How to Calculate Financial Information for Home Energy Raters, Lenders and Savvy Home Buyers

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ABSTRACT

Home ratings and energy-efficient mortgages are becoming the key vehicles in the process of moving more buyers and builders to energy efficiency that exceeds minimum code limits. The energy-efficient mortgages industry requires both the projected savings of energy-conservation measures and other key financial information for builders, realtors, buyers and lenders. This paper presents the methodology used by the one state's home rating software for calculating and reporting key financial information and for selecting the most cost-effective upgrades automatically through an optimization process.

Historically, many statistics have been calculated based on two pieces of information - the cost of the energy conservation measures and the projected savings from the measures. Unfortunately, when attempting to upgrade an existing or code-minimum new home up to a more efficient level, such as EPA's Energy Star Home program level, a number of measures interact. The savings of a package of upgrades can be determined, but a methodology was required for attributing the savings due to each measure as required for certain national mortgage products.

When examining the cash flow of measures there are a host of other factors - the amount of the upgrade that will be borrowed, the income tax rate used for deducting interest, any increase to the property that will result in higher property tax and insurance rates and the maintenance on the upgrade. These factors have been handled before in analysis, but new questions arise with energy-efficient mortgages; how do discounted interest rates or closing fees affect investment indicators? How should the cost of a home rating be incurred? Does it differ if a portion of the rating cost is borrowed? And how is the lifetime of the equipment accounted for if the economic period of analysis exceeds the lifetime? How do replacement costs get added to this initial investment? What is considered the initial investment for an internal- rate-of-return calculation when the upgrade cost is borrowed? All this must be balanced with the number of inputs software users must enter in order to compare a home with and without an improvement, as well as different loan opportunities.

The reporting of the financial analysis is of significant importance to the lending industry. This paper presents many report options contained in the Florida software, Energy Gauge, and its ability to meet the requirements of HUD, Fannie Mae, and the national HERS guidelines.

Introduction

Why include financial information?

Energy code compliance is a very poor predicator of the minimum cost of owning and operating a home. Most homes, new or existing, can be substantially improved and return money to the owner from day one. Figure 1 illustrates how these savings occur, even in proposed, new, "code-compliant" homes.

As you improve the efficiency of a new home, the present value of its mortgage cost increases - more and more rapidly as you approach the best available technology. Simultaneously, however, energy cost decreases, and there is a point at which their sum (the total cost) is minimized (marked by an arrow on the chart). It is worth noting that the cost of owning the minimum code home is greater than the cost of owning a more energy efficient home until the point indicated by the large triangle on the total cost curve is reached. Thus, substantial improvements in efficiency (and quality and comfort) are typically cost-effective.

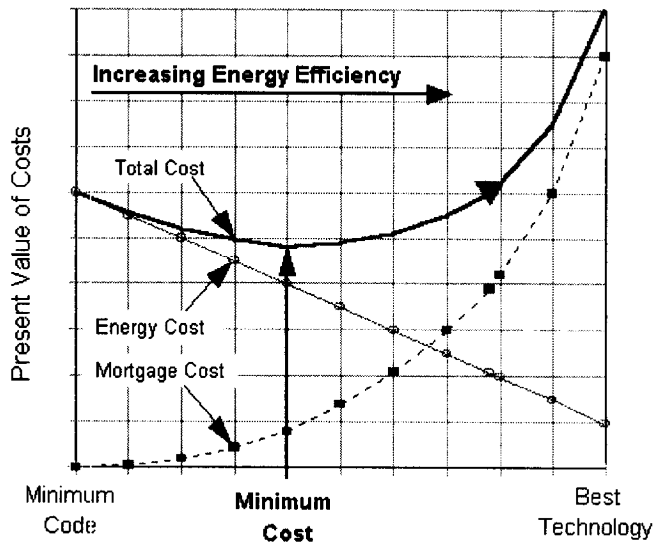

Figure 1. The cost of owning the minimum code home is greater than the cost of owning a more energy-efficient home until the point indicated by the large triangle.

This example illustrates the operating principal of the state of Florida software, *EnergyGauge/Optimization*, whereby the present values of the mortgage costs are balanced against the present value of the energy savings and only the most cost-effective improvements are incorporated into the home. Now, for the first time in Florida, there is a uniform, "expert system" in place that can measure and report on the economic and financial impacts of home energy technology decisions.

Realtors like it! Realtors like to show positive cash flow for home buyers of energy-efficient homes. It helps them to explain the economic advantage of buying a home with a higher "sticker price." Home energy rating tools that allow the rater to produce a home-specific cash flow will aid the realtor. The cash-flow presentation can be developed for a model home, helping convince buyers of the advantages of energy efficiency in the highly price-sensitive new home market.

And you can take it to the bank! There are increasing numbers of mortgage, utility and government programs that are "honoring" the energy savings projected by certified home energy rating systems (HERS). Tools like *EnergyGauge/Optimization* in the hands of Home Energy Raters make this a feasible alternative for builders, homeowners and buyers. EPA's Energy Star Homes and utility programs can be reached through cost-effective optimization, not with best guesses. And to ensure mortgage industry accreditation, misrepresentation of the results has been made purposely difficult through a policy of full disclosure in Florida's system. Each of the user-selected economic and financial assumptions and each improvement along with its cost, its cost basis (source), its lifetime and any other associated costs or benefits are clearly printed on the output reports. This is done to ensure that financial results are properly interpreted and, if necessary, can be fully replicated.

EnergyGauge/Optimization provides a new window into the integrated world of energy efficiency, mortgage financing and "home economics." Simply put, *EnergyGauge/Optimization automatically compares **what is** with **what could be** and then provides all the economic analysis necessary to make well-informed financial decisions on how best to minimize the total cost of owning a home.*

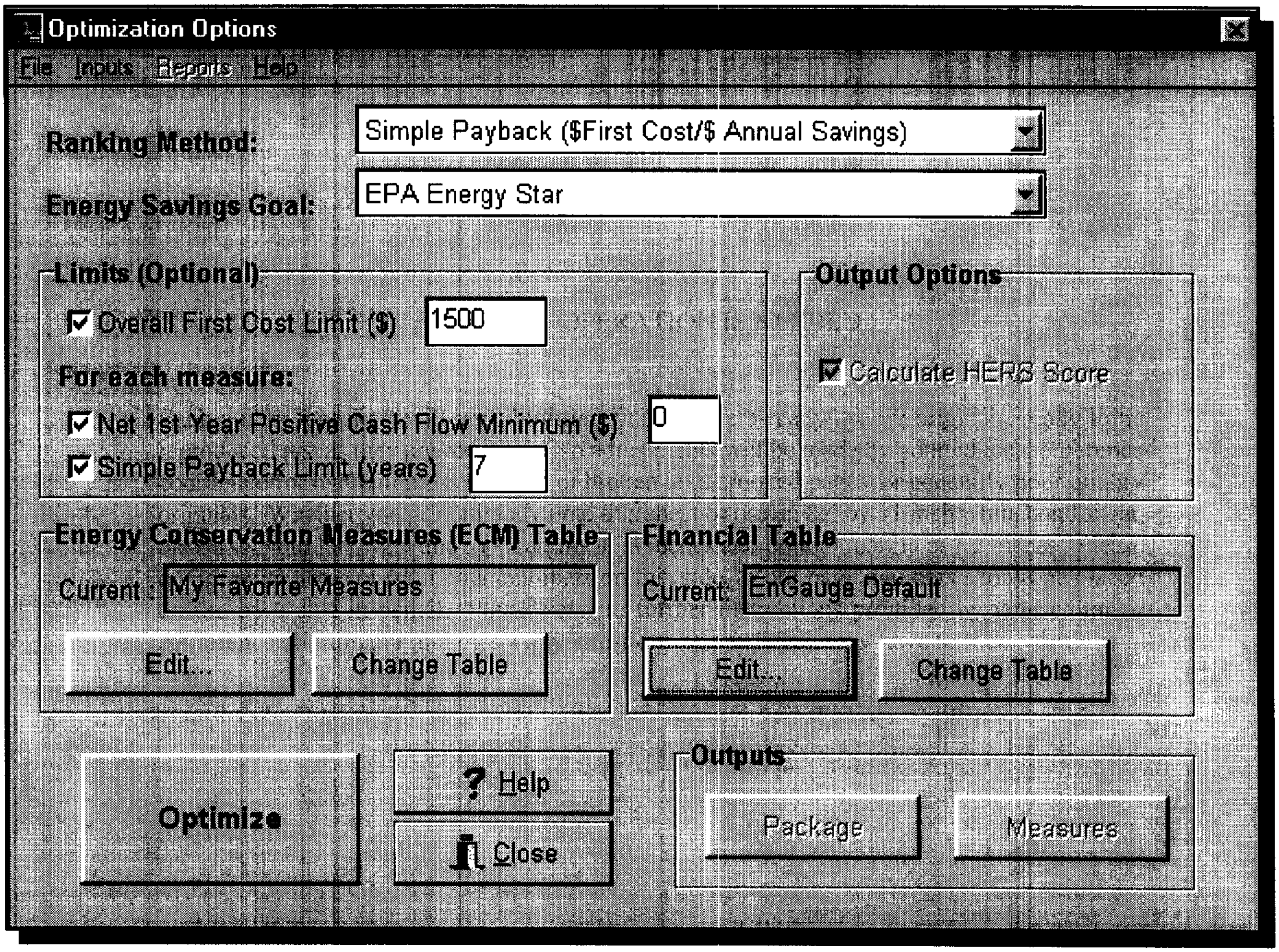

Figure 2. The optimization module allows Energy Gauge users to select their energy goal, cost/benefit ranking method and limits, energy conservation measure cost database, and financial input database.

The financial module design challenges

The authors developed the financial module to be used with energy rating software. The goal of the financial module is two-fold:

1. To choose energy conservation measures (ECMs) based on an optimum energy benefit vs. energy cost indicator, given a user-defined home and a user-selected energy target level;

2. To print financial information for a package of upgrades in variously formatted reports to be used by builders, raters, federal agencies and the mortgage industry.

On the surface the challenge may seem simple, as much effort has been put into the economics of energy measures (e.g, Duffie and Beckman, 1980). There have been rankings done for utilities comparing the cost of the ECMs to utility supply cost (Elberling and Bourne, 1996), and there have been many papers dealing with the issue of energy-efficient mortgages (Collins, Farhar, and Walsh, 1996), (Verdict, 1996), (Horowitz, 1996).

However, there were still some key decisions, including how best to incorporate the cost of the home rating, the costs of financing fees, associated costs of increased home value (home insurance, property taxes) financial incentives offered by some energy-efficient mortgages, rebates by utilities and suppliers. Furthermore, one of the financial indicators, internal rate of return, involves an investment and an annual return. In the case of financed measures that require replacement over the analysis period, determining the "investment" amount requires interpretation. The algorithms developed for this project allow each ECM measure to have a different lifetime, and the option of conducting the analysis with replacement or without replacement. Users select the mortgage and analysis periods.

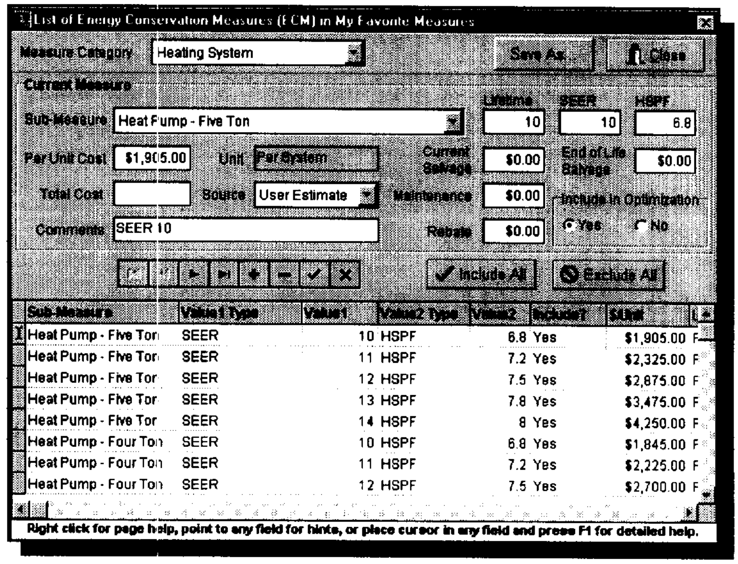

Figure 3. Users can enter their own costs into the energy conservation measure database. Raters can set up different databases for each builder.

Ranking Individual Measures by Cost-Benefit Indicators

Overview

In the software optimization procedure, each measure is individually added to the originally entered house, and the estimated annual energy use and energy costs are calculated. Then the software ranks each measure based on the cost-benefit indicator selected from the choices shown in Table 1. The top-ranked ECM measure is added to the original house description, creating an *improved* house, as long as none of the constraints shown in Table 2 have occurred. This process is repeated, adding each measure and recalculating the energy savings each time, until the user has reached a goal (choices shown in Table 3), all measures are exhausted, or adding any measure would violate one of the user constraints (Table 2). This process is shown in Figure 4.

Table 1. Cost-benefit indicators used for ranking measures.

Cost-benefit indicator
Simple Payback
Net Present Value
Present Value of Savings to Present Value of Investment Ratio
Internal Rate of Return on Investment
First-Year Cash Flow

Table 2. Constraints to Optimization in Energy Gauge Software

Constraint	Type	Typical Constraint Value
Measure does not save energy $	Mandatory	N/A
First year positive cash-flow for a measure	Optional, user-selected	$0
Simple payback for a measure	Optional, user-selected	7 yrs
Overall cost limit for all improvements	Optional, user-selected	$2000

Table 3. Optimization Energy Goals in Energy Gauge Software

Goal	Description
EPA ENERGY STAR	Requires a HERS Score of 86
HERS score	Home Energy Rating System Score based on heating, cooling and water heating analysis
HERS Stars	Based on the HERS Score, where 80 is 4 stars, 86 5 stars, etc.
Energy use ($)	User selects target annual estimated energy bill, includes all rated components - pool, range, dryer, lighting and misc. in addition to heating , cooling and water heating.
Energy use (MBtu)	User selects target annual estimated site energy use.
Energy savings ($)	User selects target annual estimated savings in total energy bill.
State Code	Passing the state code for energy efficiency.

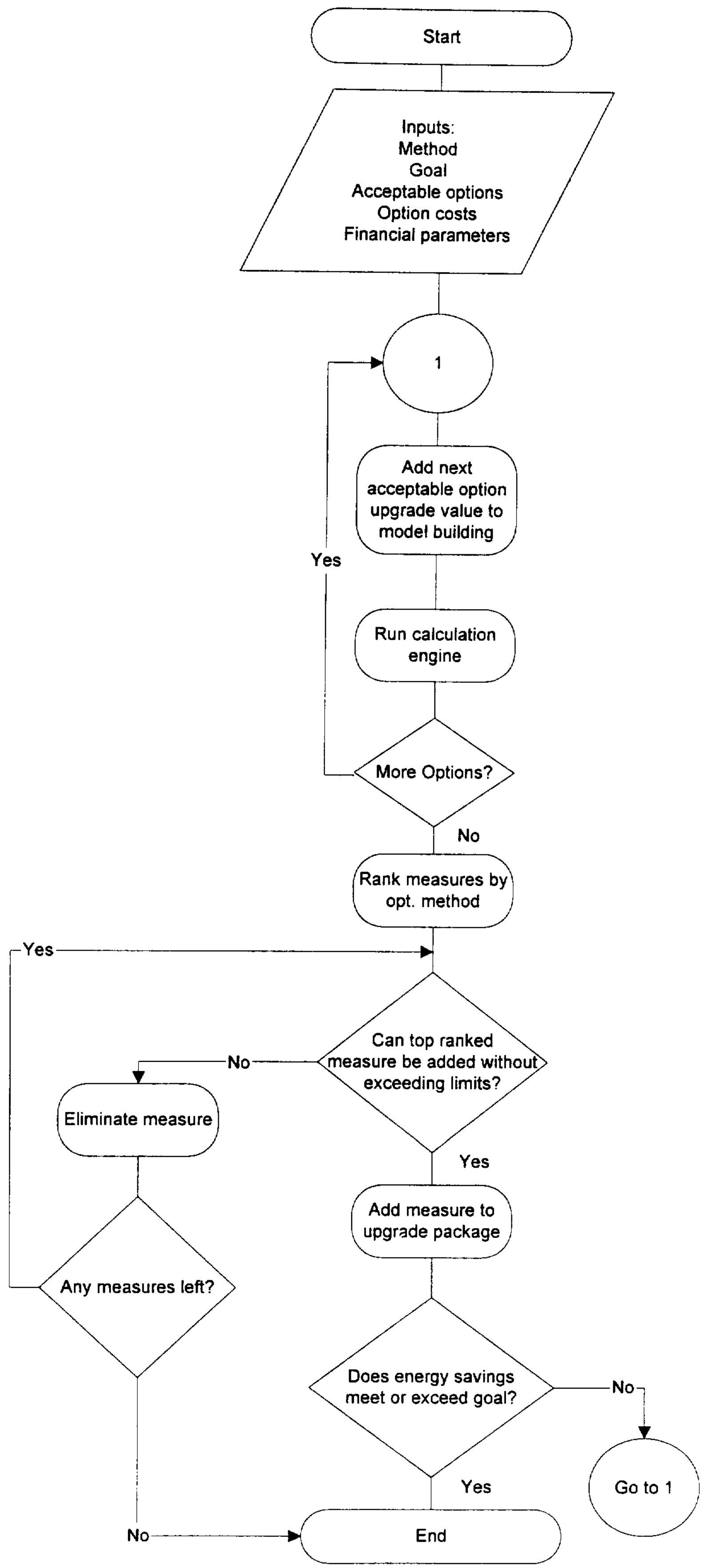

Figure 4. Optimization flowchart

Financial Inputs

There are four different sets of financial inputs required by the user. One set applies to each ECM. For each ECM there is a cost, the lifetime of the ECM, an annual maintenance cost, any rebate for the item, any scrap value for the measure if it exists in the original home, and any projected ending salvage value for the ECM at the end of the lifetime. Often, only the cost and lifetime variables are used, the others being set to zero by the user.

Another set of inputs applies to the mortgage. In addition to the down payment and term of the mortgage, fees for points, fees for PMI and other buyer-paid fees are included. The interest rate can be variable or fixed. A user may select different rates for an energy-efficient mortgage, and choose a financial rebate of closing costs as is sometimes offered, e.g., some Energy Star Home finance-partner programs.

There are rates that are home and buyer related. The property tax rate and the home insurance rate that apply for the home improvement, the income tax bracket for the buyer, and the cost of obtaining a certified rating for the home are input. A user-defined percentage for the rating fee may be borrowed.

Finally, there are three inputs required to project present and future values of annual costs and two key user-selected options. The discount rate, the fuel escalation rate, and the general inflation rate are chosen to estimate the present and future costs. The number of years of the economic analysis, and whether the analysis should be conducted replacing measures at the end of their lifetime are two very important inputs.

The software provides defaults for each variable that may be overwritten by the user, typical users will only change a few for any given home. The user can save the ECM Cost inputs in different tables (e.g., Builder A costs, Builder B costs), and the other financial inputs can be saved similarly (e.g., SuperTown bank, BigBucks Bank).

Calculating Financial Parameters for Each Measure

The upgrade cost for each measure is determined from the ECM input (reduced in *new* homes by the cost of the original measure) and adjusted for individual measure rebates and any starting salvage value. The cost of the rating and any mortgage financial incentives (rebates) are not included for the optimized ranking procedure because they apply for the entire improved home (see next major section of this paper).

Simple payback. This calculation remains in its purest form, the cost of the energy-efficient improvement item divided by the annual energy savings.

$$SimplePayback = C/E$$

First-year cash flow. The first year cash flow is calculated as the first year energy and tax savings (the income tax rate multiplied by the mortgage interest payment and the property tax) minus all expenditures for that year due to the improvement- the maintenance, the property tax, the mortgage payment, the home insurance, the private mortgage insurance (down payments are considered to take place in year zero and do not apply).

$$First\ year\ cash\ flow = E + (T_i \times (T_p + M_i)) - I_m - T_P - M_p - H_i - P_{PMI}$$

Net present value. This procedure uses the discount rate and general inflation rate (applied to replacement cost and ending salvage) to calculate the present value of each annual expense (note that the mortgage interest is not constant). For simplicity in programming and for processing speed, a variable interest rate mortgage is approximated as the rate used during the year that is one-third of the lifetime of the measure. For final analysis of an energy package of ECMs, each year's variable rate is used (see next major section). The property tax is inflated at its user-defined rate and discounted at the discount rate. The present value of these costs are added to all down payments related to the upgrade measure (including mortgage fees). Similarly, the present value of the energy savings over the lifetime, calculated using the discount rate and the fuel inflation rate, are added to the present value of the income tax savings (income tax savings depend on the present value of the mortgage interest). The net present value is the present value of savings minus the present value of expenditures. The general formula for calculating the present value using a present worth factor is given below. A more complicated procedure (Duffie and Beckman, 1980) is used to calculate the present worth of the interest payments as they change year to year. The interest payment is required separate from the total mortgage payment in order to calculate the income tax deduction.

$$X_{PV} = PWF(N,i,d) \times X \text{ where } PWF(N,i,d) = \sum_{j=1}^{N} \frac{(1+i)^{j-1}}{(1+d)^{j}}$$

Present value of savings to present value of investments. This ratio is calculated as the present value of energy savings divided by the present value of all expenditures minus the income tax savings.

$$\frac{E_{PV}}{I_{PV}} = \frac{E_{PV}}{I_{m_{PV}} + T_{p_{PV}} + M_{p_{PV}} + H_{i_{PV}} + P_{PMI_{PV}} - (T_i \times (T_p + M_i))_{PV}}$$

Internal rate of return on investment. The internal rate of return is calculated as the equivalent discount rate required so that the sum of the *proceeds* over the lifetime of the measure would equal the *investment*. The *investment* is the down payment on the upgrade cost, plus the present value of all replacements of the measure during the lifetime, minus the linearly-depreciated remaining present value at the end of the lifetime. The *proceeds* consist of the sum presented in the first year cash flow.

$$IRR = d \text{ when First year cash flow} \times PWF(N,i,d) = (C_{dp} + C_{rep_{PV}} - C_{EOL_{PV}}) \times PWF(N,i,d)$$

Financial Parameters for a Package of Upgrades

Once an energy goal is reached the optimization process is completed. However, the financial parameters derived for any individual step of the optimization process do not necessarily apply to the entire "package" of upgrades. The package started at the original building, whereas each ECM added in optimization started at the "current" home as it was optimized to that point. Furthermore, the package may consist of upgrades of different lifetimes, and the package includes rating costs and financial incentives offered by mortgage companies. Thus, if starting from a group of optimized measures some post-processing is necessary.

Post-processing the Improved Home Measures Into a Package of Upgrades

Step 1 - *Convert from individual measures accepted by optimization to package of specific upgrades*

A. Determine actual package of defined upgrades. For example, if original house started with an air conditioner of SEER 10 and electric resistance heating, but the improved home has a SEER 13 heat pump, then all in between individual measures (SEER 11 ac, SEER 11 heat pump, etc.) are combined for the purpose of reporting a package upgrade.

B. Calculate total costs for each package upgrade (from original house entered to the optimized or improved home).

Step 2 - *Calculate Energy Savings for Individual Upgrades Given in Package (Needed for HUD and Fannie Mae and Freddie Mac output)*

A. The savings for a given package upgrade are calculated as the savings for the total package minus the savings with all the upgrades but the given upgrade. $\text{Savings(\$)}_{\text{wout upgrade}} = \text{Savings(\$)}_{\text{all upgrades}} - \text{Savings(\$)}_{\text{all but this upgrade}}$. This is repeated for each upgrade.

B. The total dollar savings as just calculated are summed ($\text{Savings(\$)}_{\text{sumofwoutupgrades}} = \text{Savings(\$)}_{\text{wout upgrade1}} + \text{Savings(\$)}_{\text{wout upgrade2}} + \text{Savings(\$)}_{\text{wout upgrade3}}$ for a three-upgrade package).

C. The savings percentage for a given upgrade is calculated as the portion of the summed savings attributed to the upgrade by the removal technique ($\text{\%-of-total-savings}_{\text{this\_upgrade}} = \text{Savings(\$)}_{\text{sumofwoutupgrades}} \times \text{Savings(\$)}_{\text{wout upgrade}} \times 100$).

D. Then the percentage is applied to the overall energy savings for the package ($\text{Savings(\$)}_{\text{this\_upgrade}} = \text{\%-of-total-savings}_{\text{this\_upgrade}}/100 \times \text{Savings(\$)}_{\text{allupgrades}}$) to arrive at the annual energy savings due to the given upgrade.

Step 3 - *Calculate energy savings for groups of measures with equal lifetimes (needed for analysis without replacement)*

A. Group upgrades by those with equal lifetimes.

B. Calculate energy savings dropping out the upgrades at the end of their measure life. For example, suppose we have five upgrades, one of life 5 years, two of life fifteen years, one at twenty years and one at thirty years.

First, four groups are created (5, 15, 25, 30). Then the energy savings without the group of measures that have a lifetime of five years is calculated:

$\text{Savings}(\$)_{\text{after5}} = \text{Savings}(\$)_{\text{all upgrades}} - \text{Savings}(\$)_{\text{all but those with life=5}}$

Next, for each of the other groups:

$\text{Savings}(\$)_{\text{after15}} = \text{Savings}(\$)_{\text{all upgrades}} - \text{Savings}(\$)_{\text{all but those with life=5 or 15}}$

$\text{Savings}(\$)_{\text{after25}} = \text{Savings}(\$)_{\text{all upgrades}} - \text{Savings}(\$)_{\text{all but those with life=5 or 15 or 25}}$

$\text{Savings}(\$)_{\text{after30}} = \text{Savings}(\$)_{\text{all upgrades}} - \text{Savings}(\$)_{\text{all but those with life=5 or 15 or 25 or 30}}$

In this example, the $\text{Savings}(\$)_{\text{after30}}$ should equal 0.

Step 4 - *Needed for analysis with replacement*:
The total costs associated with each life group of upgrades.

Calculating Financial Parameters for the Overall Package

Financial parameters are calculated for the entire package for reporting purposes. These calculations work with the post-processed optimized package, or a package developed by the user via a manual rating-for-improvement. They vary slightly from those used during the ranking process in that they incorporate the cost of the rating and any financial institution rebates. The interest rate for each year, as entered for variable rate mortgages, is used in calculating the final financial reports for the package of energy improvements.

Special Reports

The program can produce a rating guide that graphically shows the effect of the improvement. Additionally, seven different reports involve the energy savings of the package of upgrades (see Table 4). The cost-benefit report shows a summary of the most useful information. However, for mortgage purposes two national forms are emulated. One is the three-page worksheet for energy-efficient mortgages required by HUD. The other is the Fannie Mae/Freddie Mac form. For the HUD report, each upgrade in the upgrade package must pass a cost benefit analysis. Similarly, each upgrade must pass a cost-benefit test for the Freddie and Fannie report, and it must be done for a lifetime of the upgrade not to exceed seven years. Thus, the reason for step 2 above. Note that due to the interactions of upgrades with one another, there is no simple way to calculate the affect of just one upgrade. After examining many situations, we have concluded that a removal technique (shown in step 2) will best estimate the percentage of the overall energy savings attributed to one upgrade of the package.

The HUD report and the payment comparison report require inputs as to the cost and down payment of the home. The payment comparison report shows the original and improved home with line item costs - most useful as a sales tool to show how even though the improved home may have a higher "sticker" price, the monthly total costs are lower. It also shows the savings due to improved financing options for energy-efficient mortgages that may offer reduction in points or interest rates. In addition to the home cost information, the HUD report requires inputs on the buyers income and debt to determine a buyer's maximum loan amount prior to the energy upgrades.

Table 4. Overview of Financial Reports Available from Energy Gauge

Form	Name	Purpose	Pages
001	Costs & Benefits of Energy Improvements	1. Provides list of measures used to upgrade home, costs of those measures, and the source of the costs. 2. Provides a summary of the energy performance of the home with improvements - including HERS Score, and Annual Energy Cost and Savings. 3. Lists economic indicators to help user determine if the investment is worth the cost: Net present value of cash flows, Present value of savings to present value of investment ratio, Internal rate of return, Simple payback, and the First year net cash flow. 4. Provides footnotes describing how costs and economic indicators were calculated. 5. Describes ranking and selection methods for optimization (if used).	1 or 2
002	Mortgage Amortization Schedule of Energy Improvement	To see a breakdown of the costs of mortgaging (principal, interest) the energy improvement package (inclusive of rating cost).	1
003	Cash Flow Schedule of Energy Improvement Cost	Overall breakdown of all the costs and savings associated with the energy improvement, including home insurance, taxes, maintenance and energy savings. Provides a cumulative net cash flow by year.	1
004	Estimated Total and Monthly Payments	1. Compares the total **home** cost, with and without the energy improvement in a line-item format. 2. Compares the total monthly payments of the **home**, with and without the energy improvement by line item (principal and interest, taxes, insurance, energy, maintenance, net payment).	1
005	HUD Worksheet Report Attachment B1 Energy Efficient Mortgage Worksheet	To produce information required by HUD for Energy Efficient Mortgages in format HUD recommends. It has three parts: 1. Qualifying the borrower worksheet (requires entry of optional fields by user). Produces mortgage payment to income ratio and total fixed payment to income ratio. 2. Compares and qualifies cost of energy-efficient items. 3. Worksheet detailing cost and premium for each measure in improvement package.	3
006	Package Summary	1. Show HERS score and estimated energy use before and after improvements. 2. Provides list of measures used to upgrade home. No costs of measures are given.	1 or 2
Freddie Mac 70A 6/89, and Fannie Mae 1004A 6/89 part 2 emulation	Estimate of Value of Energy-Efficient Items	Provides the cost/benefit analysis in the format desired by Freddie/Fannie. Compares the cost of each item to the present value of expected savings for each item with a maximum lifetime of seven years applied.	1 or 2

Uses of Financial Information

The primary use of the financial reports are for energy-efficient mortgages. In a draft procedure for economic reporting (RESNET and NASEO, 1998), proposed improvements should include:

> *1) the basis of comparison from which costs and savings are derived.*
> *2) The incremental cost and cost basis (bid, estimate, etc.) for each proposed improvement.*
> *3) The anticipated lifetime of each proposed improvement.*
> *4) The total annual cost savings resulting from all improvements when taken in aggregate as compared with the annual purchased energy costs for the unimproved property.*
> *5) Maintenance, mortgage interest rate, general inflation rate , fuel escalation rate, personal discount rate, the time period of analysis, the economic value types (present or future value) and any other costs, periodic rates considered by any economic analysis.*

The development of the financial routines described in this paper meet the needs anticipated by the industry and are being incorporated into Florida rating software. Through use of this software, raters can provide the information of which savvy buyers inquire, mortgage companies require, builders desire, and realtors admire. By having the various reports available, all parties can be enlightened to the economics of energy efficiency.

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