Why Financial Promotions Work:
Leveraging Energy Efficiency Value to Promote Superior Products

Wael El-Sharif, Geothermal Heat Pump Consortium
Marvin J. Horowitz, Demand Research

ABSTRACT

The investment value of energy efficient products is the subject matter of this paper. A framework is provided that can be used by energy service companies, manufacturers, contractors and electric utilities for designing financial instruments and programs that can increase the market penetration of targeted appl/iances and equipment. As a case in point, the financial analysis in this paper is applied to residential GeoExchange systems. These are combined heating and cooling systems that are ground-coupled and provide thermal comfort the year round. They are environmentally friendly, economically efficient and energy efficient. Like many energy efficient products, the main barrier to their adoption is that the initial capital costs of these systems are higher than those of inefficient substitutes.

Introduction

By their very nature, financial instruments such as loans are intended to promote sales. They do so by making a product more affordable to a buyer than if the item had to be purchased with a single, immediate payment. Financial instruments increase buyer affordability in one of two ways, either by lowering the cost of the purchase to the buyer or by allowing the buyer to commit a fraction of his or her future income towards the purchase. The interests of sellers are served by financial instruments in that sellers, either by providing these instruments themselves or by serving as an originator or broker for other financial institutions, employ them as marketing devices to increase their sales. Depending on the value of sales to the seller, and the responsiveness of buyers, it may be advantageous for the seller to transfer part of the sale proceeds to the buyer. Without directly lowering prices, this can be done through financial instruments.

GeoExchange investment value is measured by analyzing the economic details of investment choice from the intersecting perspectives of GeoExchange buyers and sellers. The tools used to measure investment value from buyer and seller perspectives are financial algorithms for adding and discounting sums and streams of funds. The most prominent determinants of these estimates are the inputs, assumptions and parameters inserted into the algorithms. For GeoExchange system investments, these values originate with the selection of base HVAC technologies and system fuels, and proceed through specialized assumptions related to building and occupant energy requirements for major end uses, particularly heating, cooling and domestic water heating. Also, assumptions are needed regarding relative equipment and installation costs, interest rates, discount rates and fuel prices.

Building and HVAC System Data

For illustrating buyer and seller investment value, a hypothetical home is analyzed based on the characteristics of an actual, moderate-sized suburban home in the northeast United States that was built in 1998. The hypothetical home is a two-story house of 2,850 square feet whose energy use is simulated for two different HVAC systems and levels of shell construction. The actual home, located in the northeast, was constructed with a building shell that met energy efficiency standards and which contained a GeoExchange system that was designed to provide heating, cooling and hot water services. The hypothetical house was the same home, constructed with a building shell that met existing building code specifications and which contained an air source heat pump (ASHP) HVAC system.

The initial data needed for an investment value illustration are the expected annual heating, cooling and hot water loads. These are based on the requirements of a representative household living in this home and experiencing typical annual weather conditions and, for the heating load estimation purposes, experiencing design day or extreme outdoor temperatures. These annual loads are expressed in millions of BTUs, or MMBtu, which are standardized measures of the amount of raw, input energy that must be converted into hot water and heated and cooled air to provide an average level of comfort to the household. Based on a building simulation model, Table 1 contains the required annual loads for the base case and the actual GeoExchange house.

Table 1: New Home Annual Loads (MMBtu/yr)

Annual Loads	ASHP House	GeoExchange House
Heating	114.9	47.0
Design Load (kBtu/hr)	61.8	29.3
Cooling	19.2	14.9
Design Load (kBtu/hr)	37.0	21.6
Hot Water	18.6	20.2
Other	22.9	22.9

In this service territory in the northeast, the building code allows houses to sustain up to 0.50 air changes per hour; the upgraded GeoExchange house sustains 0.35 air changes per hour. Because builders in this area discourage the use of backup electric resistance heating, the vertical ground-source GeoExchange system is sized at 3.75 tons. About 150 feet of buried pipe are required per equipment ton and the drilling costs in this area, known to be among the highest in the United States, are estimated to be $7.50 per foot.

Table 2 provides estimates of the incremental costs of building the actual home versus the base case home. These make up the buyer costs in the buyer total present value model. The incremental cost of the GeoExchange system versus the air-to-air heat pump unit is estimated to be $250; the ground drilling and pipe installation costs are estimated to be $4,219; and, the incremental cost for upgrading the house shell is estimated to have been $0.75 per square foot or a total of $2,138.

Table 2: Incremental Cost of GeoExchange House

Item	Incremental Cost *(FIRSTC)*
Upgraded Building Shell	$2,138
GeoExchange Unit	$ 250
Drilling and Pipe Installation	$4,219
TOTAL	$6,607

It is important to note that for the purposes of this illustration, both GeoExchange and ASHP systems are assumed to have the same lifetimes of 15 years and are assumed to incur the same lifetime maintenance costs. In reality, according Geothermal Heat Pump Consortium studies, GeoExchange systems incur 50 percent less in maintenance costs over their lifetimes than the comparable ASHP system and have significantly longer lifetimes.

The annual loads for the northeast U.S. new home example were calculated in the building simulation model by converting estimated annual loads into electricity consumption using the actual efficiency levels for the existing home and standard practice specifications data for the base case home. The assumptions are that the heating COP (coefficient of performance) of the ASHP is 1.8 and the COP of the GeoExchange system is 3.4; that the air conditioning SEER (seasonal energy efficiency rating) of the ASHP is 10.01 and the SEER of the GeoExchange system is 12.71; and, that the interaction effect of the ASHP on the hot water load adds 23.12% to the annual load and for the GeoExchange home the added hot water load is 13.37%.

Table 3 contains the annual energy consumption estimates for each home, disaggregated by end use. The customer or buyer bills were calculated on the basis of $0.10 per kWh and $0.80 per therm. For the comparable gas-heated house it is assumed that the gas furnace efficiency is 80 percent and that the gas-fueled water heater efficiency is 60 percent. Air conditioner use is assumed to remain the same. However, miscellaneous other electricity use increases because of added air distribution load. As such, the largest change in the buyer's bill is between the ASHP and GeoExchange systems. The main cause of this difference is heating use, which accounts for almost 90 percent of the total bill savings of $1,718. The difference between the total annual energy bill of the gas-fueled house and the GeoExchange house is $684.

Table 3: Annual Energy Usage and Bills, By Type of HVAC System

Annual Use	ASHP	GAS	GeoExchange
Heating	19,138 kWh	1,436 therms	4,045 kWh
(Buyer Bill)	*$1,914*	*$1,149*	*$405*
Cooling	1,905 kWh	1,905 kWh	1,172 kWh
(Buyer Bill)	*$191*	*$191*	*$117*
Hot Water	5,569 kWh	310 therms	4,220 kWh
(Buyer Bill)	*$557*	*$248*	*$442*
Other	6,712 kWh	7,112 kWh	6,712 kWh
(Buyer Bill)	*$671*	*$711*	*$671*
Total Buyer Bill	***$3,332***	***$2,299***	***$1,615***

Buyer and Seller Financial Assumptions

To calculate buyer investment value it is necessary to ascribe to the buyer a number of financial parameters. These include the interest rate at which buyers discount future streams of energy bill reductions, denoted *d*, and the expected future price of energy without which bill reductions could not be calculated. They also include the period of the investment and the expected rate of inflation. Table 4 contains the assumed values for these financial parameters.

Table 4: GeoExchange System Buyer Assumptions

Financial Parameter	**Assumption**
Period of Investment (*T*)	15 years
Annual Inflation Rate	0 percent
Annual Discount Rate (*d*)	6 percent
Price per kWh	10 cents
Price per Therm	80 cents

The buyer discount rate for bill reductions is taken to be the after-tax, inflation-free rate of return that a buyer would receive if, instead of investing the incremental sum in the GeoExchange house, the buyer invested the money in a financial instrument with the same level of risk as the GeoExchange house. This rate is assumed to be 6 percent, approximately the same after-tax interest rate on a 30 year, level-payment, fully amortized mortgage instrument that has been available of late. Finally, a 15-year period of investment mirrors the life expectancy of the equipment and average prices of $0.10 per kWh and $0.80 per therm reflect approximate retail energy prices in the northeast in the mid to late 1990s.

For the seller, an unregulated energy service company or *ESCO* , the opportunity cost of capital is assumed to be 10 percent. In the retail access regime that is soon to be , if not already, present in most states, of the $0.10 per kWh that is the retail price paid by the Buyer, *ESCO*s are assumed to receive $0.03 per kilowatt hours and transmission-distribution companies are assumed to receive $0.07.

Buyer and Seller Investment Value Models

The starting point for the analysis of GeoExchange investment values is the premise that for a buyer to purchase a GeoExchange system, its present value must exceed the present value of the next best alternative technology. Let *BENEFIT* represent the total stream of annual buyer energy bill savings resulting from use of the GeoExchange system rather than the standard system from year t_1 through the useful life of the systems at year *T*, and let *GXCOST* represent the full incremental cost, including financing and any other financial incentives, of the GeoExchange system and shell improvements. Then, the buyer's total present value (*TPV*) for the GeoExchange system relative to the standard HVAC system is:

$$TPV_{Buyer} = PV_{Buyer}(BENEFIT) - PV_{Buyer}(GXCOST)$$

Assuming that the lifetimes of the two technological choices are the same and that annual buyer energy bill savings are constant, the *BENEFIT* expression can be calculated using the formula for the present value for annually recurring uniform amounts. Letting d represent the buyer discount rate, the buyer's present value of energy bill savings is calculated as:

$$PV_{Buyer}(BENEFIT) = SAVINGS * \sum_{t=1}^{T} \frac{1}{(1+d)^t}$$

In this expression, *SAVINGS* is defined as the difference in the gas and electricity bills of the buyer with the GeoExchange system rather than the standard HVAC system. The analysis holds constant all the energy prices, the level of building heating, air conditioning, domestic hot water use, and any other energy end uses that may be affected by the technology choices.

For the incremental cost component of the total present value, the term *FIRSTC* represent the full incremental cost of the GeoExchange system, and the term *INCNTV* represent a one-time buyer financial incentive for the purchase of a GeoExchange system. Also, $PV_{Buyer}(PMT)$ represents the present value of the recurring uniform payment made by the buyer resulting from the financing of some amount of the incremental cost of the GeoExchange system. The present value of the incremental cost to the buyer is then:

$$PV_{Buyer}(GXCOST) = FIRSTC - INCNTV - PV_{Buyer}(PMT)$$

In this context, *PMT* is a function of the amount, *AMT*, of the incremental cost that is being financed and f represents the finance instrument's rate of interest over n periods. The periodic monthly payment is calculated as:

$$PMT_{Monthly} = AMT \ / \sum_{i=1}^{n} \frac{1}{(1+f)^i}$$

Finally, the present value of the monthly finance payments to the buyer is calculated as:

$$PV_{Buyer}(PMT) = PMT_{Monthly} \ / \sum_{i=1}^{n} \frac{1}{(1+d)^i}$$

This indicates that the present value to the buyer of the payments can differ from the face amount being financed due to the difference between the financial instrument interest rate and the buyer discount rate.

Other variables that would make the *TPV* model more rigorous and can be incorporated into the model include energy price and interest rate uncertainty, operations and maintenance costs and the extent to which the market appraises and capitalizes the value of the investment into home sale price. However, for present purposes, the sum of the defined expressions reveals the relative value to the buyer between the GeoExchange system and the next best alternative, the standard HVAC system.

Calculating investment value from the seller perspective is more complicated than doing so from the buyer perspective because of the nature of the retail energy sales industry. Since many market actors are potential sellers of GeoExchange systems, the character of the seller must be established prior to the estimation of value. Among the most likely sellers of GeoExchange systems are *ESCO*s as well as builders, HVAC contractors, equipment manufacturers, and electric utilities. The value of a sale to these parties differs depending on how broadly or narrowly their market roles are defined. Extra-market considerations, such as regulation and legislation that addresses societal benefits, also have important impacts on seller roles and economics.

While buyer value is instrumental for understanding when a GeoExchange sale is likely, seller value is central to designing financial products that increase the probability of GeoExchange sales. As rational decisionmakers, the initial condition that sellers require for engaging in commerce is that the present value of the sale must exceeds its opportunity cost. In other words, the total present value of the sale must be greater than zero. If this condition is met, then the excess of the present value of the sale over the opportunity cost can be used as leverage to promote sales.

For a given seller, the total present value of a GeoExchange sale, TPV_{Seller}, is made up of the present value of net new energy sales revenues, *BENEFIT*, and the present value of the costs of promoting the GeoExchange system sale, *GXCOST*. Parallel to the general formula for the total present value for buyers, seller value can be expressed as:

$$TPV_{Seller} = PV_{Seller}(BENEFIT) + PV_{Seller}(GXCOST)$$

Given the many actual and potential sellers of GeoExchange systems, and the many actual and potential regulatory and market conditions they may operate under, this paper limits the analysis of seller value to one that operates under the kind of retail access regime in which an unregulated *ESCO* can profit from selling electricity. An *ESCO* operating in a deregulated environment is free to promote whatever technology it wishes. In addition, to make its products more attractive, the seller may bundle the sale of equipment and services with short, mid or long-term electric power sales contracts. This seller is likely to target any customer that may gain value from a GeoExchange system, irrespective of the alternative fuel. As such, there are no lost revenues for this seller; on the contrary, all sales represent increases in revenues. The total present value for the sale of a GeoExchange system for the *ESCO* will simply be made up of the present value of new revenues and the GeoExchange sale costs, i.e.,

$$PV_{ESCO}(BENEFIT) = (NEWREV) * \sum_{t=1}^{T} \frac{1}{(1+r)^t}$$

Of course, the new revenues are not the full amount paid by the buyer for a unit of power; rather, it is only that fraction of the unit amount that is not fixed and committed to the local transmission and distribution company.

Estimation of GeoExchange Investment Value

Based on these estimates of the change in Buyer's annual bills, and provided that there are no offerings of incentives or other special financing instruments to the buyer, the buyer model of investment value for comparing the ASHP to the GeoExchange systems is:

$$
\begin{aligned}
TPV_{Buyer} &= PV_{Buyer}(BENEFIT) - PV_{Buyer}(GXCOST) \\
&= (\$143 * \sum_{t=1}^{180} \frac{1}{1+0.06^{t}}) - FIRSTC \\
&= \$16{,}961 - \$6{,}607 \\
&= \$10{,}354
\end{aligned}
$$

The results indicate that the present value of the GeoExchange system bill savings over the life of the investment is $16,961. However, this merely represents the benefits of the investment, not the costs. If the buyer pays for the incremental, first cost of the GeoExchange system at the outset of the 15 years of the investment, or can borrow this amount at an after-tax rate of 6.00 percent and amortize it over 15 years, then the total present value of the investment is $10,354. This represents the actual GeoExchange system investment value to the buyer when compared to the ASHP investment.

The buyer investment model that compares the upgraded GeoExchange system house to the identical gas heated and gas hot water heater house that is built to codes that were in place in the northeast in the late 1990s is:

$$
\begin{aligned}
TPV_{Buyer} &= PV_{Buyer}(BENEFIT) - PV_{Buyer}(GXCOST) \\
&= (\$57 * \sum_{t=1}^{180} \frac{1}{1+0.06^{t}}) - FIRSTC \\
&= \$6{,}752 - \$6{,}607 \\
&= \$145
\end{aligned}
$$

This model indicates that the investment value of the GeoExchange system is slightly positive. That is, the present value of the energy bill savings over the life of the GeoExchange investment is greater than the GeoExchange system cost. The buyer would be better off by $145, in terms of energy bills, by upgrading the house construction and installing the GeoExchange system.

An *ESCO* operating in a retail access regime in which GeoExchange systems compete with all other systems and fuels on the market can make profits on increased revenues due to electricity sales. If the retailer is able to enter into a power contract with the buyer, it would be able to receive $0.03 per kWh, or thirty percent of the retail price of electricity confronted by the buyer.

In this example, it is expected that the *ESCO* will be competing against sellers of the next best systems, which are gas-fueled heating and hot water systems. These are the next best systems because they have the next lowest costs, or in other words, because the total present value to the buyer of gas system is higher than that of ASHP system. However, in more limited circumstances, for instance where gas lines are yet to be extended into an area, the next best system may be the ASHP, in which case *ESCO* may be competing against the

ASHP system. In either case, the total present value of the GeoExchange system sale to the *ESCO* is:

$$\begin{aligned} TPV_{ESCO} &= PV_{ESCO}(BENEFIT) \\ &= \$484 * \sum_{t=1}^{15} \frac{1}{(1+.10)^t}) \\ &= \$3{,}685 \end{aligned}$$

This investment value is made up of new revenues of $484 annually.

The investment value estimates that were calculated for each buyer and seller are collected in Table 5. For the buyer, the analyses indicates that, all things being equal, the GeoExchange system will be highly favored over the ASHP system. However, the buyer will be relatively indifferent between the GeoExchange system and a gas-fueled heating and hot water system.

Table 5: Buyer and Seller Investment Value

GeoExchange System Investor	Total Present Value
Buyer	
vs. Gas Heat and Hot Water	+$ 145
vs. ASHP System	+$ 10,354
Seller	+$ 3,685

Design of Innovative Financial Instruments

The financial instruments employed in this paper fall into the categories of *cash incentives* and *credit*. The former includes marketing devices whose distinguishing feature is a one-time cash payment to the buyer once the purchase is made. These instruments include rebates, price discounts, buydowns and the like, their particular definitions depending on what actions the buyers must take to receive payment. Non-cash incentives, such as airline mileage, green stamps or giveaways, are not considered financial instruments because their value to each buyer is subjective.

The latter category of financial instruments is referred to generically as *credit*. The key feature of this category of instruments is that the buyer is permitted use of the equipment prior to having fully paid for it. With these instruments, payments on the balance of the principal owed to the seller, including interest payments, are distributed over time. Under this definition, other than tax treatment, there is no difference between loans, leases or performance contracts. The common elements are fixed terms, fixed implied or stated interest rates, level payments and full buyer ownership after the final payment.

For the purposes of this paper, this definition of financial instruments does not include instruments like closed-end leases that allow the seller to maintain ownership of the GeoExchange equipment after the buyer makes all the agreed-upon payments, or where the buyer makes payments to the seller indefinitely. These kinds of instruments are not likely to be of widespread use for items like GeoExchange system loops that become fixed parts of the real estate infrastructure and are immobile. However, they may be niche products that appeal to a special kind of market.

To illustrate the attractiveness of different financial instruments to buyers and sellers of GeoExchange systems, three different financial products are specified. They are:

1. one-quarter of the incremental cost is covered by a seller cash incentive and the remaining three-quarters is covered by a seller-provided, below market rate loan;
2. full incremental cost is financed with a seller-provided, below market-rate loan; and,
3. one-third of the incremental cost is covered by a seller-provided incentive and two-thirds of the cost is financed by a conventional, unsecured loan.

These instruments are representative of many of the more popular products that are currently available and in use for financing home improvements and energy efficiency investments. Table 6 contains the loan rates and seller incentives associated with these packages of instruments. For uniformity, all loan rates are annual rates and all loan terms are for 5 years with the buyer responsible for 60 monthly payments of equal amounts.

Table 6: ESCO Offerings of Financial Products

Financial Product	Seller Incentive	Loan Rate (*f*)
1. Incentive (25%) - Loan (75%)	$1652	5.00%
2. Loan Only (100%)	$ 0	0.90%
3. Incentive (33%) – Unsecured Loan (67%)	$2180	10.00%

These financial instrument packages or products are flexible in many different ways. Note that the seller incentive to the buyer can be adjusted to whatever proportion of incremental cost is desired. Also, the seller is free to adjust the lending rate relative to the incentive. Of course, the terms of the loans, which are fixed in these illustrations to 5 years, can be expanded or contracted, too. Many other loan features can also be adjusted.

Table 7 summarizes the results of the buyer and seller investment value models when Financial Product 1 is offered to the GeoExchange buyer. These results indicate that the financial product is extremely attractive to the buyer whether or not the alternative to the GeoExchange system was the ASHP system or the gas system. It is interesting to notice that even without the product the GeoExchange system was very attractive to the buyer relative to the ASHP system. However, the buyer contemplating a gas system would be somewhat indifferent to a GeoExchange system without the cost reduction offered by the financial package. For an *ESCO* offering GeoExchange systems and power contracts, this sale has a total present value of $1,480 regardless of whether the buyer's alternative was a gas system or an ASHP system.

Table 7: Total Present Value of Financial Product 1

GeoExchange System Investor	PV(Benefit)	PV(GXCost)	Total PV
Buyer			
vs. Gas Heat and Hot Water	$6,752	-$ 3,185	$ 3,567
vs. ASHP System	$16,961	-$ 3,185	$13,775
Seller	$3,685	-$ 2,206	$ 1,480

Financial Product 2 illustrates the effects on buyer and seller investment values of offering 100 percent financing at the highly favorable rate of 0.9 percent. The results are contained in Table 8 and indicate that at this loan rate, the total present value is substantial. Of note in this illustration is that the subsidized loan rate has a moderate effect on the total present value of the buyer. For the buyer who would have invested in a gas system, investment value rises to $925 from $145 that the buyer faced with no financial package.

Table 8: Total Present Value of Financial Product 2

GeoExchange System Investor	PV(Benefit)	PV(GXCost)	Total PV
Buyer			
vs. Gas Heat and Hot Water	$6,752	-$ 5,827	$ 925
vs. ASHP System	$16,961	-$ 5,827	$11,133
Seller	$3,685	-$ 1,305	$ 2,380

A cash incentive of 33 percent of the incremental cost of the GeoExchange system is the financial instrument identified as Financial Product 3. According to this illustration, the remaining 67 percent of the incremental cost is financed using an unsecured loan at a market rate of 10 percent. The findings for Financial Product 3 are contained in Table 9. They indicate that investment value for the buyer whose alternative is a gas system rises to $1,672. Further, the total present value for the *ESCO* is over $1,500.

Table 9: Total Present Value of Financial Product 3

GeoExchange System Investor	PV(Benefit)	PV(GXCost)	Total PV
Buyer			
vs. Gas Heat and Hot Water	$ 6,752	-$ 5,081	$ 1,672
vs. ASHP System	$16,951	-$ 5,081	$11,880
Seller	$3,685	-$ 2,180	$ 1,505

Discussion and Recommendations

It is axiomatic in the world of commerce that a sale occurs between a buyer and a seller only when both expect to receive positive value from the transaction. It follows that knowing the value of a sale or investment from the perspectives of different market actors can greatly help in understanding how markets operate and why markets grow. This understanding can be put to creative use to increase general awareness of energy efficiency products and to otherwise guide market behavior. By knowing how much leverage is available between market actors this knowledge is also helpful for designing customized financial products that promote energy efficient product sales.

The financial valuation method described in this paper has been applied to assumed financial parameters, annual building loads, incremental GeoExchange system costs and equipment efficiency levels to calculate buyer and seller GeoExchange system investment value. The assumptions are meant to be general, yet realistic, for the example of a buyer of a new, moderate-sized home in the northeast United States. Financial models were used to reestimate investment value for buyers and sellers when confronted with three different financial instruments or products. From comparisons of these estimates, several conclusions can be drawn:

- Irrespective of financial product, the total present value for buyers of GeoExchange systems, relative to ASHP systems, is substantial. Furthermore, the GeoExchange system is cost-effective relative to the gas system. However, because the cost advantage of the GeoExchange system relative to the gas system is small, the findings suggest that to increase the market penetration of GeoExchange system sales, sellers will need to transfer some investment value to buyers via customized financial instruments.
- Using any of the three hypothetical financial products, the total present value to sellers of the GeoExchange systems was moderate to highly positive.
- Seller incentives, that is, one-time cash payments or price discounts, offer the most value to buyers and are of greatest cost to sellers. Low or no interest financing offers modest value to buyers at little expense to sellers. These findings suggest that to increase GeoExchange system sales some combining of the two modes of financing is desirable.

Based on the findings of this study, it would be productive and timely to extend and refine the techniques used to estimate investment value and to design attractive financial packages to promote energy efficient products and equipment. As the analysis in this study indicates, many financial products or combinations of cash and credit financing offer positive total present value for energy efficient investments both for buyers and sellers. To determine the optimal level and combination of financing requires that for every seller in a given locale and given regulatory regime, analyses be conducted to develop realistic sales goals based on market potential. In addition, accurate forecasts must be made of the degree of sensitivity of buyers to changes in total present value of the energy efficiency investments.