.

Also, it is important to keep in mind that these hedging strategies are *not* intended to be interpreted as profit centers. They are simply designed to smooth out cash flows in an effort to decrease uncertainty and lower risk. Like all financial hedging strategies, the recipient of the hedge must be fully aware that over some time periods they will “win” (be paid off) while in other cases they will “lose” (pay out). More importantly, they must understand that these wins and losses should balance out over time and that the true benefit of the strategy is avoiding the “swings” of an unhedged position in the market.

Hedging Strategy 1: Rolling Forward

The Rolling Forward strategy falls under what this paper is calling a Direct Hedging strategy (i.e. a strategy that can be executed directly with the utility service provider). The basic framework of the rolling forward strategy is that the building operator will lock in a given percentage of the system under consideration's annual energy needs at a predetermined price (typically 5% to 11% above the current market rate)[4]. The firm then rolls this position over each year. For example, if the firm is using a 4 year cycle, they will lock in 25% of their needs in a 4 year contract. Once the operation is running at steady state (3 year later in this example), the firm will be constantly renewing a new 25% of their needs on subsequent 4 year contracts.

Hedging Strategy 2: Full Forward

The Full Forward strategy also falls under the direct hedging method. Its key difference from the Rolling Forward is that rather than only locking in a portion of the system's resource needs, the building operator would hedge 100% of the system's resource needs. They would still lock in a set forward price (again, 5% to 11% above the current market rate)[5], however they would lock in the full 100% of their needs, rolling their entire position over at the end of each contract period.

Hedging Strategy 3: Put-Call Options

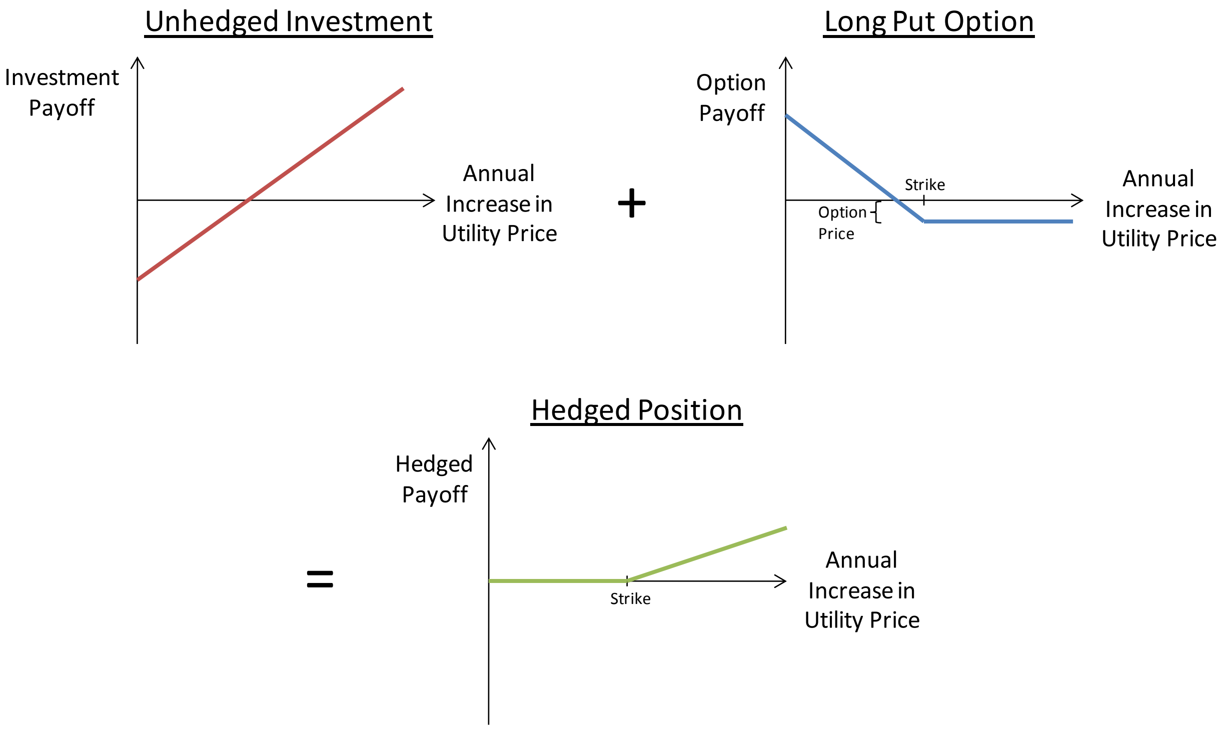
The Put-Call option strategy is the most complicated hedging strategy under consideration. This is an indirect strategy, meaning that the building operator would likely need to employee an outside financial institution to execute the option trades on one of the various exchanges such as the Chicago Board Option Exchange[6]. The high level concept of this strategy is to develop a portfolio of put and call options that synthetically smoothes future cash flows by paying the option holder when future saving fall below projected expectations and costing the option holder when future savings exceed projected expectations. The following graphs illustrate this underlying concept.

---

[4] Source: Tom Bathgate, P.E. – Principal, PWI Engineering

[5] Source: Tom Bathgate, P.E. – Principal, PWI Engineering

[6] CBOE Products: http://www.cboe.com/Products/optionsOnETFs.aspx



In the above scenario, the option strike price is being set as a percent increase over the current year's spot price. The mechanics of this transaction will be further explained in the Method of Analysis section of this paper. As these payoff diagrams illustrate, under this hedging strategy the downside risk is eliminated by the option payoff while the upside gain is muted by the price of the option, essentially acting as an insurance policy against adverse price movements.

Sample Project Background – Rohm and Haas Research Campus

To test the paper's hypothesis, an extensive Excel model has been built to simulate the returns of a slightly modified real world project under the various hedging strategies listed above. Based on essential data provided by PWI Engineering (a Philadelphia based mechanical engineering firm)[7], this paper analyzes the April '07 potential investment decision for the replacement of the Chiller system at the Rohm and Haas Research Campus located in Springfield, Pennsylvania. In essence, the chiller is the mechanical system that provides all of the cooling services for the entire campus.

This project is an ideal candidate for this analysis for the following reasons:

- The property is owned and operated by Rohm and Haas (now Dow Chemical as of 2008), meaning they will be paying all of their own utility expenses (as opposed to an office or industrial tenant who splits expenses with the building owner). Additionally, as a corporate research facility, Rohm and Haas likely intends to hold on to the property for an extended time period, giving them time to realize the sustainable upgrade's returns.
- The existing Chiller system only consumes electricity, however some replacement options consume a combination of electricity and natural gas. This allows the simulation to test a variety of scenarios. Namely, it incorporates a relatively stable priced utility (electricity) as well as a move volatile priced utility (natural gas). It also allows the analysis to incorporate the reduction of one resource due to increased efficiency (electricity), while increasing the consumption of another resource due to the duel nature of the new system (natural gas).
- All three of the replacement options (listed below) deliver approximately the same cooling capacity, meaning the analysis is purely looking at the tradeoff between instillation cost and future utility expenses (differences in annual maintenance costs were negligible).

The following table summarizes the various system options being considered. Note that the electricity consumption is given in KwH/Yr (kilowatts-hours per year) and natural gas consumption is listed as CF/Yr (cubic feet per year). Although most engineering firms and utility providers typically communicate in MwH (megawatt-hours) and MCF (million cubic feet), the data has been broken down to the KwH and CF

[7] http://www.pwius.com/

level to simplify the simulation calculations. Also, note that these are the *expected values* provided by PWI's cost and consumption analysis. The paper will further discuss the range of variation of these assumptions in the Method of Analysis section.

System Option Summary	Installed Cost ($)	Electricity Usage (KwH/Yr)	Natural Gas Usage (CF/Yr)
Existing System			
1800 Ton Chiller Lead Machine	$0	8,381,368	0
1400 Ton Chiller Lead Machine	$0	7,101,632	0
Total	**$0**	**15,483,000**	**0**
Replacement Option 1			
New 1800 Ton Chiller lead Machine	$984,840	7,164,544	0
500 Tons Winter Free Cooling, Ref. Ex. 1400 Ton Chillers	$568,698	6,723,456	0
Total	**$1,553,538**	**13,888,000**	**0**
Replacement Option 2			
New 900 Ton Centrifugal & 900 Ton Absorption Chillers Peak Shaving	**$2,416,413**	**6,886,114**	**3,088,611**
Replacement Option 3			
New 1400 Ton Centrifugal, 400 Ton Absorption Chillers, & 1.6 Meg Cogeneration Peak Shaving	**$3,879,831**	**4,437,404**	**6,360,735**

Figure 3: Rohm and Haas Replacement Campus - Chiller Replacement Options[8]

Note: Rohm and Haas was actually looking at these options for doubling their existing cooling capacity, not replacing their existing system. However, for the purpose of this study the data is perfectly adequate for evaluating the hypothetical investment decision to replace the functioning existing system with a high efficiency model in order to capture the future utility savings.

[8] Source: Extrapolated from PWI Engineering's Instillation, Energy, and Maintenance Cost Analysis of the R&H Research Campus (April 17, 2007)

Method of Analysis

Overview

The paper's hypothesis is tested by running a 1,000 trial simulation of the following hypothetical (yet common) investment scenario:

> *As part of a sustainable improvement initiative, Rohm and Haas is looking to replace their Springfield Research Campus's existing (and fully functioning) chiller system with one of the three high efficiency options listed above. Although their system still has substantial useful life remaining, they are willing to make the upfront capital expenditure now to realize future utility cost savings over the 10 year life of the project.*

Using a combination of random generation functions tied to historical pricing movements and cumulative probability distributions related to installed cost and annual gas/electricity consumption expectations, the simulation generates full project pro formas for the following 4 investment scenarios:

- No Hedging (Baseline)
- Direct Hedging – Rolling Forward Contracts
- Direct Hedging – Full Forward Contracts
- Indirect Hedging – Put & Call Option Positions

Running each of these scenarios though a 1,000 trial simulation creates the necessary data to determine the expected values and standard deviations of the investment returns. This simulation is then repeated for each of the 3 potential replacement options, determining the most profitable replacement system as well as the optimal hedging strategy for risk reduction.

Simulation Method

Utility pricing is the primary variable of this research, so significant effort went into simulating this portion of the model. The backbone of the pricing simulation comes from historical electrical and natural gas price data collected by the U.S. Department of Energy between 1973 and 2008. Both are given as average annual retail prices (as delivered) to commercial customers. The model uses this data to determine historical annual price changes, then adjusted those changes by a noise factor that allows the user to increase and decrease volatility by randomly generating a projected annual price change as a function of the original change. The model generates the noise adjusted price change assuming a normal distribution around the actual historical price change, with the standard deviation of that distribution set as a user input percentage of the original change. Additionally, the trailing 3-yr volatility and historical risk free rates are tracked and later used for generating put and call option prices (see Appendix 1 and Appendix 2 for the complete historical pricing calculations).

To simulate random variability, the model randomly chooses a year between 1975 and 2008, then applies the corresponding noise adjusted changes in price over the following 10 year time horizon. The price change simulation was approached this way in order to capture utility price regimes, as utility prices typically move in sets of either high or low volatility years. By using historical data trends, the analysis is able to capture this regime tendency. The following table is an example of a randomly generated 10 year projection of utility price changes. As noted above, additional data is projected for put and call option pricing.

Rand Year	**1976**				
Year	10 Yr Treasury	Adj. Elec. Changes	Trailing St. Dev	Adj. Gas Changes	Trailing St. Dev
0	7.61%	5.86%	36.6%	21.12%	28.5%
1	7.42%	11.35%	32.1%	25.55%	35.5%
2	8.41%	7.53%	37.0%	9.60%	31.5%
3	9.43%	6.94%	31.2%	22.56%	36.5%
4	11.43%	15.93%	55.2%	26.24%	62.1%
5	13.92%	14.91%	79.5%	18.17%	68.1%
6	13.01%	10.50%	74.9%	19.54%	72.3%
7	11.10%	1.39%	41.8%	16.16%	80.3%
8	12.46%	1.87%	11.6%	-0.72%	44.9%
9	10.62%	2.14%	14.5%	-0.90%	4.6%
10	7.67%	-0.96%	7.8%	-7.64%	26.5%

Figure 4: Random Utility Price Change Generator

In addition to price volatility, the model also simulates the potential variation in the installed cost of the replacement systems as well as the range of annual electric and natural gas consumption of both the existing and the replacement systems. The data used to generate this variability was provided by PWI

Engineering based on their considerable experience with similar projects. See the following tables for the low, expected, and high projections provided by PWI:

	Installed Cost ($)		
	Low	Expected	High
Existing: 1800 Ton Chiller lead Machine	$0	$0	$0
Existing: 1400 Ton Chiller lead Machine	$0	$0	$0
Existing: Total System	$0	$0	$0
Option 1: New 1800 Ton Chiller lead Machine	$800,000	$984,840	$1,070,000
Option 1: 500 Tons Winter Free Cooling, Ref. Ex. 1400 Ton Chillers	$461,962	$568,698	$617,874
Option 1: Total System	$1,261,962	$1,553,538	$1,687,874
Option 2: New 900 Ton Centrifugal			
& 900 Ton Absorbtion Chillers Peak Shaving	$1,962,889	$2,416,413	$2,625,364
Option 3: New 1400 Ton centrifugal, 400 Ton Absorbtion Chillers			
& 1.6 Meg Cogeneration Peak Shaving	$3,151,645	$3,879,831	$4,215,325

Figure 5: Installed Cost (By System) - Range of Projected Values[9]

	Electicity Usage (KwH/Yr)		
	Low	Expected	High
Existing: 1800 Ton Chiller lead Machine	7,578,580	8,381,368	9,638,329
Existing: 1400 Ton Chiller lead Machine	6,421,420	7,101,632	8,166,671
Existing: Total System	14,000,000	15,483,000	17,805,000
Option 1: New 1800 Ton Chiller lead Machine	6,190,562	7,164,544	8,239,122
Option 1: 500 Tons Winter Free Cooling, Ref. Ex. 1400 Ton Chillers	5,809,438	6,723,456	7,731,878
Option 1: Total System	12,000,000	13,888,000	15,971,000
Option 2: New 900 Ton Centrifugal			
& 900 Ton Absorbtion Chillers Peak Shaving	5,949,983	6,886,114	7,918,932
Option 3: New 1400 Ton centrifugal, 400 Ton Absorbtion Chillers			
& 1.6 Meg Cogeneration Peak Shaving	3,834,162	4,437,404	5,102,951

Figure 6: Annual Electricity Consumption (By System) - Range of Projected Values[10]

[9] Source: Tom Bathgate, P.E. – Principal, PWI Engineering

[10] Source: Tom Bathgate, P.E. – Principal, PWI Engineering

	Natural Gas Usage (CF/Yr)		
	Low	Expected	High
Existing: 1800 Ton Chiller lead Machine	0	0	0
Existing: 1400 Ton Chiller lead Machine	0	0	0
Existing: Total System	0	0	0
Option 1: New 1800 Ton Chiller lead Machine	0	0	0
Option 1: 500 Tons Winter Free Cooling, Ref. Ex. 1400 Ton Chillers	0	0	0
Option 1: Total System	0	0	0
Option 2: New 900 Ton Centrifugal & 900 Ton Absorbtion Chillers Peak Shaving	2,668,731	3,088,611	3,551,859
Option 3: New 1400 Ton centrifugal, 400 Ton Absorbtion Chillers & 1.6 Meg Cogeneration Peak Shaving	5,496,027	6,360,735	7,314,754

Figure 7: Annual Natural Gas Consumption (By System) - Range of Projected Values[11]

The variability has been modeled using the three point approach, in which the low and high points are estimated as follows. A low value is defined as a value so low that there is only a 10% chance that a lower value could actually occur. Conversely, a high value is defined as a value that is so high that there is a 90% chance that a lower value could actually occur. The low data point is used to represent an average of the lower 25% of the distribution curve, the expected value represents the middle 50% of the distribution curve, and the high represents the upper 25% of the distribution curve. Using a random number generator (0% through 100%), each of these assumptions is appropriately simulated using their cumulative probability distribution.

The 1,000 trial generation has been created using two methods. First, where the model is isolating the results from price variation only (i.e. modeling constant installed cost and constant annual consumption in each trial), a one-way data table (under Excel's What If Analysis) was used to create the trials where the column variable was set as a series of randomly generated years used to choose the noise adjusted projection of utility price changes. See Appendix 3 for a sample of the data produced using this tool. This method was chosen because it allows the model to later generate sensitivity tables using a combination of self-referencing IF statements and custom macros (as traditional data tables cannot build on top of each other).

[11] Source: Tom Bathgate, P.E. – Principal, PWI Engineering

The second data generation method was used to capture the full variability of the model (i.e. utility price, installed cost, and consumption fluctuation). This method utilized the Simulation Table module of the SimTools[12] add-in for Excel. See Appendix 4 for a sample of the data created using this tool.

Model Inputs

Apart from the replacement system specifications and historical utility pricing data, the model is also driven by a few more key inputs. First, the model needs time-zero utility prices for both electricity and natural gas. These numbers serve as the base point from which the simulated 10 year price changes build. As noted above, the Pricing Noise Factor allows the user to increase or decrease the volatility of the price change projection. Lastly, there are 4 main "switches" in the model that allow the user to toggle between the 3 replacement system options as well as isolate which factors contributing to the variability of future returns. The following is a summary table of the major model inputs (note: additional hedge specific input variables are discussed in the following sections).

Current Pricing Inputs	
Electricity t_0 Price ($/KwH)	$0.1028
Natural Gas t_0 Price ($/CF)	$0.0120
Pricing Noise Factor (St. Dev as % of base mean)	5.0%

Model Scenario Switches	
Replacement System Option 2	
Include Variability of Electicity Consumption	Yes
Include Variability of Thermal Consumption	Yes
Include Variability of Installed Cost	Yes

Figure 8: Model Inputs and Switches

[12] SimTools 3.31 was developed at the Kellogg School of Management, Northwestern University. © 1996-2000 by R.B. Myerson

Governing Assumptions

The following assumptions are key drivers for the analysis methodology:

- The existing system is assumed to have sufficient remaining useful life such that no additional value is given to the new system based on delaying future capital expenditures. (Conversely, one could do an identical analysis of a project investigating the replacement of a system with no remaining useful life. In that case, the utility cost savings would be calculated as the difference between two proposed replacement systems, projected against their difference in initial costs.)
- At the end of year 10, the model assumes no reversion value (i.e. they are not selling the building) and no perpetuity value.
- Future maintenance cost differences between the existing and new systems are negligible (as is supported by the PWI data).
- The sizes of all hedging contracts are based on the consumption needs of the chiller system only.
- The firm has sufficient monitoring systems in place to prevent paying significant "overage" or "underage" premiums. These premiums are paid when the building owner is unable to accurately forecast energy need, and thus ends up paying a premium for differences between the energy requisitioned and the energy consumed.
- Utility pricing has been simplified to annual averages
- The underlying asset prices of the Put and Call options move in line with retail utility prices
- Electricity and Natural Gas Put and Call option markets are efficient and can accommodate the operator's desired contract size and target strike price

Pro Forma Calculation Method

Option 1 – Unhedged Investment:

The IRR of the unhedged investment is calculated by determining the projected annual change in resource consumption (savings for electricity, additional consumption for natural gas), which is then multiplied by the simulated 10 year utility price forecasts to create a 10 year cash flow projection. See the Analysis section for the detailed pro forma.

<u>Option 2 – Rolling Forward Hedge:</u>

The IRR of the Rolling Forward analysis is calculated in a similar fashion to the unhedged investment. However, the simulated pricing forecast is not directly used to calculate the project cash flows. Conversely, because a portion of the forward contracts are rolled over each year, the model calculates a blended average of all of the prices that the owner is contracted under in a given year. Note that there is a build up period before the hedging strategy is running at steady state (i.e. before an equal portion of the resource needs are turning over each year).

This strategy has only a few key inputs: The length of the contract and the premium paid to lock in a future price. To be conservative, the model has been run assuming a 10% premium regardless of the duration of the contract. Additionally, the model results have been calculated assuming 3 year contracts for both electricity and natural gas forwards (per PWI's recommendation of realistic assumption in the current market environment). See the Analysis section for the full pro forma calculation.

<u>Option 3 – Full Forward Hedge:</u>

Again, the IRR of the Full Forward analysis is calculated similarly to the unhedged investment. However, rather than calculating future cash flows with the base-projected or blended utility pricing, this method prices 100% of each year's resource consumption at the locked-in price set forth by the single governing contract.

Similar to the Rolling Forward strategy, both natural gas and electric contracts are modeled at 10% premiums to the existing spot rate, with 3 year contract durations. See the Analysis section for the detailed pro forma.

<u>Option 4 – Put and Call Option Hedge:</u>

As noted in the Method of Utility Price Risk Mitigation section of this paper, the underlying goal of the Put-Call Option strategy is to supplement the building operator's unhedged position with the utility provider with counterbalancing option transactions. As shown in the following chart, when future electricity prices INCREASE, project returns INCREASE as well. Conversely, when natural gas prices INCREASE, project returns decrease (see Appendix 5 and Appendix 6 for additional return sensitivities).

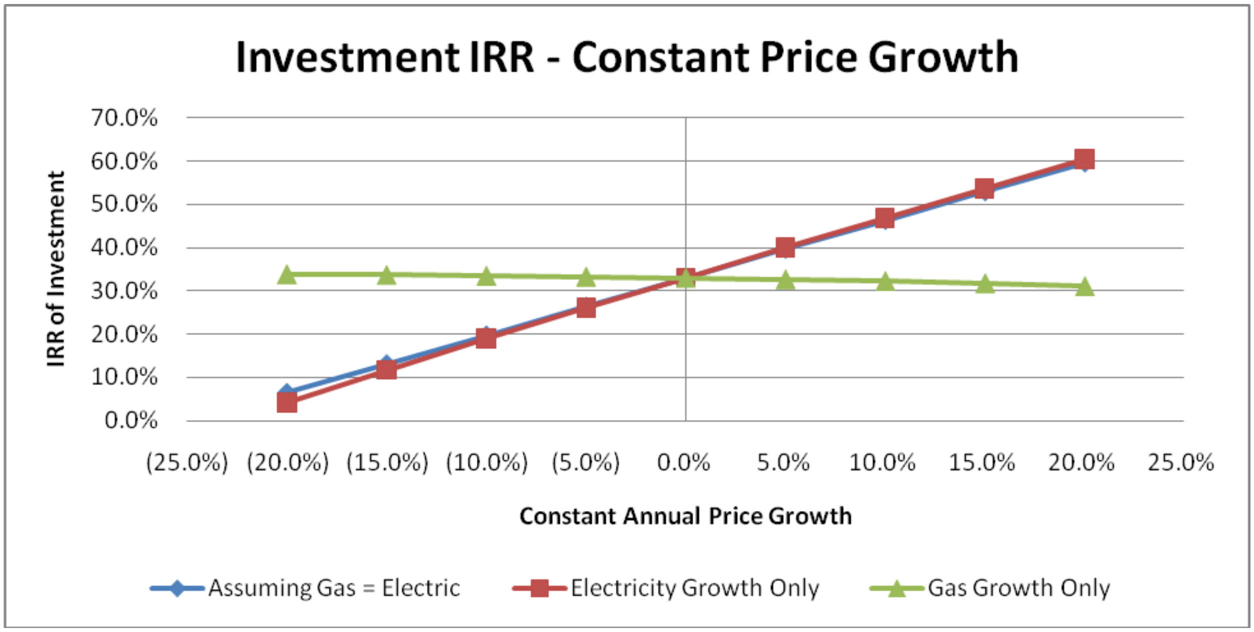


Figure 9: Rohm and Haas Project Returns (Assuming Constant, Matching Electricity and Natural Gas Price Growth) for Replacement Option 2

Therefore, to smooth overall project cash flows the owner would need to buy a 1 year put option (the right, but not the obligation to sell a unit electricity for a fixed strike price) on electricity such that it the owner receive payment in a year where price growth is less than anticipated and the owner pays out in years where price growth exceeds expectations. Conversely, the owner must buy 1 year call options (the right, but not the obligation to buy a unit of natural gas for a fixed strike price) to offset the downward sloping investment payoff diagram of natural gas. The model sets the option strike price as a user input % of the current year's spot price (in an effort to smooth prices to a constant growth rate). The price of each option is calculated as a zero dividend, European option using the Black-Scholes model. The Black-Scholes Excel functions utilized are part of an options pricing add-in[13].

To calculate the total project cash flows, the unhedged utility savings, option fees, and option payoffs were summed each year and contrasted with the initial instillation cost to determine the project IRR. The optimal size of the option contracts (as a % of anticipated consumption needs) and the target strike price were determined using a sensitivity analysis (shown in the Sensitivity Analysis section).

[13] Developed at the Kellogg School of Management, Northwestern University © 1994-2000 by Robert McDonald

Analysis

Forecasts and Pro Formas

Consumption and Market Pricing Forecasts

Replacement System Option 2

Consumption Forecast	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Existing System	0.33	0.67	0.46	0.50	0.72	0.08	0.64	0.24	0.56	0.27	0.99
Electricity	15,483,000	15,483,000	15,483,000	15,483,000	15,483,000	14,000,000	15,483,000	14,000,000	15,483,000	15,483,000	17,805,000
Natural Gas	0	0	0	0	0	0	0	0	0	0	0
Low Cost New System	0.43										
Installed Cost	$ (2,416,413)										
Electricity	6,886,114	6,886,114	6,886,114	6,886,114	6,886,114	5,949,983	6,886,114	5,949,983	6,886,114	6,886,114	7,918,932
Natural Gas	3,088,611	3,088,611	3,088,611	3,088,611	3,088,611	2,668,731	3,088,611	2,668,731	3,088,611	3,088,611	3,551,859
Change in Consumption											
Electricity	8,596,886	8,596,886	8,596,886	8,596,886	8,596,886	8,050,017	8,596,886	8,050,017	8,596,886	8,596,886	9,886,068
Natural Gas	(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)	(2,668,731)	(3,088,611)	(2,668,731)	(3,088,611)	(3,088,611)	(3,551,859)

Market Pricing Forecast	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Electricity Price Forecast											
Year over Year Change in Price		7.16%	7.49%	16.26%	14.58%	8.79%	1.46%	1.89%	2.18%	-0.96%	-1.67%
EOY Market Price ($/KwH)	*$0.1028*	*$0.1102*	*$0.1184*	*$0.1377*	*$0.1577*	*$0.1716*	*$0.1741*	*$0.1774*	*$0.1813*	*$0.1795*	*$0.1765*
Natural Gas Price Forecast											
Year over Year Change in Price		8.77%	21.40%	24.12%	16.91%	19.97%	17.28%	-0.72%	-0.90%	-7.64%	-6.10%
EOY Market Price ($ / CF)	*$0.0120*	*$0.0130*	*$0.0158*	*$0.0197*	*$0.0230*	*$0.0276*	*$0.0323*	*$0.0321*	*$0.0318*	*$0.0294*	*$0.0276*

Investment Option 1 - Invest in Green Upgrade w/ NO Contractual Hedging (Spot Contract)

Replacement System Option 2

Project IRR: New vs. Existing Syste	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Reduction (Increase) in Consumption											
Electricity (KwH/Year)		8,596,886	8,596,886	8,596,886	8,596,886	8,596,886	8,596,886	8,596,886	8,596,886	8,596,886	8,596,886
Natural Gas (CF/Year)		(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)
Market Price of Resource (EOY)											
Electricity ($/KwH)		$0.1127	$0.1145	$0.1164	$0.1187	$0.1175	$0.1156	$0.1149	$0.1176	$0.1203	$0.1235
Natural Gas ($/CF)		$0.0146	$0.0169	$0.0168	$0.0166	$0.0154	$0.0144	$0.0140	$0.0143	$0.0146	$0.0145
Annual Cash Flows											
Installed Cost	($2,416,413)										
Annual Elect Savings (Loss)		$968,933	$983,967	$1,001,022	$1,020,068	$1,010,246	$993,409	$987,796	$1,011,354	$1,033,781	$1,061,826
Annual Gas Savings (Loss)		($45,165)	($52,263)	($51,889)	($51,421)	($47,495)	($44,596)	($43,287)	($44,273)	($45,064)	($44,877)
Project Cash Flows	$ (2,416,413)	$ 923,768	$ 931,704	$ 949,133	$ 968,647	$ 962,752	$ 948,813	$ 944,509	$ 967,080	$ 988,717	$ 1,016,949

Option 1: Project IRR	**37.44%**

Investment Option 2 - Invest in Green Upgrade w/ Rolling Forward Hedging Contracts

(The firm rolls an equal portion of their resource needs into a new FORWARD contract each year)

Replacement System Option 2

Rolling Forward Contract Structure:			
	Electric	**Gas**	
Individual Contract Duration	3	3	Years
Price Premium Over Market Rate	10%	10%	

Project IRR: New vs. Existing Syste	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Reduction (Increase) in Consumption											
Electricity (KwH/Year)		8,596,886	8,596,886	8,596,886	8,596,886	8,596,886	8,596,886	8,596,886	8,596,886	8,596,886	8,596,886
Natural Gas (CF/Year)		(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)
Market Price of Resource (EOY)											
Electricity ($/KwH)		$0.1127	$0.1145	$0.1164	$0.1187	$0.1175	$0.1156	$0.1149	$0.1176	$0.1203	$0.1235
Natural Gas ($/CF)		$0.0146	$0.0169	$0.0168	$0.0166	$0.0154	$0.0144	$0.0140	$0.0143	$0.0146	$0.0145
Blended Effective Hedged Pricing (Through EOY) - Includes Forward Premium											
Electricity ($/KwH)		$0.1240	$0.1246	$0.1260	$0.1282	$0.1293	$0.1290	$0.1276	$0.1276	$0.1294	$0.1325
Natural Gas ($/CF)		$0.0161	$0.0169	$0.0177	$0.0185	$0.0179	$0.0170	$0.0161	$0.0157	$0.0157	$0.0159
Annual Cash Flows											
Installed Cost	($2,416,413)										
Annual Elect Savings (Loss)		$1,065,827	$1,071,339	$1,083,105	$1,101,854	$1,111,490	$1,108,699	$1,096,866	$1,097,272	$1,112,075	$1,139,219
Annual Gas Savings (Loss)		($49,682)	($52,284)	($54,749)	($57,043)	($55,295)	($52,621)	($49,639)	($48,458)	($48,629)	($49,212)
Project Cash Flows	$ (2,416,413)	$ 1,016,145	$ 1,019,055	$ 1,028,355	$ 1,044,811	$ 1,056,195	$ 1,056,077	$ 1,047,227	$ 1,048,814	$ 1,063,446	$ 1,090,007

Option 2: Project IRR	**41.31%**

Investment Option 3 - Invest in Green Upgrade w/ Full Forward Hedging Contracts

(Firm hedges 100% of the project's resource needs in a single FORWARD contract, resetting at the end of each contract duration)

Replacement System Option 2

Forward Contract Structure:			
	Electric	**Gas**	
Contract Duration	3	3	Years
Price Premium Over Market Rate	10%	10%	

Project IRR: New vs. Existing Syste	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Reduction (Increase) in Consumption											
Electricity (KwH/Year)		8,596,886	8,596,886	8,596,886	8,596,886	8,596,886	8,596,886	8,596,886	8,596,886	8,596,886	8,596,886
Natural Gas (CF/Year)		(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)
Market Price of Resource (EOY)											
Electricity ($/KwH)	$0.1028	$0.1127	$0.1145	$0.1164	$0.1187	$0.1175	$0.1156	$0.1149	$0.1176	$0.1203	$0.1235
Natural Gas ($/CF)	$0.0120	$0.0146	$0.0169	$0.0168	$0.0166	$0.0154	$0.0144	$0.0140	$0.0143	$0.0146	$0.0145
Contracted Price (Through EOY) - Includes Forward Premium											
Electricity ($/KwH)		$0.1131	$0.1131	$0.1131	$0.1281	$0.1281	$0.1281	$0.1271	$0.1271	$0.1271	$0.1323
Natural Gas ($/CF)		$0.0132	$0.0132	$0.0132	$0.0185	$0.0185	$0.0185	$0.0159	$0.0159	$0.0159	$0.0160
Annual Cash Flows											
Installed Cost	($2,416,413)										
Annual Elect Savings (Loss)		$972,136	$972,136	$972,136	$1,101,124	$1,101,124	$1,101,124	$1,092,750	$1,092,750	$1,092,750	$1,137,159
Annual Gas Savings (Loss)		($40,736)	($40,736)	($40,736)	($57,078)	($57,078)	($57,078)	($49,056)	($49,056)	($49,056)	($49,570)
Project Cash Flows	$ (2,416,413)	$ 931,400	$ 931,400	$ 931,400	$ 1,044,047	$ 1,044,047	$ 1,044,047	$ 1,043,694	$ 1,043,694	$ 1,043,694	$ 1,087,589

Project IRR	**38.68%**

Investment Option 4 - Invest in Green Upgrade w/ Call and Put Option Hedging Contracts

(Firm hedges the certain portion of the project's resource needs with 1 year PUT and CALL OPTION contracts purchased through a financial institution, resetting at the end of each year)

Replacement System Option 2

Option Contract Structure:	Electric	Gas
Contract Size as % of Anticipated Consumption	60%	60%
Target Strike Price as % Increase of Spot	15%	15%

Project IRR: New vs. Existing Syste	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Reduction (Increase) in Consumption											
Electricity (KwH/Year)		8,596,886	8,596,886	8,596,886	8,596,886	8,596,886	8,596,886	8,596,886	8,596,886	8,596,886	8,596,886
Natural Gas (CF/Year)		(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)	(3,088,611)
Market Spot Price of Resource (EOY)											
Electricity ($/KwH)	$0.1028	$0.1127	$0.1145	$0.1164	$0.1187	$0.1175	$0.1156	$0.1149	$0.1176	$0.1203	$0.1235
Natural Gas ($/CF)	$0.0120	$0.0146	$0.0169	$0.0168	$0.0166	$0.0154	$0.0144	$0.0140	$0.0143	$0.0146	$0.0145
Electricity PUT Option Contracts											
10 Year Treasury Yield	13.9%	13.0%	11.1%	12.5%	10.6%	7.7%	8.4%	8.9%	8.5%	8.6%	7.9%
Trailing Volatility	74.2%	67.9%	38.2%	11.4%	12.8%	6.7%	9.5%	8.3%	8.7%	16.3%	17.9%
Strike Price ($/KwH)	$0.1182	$0.1296	$0.1316	$0.1339	$0.1365	$0.1351	$0.1329	$0.1321	$0.1353	$0.1383	$0.1420
PUT Option Price ($/KwH)	$0.0298	$0.0306	$0.0193	$0.0063	$0.0084	$0.0084	$0.0086	$0.0076	$0.0084	$0.0118	$0.0135
Natural Gas CALL Option Contracts											
10 Year Treasury Yield	13.9%	13.0%	11.1%	12.5%	10.6%	7.7%	8.4%	8.9%	8.5%	8.6%	7.9%
Trailing Volatility	65.1%	78.3%	83.5%	43.8%	4.6%	26.5%	37.5%	23.6%	7.5%	9.8%	4.5%
Strike Price ($/CF)	$0.0138	$0.0168	$0.0195	$0.0193	$0.0191	$0.0177	$0.0166	$0.0161	$0.0165	$0.0168	$0.0167
CALL Option Price ($/CF)	$0.0031	$0.0044	$0.0053	$0.0028	$0.0001	$0.0012	$0.0018	$0.0010	$0.0001	$0.0003	$0.0000
Option Payoff (Less Option Price)											
Electricity ($/KwH)		($0.0242)	($0.0155)	($0.0041)	$0.0090	$0.0106	$0.0112	$0.0094	$0.0069	$0.0067	$0.0030
Natural Gas ($/CF)		($0.0022)	($0.0043)	($0.0053)	($0.0028)	($0.0001)	($0.0012)	($0.0018)	($0.0010)	($0.0001)	($0.0003)
Annual Cash Flows											
Installed Cost	($2,416,413)										
Annual Elect Savings (Loss)		$968,933	$983,967	$1,001,022	$1,020,068	$1,010,246	$993,409	$987,796	$1,011,354	$1,033,781	$1,061,826
Annual Gas Savings (Loss)		($45,165)	($52,263)	($51,889)	($51,421)	($47,495)	($44,596)	($43,287)	($44,273)	($45,064)	($44,877)
Electricity Put Option Proceeds (Loss)		($125,074)	($79,893)	($21,124)	$46,346	$54,477	$57,719	$48,577	$35,528	$34,445	$15,455
Natural Gas Call Option Proceeds (Loss)		($4,127)	($7,946)	($9,803)	($5,214)	($194)	($2,265)	($3,341)	($1,877)	($254)	($486)
Project Cash Flows	$ (2,416,413)	$ 794,567	$ 843,864	$ 918,206	$ 1,009,779	$ 1,017,035	$ 1,004,266	$ 989,745	$ 1,000,731	$ 1,022,908	$ 1,031,918

Project IRR	**35.58%**

Results

As hypothesized, engaging in any of the proposed hedging strategies significantly decreased the standard deviation of returns without substantially reducing their magnitude, thus creating alpha.

The following charts show the comparison of expected return to standard deviation for each of the various hedging strategies. These charts show the results of Replacement Option 2, which has the highest risk adjusted return of any of the three replacement systems. Under the Full Forward hedging strategy, the standard deviation of returns drops from 7.29% to 5.54% (a 24% reduction in risk) while the expected IRR actually increased from 40.9% to 41.9% (see Appendix 7 for the cumulative probability return distribution).

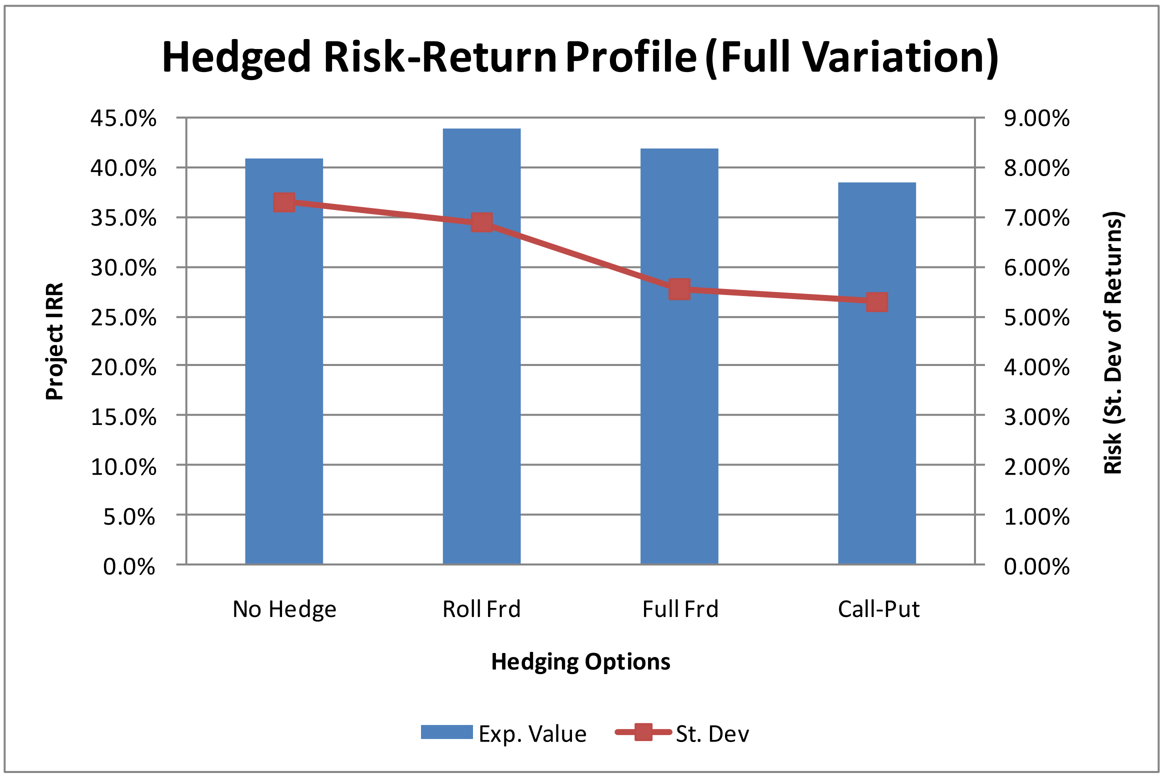


Figure 10: Rohm and Haas Project Returns Under Various Hedging Scenarios: Varying Initial Cost, Annual Consumption, and Utility Prices (Replacement Option 2)

Additionally, by isolating the future cash flow variability to utility prices only, the analysis shows that under the Full Forward hedging strategy the standard deviation of returns drops from 5.83% to 2.87%

(almost a 51% reduction in risk) while the expected IRR actually increased from 38.5% to 39.5% (see Appendix 7 for the cumulative probability return distribution). This scenario would be appropriate if the building owner/operator took addition steps to reduce or eliminate the potential volatility of the projects initial cost or the annual resource consumption.

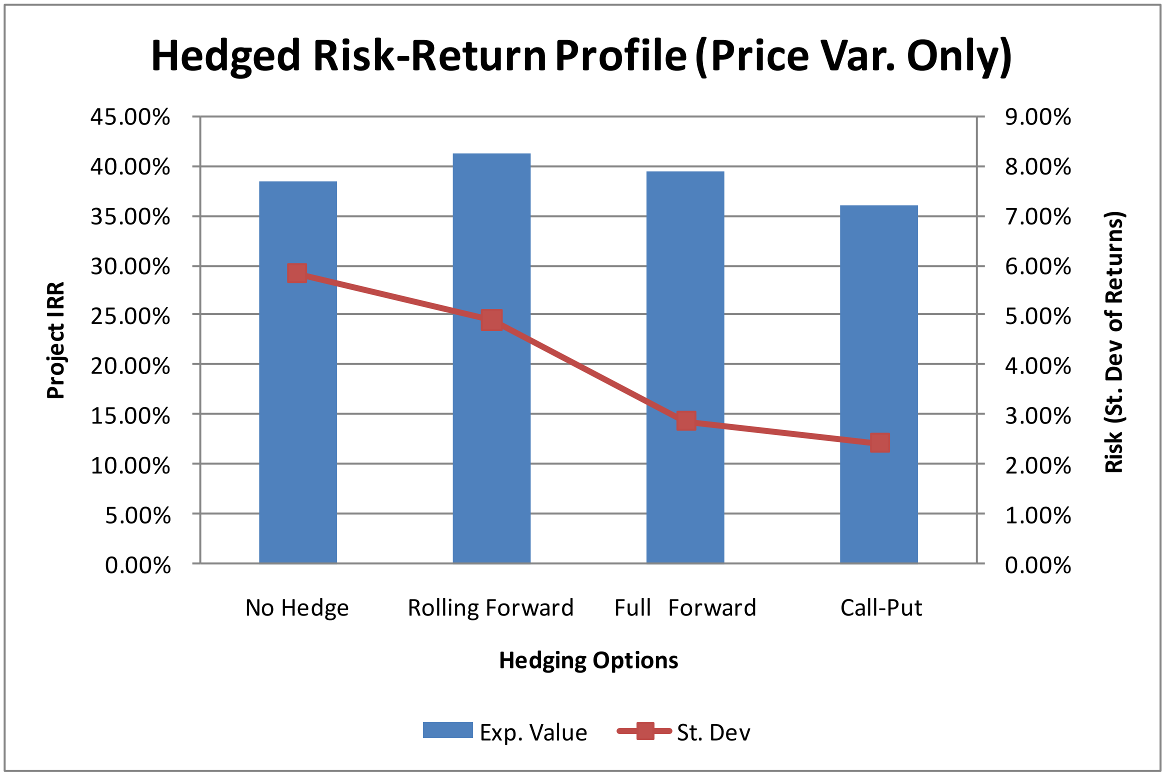


Figure 11: Rohm and Haas Project Returns Under Various Hedging Scenarios: Varying Utility Prices Only (Replacement Option 2)

Lastly, as the following tables show, the trend of risk reduction without significant return degradation continues for all three replacement options. These tables also highlight the obvious investment decision to choose Replacement Option 2 while engaging in the Full Forward hedging strategy.

Replacement Option #1 - IRR Returns (Full Variability)				
	No Hedge	Roll Frd	Full Frd	Call-Put
Exp. Value	7.5%	8.8%	8.0%	6.3%
St. Dev	4.68%	4.25%	3.56%	3.13%

Replacement Option #2 - IRR Returns (Full Variability)				
	No Hedge	**Roll Frd**	**Full Frd**	**Call-Put**
Exp. Value	40.7%	43.8%	41.9%	38.1%
St. Dev	7.46%	7.00%	5.57%	5.01%

Replacement Option #3 - IRR Returns (Full Variability)				
	No Hedge	**Roll Frd**	**Full Frd**	**Call-Put**
Exp. Value	31.2%	33.7%	32.1%	28.9%
St. Dev	6.77%	6.33%	5.15%	4.68%

Figure 12: Rohm and Haas Project Returns: Replacement Option Comparison

Sensitivity Analysis

The following table shows the sensitivity of the expected value and standard deviation of the IRR of Replacement Option 2 under various levels of utility pricing noise. (Note: All of the following sensitivity tables show results for the scenario where ONLY price volatility is modeled). Not surprisingly, as the noise increases, so does the standard deviation of returns. Additionally, as the volatility increases, so does the effectiveness of the hedging positions. For example, under the Full Forward hedging method, the risk reduction remains around 50% in each noise scenario.

Sensitivity Analysis - Pricing Noise Factor (St. Dev as % of Base Mean)					
	Noise	**No Hedge**	**Rolling Frd**	**Full Forward**	**Call-Put**
Exp Value	5%	38.45%	41.31%	39.46%	36.11%
St. Dev	5%	5.83%	4.89%	2.87%	2.43%
Exp Value	25%	38.40%	41.27%	39.44%	36.12%
St. Dev	25%	5.83%	4.90%	2.87%	2.53%
Exp Value	50%	38.51%	41.37%	39.49%	36.19%
St. Dev	50%	6.25%	5.28%	3.08%	2.88%
Exp Value	75%	38.43%	41.31%	39.44%	36.09%
St. Dev	75%	6.50%	5.57%	3.18%	3.41%
Exp Value	100%	38.21%	41.13%	39.32%	35.77%
St. Dev	100%	7.16%	6.14%	3.53%	3.96%

Figure 13: Sensitivity Table: Utility Price Projection Noise vs. Expected Return and Standard Deviation (Price Volatility Only)

Additionally, sensitivity tables have been created to look at the hedge-specific inputs' impact on the expected return and standard deviation of project IRR's for Replacement Option 2. In both of the forward hedge scenarios, a 10% forward premium is assumed for all contract durations (which is conservative). As expected, the electricity contract duration has a much greater impact on returns than the natural gas contract. Also unsurprising, as expected returns increase with the shortening of the electrical contract lengths, the riskiness of those returns also increases.

Rolling Forward Hedge Scenario

Expected Return		Natural Gas Contract Duration					
		1	2	3	4	5	6
Electricity Contract Duration	1	42.5%	42.5%	42.6%	42.6%	42.6%	42.7%
	2	41.8%	41.8%	41.9%	41.9%	41.9%	42.0%
	3	41.2%	41.3%	41.3%	41.3%	41.4%	41.4%
	4	40.7%	40.8%	40.9%	40.9%	40.9%	41.0%
	5	40.4%	40.5%	40.5%	40.6%	40.6%	40.6%
	6	40.1%	40.2%	40.2%	40.3%	40.3%	40.3%

St. Dev		Natural Gas Contract Duration					
		1	2	3	4	5	6
Electricity Contract Duration	1	6.05%	6.08%	6.12%	6.14%	6.14%	6.18%
	2	5.37%	5.40%	5.41%	5.44%	5.47%	5.49%
	3	4.80%	4.87%	4.90%	4.90%	4.95%	4.94%
	4	4.36%	4.41%	4.47%	4.47%	4.51%	4.53%
	5	4.06%	4.11%	4.13%	4.16%	4.15%	4.17%
	6	3.77%	3.81%	3.85%	3.89%	3.91%	3.91%

Full Forward Hedge Scenario

Expected Return		Natural Gas Contract Duration					
		1	2	3	4	5	6
Electricity Contract Duration	1	40.7%	40.8%	40.8%	40.9%	40.9%	40.9%
	2	40.0%	40.0%	40.1%	40.1%	40.2%	40.2%
	3	39.3%	39.4%	39.5%	39.5%	39.6%	39.6%
	4	38.8%	38.9%	38.9%	39.0%	39.0%	39.0%
	5	38.2%	38.3%	38.4%	38.4%	38.4%	38.5%
	6	37.9%	38.0%	38.1%	38.1%	38.1%	38.2%

St. Dev		Natural Gas Contract Duration					
		1	2	3	4	5	6
Electricity Contract Duration	1	4.19%	4.25%	4.26%	4.28%	4.31%	4.33%
	2	3.44%	3.48%	3.51%	3.54%	3.58%	3.59%
	3	2.80%	2.82%	2.87%	2.90%	2.93%	2.95%
	4	2.22%	2.26%	2.30%	2.32%	2.36%	2.38%
	5	1.68%	1.71%	1.76%	1.78%	1.82%	1.83%
	6	1.29%	1.33%	1.37%	1.39%	1.43%	1.44%

Lastly, a number of sensitivity tables were created for the Put and Call Option hedging scenario to test various contract sized in combination with different target strike price values. Because historical electricity and natural gas prices movements are highly correlate (.89), it is likely that the two utility costs will generally move together in future. As such, the electricity and natural gas target strike price combinations considered were all within 5% of each other. The following sensitivity table investigates the scenario where the future electricity and natural gas strike prices are both set as 15% of the current year's spot price. Based on this analysis, the model has been run at contract sizes of 60% of anticipated annual consumption needs for both electricity and natural gas. See Appendix 8 for additional spot price combinations.

Expected Return		Natural Gas Contract Size					
		0%	*20%*	*40%*	*60%*	*80%*	*100%*
Electricity Contract Size	*0%*	38.5%	38.4%	38.3%	38.2%	38.1%	38.1%
	20%	37.8%	37.7%	37.7%	37.6%	37.5%	37.4%
	40%	37.1%	37.0%	37.0%	36.9%	36.8%	36.7%
	60%	36.4%	36.3%	36.2%	36.1%	36.0%	35.9%
	80%	35.6%	35.5%	35.4%	35.3%	35.2%	35.1%
	100%	34.6%	34.5%	34.4%	34.3%	34.2%	34.1%

St. Dev		Natural Gas Contract Size					
		0%	*20%*	*40%*	*60%*	*80%*	*100%*
Electricity Contract Size	*0%*	5.83%	5.79%	5.75%	5.70%	5.67%	5.61%
	20%	4.57%	4.54%	4.51%	4.45%	4.42%	4.39%
	40%	3.39%	3.36%	3.33%	3.29%	3.27%	3.22%
	60%	2.46%	2.45%	2.43%	2.44%	2.43%	2.44%
	80%	2.40%	2.46%	2.51%	2.56%	2.63%	2.68%
	100%	3.61%	3.71%	3.81%	3.90%	4.01%	4.13%

Conclusions and Recommendations

The data presented in this paper clearly shows that there is an opportunity to generate alpha on sustainable real estate investments by reducing risk (without significantly impacting expected returns) through a variety of hedging methods. Based on the findings under this specific investment scenario, the Full Forward hedge produces the best overall risk adjust returns. Operationally, this is also the easiest hedge to construct as it is set up directly with the utility provider and requires less annual oversight than the rolling forward strategy.

It is important to note that the Put-Call Option hedging scenario delivers the greatest reduction in risk, however it also reduces expected return due to the costly nature of the transactions. Although this hedge would also be the most complicated to construct, it is conceivable that a real estate operator could see the benefit of such a strategy given a large enough scale. Additionally, this model took a simplified approach to pricing the options (using Black-Scholes to estimate an approximate price). However, this strategy could potentially be honed even further with a more appropriate option pricing model, such that the negative impact of the option prices on expected returns would be less severe.

This indirect Put-Call option hedge could be provided by three potential groups. The following is a breakdown of the pro and cons for each potential provider:

1) *Building/Institutional Owner*

   Pros: It would be easy to tailor the hedge precisely to the firm's specific needs

   Cons: Option trading is complicated and outside of most real estate firms' area of expertise
   Can require disproportionately large amount of resources to maintain trading positions
   Transaction costs could create significant fee drag on small scale operations

2) *Energy Service Provider (Utility Company)*

   Pros: Have inside knowledge and understanding of potential movements in energy pricing
   Have access to large scale client base to rationalize additional necessary resources

   Cons: Option trading is outside of most organizations' area of expertise
   Have limited insight into underlying real estate operational needs

3) *Financial Services Company*

   Pros: Have sophisticated knowledge of hedging transactions
   Have staff and resources in place to handle daily maintenance of trading positions

   Cons: Have limited insight into underlying real estate operational needs
   Additional level of fees could limit attractiveness to clients (real estate owners)

Based on the above pro/con analysis, financial service providers are the most reasonable source to provide this indirect hedging service. Given the complicate nature of utility option trading, it is unlikely that a real estate firm or even a utility company would be willing to invest in the trading resources to be able to successfully execute the strategy.

Lastly, this study investigates a relatively small scale sustainable project (approximately $2.4M capital expenditure), however a full scale hospital central utility plant replacement can cost upwards of $50M. Additionally, Chicago's Willis Tower (formerly the Sears Tower) is currently undergoing a $350M sustainable renovation[14]. In these cases, reducing investment risk on their utility savings payback will be even more crucial in the fund raising and board approval process.

In summary, this study proves that utility price volatility cannot be overlooked in a sustainable investment analysis. Additionally, the study shows that there are multiple hedging strategies available to minimize this investment risk while maintaining the level of expected returns necessary to move forward with the investment.

[14] http://www.willistower.com/icon/

Appendix

Appendix 1: Electricity Price Data and Adjustments

	Risk Free	Electricity				
Year	10 Yr Treasury	Electricity Price ($ / 100 KwH)	% Change	Noise Adjusted % Change	Noise Adjusted Price	3 Yr. Trailing St. Dev
1973	6.9%	$2.40			$2.40	
1974	7.6%	$3.00	25.0%	26.7%	$3.04	
1975	8.0%	$3.50	16.7%	15.5%	$3.51	55.8%
1976	7.6%	$3.70	5.7%	6.3%	$3.73	35.4%
1977	7.4%	$4.10	10.8%	10.5%	$4.12	31.0%
1978	8.4%	$4.40	7.3%	7.8%	$4.45	35.7%
1979	9.4%	$4.70	6.8%	6.5%	$4.73	30.5%
1980	11.4%	$5.50	17.0%	16.9%	$5.53	56.4%
1981	13.9%	$6.30	14.5%	14.9%	$6.36	81.3%
1982	13.0%	$6.90	9.5%	9.3%	$6.95	71.0%
1983	11.1%	$7.00	1.4%	1.4%	$7.05	37.2%
1984	12.5%	$7.13	1.9%	1.8%	$7.17	11.3%
1985	10.6%	$7.27	2.0%	2.1%	$7.32	13.8%
1986	7.7%	$7.20	(1.0%)	(1.0%)	$7.25	7.5%
1987	8.4%	$7.08	(1.7%)	(1.7%)	$7.13	9.7%
1988	8.9%	$7.04	(0.6%)	(0.6%)	$7.09	8.4%
1989	8.5%	$7.20	2.3%	2.4%	$7.26	8.9%
1990	8.6%	$7.34	1.9%	1.9%	$7.40	15.4%
1991	7.9%	$7.53	2.6%	2.4%	$7.58	15.7%
1992	7.0%	$7.66	1.7%	1.8%	$7.71	15.6%
1993	5.9%	$7.74	1.0%	1.1%	$7.79	11.0%
1994	7.1%	$7.73	(0.1%)	(0.1%)	$7.78	4.6%
1995	6.6%	$7.69	(0.5%)	(0.5%)	$7.74	2.7%
1996	6.4%	$7.64	(0.7%)	(0.7%)	$7.69	4.5%
1997	6.4%	$7.59	(0.7%)	(0.7%)	$7.64	5.0%
1998	5.3%	$7.41	(2.4%)	(2.4%)	$7.46	12.2%
1999	5.7%	$7.26	(2.0%)	(2.0%)	$7.31	16.6%
2000	6.0%	$7.43	2.3%	2.4%	$7.49	9.5%
2001	5.0%	$7.92	6.6%	6.5%	$7.97	34.4%
2002	4.6%	$7.89	(0.4%)	(0.4%)	$7.94	27.4%
2003	4.0%	$8.03	1.8%	1.8%	$8.09	7.5%
2004	4.3%	$8.17	1.7%	1.7%	$8.23	14.1%
2005	4.3%	$8.67	6.1%	6.6%	$8.77	36.1%
2006	4.8%	$9.46	9.1%	9.6%	$9.61	69.8%
2007	4.6%	$9.65	2.0%	2.0%	$9.81	55.1%
2008	3.7%	$10.28	6.5%	6.8%	$10.48	45.4%
2009	6.9%	$12.85	25.0%	24.0%	$12.99	167.6%
2010	7.6%	$14.99	16.7%	16.3%	$15.11	231.8%
2011	8.0%	$15.85	5.7%	5.7%	$15.97	153.7%
2012	7.6%	$17.56	10.8%	9.7%	$17.52	122.4%
2013	7.4%	$18.85	7.3%	7.8%	$18.89	145.7%
2014	8.4%	$20.13	6.8%	6.8%	$20.18	132.8%
2015	9.4%	$23.56	17.0%	16.0%	$23.40	232.4%
2016	11.4%	$26.99	14.5%	14.9%	$26.89	335.8%
2017	13.9%	$29.56	9.5%	9.2%	$29.38	300.3%
2018	13.0%	$29.98	1.4%	1.5%	$29.83	158.0%

Appendix 2: Natural Gas Price Data and Adjustments

	Risk Free	Natural Gas				
Year	10 Yr Treasury	Natural Gas Price ($ / 1,000 CF)	% Change	Noise Adjusted % Change	Noise Adjusted Price	3 Yr. Trailing St. Dev
1973	6.9%	$0.94			$0.94	
1974	7.6%	$1.07	13.8%	13.6%	$1.07	
1975	8.0%	$1.35	26.2%	26.9%	$1.36	21.3%
1976	7.6%	$1.64	21.5%	22.5%	$1.66	29.6%
1977	7.4%	$2.04	24.4%	26.1%	$2.09	37.1%
1978	8.4%	$2.23	9.3%	8.8%	$2.28	31.7%
1979	9.4%	$2.73	22.4%	21.7%	$2.77	35.2%
1980	11.4%	$3.39	24.2%	26.3%	$3.50	61.6%
1981	13.9%	$4.00	18.0%	19.2%	$4.18	70.1%
1982	13.0%	$4.82	20.5%	21.2%	$5.06	78.2%
1983	11.1%	$5.59	16.0%	16.6%	$5.90	86.3%
1984	12.5%	$5.55	(0.7%)	(0.7%)	$5.86	47.3%
1985	10.6%	$5.50	(0.9%)	(0.9%)	$5.81	4.8%
1986	7.7%	$5.08	(7.6%)	(7.6%)	$5.36	27.3%
1987	8.4%	$4.77	(6.1%)	(6.1%)	$5.04	38.7%
1988	8.9%	$4.63	(2.9%)	(2.9%)	$4.89	24.3%
1989	8.5%	$4.74	2.4%	2.1%	$4.99	7.6%
1990	8.6%	$4.83	1.9%	1.8%	$5.08	9.8%
1991	7.9%	$4.81	(0.4%)	(0.4%)	$5.06	4.8%
1992	7.0%	$4.88	1.5%	1.5%	$5.14	4.0%
1993	5.9%	$5.22	7.0%	7.1%	$5.50	23.5%
1994	7.1%	$5.44	4.2%	4.1%	$5.73	29.8%
1995	6.6%	$5.05	(7.2%)	(7.2%)	$5.32	20.6%
1996	6.4%	$5.40	6.9%	6.3%	$5.66	21.9%
1997	6.4%	$5.80	7.4%	8.0%	$6.11	39.6%
1998	5.3%	$5.48	(5.5%)	(5.5%)	$5.77	23.5%
1999	5.7%	$5.33	(2.7%)	(2.7%)	$5.61	25.3%
2000	6.0%	$6.59	23.6%	21.5%	$6.82	65.5%
2001	5.0%	$8.43	27.9%	28.3%	$8.75	158.0%
2002	4.6%	$6.63	(21.4%)	(21.4%)	$6.88	109.6%
2003	4.0%	$8.40	26.7%	26.5%	$8.70	106.6%
2004	4.3%	$9.43	12.3%	12.6%	$9.80	147.4%
2005	4.3%	$11.34	20.3%	20.9%	$11.84	159.5%
2006	4.8%	$12.00	5.8%	5.8%	$12.53	142.3%
2007	4.6%	$11.32	(5.7%)	(5.7%)	$11.82	40.3%
2008	3.7%	$11.99	5.9%	5.8%	$12.51	40.4%
2009	6.9%	$13.65	13.8%	13.9%	$14.25	125.0%
2010	7.6%	$17.22	26.2%	25.9%	$17.94	277.2%
2011	8.0%	$20.92	21.5%	20.1%	$21.53	364.4%
2012	7.6%	$26.02	24.4%	24.0%	$26.71	441.1%
2013	7.4%	$28.44	9.3%	9.2%	$29.16	389.3%
2014	8.4%	$34.82	22.4%	23.4%	$35.98	480.2%
2015	9.4%	$43.24	24.2%	23.7%	$44.49	768.3%
2016	11.4%	$51.02	18.0%	17.8%	$52.42	822.3%
2017	13.9%	$61.48	20.5%	19.5%	$62.64	909.9%
2018	13.0%	$71.30	16.0%	16.5%	$72.99	1,028.7%

Appendix 3: Simulation Data (Utility Price Variation Only) Sample

Simulation Data - IRR Returns (Price Variation Only)

Random Date Generator **1986**

	No Hedge	Roll Frd	Full Frd	Call-Put
	33.5%	37.0%	37.2%	35.1%
2005	46.0%	47.5%	42.4%	37.2%
1998	34.6%	37.7%	37.8%	34.2%
1992	32.8%	36.8%	36.7%	34.1%
2004	44.0%	45.5%	42.2%	37.2%
1989	34.8%	38.5%	37.8%	36.0%
1997	33.3%	36.6%	36.9%	33.5%
1986	33.5%	37.0%	37.2%	35.1%
2008	53.7%	55.4%	45.8%	36.4%
1982	34.2%	37.8%	37.5%	34.0%
1984	33.8%	37.7%	37.1%	35.5%
2007	50.3%	50.4%	46.0%	37.0%
1975	44.0%	45.6%	42.5%	40.3%
2007	50.2%	50.4%	45.8%	37.0%
1998	34.7%	37.8%	37.9%	34.3%
1995	32.2%	36.1%	36.5%	33.4%
1992	32.8%	36.8%	36.7%	34.1%
1995	32.3%	36.1%	36.5%	33.4%
1993	32.4%	36.3%	36.5%	33.7%
2004	44.4%	45.9%	42.3%	37.6%
1988	35.4%	39.0%	38.1%	36.6%
2005	45.2%	46.9%	42.1%	36.6%
1998	34.6%	37.7%	37.8%	34.2%
1995	32.2%	36.1%	36.5%	33.4%
1989	35.0%	38.7%	37.9%	36.1%
1995	32.2%	36.1%	36.5%	33.4%
2000	38.0%	41.0%	39.0%	35.9%
1976	45.1%	47.1%	42.5%	41.8%
1981	37.7%	41.6%	38.8%	35.5%
2007	49.3%	49.8%	45.4%	36.2%
1992	32.8%	36.8%	36.7%	34.0%
2007	49.8%	50.2%	45.7%	36.8%
1982	34.3%	38.0%	37.6%	34.0%
2000	37.9%	40.9%	38.9%	36.1%
1987	34.5%	37.9%	37.7%	35.9%
2004	43.8%	45.4%	42.1%	37.3%
1997	33.2%	36.6%	36.9%	33.5%
2007	49.8%	50.2%	45.6%	36.4%
1981	37.7%	41.6%	38.8%	35.4%

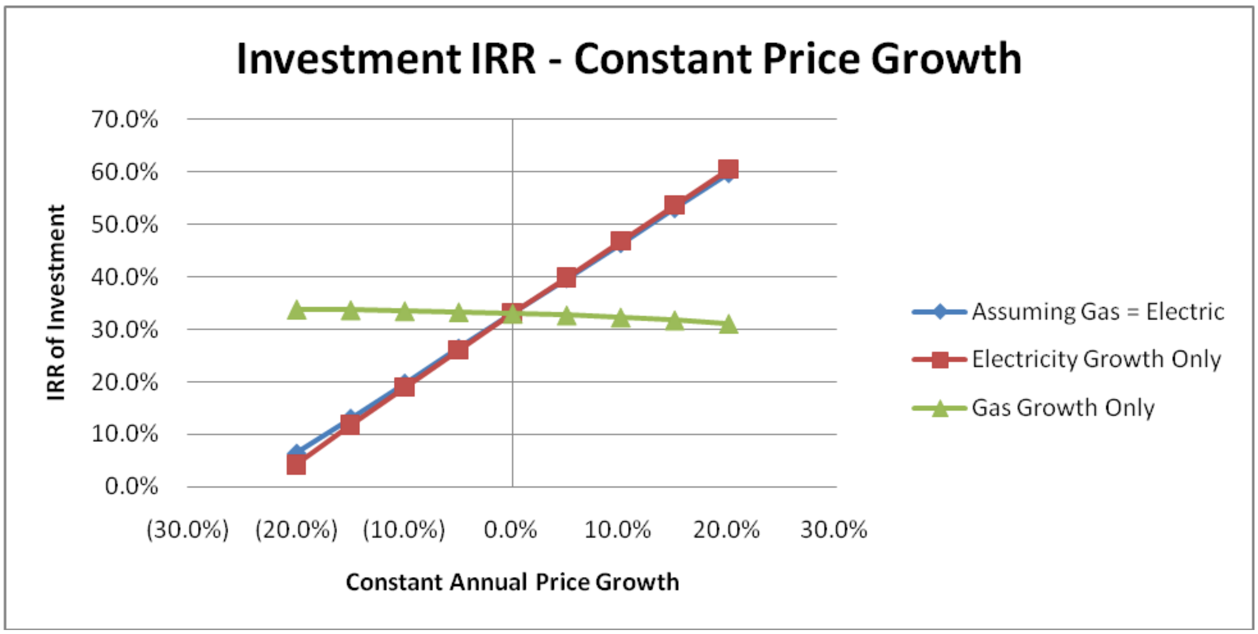
Appendix 4: Simulation Data (Full Variation) Sample

Simulation Data - IRR Returns (Full Variation)				
	No Hedge	**Roll Frd**	**Full Frd**	**Call-Put**
SimTable	33.49%	37.01%	37.21%	35.08%
0	32.7%	36.6%	36.8%	34.1%
0.001001001	45.4%	48.8%	46.6%	43.5%
0.002002002	34.1%	38.3%	38.5%	35.6%
0.003003003	46.0%	46.8%	44.0%	35.9%
0.004004004	34.1%	37.8%	37.1%	35.1%
0.005005005	33.7%	37.3%	37.0%	33.3%
0.006006006	48.2%	52.1%	50.7%	47.0%
0.007007007	38.8%	40.8%	39.0%	34.7%
0.008008008	42.0%	43.7%	41.9%	37.2%
0.009009009	40.0%	41.6%	38.8%	36.7%
0.01001001	31.2%	35.0%	35.2%	32.5%
0.011011011	47.2%	52.6%	52.8%	49.2%
0.012012012	37.8%	40.7%	38.7%	35.8%
0.013013013	41.9%	46.0%	46.3%	43.8%
0.014014014	47.0%	48.9%	43.9%	38.3%
0.015015015	43.1%	44.7%	41.6%	39.6%
0.016016016	43.6%	44.1%	41.5%	33.1%
0.017017017	42.9%	47.4%	47.5%	45.1%
0.018018018	32.2%	35.5%	35.3%	33.5%
0.019019019	44.2%	46.0%	42.3%	41.1%
0.02002002	33.7%	37.6%	37.2%	34.8%
0.021021021	43.5%	48.4%	47.8%	44.9%
0.022022022	41.5%	43.2%	41.6%	36.9%
0.023023023	33.7%	37.1%	37.3%	35.2%
0.024024024	32.0%	36.0%	35.9%	33.3%
0.025025025	47.3%	50.1%	48.4%	43.6%
0.026026026	54.7%	56.5%	47.0%	38.3%
0.027027027	39.7%	41.8%	39.9%	36.0%
0.028028028	39.9%	43.3%	41.3%	38.0%
0.029029029	33.5%	37.1%	36.7%	33.5%
0.03003003	44.4%	46.0%	41.0%	36.0%
0.031031031	38.9%	41.1%	39.3%	35.2%
0.032032032	35.8%	39.4%	39.1%	37.3%
0.033033033	31.7%	34.9%	35.1%	31.9%
0.034034034	37.9%	40.9%	39.8%	36.7%
0.035035035	34.3%	38.6%	38.7%	35.8%
0.036036036	43.1%	47.4%	47.7%	45.1%
0.037037037	33.6%	37.8%	37.9%	35.1%

Appendix 5: Constant Growth IRR Sensativity (Replacement Option 2)

IRR Matrix		**Gas Price Growth**								
		(20.0%)	*(15.0%)*	*(10.0%)*	*(5.0%)*	*0.0%*	*5.0%*	*10.0%*	*15.0%*	*20.0%*
Electric Price Growth	*20.0%*	60.9%	60.8%	60.7%	60.6%	60.5%	60.3%	60.1%	**59.9%**	**59.6%**
	15.0%	54.2%	54.1%	53.9%	53.8%	53.7%	53.5%	**53.2%**	**53.0%**	**52.7%**
	10.0%	47.4%	47.3%	47.1%	47.0%	46.8%	**46.6%**	**46.3%**	**46.0%**	45.6%
	5.0%	40.6%	40.5%	40.3%	40.2%	**39.9%**	**39.7%**	**39.3%**	38.9%	38.4%
	0.0%	33.8%	33.7%	33.5%	**33.3%**	**33.0%**	**32.7%**	32.3%	31.8%	31.1%
	(5.0%)	27.0%	26.8%	**26.6%**	**26.4%**	**26.0%**	25.6%	25.1%	24.4%	23.5%
	(10.0%)	20.2%	20.0%	19.7%	19.4%	19.0%	18.4%	17.7%	16.7%	15.3%
	(15.0%)	13.3%	13.1%	12.7%	12.3%	11.7%	10.9%	9.9%	8.3%	5.8%
	(20.0%)	6.4%	6.1%	5.6%	5.0%	4.2%	3.0%	1.2%	(1.9%)	(10.2%)

Note: The statistical correlation between historic electricity and gas pricing is .891



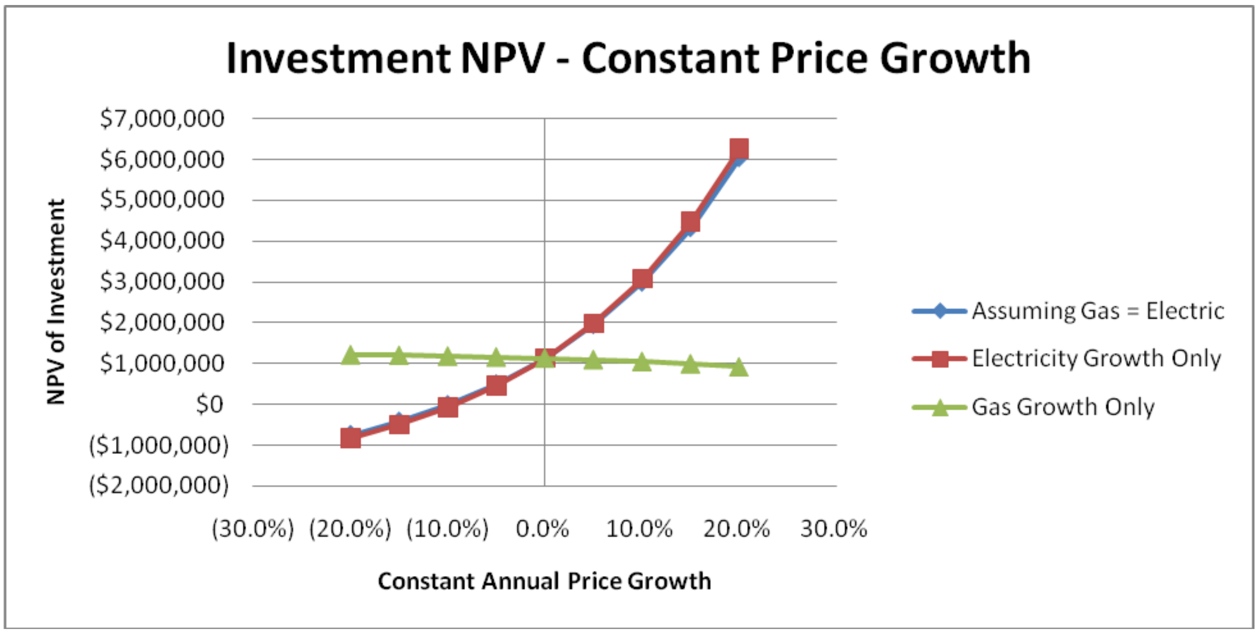
Appendix 6: Constant Growth NPV Sensativity (Replacement Option 2)

Hurdle Rate	20.0%

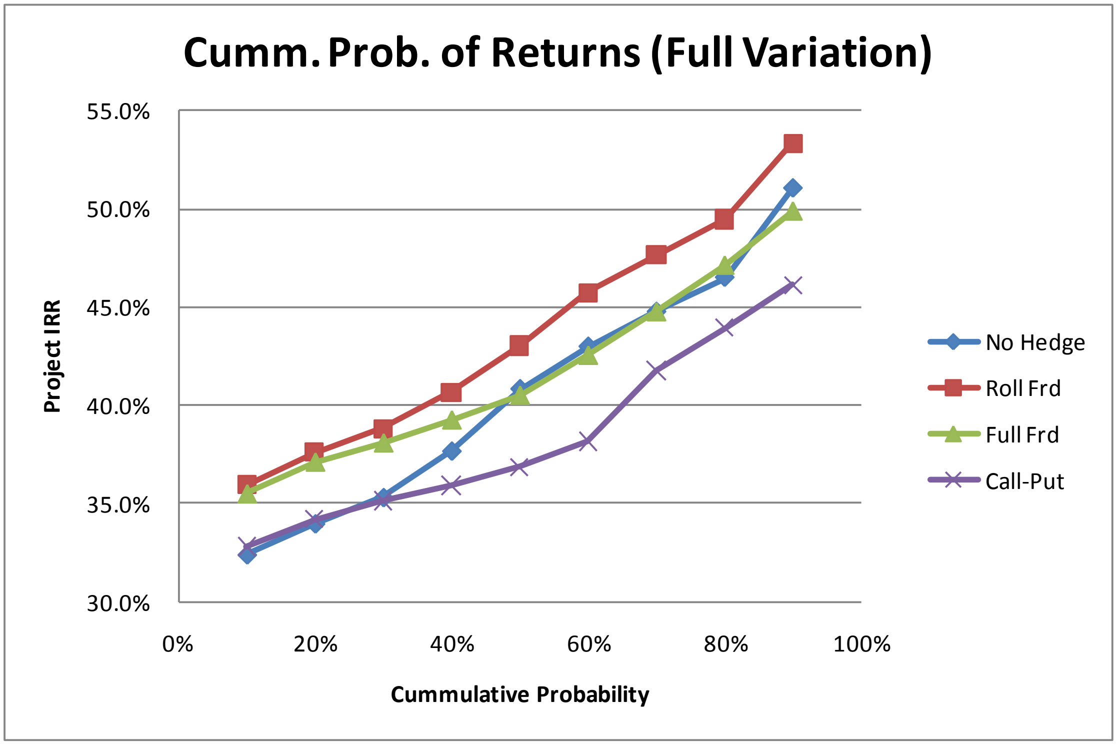
NPV Matrix

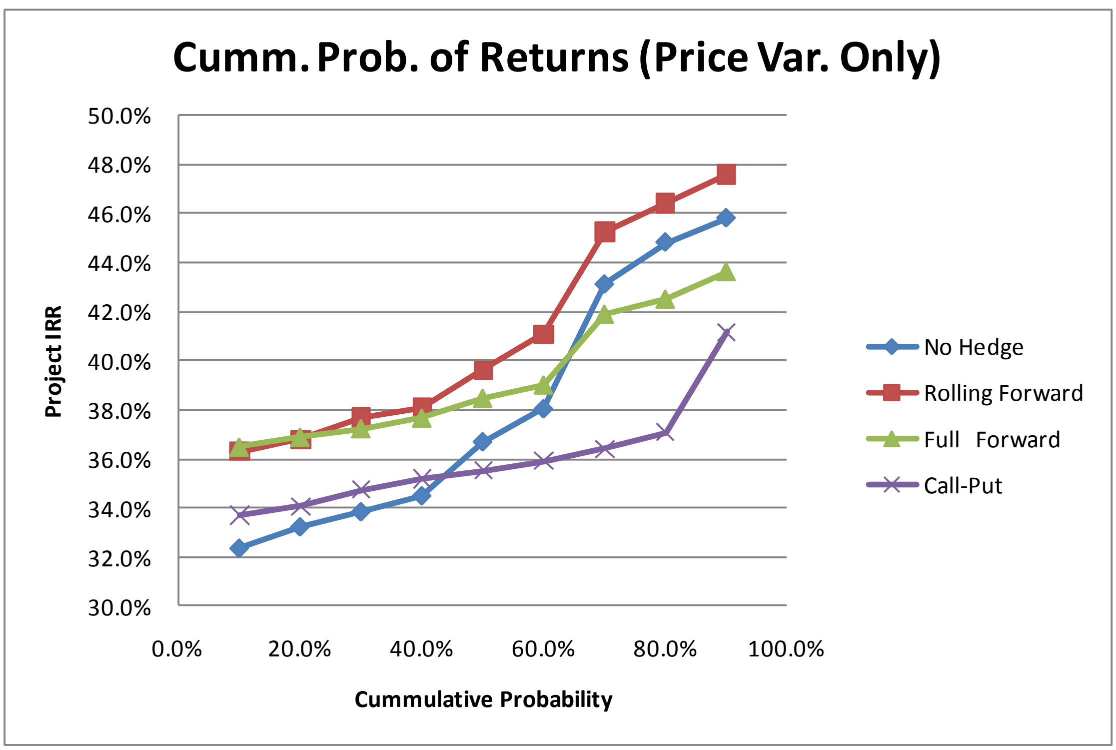
Electric Price Growth	Gas Price Growth: (20.0%)	(15.0%)	(10.0%)	(5.0%)	0.0%	5.0%	10.0%	15.0%	20.0%
20.0%	$6,348,405	$6,334,109	$6,316,345	$6,294,070	$6,265,928	$6,230,155	$6,184,472	**$6,125,953**	**$6,050,861**
15.0%	$4,556,367	$4,542,071	$4,524,306	$4,502,032	$4,473,890	$4,438,116	**$4,392,434**	**$4,333,915**	**$4,258,823**
10.0%	$3,159,850	$3,145,554	$3,127,789	$3,105,515	$3,077,373	**$3,041,600**	**$2,995,917**	**$2,937,398**	$2,862,306
5.0%	$2,069,656	$2,055,360	$2,037,595	$2,015,321	**$1,987,179**	**$1,951,406**	**$1,905,723**	$1,847,204	$1,772,112
0.0%	$1,215,945	$1,201,649	$1,183,884	**$1,161,610**	**$1,133,468**	**$1,097,695**	$1,052,012	$993,493	$918,401
(5.0%)	$544,350	$530,054	**$512,289**	**$490,015**	**$461,873**	$426,099	$380,417	$321,898	$246,806
(10.0%)	$12,783	($1,513)	($19,277)	($41,552)	($69,694)	($105,467)	($151,150)	($209,669)	($284,761)
(15.0%)	($411,163)	($425,459)	($443,224)	($465,498)	($493,640)	($529,414)	($575,096)	($633,615)	($708,707)
(20.0%)	($752,325)	($766,621)	($784,386)	($806,660)	($834,802)	($870,576)	($916,258)	($974,777)	($1,049,869)

Note: The statistical correlation between historic electricity and gas pricing is .891



Appendix 7: Cumulative Probability of Returns (Replacement Option 2)





Appendix 8: Put & Call Option Sensitivity Tables (Replacement Option 2)

Current Scenario:	
Target Strike (Electricity):	5%
Target Strike (Gas):	10%

Expected Return

		Natural Gas Contract Size					
		0%	*20%*	*40%*	*60%*	*80%*	*100%*
Electricity Contract Size	*0%*	38.4%	38.4%	38.3%	38.2%	38.1%	38.1%
	20%	37.6%	37.5%	37.5%	37.4%	37.3%	37.2%
	40%	36.7%	36.7%	36.6%	36.5%	36.4%	36.3%
	60%	35.8%	35.7%	35.6%	35.6%	35.5%	35.4%
	80%	34.8%	34.7%	34.7%	34.6%	34.5%	34.4%
	100%	33.8%	33.7%	33.5%	33.5%	33.4%	33.2%

St. Dev

		Natural Gas Contract Size					
		0%	*20%*	*40%*	*60%*	*80%*	*100%*
Electricity Contract Size	*0%*	5.81%	5.79%	5.76%	5.72%	5.69%	5.63%
	20%	4.76%	4.73%	4.69%	4.66%	4.61%	4.57%
	40%	3.70%	3.67%	3.66%	3.63%	3.59%	3.55%
	60%	2.82%	2.79%	2.78%	2.77%	2.75%	2.74%
	80%	2.43%	2.46%	2.48%	2.50%	2.55%	2.59%
	100%	3.04%	3.12%	3.22%	3.28%	3.37%	3.47%

Current Scenario:	
Target Strike (Electricity):	10%
Target Strike (Gas):	10%

Expected Return

		Natural Gas Contract Size					
		0%	*20%*	*40%*	*60%*	*80%*	*100%*
Electricity Contract Size	*0%*	38.5%	38.4%	38.3%	38.2%	38.1%	38.1%
	20%	37.7%	37.6%	37.5%	37.5%	37.4%	37.3%
	40%	36.9%	36.8%	36.8%	36.7%	36.6%	36.5%
	60%	36.1%	36.0%	35.9%	35.8%	35.7%	35.7%
	80%	35.2%	35.1%	35.0%	34.9%	34.8%	34.7%
	100%	34.2%	34.1%	34.0%	33.8%	33.7%	33.6%

St. Dev

		Natural Gas Contract Size					
		0%	*20%*	*40%*	*60%*	*80%*	*100%*
Electricity Contract Size	*0%*	5.82%	5.79%	5.75%	5.72%	5.68%	5.64%
	20%	4.63%	4.61%	4.56%	4.52%	4.48%	4.45%
	40%	3.48%	3.44%	3.43%	3.39%	3.36%	3.33%
	60%	2.53%	2.53%	2.52%	2.51%	2.50%	2.51%
	80%	2.35%	2.39%	2.42%	2.48%	2.53%	2.59%
	100%	3.35%	3.46%	3.53%	3.66%	3.76%	3.83%

Current Scenario:	
Target Strike (Electricity):	15%
Target Strike (Gas):	10%

Expected Return		Natural Gas Contract Size					
		0%	*20%*	*40%*	*60%*	*80%*	*100%*
Electricity Contract Size	*0%*	38.5%	38.4%	38.3%	38.2%	38.2%	38.1%
	20%	37.8%	37.7%	37.6%	37.6%	37.5%	37.4%
	40%	37.1%	37.0%	37.0%	36.9%	36.8%	36.7%
	60%	36.4%	36.3%	36.2%	36.1%	36.0%	35.9%
	80%	35.6%	35.5%	35.4%	35.3%	35.2%	35.1%
	100%	34.6%	34.6%	34.4%	34.3%	34.2%	34.1%

St. Dev		Natural Gas Contract Size					
		0%	*20%*	*40%*	*60%*	*80%*	*100%*
Electricity Contract Size	*0%*	5.84%	5.79%	5.77%	5.72%	5.69%	5.66%
	20%	4.59%	4.55%	4.50%	4.48%	4.44%	4.40%
	40%	3.39%	3.36%	3.33%	3.30%	3.28%	3.26%
	60%	2.47%	2.46%	2.45%	2.45%	2.46%	2.44%
	80%	2.41%	2.46%	2.52%	2.55%	2.63%	2.69%
	100%	3.58%	3.64%	3.80%	3.88%	4.01%	4.12%

Current Scenario:	
Target Strike (Electricity):	20%
Target Strike (Gas):	15%

Expected Return		Natural Gas Contract Size					
		0%	*20%*	*40%*	*60%*	*80%*	*100%*
Electricity Contract Size	*0%*	38.5%	38.4%	38.3%	38.2%	38.1%	38.1%
	20%	37.9%	37.8%	37.7%	37.7%	37.6%	37.5%
	40%	37.3%	37.2%	37.1%	37.1%	37.0%	36.9%
	60%	36.7%	36.6%	36.5%	36.4%	36.3%	36.2%
	80%	35.9%	35.9%	35.8%	35.7%	35.6%	35.5%
	100%	35.1%	35.0%	34.9%	34.8%	34.7%	34.6%

St. Dev		Natural Gas Contract Size					
		0%	*20%*	*40%*	*60%*	*80%*	*100%*
Electricity Contract Size	*0%*	5.82%	5.81%	5.75%	5.71%	5.66%	5.62%
	20%	4.58%	4.54%	4.49%	4.46%	4.42%	4.38%
	40%	3.40%	3.37%	3.34%	3.30%	3.27%	3.25%
	60%	2.51%	2.50%	2.50%	2.50%	2.49%	2.50%
	80%	2.54%	2.59%	2.64%	2.68%	2.75%	2.82%
	100%	3.73%	3.84%	3.92%	4.06%	4.15%	4.25%