COST-BENEFIT ANALYSIS OF GREENING AN OLDER MODEST-SIZED HOME
IN THE SAN FRANCISCO BAY AREA

A Professional Project Presented To the Faculty of
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Master of City and Regional Planning

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Abstract

COST-BENEFIT ANALYSIS OF GREENING AN OLDER MODEST-SIZED HOME IN THE SAN FRANCISCO BAY AREA

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This professional project estimates the upfront costs and utility savings expected from greening an approximately 1,100 square foot home built in the 1950s in the San Francisco Bay Area. Two sets of upgrades (alternative and original) were compared for costs and benefits. The alternative set (which included ceiling insulation and omitted upgrading to dual-pane windows) clearly out performed the original set. The alternative set would be expected to reduce resident utility bills by 28% annually, and to prevent approximately 2,700 lbs of carbon dioxide emissions annually. The water efficiency upgrades were the best performing group of upgrades, as they had the lowest upfront cost and shortest payback period. (These water efficiency upgrades consisted of modifying toilets, faucets, and showerhead, as well as upgrading the dishwasher and clothes washer to efficient models.) Future very low-budget greening programs, in nearly all cases, should include a full-set of water fixture modifications, weatherstripping, and clotheslines. As budgets allow, other upgrades from alternative upgrades list are recommended, such as ceiling fans, programmable thermostats, and ceiling insulation. Whenever possible, workforce development labor should be used to simultaneously reduce labor costs and multiply the social benefit of each project dollar by providing entry-level green collar jobs.

Keywords: Affordable housing, low-income, moderate-income, established neighborhood, Richmond, California, Bay Area, 1950s, small homes, green, energy efficiency, water efficiency, environment, greenhouse gases, cost-benefit analysis.

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Executive Summary

Cost-Benefit Analysis of Greening an Older Modest-Sized Home in the San Francisco Bay Area

Delilah Zoe Leval

This professional project provides estimated upfront costs and future utility savings expected from upgrading an older, modest-sized home with certain green features. A home model was created based on available data for an established Bay Area neighborhood of single family homes built in the 1950s near Richmond, California. The model represents the neighborhood's average home dimensions and structural features. Materials and labor costs were estimated for two sets of green upgrades to improve water efficiency, energy efficiency, and indoor air quality of the home model. The original green upgrades were based on a series of upgrades devised in 2009 by Contra Costa County for a related HUD grant. The alternative green upgrades were a variation on the original series, modified with what were hypothesized to be less expensive, better performing measures. The "green premium," which is the average cost difference between green and conventional upgrades (comparable non-green versions) was also determined.

The following approach was used to estimate costs and benefits. First, material costs for both green and conventional upgrades were estimated by selecting economy models at a popular retailer and recording the list price. This information was used to obtain labor quotes from a reputable Bay Area contractor previously used by Contra Costa County. To estimate utility usage changes, parameters representative of the different home configurations were input into online energy and water savings calculators (created and endorsed by US government agencies). The cost and savings figures generated for this study's home model were then compared to case studies of greened existing housing in both the non-profit and government sectors. In addition, prior

research on the health and environmental co-benefits of improved indoor air quality, home warmth, and resource conservation were discussed. Finally, policy implications were drawn from the findings, and specific recommendations on how to formulate the most cost-effective sets greening measures were provided.

The study concludes that the alternative upgrades, which are a variation on the original upgrades, were superior to the original upgrades. The alternative set of upgrades, which could be tailored to meet the needs of future green retrofitting programs, is detailed in Appendix 2. The estimated cost (labor and materials combined) to implement the original green upgrades in the County's NSP2 application was \$24,501. The alternative upgrade set had an estimated cost of approximately \$4,100 less, at \$20,367. Further, the original upgrades were projected to save the residents \$517 over baseline annual utility bills, whereas the alternative upgrades were projected to save the residents \$740 over baseline annual utility bills—a difference of over \$200 in additional savings per year, reducing utility costs by 28%. The green premium (the average additional upfront cost of choosing a green model over a conventional model) was estimated to be \$363, or an average of 41% over the conventional equivalent. Additionally, the alternative upgrades would save an estimated 2,700 lbs of carbon dioxide per upgraded home (annually) due to reduced electricity generation, lessening housing stock's contribution to anthropogenic climate change.

Other important monetary benefit findings were made when costs and benefits were divided across improvement sector (energy, water, and indoor air quality). The alternative water sector upgrades had the shortest payback period, at approximately 6.4 years. This suggests water sector upgrades, as a category, are the green upgrades from a financial investment perspective. Among the individual energy sector upgrade measures, according to the literature and academic opinion, blown-in ceiling insulation has the greatest savings potential and cost-effectiveness. The indoor air quality upgrades proved to be the most expensive individual upgrades, and their benefits were difficult to quantify, as they are thought to improve respiratory health. It was also determined that labor contributed between

half and two-thirds of implementation cost. Future research which more thoroughly investigates the cost-benefit performance of a wider range of indoor air quality measures would be valuable to the field.

To formulate the most cost-effective greening program strategies, program planners are encouraged to 1) incorporate weatherization energy efficiency improvement measures, 2) source labor from workforce development programs, and 3) adopt greening measures like those in the alternative upgrade set in this study (see detailed product information and pricing in Appendix 2). In nearly all cases, low-cost green upgrade programs should include a full set of water saving devices, weatherstripping, clotheslines, and blown-in cellulose ceiling insulation. As budgets allow, additional energy saving measures from the alternative set such as digital thermostats, ceiling fans, and Energy Star rated refrigerators should be incorporated. As available, local weatherization methodology should be incorporated. Finally, when homes are located in areas with poor air quality, or if residents suffer from respiratory ailments, upgrade programs should include air quality measures, which can include measures such as removing carpeting and using only low VOC flooring, paints, and finishes.

Chapter 1.0 - Introduction

This professional project provides estimated upfront costs, future utility savings, and greenhouse gas emission reductions expected from upgrading an older, modest-sized home with green features. These findings are combined with case studies of previously greened or weatherized dwellings and professional literature and expertise to formulate a cost-effective approach to green retrofitting. The study concludes with policy recommendations for HUD on improving its greening guidance in future programs.

The following describes the cost-benefit methodology used. A home model was created based on available data for an established Bay Area neighborhood of single family homes built in the 1950s near Richmond, California, in Contra Costa County. The model represents the neighborhood's typical home dimensions and structural features. Upfront costs consisting of material and labor costs were estimated for two sets of green upgrades intended to improve water efficiency, energy efficiency, and indoor air quality. The first set of green upgrades analyzed is the original upgrades proposed in a 2009 HUD grant application from Contra Costa County. The second set of green upgrades analyzed, the alternative set, is a variation on the original set based on recommendations from professional, government, and academic sources. The alternative set also fulfills the 2009 HUD grant application criteria. In addition, a series of upgrades analogous to the original green upgrades set but conventional (i.e., not energy or water efficient) were cost estimated for comparison to determine the "green premium" (the cost difference between green and conventional upgrades). Online energy and water usage calculators from US government agencies were used to estimate utility usage under for the home under baseline conditions and configured with the two green upgrade sets. In turn, these utility usage figures were used to estimate projected annual savings on utility bills, payback periods for the green upgrades, and ten-year savings (corrected for net present value). Non-monetary benefits established by

previous research on the health benefits of improved indoor air quality and home warmth are also presented. The set of green upgrades that yields the highest estimated cost-benefit ratio is identified.

HUD NSP2 Program Description

In May of 2009 the US Department of Housing and Urban Development (HUD) released notification that it would fund local government efforts to purchase and rehabilitate (repair) foreclosed homes in low-income neighborhoods suffering under high concentrations of vacancy and foreclosure, associated with the recession (HUD, 2009a). The improved homes were then to be resold as affordable houses to qualified buyers (such as first-time homebuyers and low-income families). The program, called Neighborhood Stabilization Program 2 (NSP2), was the second version of a similar program, this time funded through ARRA (American Recovery and Reinvestment Act of 2009, a Congressional Act). The second version of NSP was a competitive grant program with a newly added dimension: a directive to “green” these existing buildings.

According to the EPA and academic literature, green buildings use resources efficiently, reduce waste, and protect occupant health, and are thus environmentally responsible (EPA, 2010a; Retzlaff, 2009). Buildings account for 68% of electricity usage, 12% of water usage, and 38% of carbon dioxide emissions in the United States, thus improving their resource efficiency holds great promise for reducing environmental degradation (EPA, 2010a). The NSP2 HUD funding notice specifies energy efficiency, water efficiency, and improved indoor air quality as its greening objectives.

In its notification, HUD specifically encourages use of Energy Star labeled appliances (which perform better using less energy than comparable devices) and following the non-profit group Enterprise’s “Green Community” list, which is a touted as a series of moderately priced green modifications (Energy Star, n.d a; Enterprise, 2008; HUD, 2009a, p. 28-29). Other examples of modifications that would meet these criteria could include replacing

incandescent light bulbs with compact fluorescent light bulbs (CFLs), which use 75% less energy, replacing existing water fixtures with low-flow versions, and repainting surfaces with paint free of VOC (volatile organic compound) fumes which aggravate asthma (EPA, 2010b). Further discussion of the merits of particular green building modification measures is presented in later chapters.

The County¹ formulated its green upgrades approach for NSP2 under a tight deadline and without the advantage of a case study on low-cost greening of modest-sized single-family homes or even rough cost estimates. Guidance on affordable green upgrades for single-family homes was sought from the websites of two green building organizations—Enterprise Green Communities (which HUD recommended) and GreenPoint Ratings (cited in the County application). However, both suggested several major upgrades that were perceived as too expensive, and neither resource provided any pricing guidance (BuilditGreen, 2007; Enterprise, 2008). Thus in formulating the green upgrades of its commitment list for the greening element, the County chose upgrades from among those suggested from GreenPoint Rating, Enterprise Green Communities, and the HUD notification, using best personal judgment.

This study helps to fill the information gap with a cost-benefit analysis of the low cost green upgrades to which the County committed, from the perspective of the homeowner, the affordable housing organization, and the policy maker. Based on the literature search done for this professional project in late 2009, published peer reviewed academic literature on greening affordable housing was scarce. Professional resources on green affordable housing were also unhelpful, as they primarily addressed new construction, or greening

¹ The Contra Costa Consortium consists of the Cities of Antioch, Pittsburg, Richmond, Walnut Creek, as well as Contra Costa County “urban area” (urbanized areas within the County limits) (Contra Costa Consortium [CCC], 2009, p6). These entities jointly applied for NSP2 funds. For the sake of simplicity, and because Contra Costa County was the designated lead applicant, this study refers to Contra Costa County (“the County”) as the decision body and author of the 2009 NSP2 application.

apartment units, not existing modest-sized single-family homes. Few papers or articles addressed the informational needs of the Neighborhood Stabilization Program, as most of the work done through the program is likely to be greening modest-sized, existing single-family homes. This study will give affordable housing professionals a starting point from which to formulate a low cost yet effective greening program feasible when given a modest project budget. Finally, it will reflect on the policy decision to add a green element to this affordable housing program, and how the HUD Neighborhood Stabilization Program guidance and notification could have been improved.

Problem Definition

The NSP2 application required jurisdictions to make a commitment statement that specified how many units they would purchase, repair, upgrade with green features, and help finance; the County committed to 250 units. The County was also required to draft a budget allocating money to each program component which matched the total grant dollar amount requested; the County requested the maximum budget limit of \$50 million and committed itself to a budget of \$250,000 per home². The County allocated a budget of \$15,000 per home for green upgrades, based on the planners' experience of pricing green upgrades for their own residences. The County consulted the Enterprise Green Communities publication (referenced in the HUD funding notification) and BuilditGreen's GreenPoint Rating for what specific upgrades to perform, but neither of these guides provided price ranges for the upgrades they recommend, thus their help in building the greening budget was negligible (HUD, 2009a, p. 29; Enterprise, 2008). The County chose to commit to the following green upgrades, selected from a sample list in the funding notification (HUD, 2009, p. 14; CCC, 2009, p. 34): renewable flooring, low VOC paint, windows, weatherstripping, WaterSense fixtures, and Energy Star rated light fixtures and other appliances. Competition for federal dollars to improve foreclosed homes was very

² One budget assumption was that homes repaired and sold earlier through the program would fund homes entering the program later.

strong in 2009, and Contra Costa County was not selected as a federal grant recipient, despite the considerable number of foreclosed homes in the area.

In ideal circumstances, jurisdictions participating in NSP2 would have had research-backed guidance as to which upgrades are the most affordable and cost-effective, so that project dollars would be spent efficiently and used to the greatest public benefit possible. Further, a greening budget would have ideally been based on local material and labor cost estimates specific to the homes in the nominated Census Tracts, using typical home dimensions and construction type.

Project Objectives

This study will help fill the information gap of the cost-effectiveness of greening existing modest single-family homes on a small budget by providing a hypothetical case study. Estimated material and labor costs and expected future utility bill savings will be generated for two sets of green upgrades applied to a home model representative of a nominated neighborhood. These two sets are 1) the original green upgrades from the Contra Costa County NSP2 grant proposal, and 2) an alternative set of green upgrades based on recommendations from Professor Di Santo, professional literature and academic literature. A set of conventional (non-green) upgrades is used for material and labor cost comparisons as well. This study will be of particular interest to Contra Costa County, but other groups looking for estimated costs for green upgrades to small homes will benefit as well. The project will provide the following information:

1. An estimated cost for materials and labor for the original green upgrades to which the County committed, and an alternative set of green upgrades (per upgraded unit).
2. A cost comparison between the original green upgrades proposed and their conventional counterparts.
3. A projection of long-term operation cost savings for the original and alternative green upgrades (per unit), with additional estimates for savings in kilowatts, BTUs, gallons of water, and greenhouse gases emissions prevented (as applicable).
4. A description of health and environmental benefits associated with green housing.

Chapter 2.0 – Community Profile

Figure 3.1 : Location Map. Indicates Contra Costa County's location in the state, and Montalvin's location in the County. Incorporated cities shaded. Source: Contra Costa County, 2009.

Contra Costa County

Contra Costa County is located in Northern California, and is one of the nine counties that make up the San Francisco Bay Area (see Figure 3.1). The County covers 733 square miles and in 2009 had an estimated population of 1,041,274 (US Census, 2010). Contra Costa County's land uses are diverse; the far western and northern portions host heavy industry (such as oil refineries), its far eastern areas are still primarily rural/agricultural, while its center is dominated by suburban/residential neighborhoods and commercial with pockets of light industry (CCC, 2009). Areas under jurisdiction of County planning include not only the unincorporated rural areas mostly in the east (white areas in Figure 3.1), but also unincorporated "urbanized areas"—suburban or industrial areas that lie directly across the

borders of incorporated cities (gray areas in Figure 3.1). Examples of these urbanized unincorporated communities are Bayview-Montalvin Manor (indicated in red in Figure 3.1, located next to San Pablo), Bay Point (next to Pittsburg), North Richmond (next to Richmond), and Rodeo (next to Pinole).

Figure 3.2 : Foreclosures in 2008 in Contra Costa County. (Incorporated cities are outlined).
Source: Contra Costa County, 2009.

Figure 3.2 depicts county borders, marks the city limits of incorporated cities within its boundaries, and displays where foreclosures occurred (one red dot indicates one foreclosure). The concentration of red indicates high foreclosure concentrations occurred in the north and the west. These areas include the unincorporated communities of Bayview-Montalvin Manor, Bay Point, North Richmond, and Rodeo. Predatory lending was widespread in these communities, and nearly one out of every ten homes was hit by the foreclosure crisis that began in 2007 (CCC, 2009). A significant number of the homes in these communities are over thirty years old and are in need of serious repairs, further contributing to the poor physical condition of the neighborhoods.

Figure 3.3 : Aerial map of Bayview-Montalvin Manor neighborhood in unincorporated Contra Costa County. Source: Google, 2010.

Montalvin Manor Background

The Bayview-Montalvin Manor neighborhood (hereon “Montalvin”) is an unincorporated suburban Contra Costa County community on San Pablo Bay. Figures 3.1 and 3.2 indicate the community’s location and proximity to other cities in western Contra Costa County. Montalvin is located approximately four miles north of the city of Richmond, one mile north of Interstate 80, and is sited immediately north of San Pablo Avenue, a main thoroughfare that connects to Oakland. Montalvin is a part of a Census Designated Place, identified by Census Tract number 3640.01 (Douglas, K., personal communication, June 16 2010). According to the 2000 Census 5,144 people lived in the Census track that includes Montalvin, with an average household size of 3.42 people

(4.82 for Hispanic households), as shown in Table 3.1. Other Census findings relevant to this project are that the majority (89%) of households used natural gas for heating, and median home price asked in year 2000 was \$162,000 (US Census, n.d.).

Table 3.1. Census Tract 3640.01 population data for 2000

Population, Household Size (Overall Average and by Race)			
	Population	Percent	Avg. Household Size
Hispanic (white or other)	1,747	33.96	4.82
White, not Hispanic	1,754	34.10	2.79
Asian, not Hispanic	791	15.38	4.22
Black, not Hispanic	607	11.80	3.74
Other	245	4.76	1.53
TOTAL	5,144	100.00	3.42
			(1,504 households)

Source: Census Bureau, n.d.

A 2007 study undertaken by Gabriel Lemus and assistant Ryan Aguilar of Contra Costa County collected detailed information about the homes in the Montalvin neighborhood. The research found that the neighborhood consisted of 638 homes on 168 acres, most of which were built between 1952 and 1953. To find typical home size, homes were grouped into three categories by interior floor space size; plotting the home sizes produces the distribution show in Figure 3.4. Using the midpoints for the aggregated data, I estimated the average house size to be 1,113 square feet. Lemus and Aguilar also looked into the typical number of bedrooms. A distribution of the number of bedrooms (Figure3.5) shows that majority (61%) have three bedrooms, some which were converted garages.

Figure 3.4 House Size Distribution in Montalvin. Based on data from Lemus 2007.

Figure 3.5. Number of bedrooms per home, distribution in Montalvin. Based on data from Lemus 2007.

Lemus also confirmed the following were true of the typical Montalvin home

features/construction:

- Single story construction, limited variety of floor plans throughout neighborhood
- No ceiling or wall insulation
- One or two bathrooms (1.5 used to represent average)
- Dishwasher

Chapter 3.0 – Methods

This study estimates the costs and benefits of modifying an older, modest-sized home with two sets of green modifications: the original upgrades specified in Contra Costa County's NSP2 application, and an alternative set devised in the course of this project which also met the NSP2 program criteria. The method of evaluation consists of:

- 1) creating a home model representing the typical home in an eligible neighborhood
- 2) obtaining price quotes for labor and materials consistent with:
 - a) the original upgrades in the NSP2 proposal
 - b) the alternative set of green upgrades
 - c) the conventional equivalents of the original upgrades
- 3) estimating savings of water and energy, converted to net present value dollars, and
- 4) comparing initial cost to annual utility savings to estimate payback time.

The cost and benefit figures provide a hypothetical case study analyzing the cost-effectiveness of the two different upgrade approaches. Combined with findings in professional and academic literature, they provide the basis of a reflection on how the NSP2 program and Contra Costa County's proposal could have been improved, and the HUD decision to include a greening element in the second version of the NSP program.

Eligible Neighborhoods

The County nominated 25 unincorporated urban Census Tracts that qualified for the NSP2 funds (CCC, 2009, p. 38). These neighborhoods are located in the northern and western sides of the county, and include Bayview-Montalvin Manor, Bay Point, North Richmond, and Rodeo (adjacent to the better known cities of Antioch, Pittsburg, Pinole, and Richmond). The neighborhoods consist mostly of the modest-sized, older homes; on average 79% of the households in these Census Tracts are classified as low-income or moderate income (CCC, 2009, p. 38). To optimally estimate the costs and benefits of the

greening component of the Contra Costa County NSP2 proposal, one would need to collect detailed information of the dimensions and construction of homes across all 25 Census Tracts for the purpose of obtaining quotes for materials and labor, as well as to run utility savings calculators (in addition to supplemental data from US Census on household sizes and National Weather Service information on local climate). Detailed information on homes was not readily available for all nominated neighborhoods; it was not feasible to retrieve original building records for homes from these neighborhoods as the County did not regularly retain permits when homes were built in the 1950s and 1960s. Any records that did exist were not readily accessible within a timeframe appropriate for this project (Brockbank, D. personal communication, August 20, 2009). Thus, the optimal method of investigation based on information on the homes in all 25 Census Tracts was not possible.

Montalvin Data

Information on home dimensions and construction was readily available, however, for the unincorporated neighborhood of Bayview-Montalvin Manor (hereafter “Montalvin”) from a 2007 study by Gabriel Lemus, Senior Redevelopment Planner for the area, and assisted by Ryan Aguilar. Montalvin is located on the west side of the County near Richmond and San Pablo in Census Tract 3640.01. Montalvin was eligible and nominated for NSP2 funds. Lemus and Aguilar generously shared data, floor plans, and general knowledge of Montalvin, which included total square footage and number of bedrooms for every house in the neighborhood, as well as one set of highly detailed, computer-drawn floor plans. County planner Gabriel Lemus and building inspector Joe Hatfield were also able to answer questions on insulation, appliances, and foundation types, based on records and personal observations. In combination, the study data on home sizes, information from these two County personnel and the collection of floor plans lent themselves very well to estimating the costs and benefits of the NSP2 greening element for Montalvin.

Montalvin is made up of single-family homes built in the 1950s near San Pablo, California. According to Lemus, the homes had limited variety when originally built, with one floor plan per style (i.e., a one floor plan for three bedroom homes). As of 2009, the most common (61% of homes) style is a three-bedroom model, with a converted garage or carport serving as one bedroom (Lemus, 2007). One set of floor plans provided was detailed and computer illustrated, depicting a three bedroom, two full bath home, in which one bedroom was formerly the garage (see Figure 3.6) .

Figure 3.6 : Interior floor plan for Montalvin neighborhood home on Karen Road.
Credit: Norma Jean Munoz.

The floor plans depict a home located on Karen Road in Montalvin, 1,394 square feet in total size, making it larger than the estimated average size of 1,113 square feet. The Karen Road home also has a second full bath, compared to an estimated average of one and a half bathrooms across all Montalvin homes. However, if modified by scaling the dimensions to 87% of original size, and eliminating the shower/tub from the second bathroom, this

modified version of the Karen Road home has enough similarity to the average home in Montalvin to serve as a good representative for the typical home. According to architecture professor Tom Di Santo, scaling the rooms and windows in this manner is realistic and appropriate for this purpose (personal communication, April 8, 2010). The combination of the neighborhood's relative uniformity in floor plans, the availability of construction data from Lemus and Aguilar, and the detailed, readily scalable computer-drawn floor plan offered a suitable basis for creating a home model representing the average home in the Montalvin neighborhood. This home model could then be used to price the amount/sizes of green materials, and to solicit contractor labor quotes for installation. Thus, a hypothetical case study of the cost-effectiveness of the green component of Contra Costa County's NSP2 proposal could be built from a representative Montalvin home model.

Home Model

A model was created based on the Montalvin neighborhood's average home dimensions, a scaled version of the detailed floor plan for the home on Karen Road, and from conversations with the Lemus fire fighters reports, and professor of architecture Di Santo (Lemus, 2007; CFBT-US, n.d.; Di Santo, D., personal communication, April 9, 2010). This home represents the average house in the neighborhood. The model was used to calculate the amounts and sizes of materials or products needed, and respectively the labor needed to green the home. The home model dimensions and characteristics as follows:

- 1,113 square feet total
- Windows and rooms scaled to 87% of Karen Road home dimensions
- Single story
- Flat roof of tar and gravel
- 8 foot tall ceilings
- 3 bedrooms (one is a converted garage)
- 1.5 bathrooms
- No insulation in the ceiling, no insulation in the walls
- Knob and tube electrical wiring
- Natural gas for water heater and for wall furnace
- Conventional appliances typical to modest homes (includes dishwasher)
- Carpet in bedrooms and living room, vinyl linoleum in bathroom and kitchen

Typical Household

Montalvin is in Census Tract 3406.01, and according to the 2000 Census, the median household size was 3.42 (Census, n.d.). Based on this fact, my representative household was three people.

Climate (Historical)

Climate is another factor important to estimating energy savings, as well as in selecting the appropriate upgrades. Temperature regime helps predict how much people will likely use heating and cooling systems, which make up a significant portion of annual household energy bills. The closest NOAA (National Oceanic & Atmospheric Administration) weather station is sited in Richmond, California, approximately 4 miles southwest of Montalvin (NOAA, 2004). NOAA provides a data set that reports temperature means and extremes for each of the twelve months, aggregated from the year 1971 to year 2000 (NOAA, 2004). Over the thirty-year period, the mean winter lows for the Richmond area was in the 40s (Fahrenheit) and summer highs was in the low 70s (see Figure 3.7 below). Extreme recorded events have pushed temperatures up to 107°F and down to 24°F. Overall, Richmond has historically had mild weather, and occupants may be most comfortable with a building that retains heat year round, with some features to quickly dissipate extreme heat on the few severe weather days (i.e., windows and ceiling fans).

Figure 3.7 Historic Richmond Annual Temperature Regime (in Fahrenheit). Based on NOAA, 2004.

Chapter 4.0 – Original Green Upgrades

Homes with green modifications perform better than unimproved homes, which contribute to their improved affordability and smaller environmental footprints. Greened homes also improve occupant health (Connelly 2006, USGBC 2007 as cited in Sparks, 2007). In the NSP2 affordable housing program, applicants were required to commit to greening homes. Specifically, HUD required jurisdictions to improve the water efficiency, energy efficiency, and indoor air quality of foreclosed homes they would purchase, repair, and offer as affordable housing (HUD, 2009a, p. 14, 82). In this section, the original green upgrades set (proposed in the County's NSP2 application) are listed then interpreted and applied to the home model. Cost estimates for labor and materials to execute the original set of green upgrades are presented, and to estimate a "green premium" (a higher initial cost for green products and associated installation), an additional set of upgrades comparable to the original upgrades but conventional (not water or energy efficient) were also cost estimated for materials and labor.

Original Green Upgrades

At the time the original green upgrades set was developed, no professional greening guides, upgrade checklists, or academic papers were identified to serve as a suitable stand-alone guide for the County the small budget and scope of the County. The Enterprise Green Communities guide (which HUD recommended), and the GreenPoint Ratings guide (which the County ultimately referenced), and HUD's funding notification itself were found insufficient. These guides recommended major upgrades that were perceived as inappropriate or too expensive (rightly or wrongly) such wall insulation, changing building orientation, green roofing, or solar panels (Enterprise, 2008; BuildItGreen, 2007; HUD, 2009a, p. 80). Further, none of these guides provided pricing guidance. Due to the short time timeframe in which the application was prepared (June

12, 2009 to July 15, 2009) and lack of robust guidance, County planners selected perceived low-cost upgrades from the three sources (Enterprise, BuilditGreen, and HUD) to formulate the original upgrades list, using best personal judgment and experience in estimating costs for similar upgrades to green their own residences. Without time for formal cost estimation, County planners used best personal judgment to allocate a budget of \$15,000 per house, intended to cover labor and materials to implement the green upgrades. Though the County identified the GreenPoint Existing Home Rating System as the rating system it would follow, the upgrade list the County committed itself to was mostly based on upgrades mentioned in the funding notification from HUD (CCC, 2009; p 4, HUD, 2009a, p14, 28-29, 80-83). The County committed to upgrading seven features of all units, which are reproduced here, verbatim from the application (Figure 4.1).

1. Replace conventional faucets, showerheads, and toilets with water-saving/low-flow components.
2. Paint surfaces with low volatile organic compound (low VOC) paints.
3. Install Energy Star rated appliances.
4. Install Energy Star qualified light fixtures with energy efficient light bulbs.
5. Replace standard windows with low-emissivity, double paned windows.
6. Install low-VOC carpet or renewable bamboo.
7. Properly seal openings to the outside with weather stripping and pest barriers.

Figure 4.1 Original green upgrades commitment from Contra Costa County NSP2 application. Source: CCC, 2009, p34.

As shown in Figure 4.1, the upgrades primarily consisted of replacing existing items with Energy Star or WaterSense labeled products. Energy Star is a joint program of the US Environmental Protection Agency (EPA) and US Department of Energy (DoE). The Energy Star label signifies an appliance is more energy efficient compared to

conventional versions (Energy Star, n.d.a). WaterSense is a program of the US EPA. WaterSense label ensures water efficiency and performance to EPA standards, verified by third-party certifiers (EPA, 2010c). Low VOC paints and low VOC carpet were intended to improve indoor air quality, while double paned windows and weatherstripped doors were intended to improve warmth retention in winter and coolness retention in summer.

Original Materials Selection Overview

Each broad upgrade commitment from the application (Figure 4.1) was converted into green and conventional versions, appropriately sized for the home model created for this study (see Chapter 3). Alongside this, the equivalent conventional version was selected and price for materials and labor. Appendix A1 presents the details of the green and conventional material items selected to implement the upgrades: the model, brand, amount or size, retailer item number, along with item-by-item material costs and labor cost quotes from a respected local contractor. (Note that details for labor cost procurement are at the end of the chapter, following the materials selection sections.) For each original upgrade measure, this chapter provides material selection rationale, general product descriptions, and a table with the combined material and labor costs for each measure, in both a green and conventional of each. Material selection rationale includes a description of how the measure relates improving air quality, or water and/or energy efficiency. Most material selection had two components: amount or size, and model and brand. Method of calculation for sizing or amount of products varied accordingly with the model home feature under study, as described in the appropriate section. Most materials were cost estimated at major home improvement retailer Home Depot through their website or during trips made in person. The exception is a cost quote for the green (zero VOC) paint from Kelly-Moore (sold only from their stores) that was obtained by phone. The brand and model selected for each upgrade in green and

conventional versions were “economy” models; that is, the cost and item number of the lowest-priced item available was recorded, unless it received a significant number of negative customer comments (more than a third of posted comments) on the website. In these instances, a slightly more expensive model was selected with fewer negative comments. Finally, the full price (not sales price) was recorded.

Two other considerations should be kept in mind related to material costs. First, Energy Star offers a bulk purchasing program which could potentially bring prices down further for certain items, but this avenue was not explored since bulk purchase was not mentioned by the planners or in the HUD funding notice, and this study was more interested in the cost difference between conventional and green equivalents, either of which could feasibly be purchased in bulk. Second, like many government-funded projects, NSP2 originally had a “Buy American” clause that strongly promotes purchase of American-made products in public structures. NSP2 homes would be subject to the clause, as they are considered “a residential structure owned by a governmental entity” (HUD, 2009b). However, HUD issued a waiver in October 2009 that excluded property with less than eight units, and this seems to have included single-family homes repaired through NSP2 (HUD, 2009b). The only item in this study that was known to be made in America was the Kelly-Moore zero-VOC paint.

Appliances

Table 4.1 Costs for green and conventional models of household appliances.

Appliance - Clothes Washer	Conv.	Economy model, over 3 cubic feet	\$559.00
	Green	EnergyStar rated economy model, over 3 cubic feet	\$848.00
Appliance - Dishwasher	Conv.	Economy model	\$669.00
	Green	EnergyStar rated economy, water efficient model	\$849.00
Appliance - Refrigerator	Conv.	Economy model, over 25 cubic sq. feet	\$959.00
	Green	EnergyStar rated, over 25 cubic sq. feet, economy model	\$859.00

Appliances account for two-thirds of the electricity used in American homes (DoE 1999 as cited in Sparks, 2007). Replacement of conventional appliances with Energy Star rated appliances was specifically mentioned in the HUD funding notice as a measure that satisfies the green component of the NSP2 proposal (HUD, 2009a, p.14). According to the categorization of products on the Energy Star website, the category “appliances” specifically includes clothes washers, dishwashers, refrigerator/freezers, dehumidifier/air purifiers, and water coolers. The last two items seemed to be non-essential household appliances, and were thus omitted. Cost estimates were made for the three household appliances in both a conventional economy model and an Energy Star rated economy model. The capacity or power of the item was appropriate to the model home dimensions or household size, per government or retailer guides for size selection. Specifically, the refrigerator’s size was based on recommendations from Home Depot, dishwasher size was identical to the original appliance in the Karen Road home kitchen (see page 16), and the clothes washer was “full size” (appropriate for a family) with at least 3.1 cubic feet capacity (Best Buy, 2007; Home Depot, 2010).

Flooring and Paint

Table 4.2 Costs for green and conventional models of flooring and paint.

Flooring	Conv.	\$3,375.12
	Green	\$5,672.24
Paint	Conv.	\$3,115.72
	Green	\$3,202.04

According to the United States Center for Disease Control, low-income people endure the highest rates of asthma, with many known and suspected triggers linked to conditions in the home (ECP 2007 as cited in Sparks, 2007). Using certain types of paint and flooring can reduce asthma triggers from poor indoor air quality. Carpet attracts allergens, but conventional laminate flooring is made of plastic (petroleum) and thus is unsustainable. A suitable replacement is bamboo (which is natural and renewable). Found in paint, volatile organic compounds (VOCs) are associated with asthma and the elderly, those with weak immune systems, and young children are most prone to the effects of VOCs (Global Green 2006, as cited in Sparks, 2007, p. 71). A green choice is zero or low-VOC paint. To determine the amount of paint and flooring needed, the surface area of the interior of the home model (see page 16) was calculated. Square footage was already estimated during the home model design phase. Ceiling height was assumed to be eight feet, based on ceiling height of another home in the neighborhood, and eight feet is also considered a height typical for modest homes (CBFT-US, n.d.; Di Santo, T. personal communication, April 7, 2010). Paint was calculated to be sufficient to cover all surfaces, including the ceilings and insides of closets; the assumption was made that one gallon covers 350 square feet of surface, a common rule of thumb (Kimbell, R., personal communication March 22, 2010). Flooring amount was calculated to be sufficient to cover all rooms, plus 10% extra to allow

for mistakes in cutting tiles for edges and corners, per industry recommendation (efloors.com, n.d.). Low and zero VOC paint (the “green version” of paint) was difficult to find at major retailers. Ultimately Kelly-Moore Green Coat, a zero VOC paint, was selected because it is a relatively inexpensive zero VOC paint and Kelly-Moore is a Bay Area-based company with a store located four miles from the project site, thus it seemed to be the most appropriate choice for the project. Additionally, speaking with the contractor who provides lead based paint safety services, a minimum of \$600 to test and certify that the home is lead free due to federal regulations effective April 2010 (Baxter, N. personal communication May 27, 2010). This cost was included in my calculations, as it would be incurred whether or not green or conventional paint were being used, and even if lead testing was negative. If lead test were positive, painting costs were quoted to increase from \$900-\$1,500 for removal before painting could be done. The green flooring selected was the economy model of bamboo, a quickly renewing wood alternative to hardwood flooring carried by Home Depot. The conventional version of paint was the cheapest on the Home Depot website, and the conventional flooring was the economy model laminate, as detailed in Appendix A1.

Lights and Bathroom Fan with Built in Light

Table 4.3 Costs for green and conventional models of lights and lights with fans.

Lights and Fan for Bathroom	Conv.	Economy model	\$821.00
	Green	EnergyStar rated economy model	\$1,244.00
Lighting for Other Rooms	Conv.	Economy single bulb fixtures and motion sensor lights	\$1,646.93
	Green	EnergyStar rated economy single bulb fixtures and motion sensor lights	\$2,244.35

Energy Star qualified lighting uses two-thirds less energy and lasts six to ten times longer than traditional lighting, resulting in reduced energy use, lower utility costs, and lower greenhouse gas emissions (ECP 2007, NAHB 2006 as cited in Sparks 2007). Compact fluorescent light bulbs (CFLs) use two-thirds less energy than a standard incandescent bulb and must meet additional operating and reliability guidelines (Doxley, 2006 as cited in Sparks, 2007). Cost estimates are provided for four types of light fixtures, in green and conventional version economy models. These are as follows. 1) Motion detectors. No Energy Star motion detector lights were found, so both green and conventional cost estimates used the same model motion detectors. Labor costs were procured for installation of 4 (instead of 5) motion detectors; to correct for this error, the installation cost was increased by 25%. 2) Bathroom bar-style fixtures. These are horizontal fixtures with multiple bulbs designed for bathrooms. Two were cost estimated, one for each of the two bathrooms. The conventional bar-style bath light did not include light bulbs, so appropriately sized standard economy bulbs were priced for the conventional model. 3) Bathroom overhead fans with built-in lights. The green version was selected by cross-referencing the qualified fixtures listed on the Energy Star website with low cost models available at major retailers. The conventional model was the

comparable, modestly priced model. Labor quotes were procured without inaccuracies.

4) Single-bulb fixtures. Floor plans for the Karen Road home indicate 10 existing standard single-bulb overhead light fixtures for the living spaces and laundry room. The laundry room light fixture was omitted from upgrades, as it was assumed this light is seldom used. The green single-bulb fixture selected was an economical Energy Star rated fixture that included bulbs, while the conventional version was similarly economical but required additional purchase of corresponding economy bulbs. In both green and conventional upgrade schemes, the converted garage bedroom was wired for an overhead single bulb. The labor quote for conventional upgrades to single-bulb fixtures was incorrectly procured—replacement of eight standard fixtures (instead of nine) was priced, which also included the costs for wiring one room. To conservatively correct for this error, one-eighth of the labor quote has been added in labor column for lighting upgrades in the summary sheet, Appendix A1. For details on the three lighting configurations cost estimated for this study, see Appendix B.

Water Fixtures

Table 4.4 Costs for green and conventional models of water fixtures.

Water Fixture - Bath Faucets	Conv.	Economy faucet model	\$196.00
	Green	WaterSense low-flow	\$516.00
Water Fixture - Kitchen Faucet	Conv.	Economy faucet model	\$150.00
	Green	Conventional economy model plus aerator	\$186.00
Water Fixture - Showerhead	Conv.	Standard	\$54.85
	Green	WaterSense low-flow	\$87.87
Water Fixture - Toilets	Conv.	Standard, Single flush	\$537.00
	Green	WaterSense, Dual flush	\$586.00

Sixty percent of urban water use is residential, and improving water efficiency means a greater number of households can be served with existing water supplies. In cases where surface water is used, such as in the Bay Area, increased water efficiency can also mean decelerated competition for water with wildlife. (While indoor water fixtures were addressed, outdoor water fixtures were omitted from the County upgrades as an upfront cost minimization strategy.) Showerheads and faucets account for approximately 25% of indoor water use, while toilets account for approximately 24% (Ogorzalek 2003, USGBC 2007 as cited in Sparks 2007). In their NSP2 proposal, the County committed to replacing existing indoor water fixtures with WaterSense labeled fixtures. WaterSense is a program of the US EPA that recognizes products that enhance water efficiency and perform well, surpassing maximum flow rate standards set by the federal government (EPA, 2010c). Table 4.5 compares federal maximum flow rate standards with the stricter WaterSense standards, as well as showing the flow rates possible with the free water fixture devices offered by EBMUD (East Bay Municipal Utility District), a Bay Area water supplier, which supplies the subject neighborhood. Most free modification devices would effectively reduce flow rate to meet federal standards, but the free toilet modification device would not have met federal standards.

Table 4.5 Comparison of water flow rates standards for devices, in gallons per minute.

FIXTURE	Federal Requirement	WaterSense Standard	EBMUD Free Device
Toilet	1.6	1.28	2.7
Bath Faucet	2.2	1.5	1.0
Kitchen Faucet	2.5	N/A	1.5
Showerhead	2.5	2.0	2.5

Sources: EPA 2008; EPA 2010c; EBMUD 2010.

To cost estimate the green version of upgrade products, the price and item number of the most economical WaterSense labeled fixtures found at Home Depot were recorded. For the conventional versions, the lowest cost economy fixtures not labeled with the WaterSense label were recorded (which by default met federal standards). However, since the EPA does not include kitchen faucets in the WaterSense program as of 2010, the best representation of the commitment to a new green kitchen faucet would be combining the new conventional economy model faucet with an aerator, as cost estimated in Table 4.4. Also, the green (low-flow) showerhead selected was not the least expensive green model, as the absolute least expensive WaterSense model appeared quite flimsy. A more robust item would more likely be selected by the County staff, as there was a small price increase for a seemingly more durable product.

It should be noted that the County could have met its water-saving goals, alternatively, by modifying existing fixtures with water saving devices. The third column of Table 4.5 shows the typical flow rates of existing fixtures when modified with water saving devices provided free as of 2010 by EBMUD, Montalvin's water supplier. While the County seemingly obligated itself to fixture replacement in its original proposal, homes in Montalvin and other areas serviced by utility provider EBMUD are eligible for free water saving devices (maximum two each), including toilet tank displacement bags, low-flow showerhead, and

kitchen and bath faucet aerators. The upfront material cost would have been significantly cheaper than paying for new fixtures. Although EBMUD typically only provides these items to customers able to present a utility bill, a senior customer service representative stated by email (EBMUD, personal communication, March 24, 2009) that a County employee bearing identification could pick up the devices if they provide documentation showing County's ownership of a home in EBMUD territory, and proof of rehabilitation (perhaps for instance, contractor estimates with the home address).

Weatherstripping

Table 4.6 Costs for Weatherstripping

Weatherstripping	Conv.	none (no equivalent)	\$0.00
	Green	Door sweeps and silicon tubing	\$110.72

Weatherstripping is the addition of flexible material to the edges of windows and doors to reduce drafts of air between the home and the outside but still allow for easy opening and closing. Typically, this consists of adhering rubber or foam strips to the threshold of the door or as a metal door sweep, or small gaps between the window and sill. Weatherstripping can “significantly” reduce heating and cooling costs, improve building durability, and create a healthier indoor environment, and pays for itself in one year (DoE 2001, DoE 2009a). The Karen Road home has two doors that open to outside and would be candidates for weatherstripping. The door sweeps and rubber material selected were economy models that appeared durable, and were ordered according to the 5-10% extra rule of thumb (DoE, 2001).

Windows

Table 4.7 Costs for green and conventional models of windows.

Windows	Conv.	Single paned vinyl frame	\$7,588.13
	Green	Dual paned, low emissivity	\$7,975.50

According to the Department of Energy, when single paned windows are replaced with Energy Star qualified windows, energy costs are estimated to fall by \$124 dollars a year (in 2009 dollars), or generally up to 15% (Energy Efficiency Partnership [EEP], 2010a). The Karen Road floor plans provided a list of window sizes. These were scaled down to 87% of original size for the home model, with the exception of three windows that had to be slightly larger than scale to be adequate for fire egress (Bray, S., personal communication, March 23, 2010). The dimensions were treated as the window openings for replacement windows. Per the recommendation of architecture Professor Di Santo, Milgard brand dual pane low emissivity windows were selected for the green version; the Style Line model was the most economical model that met these specifications and was accordingly used. The most economical conventional (single pane) replacement windows were from manufacturer Jeld-Wen, specifically the single paned 600 Series model. Specific model recommendations for both green and conventional windows were made by The Home Depot window specialist (Home Depot, personal communication, March 24, 2010).

An error was made in window size calculations. Window price quotes were made using a set of dimensions for windows that were not scaled precisely to 87%. The errors were mostly less than five inches on width or height, but two windows were short by 13 inches in height. The correct calculations are supplied in (Appendix B). Since both single and dual pane windows price quotes were made using the same dimensions, the assumption was made that the cost difference between the single and dual pane windows obtained with the incorrect dimensions also represents the price difference between correctly scaled single and dual pane windows.

Labor Quotes

Two contractors, which previously worked for the County on home repair or rehabilitation projects, were asked to submit labor quotes. Though both Contractors responded to phone calls and indicated willingness to participate, only one actually followed through and returned a full estimate, and even provided a breakdown of anticipated hours of labor in addition to line-by-line cost estimates. This was Hodges Construction, which is based in Concord, CA. Since the labor estimates were not statistically sampled, they are intended serve two purposes: 1) to provide a rough “ballpark” estimate of what the labor for upgrades cost, 2) to provide an estimate of the cost difference between the green and conventional upgrades. The request for estimates packet included a cover letter openly stating that the estimates were for my master’s project, provided a description of the model home, and two spreadsheets for the conventional and green upgrades, named “Estimate 1” and “Estimate 2,” respectively (see Appendix C1 and C2 for these materials). The spreadsheets distinctly categorized the upgrade types (water fixtures, lighting, appliance replacements, etc.) and provided the Home Depot item numbers for easy reference. The reader will see that the quotes included work beyond the scope of Contra Costa County’s NSP2 application, to assist with a later part of this analysis. Any errors in the quote procurement spreadsheet and measures to compensate or correct are described in the appropriate material description sections.

Chapter 5.0 – Findings for Original Green Upgrades

Cost

Table 5.1. Summary of Original Green Upgrade Costs, with Conventional Equivalents

ITEMS	Version	Cost L + M	Cost - Material	Cost - Labor	Green - Conv. Difference
Appliance - Clothes Washer	Conv.	\$559.00	\$359.00	\$200.00	\$289.00
	Green	\$848.00	\$448.00	\$400.00	
Appliance - Dishwasher	Conv.	\$669.00	\$219.00	\$450.00	\$180.00
	Green	\$849.00	\$399.00	\$450.00	
Appliance - Refrigerator	Conv.	\$959.00	\$899.00	\$60.00	-\$100.00
	Green	\$859.00	\$799.00	\$60.00	
Flooring	Conv.	\$3,375.12	\$1,225.12	\$2,150.00	\$2,297.12
	Green	\$5,672.24	\$3,672.24	\$2,000.00	
Lights and Fan for Bathroom	Conv.	\$821.00	\$176.00	\$645.00	\$423.00
	Green	\$1,244.00	\$344.00	\$900.00	
Lighting for Other Rooms and Outdoors	Conv.	\$1,646.93	\$194.43	\$1,452.50	\$717.42
	Green	\$2,364.35	\$251.85	\$2,112.50	
Paint	Conv.	\$3,115.72	\$265.72	\$2,850.00	\$86.32
	Green	\$3,202.04	\$352.04	\$2,850.00	
Water Fixture - Bath Faucets	Conv.	\$196.00	\$46.00	\$150.00	\$320.00
	Green	\$516.00	\$116.00	\$400.00	
Water Fixture - Kitchen Faucet	Conv.	\$150.00	\$30.00	\$120.00	\$36.00
	Green	\$186.00	\$36.00	\$150.00	
Water Fixture - Showerhead	Conv.	\$54.85	\$4.85	\$50.00	\$33.02
	Green	\$87.87	\$12.87	\$75.00	
Water Fixture - Toilets	Conv.	\$537.00	\$187.00	\$350.00	\$49.00
	Green	\$586.00	\$236.00	\$350.00	
Weatherstripping	Conv.	\$0.00			0
	Green	\$110.72	\$35.72	\$75.00	
Windows	Conv.	\$7,588.13	\$2,188.13	\$5,400.00	\$387.37
	Green	\$7,975.50	\$2,775.50	\$5,200.00	
TOTAL	Conv.	\$19,671.75	\$5,794.25	\$13,877.50	\$4,718.25
TOTAL	Green	\$24,500.72	\$9,478.22	\$15,022.50	
GREEN Labor + Materials Costs: \$24,501					L + M
CONVENTIONAL Labor + Material Costs: \$19,671					L + M

Table 5.1 summarizes the costs of the original green upgrades as compared to the conventional equivalents. Overall, the cost of labor and material needed to implement the original green upgrades in the County's NSP2 application combined came to \$24,501, compared to \$19,671 for the conventional equivalents. (As a reminder, the County had budgeted \$15,000 for its green upgrades commitment.) The total cost of the green upgrades exceeded the conventional equivalents by \$4,718, most of which was contributed by an additional in materials costs at \$3,684, though additional labor costs \$1,144 also contributed, as found by subtracting the difference in total green and conventional material and labor costs, in Table 5.1. The green premium, the average price difference between individual green and conventional upgrades, is \$363. One of the upgrades was actually less expensive in the green version than conventional version; this was the green refrigerator, as Home Depot did not carry any conventional refrigerators below the regular price of its green models. The greatest price difference for a single upgrade between the green and conventional version was the flooring—the price difference between the bamboo and conventional laminate was \$2,297. This raises the question if another zero-VOC flooring could have been less expensive and still improved indoor air quality, although bamboo is a renewable natural resource and its production may potentially have less environmental impact than synthetic materials. Overall the most expensive original green upgrade was the dual-paned windows at \$7,975. (This high cost coupled with information that ceiling insulation typically yields a much greater benefit than dual pane windows prompted window upgrades to be eliminated from the alternative upgrade set.) The three least expensive green upgrades at \$87, \$110, and \$186 (for materials plus labor) were the low-flow showerhead, weatherstripping, and new kitchen sink faucet with aerator, respectively. These three affordable upgrades seemed a good fit for the County's tight budget, and were retained in the alternative upgrade strategy.

Benefits - Energy Savings

Estimates for the dollar value and amount of the energy that would be saved by implementing the original green upgrades per the NSP2 application were projected with an online calculator from the Lawrence Berkeley National Laboratory (LBNL) (LBNL, 2010). The LBNL calculator was also used to estimate the reduction in greenhouse gas emissions from implementing the upgrades. This calculator, called Home Energy Saver™, was used to generate the figures for the existing house configuration (“baseline”) and for the home under the original upgrades configuration (Appendix D1 and D2, respectively). For each configuration of the home model, the calculator was loaded with information on all energy draws (i.e., appliances) including age, efficiency, and hours of use. Specifically, the following information on appliances, construction features, and climate were loaded into the LBNL calculator:

- room sizes and overall house size
- foundation type
- window placement, type, and size
- ceiling and wall insulation type and amount
- ventilation, heating, and cooling system type
- types and ages appliances
- number of occupants
- climate, comparable with nearest large US city

The LBNL calculator then factors in construction features of the house model that reduce energy needs (such as insulation and building orientation), as well as local climate, another important aspect of home energy usage. The LBNL calculator used climate and energy usage data for Oakland, California (the nearest large US city with a comparable climate) that was collected in studies in 1992 and 1997. Finally, to estimate energy costs, the LBNL

calculator used state energy rates for electricity and natural gas to generate expected costs. Specifically, the rates used were the California state average prices for electricity and natural gas in year 2009, as reported by the Energy Information Administration (LBNL, 2010). Estimates for both the existing home (“baseline”) and the upgraded home configuration are shown in Table 5.2. The energy and dollar savings figures reported are the difference between the baseline and original upgrades. (Appendix D1 and D2 are the LBNL reports which includes details of input for each configuration.)

Benefits – Water Savings

Water usage and projected water use reductions attributed to implementation of the original green upgrades per the NSP2 application were estimated with an online calculator from the City of Tampa, Florida (City of Tampa, 2010). (The outdoor water usage portion of the calculator was omitted, as no upgrades addressed outdoor water usage.) The Tampa water calculator takes into account the following parameters:

- household size
- fixture flow rate (toilets, faucets, and showerhead)
- volume used by water-using devices (dishwasher and clothes washer)
- duration or frequency of fixture or appliance usage

Each of these parameters can be customized, or set on the defaults. To analyze water usage for the existing home model, the default settings for water fixtures and water-using appliances were used, as this information was unknown. For the analysis of the original green upgrades, the flow rates of the particular water fixtures and usage rate of the appliances reported by the manufacturer (as relayed on the retailer's website) were loaded into the calculator. For duration and frequency of usage, I assumed:

- 1 shower (0 baths) per person daily (20 minutes long)
- 5 total hand washing, shaving, or tooth brushing sessions per person daily (4 minutes long)
- 1 laundry load person per week, plus 1 shared load for all members
- dishwasher used 2 times a week, dishes hand washed 4 times daily (8 minutes long)

Water usage was then converted into estimated costs by using the local water provider EBMUD's rates (EBMUD, 2010). EBMUD single-family homes using less than the threshold limits are charged flat rates; households exceeding the second threshold are charged per every additional 100 cubic feet of water over the threshold. The energy and dollar savings figures reported are the difference between the baseline and original upgrades.

Summary of Benefits from Original Upgrades

Table 5.2. Estimated utility usage and GHG emissions of baseline home and original green upgrades. Annual savings, 10 year savings, and payback period for upgrades also shown.

ENERGY	Annual KwH Used	Annual Therms Used	Annual Energy Cost	CO ₂ lbs Emitted
Baseline	5,837	495	\$1,470	8,695
Original Upgrades	5,111	409	\$1,255	7,328

WATER	Daily Per Capita	Annual Gallons Used	Annual Water Cost
Baseline	199	217,905	\$1,207
Original Upgrades	105	114,975	\$905

Payback and Cost-Benefit	Annual Savings	Cost to Upgrade	Payback Period in Years	10 Year Savings	CO ₂ lbs Saved Annually
Original Upgrades	\$517	\$24,179.72	46.77	\$5,170	1,367

Table 5.3 Estimated payback periods for original upgrades, by sector.

Original Upgrades Savings & Paybacks By Sector			
Upgrade	Cost (L+M)	Annual Savings	Payback (in Years)
WATER	\$2,653.87	\$302	8.8
ENERGY	\$12,972.57	\$215	60.3
AIR QUALITY	\$8,874.28	unknown	unknown
All Upgrades	\$24,500.72	\$517	

Monetary benefits of the green upgrades would result from reduced use of natural gas, electricity, and water, which would subsequently lower residents' utility bills. The utility savings estimates in this analysis should be considered conservative estimates, as they do not account for future energy and water cost increases. With this factor in mind, the original Contra Costa County's original green upgrades per the NSP2 application would be expected to save \$517 dollars a year in water and energy bills (see Table 5.2). These savings, across ten years, would amount to \$5,170. When corrected for net present value (using a discount

rate of 5%, as in Bradshaw's similar cost-benefit analysis), the cash flow amount reduces to \$3,992 (Bradshaw et al., 2005; Investopedia, 2010). The LBNL calculator also projected that the energy efficiency upgrades would reduce greenhouse gas emission by 1,367 pounds of carbon dioxide annually. (Non-monetary and indirect benefits will be discussed in the Chapter 9.) The payback period needed to recover the initial costs of all original upgrades was estimated at over 47 years, as in Table 5.2.

In Table 5.3, payback periods were analyzed by sector by allocating upgrade costs and utility savings to the water, air quality, or energy sector, as appropriate. In the instance of upgrades that improved both energy and water efficiency (such as the dishwasher), half the cost was allocated to each sector. Broken down by sector, the payback period of the original water efficiency upgrades was dramatically shorter, at 8.8 years, compared to the original energy efficiency upgrades, at over 60 years. In addition to the lower initial cost, the water upgrades have higher annual savings than the energy upgrades. This suggests that original water efficiency upgrades proposed are significantly more cost-effective than the original energy upgrades. Due to the imprecision of monetizing the air quality benefits (which directly benefit health), benefits from air quality were considered unknown.

Chapter 6.0 – Alternative Green Upgrades

In this section, the alternative upgrades are listed then interpreted, applied, and cost estimated for the home model. The alternative upgrades set was formulated subsequent to review of a variety of energy and water efficiency strategies. Sources included government websites, professional and academic literature, recommendations of architecture Professor Di Santo, and the results of the utility calculators. (See the following material selection sections for specifics.) The research suggested that the cost-benefit performance of the County's original green upgrades could be improved upon; that is, a different set of upgrades could be less expensive and could save even more water and energy, reducing bills even further than the original upgrades.

Table 6.1. Alternative green upgrades, as compared to original green upgrades.

ORIGINAL UPGRADES	ALTERNATIVE UPGRADES
Appliance - Clotheswasher	Appliance - Clotheswasher
Appliance - Dishwasher	Appliance - Dishwasher
Appliance - Refrigerator	Appliance - Refrigerator
Bathroom Fan	Bathroom Fan
Flooring	Ceiling Fans - NEW
Lights - Bathroom	Clothesline - NEW
Lights - Room & Outside	Flooring
Painting	Insulation - NEW
Water Fixture - Bath Sink Faucets	Lights - Bathroom
Water Fixture - Kitchen Faucet	Lights - Room & Outside
Water Fixture - Showerhead	Painting
Water Fixture - Toilets	Thermostat - NEW
Weatherstripping (outside door)	Water Fixture - Bath Sink Faucets
Windows	Water Fixture - Kitchen Faucet Aerator - New
	Water Fixture - Showerhead
	Water Fixture - Toilet Tank Bags - NEW
	Waterheater - NEW
	Weatherstripping (outside door)

The alternative set was formulated by maintaining the NSP2 program goals of improved water efficiency, energy efficiency, and improved indoor air quality, as well as using the original upgrades as the starting point from which the alternative set would be formulated. The formulation strategy was to 1) eliminate or replace expensive upgrades with low-cost alternatives that could achieve similar or better performance, and 2) add low-cost upgrades research suggested could significantly improve water or energy savings. As shown in Table 6.1, the original upgrades proposed in the County NSP2 application were adjusted with following eight amendments:

Addition of:

- ceiling fans
- ceiling insulation
- clotheslines
- energy star water heater
- programmable thermostat

Exchange of:

- toilet tank displacement bags (instead of new dual flush toilets)
- kitchen faucet aerator (instead of new kitchen faucet plus aerator)

Elimination of:

- dual pane windows

Material Selection and Labor Cost Estimation

Material cost estimates and labor cost estimates for the alternative upgrades were collected simultaneously with the original upgrades using the same methods that generated the original upgrade cost estimates. Because the majority of the upgrades in the alternative set are identical to the original upgrades, this section only details the selection and cost estimation for the amendments (additions, substitutes, and eliminations). Since all cost

estimates for materials and labor were collected item-by-item, this allowed for the contents of the two green upgrade sets to be tailored at a later date, while maintaining consistency and comparableness across sets.

For brevity, this chapter presents upgrade summaries with a general description of the product, with the price of material and labor combined. The general principle behind the upgrade (improving air quality, or water and/or energy efficiency) is also discussed in the pertinent sections. As with the original upgrades, each additional or substitute upgrade was converted into specifics, appropriately sized for the home model created for this study (see Chapter 3). Material selection had two components: amount or size, and model and brand. Method of calculation for sizing or amount of products varied accordingly with the model home feature under study, as described in the appropriate section. For full details, see Appendix A2 which details the specifics of the products selected to implement the alternative upgrades: the model, brand, amount or size, retailer item number, along with item-by-item material costs and labor cost quotes from a respected local contractor. Most materials were estimated at major home improvement retailer Home Depot through their website or during trips made in person. The two exceptions are the toilet tank displacement bag, which could only be found online at Amazon.com, and the ceiling insulation that was cost estimated through Bay Valley Insulation, Inc., a local roofing specialist (Roth, G., personal communication, May 12, 2010). The brand and model selected for each upgrade were “economy” versions; that is, the cost and item number of the lowest-priced item available was recorded, unless it received a significant number of negative customer comments (more than a third of posted comments) on the website. In these instances, a slightly more expensive model was selected with fewer negative comments. Finally, the full price (not sales price) was recorded.

Ceiling Fans

Table 6.2 Ceiling Fan Materials And Installation Cost

Ceiling Fans	Economy models, (4 large, 1 small)	\$1,222.85
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Home cooling needs were addressed with ceiling fans. Two-thirds of homes in the US have air conditioning units, and on average each use enough electricity to emit two tons of carbon into the atmosphere annually (DoE, 2009b). In temperate climates, or during moderately hot weather, ceiling fans may allow residents may to avoid air conditioners altogether. Ceiling fans are considered the most effective circulating fans, creating a draft that results in a wind chill effect on the skin (DoE, 2010a). The energy and carbon savings from this alternative upgrade expected to be appreciable in the benefits analysis.

Although Energy Star rates ceiling fans, no online retailer searched carried these models. Hence, the lowest cost models of appropriately sized fans were selected. A total of 5 ceiling fans were sized and cost estimated for each of the three bedrooms, the living room, and kitchen (Energy Star, n.d.b). These ceiling fans would be installed in place of five existing single bulb fixtures, each fan having a built-in light to maintain ceiling light function. The exception was in the converted garage bedroom, where no light fixture previously existed. The labor contractor was asked for the cost to wire the converted garage bedroom for the ceiling fan in a line-by-line green upgrade labor estimate quote. A corollary of installing five ceiling fans into overhead single bulb fixtures space is that five fewer Energy Star single bulb fixtures are needed compared to the original green upgrades configuration. Table 6.3 illustrates the configuration schemes, further detailed in Appendix B. (Note that the laundry room light was consistently omitted from both original and alternative upgrades.)

Table 6.3. Bulb replacement scheme for ceiling fans and Energy Star fixtures. Baseline, original upgrades, and alternative green upgrade configurations shown. See Appendix B for details.

BASELINE	ORIGINAL UPGRADES	ALTERNATIVE UPGRADES
0 ceiling fans	0 ceiling fans	5 ceiling fans
9 single bulbs*	9 Energy Star fixtures + bulbs	4 Energy Star fixtures + bulbs
*laundry room light omitted	(1 newly wired single bulb fixture)	(1 newly wired ceiling fan)

Ceiling Insulation

Table 6.4 Ceiling insulation materials and labor cost.

Ceiling Insulation	Flat ceiling, labor and materials.	\$2,782.50
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HUD considers insulation a moderate-cost home rehabilitation item, and an effective way to address one of the primary sources of energy loss. Also according to a 2008 manual from HUD, adding ceiling insulation has a short payback period, making it cost-effective and appropriate for affordable housing (HUD, 2008 p. 58, 62). Because the home model was built prior to newer building codes, knob-and-tube wiring is assumed, which is not compatible with wall insulation. If insulation were to be added to the walls, an electrician would need to modify the knob-and-tube wiring in the walls. Further, in terms of effectiveness, ceiling insulation is far superior to wall insulation (Di Santo, T., personal communication, April 7, 2010). Thus, to reduce costs, only ceiling insulation was upgraded. Insulation is given an R-value, and the extent to which the insulation resists heat flow, limiting heat transfer. R-38 is recommended for ceilings, and is relatively easy to achieve in homes with pitched roofs and attics (HUD, 2008, p. 62). However, the home model has no

attic; it has a flat roof (also known as a composite roof). According to Di Santo and the contractor, the home model (based on the Karen Road home, see Chapter 3) is likely to be an 8 to 9 inch gap between the ceiling and roof , which could accommodate insulation that would be rated as R-21. Since Hodge Construction (the labor contractor used for all other work) did not have expertise in insulation, a local contractor specializing in insulation was given the home model specifics and asked for a quote for the blown-in insulation. This insulation product is formaldehyde-free cellulose, made from materials such as recycled newspapers. The quote in Table 6.4 from Bay Valley, Inc. manager Guy Roth includes costs for labor and blown-in cellulose insulation materials (Roth, G. personal communication, April 5, 2010).

Clotheslines

Table 6.5 Clothesline materials and installation cost.

Clothesline	Retractable clotheslines	\$143.88
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According to the California Energy Commission (CEC), clothes dryers are usually the second-highest energy drawing home appliance, after refrigerators (CEC, 2010a). Energy Star does not rate clothes dryers, stating that research has shown no appreciable difference in energy efficiency between models (Energy Star, n.d.c). As Energy Star does not label clothes dryers, they did not fall under the original upgrades commitment to replace existing appliances with Energy Star rated appliances. However, clotheslines would have met the energy efficiency and cost saving goal, as clotheslines use the power of the sun and wind, providing a (nearly) free service and also preventing greenhouse gas emissions. Since Richmond historical weather data reports station reports average temperatures above 70°F for six months of the year, it was assumed that clotheslines could be used to dry all laundry

for half the year, thereby reducing annual dry usage by half (see Figure 3.7). Cost estimates for three retractable clotheslines installed in the backyard are listed in Table 6.5.

Programmable Thermostat

Table 6.6 Programmable digital thermostat materials and installation cost.

Digital Thermostat	Economy model programmable thermostat	\$109.00
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Programmable thermostats (typically digital) turn off the heating or air conditioning when the air achieves pre-set temperatures designation, maintaining a home at comfortable temperatures while occupied by but allowing the home to swing outside comfortable temperatures while the residents are away or sleeping. Programmable thermostats are considered a “key component” of energy efficiency, and are more convenient and accurate than manual thermostats. According to DoE and HUD, when used properly, households can save \$150 to \$180 a year, or at least 15%, on energy bills (HUD, 2008, p62; DoE, 2010b; CEC, 2006). The home model did not specify the location of the existing thermostat, but it was assumed that the existing thermostat was properly located (away from direct light or windows), and therefore would not need additional labor to be repositioned (DoE, 2010b). The digital thermostat selected was the lowest priced programmable model available at the retailer.

Kitchen Faucet Aerator

Table 6.7 Kitchen faucet aerator materials and installation cost.

Water Fixture - Kitchen Faucet Aerator	Alternative	\$36.00
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Bath and kitchen faucets account for more than 15% of indoor household water use. Older kitchen faucets can use as much as 4 to 7 gallons per minute (EEP, 2010a). One way

to reduce water usage is to reduce flow rate of the fixture. Kitchen faucet aerators can reduce flow by 30% to as little as 2.2 gallons per minute. Aerators add air to the water stream with a sieve-like action, actually increasing the area of coverage and not sacrificing performance, yet conserving water (EEP, 2010b).

The original upgrade committed the County to *replacing* the fixtures with WaterSense labeled fixtures, necessitating the additional cost of a new kitchen faucet. Under the alternative upgrade approach, the kitchen faucet upgrade would be more aptly described as *modification* of the existing kitchen fixture to reduce flow rate. Since the original upgrade cost estimate was identical but included the new faucet, therefore the cost estimate for the alternative was simply the same, but subtracting the new faucet cost, thus it just covered the aerator and labor. This estimate is shown in Table 6.7.

Toilet Displacement Bags

Table 6.8 Toilet tank displacement materials and installation cost.

Water Fixture - Toilets Tank Bag	Toilet tank displacement bags	\$67.98
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Toilets prior to the 1970s used as much as 7 gallons per flush, while those built in the 1980s used 5.5 to 3.5 gallons per flush (EPA, 2008a; City of Roseville, n.d.). New toilets today use 1.6 gallons per flush, or even as little as 1.28 gallons per flush. The difference in water usage is substantial, and when multiplied across multiple users flushing several times a day for 365 days a year, the difference of thousands of gallons make toilets an serious target for water conservation. While toilet replacement would save much more water, using a displacement bag (which takes up space in the toilet tank, thereby reducing flushing volume) is less expensive in terms of material and labor. In addition, use of toilet displacement bags instead of replacing a toilet prevents a disposed toilet from taking up landfill space, and does not necessitate a new toilet being manufactured, which saves

material and energy (Alliance For Water Efficiency, 2010). It should also be noted that materials costs could be zero: free devices are offered from the local water provider, EBMUD, and would be available to any County employee bearing an employee ID card and evidence that the home they were gathering devices for was owned by the County (for instance, the title report). The toilet tank bag, the only model found, was cost estimated at Amazon.com (the only retailer found to carry the item). Labor, which consists of filling the bag with water and placing it in the toilet tank, was not quoted from the contractor, but was conservatively estimated based on showerhead replacement cost. Finally, displacement bags are not appropriate for toilets that use less than 3.5 gallons per flush, and have been described as a temporary solution, as they have a fixed lifetime (Alliance for Water Efficiency, 2010). However, the bags can be replaced in the future.

Water Heater

Table 6.9 Water heater materials and installation cost.

Waterheater	EnergyStar rated economy water heater	\$1,403.04
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Water heaters consume between 14% and 25% of household energy (DoE, 2009c). One strategy to reduce energy usage and energy bills is to replace older water heaters with a newer model, since modern models are much more energy efficient than models made in decades past (CEC, 2010b). An Energy Star qualified gas storage water heater is expected to save \$30 a year over a standard water heater (Energy Star, n.d.d). In California natural gas to heat water as it is less expensive than electricity, and according to the 2000 Census, most homes in the Montalvin Census Tract use natural gas for heating. As such, it was assumed that the Montalvin model home has an existing natural gas water heater (Census

Bureau, n.d., CEC, 2010b). The gas storage water heater model selected was an economy Energy Star model available at Home Depot. Its manual indicates that a water heater blanket was unnecessary (Rheem Manufacturing Co., 2006). The 50-gallon size is the mid-range sizing recommendation for a 1.5 bathroom, 3 bedroom home from a state of California energy saving organization (EEP, 2010c). The cost estimate for materials and labor for the water heater are shown in Table 6.9. (Note that other more efficient water heater options, such as tankless heaters, are encouraged in formulating future programs, if budget allows for the higher expense.)

A Note on Dual Pane Windows Elimination

For improved cost-effectiveness, the measure to upgrade existing windows to dual pane windows was eliminated. According to Professor Di Santo and cost findings from the original upgrades section, the dual pane windows were both expensive and low performing (personal communication, April 9, 2010). Instead, to improve building envelop performance, ceiling insulation was included. See ceiling insulation section and Table 6.4.

Chapter 7.0 – Findings for Alternative Green Upgrades

Cost

Table 7.1 Alternative upgrade set itemized material and labor costs. New upgrades are indicated in the “set” column.

ITEM	Set	Cost L + M	Cost - Material	Cost - Labor
Appliance - Clothes Washer	Original	\$848.00	\$448.00	\$400.00
Appliance - Dishwasher	Original	\$849.00	\$399.00	\$450.00
Appliance - Refrigerator	Original	\$758.00	\$698.00	\$60.00
Ceiling Fans (with lights)	Alternative	\$1,222.85	\$247.85	\$975.00
Ceiling Insulation	Alternative	\$2,782.50	\$2,782.50	\$0.00
Clothesline	Alternative	\$143.88	\$53.88	\$90.00
Digital Thermostat	Alternative	\$109.00	\$39.00	\$70.00
Flooring	Original	\$5,672.24	\$3,672.24	\$2,000.00
Lights & Fans with Lights for Bathrooms	Original	\$1,244.00	\$344.00	\$900.00
Lighting - Indoor & Outdoor (excludes bathrooms)	Original	\$1,314.35	\$161.85	\$1,152.50
Paint	Original	\$3,202.04	\$352.04	\$2,850.00
Water Fixture - Bath Faucets	Original	\$516.00	\$116.00	\$400.00
Water Fixture - Kitchen Faucet Aerator	Alternative	\$36.00	\$6.00	\$30.00
Water Fixture - Showerhead	Original	\$87.87	\$12.87	\$75.00
Water Fixture - Toilets Tank Bag	Alternative	\$67.98	\$7.98	\$60.00
Waterheater	Alternative	\$1,403.04	\$603.04	\$800.00
Weather- stripping	Original	\$110.72	\$35.72	\$75.00
TOTAL	Alternative Upgrades Set	\$20,367	\$9,980	\$10,388

The cost estimate for the alternative upgrades set is shown in Table 7.1, with itemized labor and materials cost estimates for each individual upgrade. (The details such as brand, model, and Home Depot item number are provided in Appendix A2.) Note that the full set of alternative upgrades is the combination of the additional or changed upgrades (such as ceiling fans and toilet tank bags) indicated as “alternative,” plus the unchanged original upgrades (such as weatherstripping) indicated as “original.” Overall, the total estimated cost of implementing the alternative upgrade set is \$20,376, with approximately half of costs attributed to materials (\$9,980) and half attributed to labor (\$10,388). It is interesting to note that for the original upgrade set, the ratio of estimated labor/material cost ratio is one-third material cost to two-thirds labor cost. In the alternative upgrades, the ratio is half material cost and half labor cost. It is likely that the labor cost could be reduced if groups such as the non-profit workforce development programs Rising Sun (of the San Francisco Bay Area) or Community Action Network (nationwide) provided labor for basic labor such as installing clotheslines, weatherstripping, faucet aerators, and toilet tank displacement bags. The greatest contributor to upfront cost savings over the original upgrade set was elimination of the dual pane windows, saving \$7,975. This savings is more than the combined cost of the additional seven new/modified upgrades added (\$5,743), which includes the cost of ceiling insulation. It should also be noted that the two original upgrades that were exchanged/modified for lower cost strategies saved \$150 and \$518, respectively. These were adding a kitchen faucet aerator to the existing faucet (instead of a new low-flow kitchen faucet) and using toilet tank bags (instead of buying new low-flow toilets).

Another interesting finding, in regards to specific upgrades, is that the two most expensive alternative upgrades were the bamboo flooring and zero-VOC paint—both intended to improve indoor air quality—at \$5,672 and \$3,202, respectively. In the case of the zero-VOC paint, the labor cost estimate portion accounted for 90% of the costs, far outweighing the materials cost. This is partially due to additional contractor fees for meeting the lead paint testing and certification requirements of the EPA (under the Toxic Substances

Control Act), because the home was built before 1978 and would be painted by a contractor (EPA, 2010d). In the case of the bamboo flooring, however, the materials cost (\$3,672) exceeded labor cost estimates (\$2,000). Bamboo is promoted as a sustainable wood product, which is one reason it was selected as an original upgrade. However, due to the high cost, substitute non-VOC flooring might be preferred in formulating future upgrade programs.

Summary of Benefits from Alternative Upgrades

Table 7.2. Estimated utility usage and GHG emissions of baseline home, original upgrades, and alternative upgrades. Annual savings, 10-year savings, and payback period for upgrades also shown.

ENERGY	Annual Kwh Used	Annual Therms Used	Annual Energy Cost	CO ₂ lbs Emitted
Baseline	5,837	495	\$1,470	8,695
Original Upgrades	5,111	409	\$1,255	7,328
Alternative Upgrades	4,279	328	\$1,032	5,967

WATER	Daily Per Capita	Annual Gallons Used	Annual Water Cost
Baseline	199	217,905	\$1,207
Original Upgrades	105	114,975	\$905
Alternative Upgrades	118	129,210	\$905

Payback and Cost-Benefit	Annual Savings	Cost to Upgrade	Payback Period in Years	10 Year Savings	CO ₂ lbs Saved Annually
Original Upgrades	\$517	\$24,179.72	46.77	\$5,170	1,367
Alternative Upgrades	\$740	\$21,176.48	28.62	\$7,400	2,728

Table 7.3 Estimated payback periods for alternative upgrades, by sector.

Alternative Upgrades Savings & Paybacks By Sector			
Upgrade	Cost (L+M)	Annual Savings	Payback (in Years)
WATER	\$1,935.35	\$302	6.4
ENERGY	\$9,557.84	\$438	21.8
AIR QUALITY	\$8,874.28	unknown	unknown
All Upgrades	\$20,367.47	\$740	

The same methods and tools used to estimate the monetary benefits (i.e., utility savings) from implementation of the original upgrades were used to generate the projections for the alternative upgrades. Energy usage was projected with the LBNL calculator, and water usage was projected with the City of Tampa water usage calculator (LBNL, 2010; City of Tampa, 2010). (See Chapter 5 for greater detail.) Inputs representing the original upgrades were changed to reflect the new configurations. Specifically, the LBNL energy calculator inputs were changed to reflect the new alternative upgrades energy-saving features--ceiling fans, ceiling insulation, digital thermostat, and water heater were added; the dual pane windows from the original set were reversed to single pane windows, as these had been omitted from the alternative upgrades set. The Tampa water use calculator inputs were unchanged, except to reflect the toilet tank displacement bags (the alternative green upgrade). The original upgrade for the toilet proposed replacing the existing toilet with a WaterSense labeled a low-flow, dual flush toilet, and this was represented in the calculator by the WaterSense standard of 1.28 gallons per flush rate (see Table 4.5). The alternative upgrade, the toilet tank displacement bags, would lower the amount of water used by the existing toilet by 0.625 gallons (2.5 quarts). The calculator default of 5 gallons per flush was assumed representative of the baseline (existing) toilet, thus the flush rate used for the alternative green upgrade is 4.375 gallons per toilet flush.

Table 7.2 compares the projected monetary benefits and resource conservation potential of the alternative upgrades with original upgrades and the baseline (existing) home. The alternative upgrades are projected to outperform the original upgrades in all sectors, with the exception of slightly higher water usage. The alternative upgrades save an additional \$223 dollars over the original upgrades, bringing the estimated combined water and energy bills for alternative upgrades configuration to \$1,937 annually. This would be 28% lower than the existing home's combined water and energy bills estimated at \$2,677 annually. Annual carbon dioxide emissions would also be reduced by one-third. The existing

home configuration is estimated to emit 8,695 lbs annually, while the alternative upgrades would reduce emissions to an estimated 5,967 lbs. It is important to explain that while annual water usage is 14,235 gallons lower under the original upgrades than under the alternative upgrades, because of the threshold structure of the local provider EBMUD, the water usage fee does not increase, making the charge \$905 annually under both upgrade configurations. Together, the savings from the higher energy and water efficiency across ten years would amount to \$7,400. When corrected for net present value (using a discount rate of 5%, as in Bradshaw et al.'s similar cost-benefit analysis), the net present value of the cash flow amounts to \$5,714 (Bradshaw et al., 2005; Investopedia, 2010). (Non-monetary and indirect benefits will be discussed in Chapter 9.)

The combined payback period of the alternative upgrades, noted in Table 7.2, is 27.5 years, compared to 47.4 years for the original upgrades (see Table 5.2). To analyze the upgrades sector, the upgrade costs and utility savings were allocated to the water, air quality, or energy sector, as appropriate (Table 7.3). If a particular upgrade measure improved both energy and water efficiency (such as the dishwasher), half the cost was allocated to each sector. When broken into a sector analysis, the alternative water efficiency upgrades had a payback period of 6.4 years, while the alternative energy efficiency upgrades had a payback period 21.8 years, more than three times as long. Although the annual savings from the alternative energy upgrades is \$136 higher compared to the annual savings from the alternative water upgrades, the initial cost of implementing the alternative energy efficiency upgrades is \$3,622 higher than implementing the alternative water upgrades. This means that alternative water efficiency upgrades are the more cost-effective upgrades, and as a group, out-perform the alternative air quality and energy efficiency upgrade sectors.

Chapter 8.0 – Comparison of Findings

This chapter will explore previous findings related to the cost-benefits of greening affordable housing, specifically older, modest-sized existing single-family homes. The sources for comparisons are academic and professional literature, which document the results of reputable non-profit organizations and state weatherization programs. Non-monetary co-benefits of greening affordable homes, such as improved health, will also be presented.

Non-Profit Organization Case Studies

Table 8.1 Rehabilitation case studies summary.

<u>Project Name</u>	<u>Green Premium per sqft</u>	<u>Utility Savings(%)</u>	<u>Features Upgraded (Indoor only)</u>	<u>Upgrading 1,000 sq feet</u>
Montalvin NSP (CA) Single Family Homes - Proposed Original Upgrades	\$4.01	28%	Energy: bath fans, ceiling insulation, ceiling fans, clothes washer, dishwasher, indoor and outdoor lighting and CFLs, refrigerator. Water: faucet aerators, low-flow showerheads, toilet displacement bags. Air: bamboo flooring, low-voc paints.	\$4,009.88
Johnson Creek (OR) - Condominiums	\$7	76% (Energy only)	Energy: baseboard heaters, dual pane windows and doors, R-38 ceiling/R-30 floors/R-8 walls insulation, water heaters. Water: aerators, clothes washers, toilet tank disp. bags. Air: bathroom fans, low VOC carpet, Marmoleum flooring, low VOC paint . (Outside: Hardiplank cement siding.)	\$7,000.00
20th Street (CA) - Apartments	\$3.61	25%	Energy: dual pane windows, insulation: R-30 attic, R-11 walls, light fixtures and CFLs, programmable thermostats, repaired/upgraded existing solar water heater, skylights. Water: Low-flow faucets, showerheads, toilets. (No air features.)	\$3,610.00
Columbia Terrace (MA) Apartments	\$1.51	36%	Energy: dishwasher, insulated doors, rangehood, refrigerator, repairs to heating system, lighting and CFLs. Water: low-flow showerheads, toilets. Air: ceramic tiles, Marmoleum, low-voc paints.	\$1,510.00
Woodlawn Development Assoc. (IL) - Apartments	\$4.74	unknown	Energy: dual pane windows, furnances, insulation: r-18 walls/R-43 attic rock wall, reflective roof coating, lighting, photovoltaic, weatherstripping, water heaters. Water: low-flow bath/kitchen fixtures, including showerheads. Air : Safecoast caulk, Mohawk recycled carpet, low VOC primer, recycled tile, Low VOC wood finish. (Blower door test used.)	\$4,740.00
Positive Match (CA) - Apartments	\$11.55	13%	Energy: hydronic (baseboard) heating, refrigerator. (No water measures.) Air Quality: non-carpet (bamboo, rubber, cork, tile, (natural) linoleum, and no VOC paint.	\$11,550.00
<i>Average</i>	\$5.68	38%	n/a	\$5,682.00

Source: Bradshaw et al., 2005.

Bradshaw et al. present a collection of case studies with analysis of costs and projected benefits. Of the 16 non-profit green affordable housing projects documented, only five involved the upgrading of existing buildings (Bradshaw et al., 2005, p. 41). Of these five rehabilitation projects, and only one upgraded detached dwelling units (Johnson Street in Oregon) (Bradshaw, et al., 2005, p. 98). Additionally, one of these five non-profit projects (Positive Match in California) focused almost exclusively on improving indoor air quality, thus it was somewhat dissimilar to the proposed NSP2 rehabilitations (Bradshaw et al., 2005, p. 127). Nonetheless, while these cases are not precisely comparable to the NSP2 program which improves energy efficiency, water efficiency, and indoor air quality of existing single family homes, these five case studies do provide details on the improvements made, what materials were selected, implementation costs, and expected utility savings.

Table 8.1 presents a summary of the upgraded features, projected utility savings, as well as the green premium. The green premium is the added cost of rehabilitating the dwelling units using green materials and products instead of conventional versions, such as using carpet made from recycled plastic bottles instead of conventional carpet. Due to the fact that dwelling unit sizes varied, for comparison purposes, each was calculated for a 1,000 square foot unit, representing a modest-sized home. On average, across the five case studies, the green premium was \$5.68 per square foot; had Positive Match (which is an outlier at \$11.55 per square foot) been excluded, the average green premium would have been \$4.22 per square foot (Bradshaw et al., 2005, p. 129). According to findings in Table 5.1, Montalvin's original upgrades had a green premium of \$4.01 per square foot (\$4,463 divided by 1,113 square feet), matching this almost perfectly. Multiplying the individual project green premiums by 1,000 square feet provided a range of greening modest sized units from \$1,510 to \$11,550, with an average of \$5,682; when Positive Match is excluded, the average per unit upgrade cost is \$4,215. For the original upgrades, the Montalvin green premium per unit was \$4,463, which is higher than somewhat higher than the \$4,215 average of the four more comparable projects.

Non-Profit Green Upgrades

Another interesting aspect of the case studies is examining which particular green upgrade measures were included. Most projects (at least three of five) included green upgrades related to the following:

- ceiling or attic insulation
- dual pane windows
- lighting (energy efficient)
- low flow bath/kitchen devices
- low VOC paint
- refrigerator (energy efficient)
- water heater (energy efficient)

One can assume that these particular measures were included at least in part due to project priorities and perceived cost-effectiveness. For example, water saving devices have been shown to have low initial costs and quicker payback period relative to other upgrades (see Table 7.3). Another important note is that many projects reported being able rebates (for instance, for dual windows) that the Montalvin project, run by a local government, did not seem eligible to receive (Bradshaw et. al, 2005, p. 47, 78, 81, 99, 129). In contrast, these four upgrades were used by only one project each:

- insulated doors
- photovoltaic panels
- reflective roof coating
- skylights

The infrequent use of these upgrades suggests these upgrades were perceived to have lower cost-effectiveness. It is useful to note that photovoltaic panels used by one project were partially paid for by the State of Illinois (Bradshaw et al., 2005, p. 153).

Weatherization Review (Government Program)

Weatherization is the largest residential energy conservation program in the country, having improved the energy efficiency of approximately 6.3 million homes as of 2010, and typically upgrading 100,000 homes a year (Reamy and Gates, 2009). The Weatherization Assistance Program (WAP) was established by Congress in 1976 under Title IV of the Energy Conservation and Production Act with a mandate to retrofit the single-family homes, apartments, and mobile homes of low-income households for greater energy efficiency (Kaiser and Pulsipher, 2004). Owner or renter households at or below 200% of the federal poverty level are eligible, as are those at or below 60% of state median income; for a family of four in California as of 2010, this is \$57,291 annually (Tonn, 2003; Reamy and Gates, 2009; California Community Services and Development Department [CSD], 2007; CSD, 2008). WAP is supported with funding and technical assistance from the US Department of Energy but is implemented by over 900 local government divisions (such as community development departments) and non-profit agencies, typically members of the Community Action Partnership Network (CSD, 2010).

Table 8.2 Rehabilitation case studies summary.

<u>Project Name</u>	<u>Green Premium (per unit)</u>	<u>Utility Savings(%)</u>	<u>Features Upgraded (Indoor only)</u>
WAP Nationwide	\$1,069 per home	23%	Energy: caulking, cooling system repairs, furnace repairs, insulation (attic), light fixtures, shades and screening, storm windows, weatherstripping. Water: low-flow showerheads, faucet aerators. (No air quality measures.)
WAP California	\$2,018 per home	\$418 in energy savings	Energy: appliances, insulation, weatherstripping.
WAP Contra Costa 08-09	\$3,207 per home	unknown	Energy: caulking, ceiling insulation, lighting and CFLs, programmable thermostat, refrigerator, water heater.
<i>Average</i>	\$2,098 per home	n/a	n/a

Source: Kaiser and Pulsipher, 2004; Campanella, L., personal communication, January 6, 2010; Reamy and Gates, 2009; California Community Services and Development Department [CSD], 2008.

Costs and Benefits of Weatherization

As shown in Table 8.2, WAP agencies typically achieve appreciable energy savings with implementation costs much lower than most of the non-profit case studies or the Montalvin NSP2 proposal. (It should be noted, however, that the scope of WAP is energy efficiency, with limited water efficiency and no air quality enhancement scope.) On a nationwide average, WAP agencies upgrade homes for an average of \$1,069 (in 2010 dollars) and residents typically save 23% on their energy bills (Berry and Brown, 1995; Tonn, Schmoyer, and Wagner, 2003). The WAP has an established history of reducing home utility bills at a reasonable cost of implementation. On average, the program returns \$1.65 in energy related benefits for every \$1 invested (Reamy and Gates, 2009).

Also shown in Table 8.2, the typical California non-profit or government agency spends \$2,018 to improve the energy efficiency of a home, saves the residents \$447 annually (in 2010 dollars), and results in a payback period of under 5 years (CSD, 2009b; CSD, 2007). With a payback period nearly one-fifth of the Montalvin alternative energy-related upgrades (Table 7.3), the WAP implementation is substantially more cost effective and affordable.

There is great diversity in the methods and energy conservation measures used by organizations implementing weatherization across the US, influenced in part by the housing stock and climate (Brown and Berry, 1995). Thus, it is difficult to definitively describe the average weatherization measures. However, a nationwide, statistically valid study indicated that substantial energy savings could be attributed to the following weatherization measures (Brown and Berry, 1995, p. 734, 736-737) :

- attic and wall insulation
- water heater efficiency upgrades
- furnace replacement
- air sealing (weatherstripping and caulking)
- low-flow showerheads (due to reduced need for hot water)

Local Weatherization Upgrades

Contra Costa County government itself provides weatherization services, and according to County records obtained, the cost (labor and materials) to implement weatherization upgrades was an estimated \$3,207 per dwelling during 2008-2009. Although this figure is higher than the national or state average WAP per dwelling cost, it is still \$7,538 lower than the \$10,745 estimated cost of labor and materials for the alternative energy upgrades proposed for the Montalvin NSP2 (Table 7.3). The energy efficiency measures implemented during fiscal year 2008- 2009 by the Contra Costa County WAP (as reported to the State were the following upgrades (Campanella, L. personal communication, January 6, 2010):

- ceiling insulation (R-30)
- caulking
- compact fluorescent lamps
- programmable thermostat
- refrigerator
- water heater replacement

Overall, while the Weatherization Assistance Program is not entirely comparable to the NSP2 green goals, particularly in its omission of improving indoor air quality, the program does offers a model series of affordable upgrades that improve energy and water efficiency.

HUD Recommended Upgrades

A 2008 HUD publication recommends particular green building measures moderate rehabilitation (i.e., significant repair and upgrades of dwelling features, but not structural changes) of affordable housing. This manual, *Building ENERGY STAR Qualified Homes and Incorporating Energy Efficiency and 'Green' Building Practices into HOME-Funded Affordable Housing*, was not referenced in HUD's 2009 NSP2 funding notification, nor does it provide cost estimate ranges, relative costs, or cost-benefit analysis. The manual states

that although incorporating green building elements into affordable dwelling units reduces operating and maintenance costs for owners and residents, and improves quality of life for residents, it states that jurisdictions “face the challenge of determining which green building practices are feasible and cost-effective...(HUD, 2008, p80).” With the pricing challenge acknowledged, the manual indicates that in most older homes, four elements are responsible for most energy loss: 1) air leakage, 2) poor-functioning heating and cooling systems, 3) insufficient and poorly installed insulation, and 4) inefficient or leaky windows (p. 58). It then promotes the following energy conservation strategies as having low initial implementation costs, or have short payback periods, making them cost effective. These strategies, which begin to address the main causes of energy loss, are as follows (p. 58):

- sealing (caulking) air leaks
- sealing and insulating ducts
- repairing/upgrading combustion equipment
- increasing insulation
- installing programmable thermostats

Interestingly, the HUD manual mentions that some of these upgrades may coincide with existing local Weatherization Assistance Programs (WAP) services, and suggests weatherization may be able to “support” other projects, perhaps through lending subject matter expertise.

Other green energy upgrades discussed in the manual, such as appliances, windows, and water saving devices, were categorized as measures with moderately expensive initial cost and longer payback period. Replacing appliances was recommended if existing appliances were near the end of their expected life or if in poor repair, as this measure is usually a cost-effective in moderate rehabilitation cases, saving up to \$80 a year in energy costs (p. 20, 64). Additionally, Energy Star dishwashers and clothes washers reduce water demand, saving money on water bills. According to the 2008 manual from HUD, replacing

the five most frequently used light fixtures with Energy Star versions can save about \$65 each year in energy costs, as compact fluorescent light bulb (CFL) use 75% less energy incandescent bulbs (p. 20). Installing Energy Star windows can help reduce energy bills up to 15% according to the HUD manual, depending on geographic location (p. 65). These windows help keep cold air out of the home as well as hinder summer heat transfer from the sun (p. 65). R-value is the capacity of a material to impede heat flow and measure as thermal resistance (p105). Older single pane windows have less than one-tenth of the R-value of typical exterior walls, and if loose fitting, damaged, or missing weather stripping, putty, or caulk, these older windows can easily leak. However, the HUD manual notes that replacing all the windows in a property can quickly become expensive, and if the cost is prohibitive, existing windows should be caulked properly to prevent leakages (p. 65).

HUD did not overlook cost-effective water efficiency upgrades, as the manual states that with “simple upgrades” (not specified), households can save about \$170 per year (p89). WaterSense labeled products (a labeling program of the EPA) were described as appropriate for rehabilitation projects, as these high-efficiency fixtures can reduce standard flow by more than 30% without sacrificing performance. Specifically, the manual recommends WaterSense labeled high efficiency toilets which use less than 1.3 gallons per flush, and the bathroom sink faucets which use no more than 1.5 gallons per minute (p. 89). While tankless water heating systems (which heat water instantly at the tap) are mentioned specifically as both a way to save water and energy, the cost or cost-effectiveness of these systems is not addressed, thus perhaps this measure can be considered a weak recommendation (p. 89). Another recommended measure is educating residents on how to use their energy equipment effectively and efficiently. Behaviors such as turning out lights in empty rooms and turning off the heating/cooling system when the home is unoccupied are considered important lessons that should be taught to residents to appreciably reduce energy use (p. 47).

Chapter 9.0 – Co-Benefits of Greening Existing Housing

Greening existing older homes results in monetary benefits in the form of utility bill savings, as demonstrated with the projections and case studies presented in previous chapters. However, the benefits of green upgrades are not limited to those that are easily monetized. Greening existing building stock, including affordable homes, is anticipated to contribute appreciable improvements in resident health and reduced environmental impacts. In this section, the valuable co-benefits gained by improving the energy and water efficiency of existing housing stock will be briefly explored, including health-related benefits and greenhouse gas emissions reductions.

Health Benefits

Indoor air pollution is one of the top four environmental health risks identified by the US EPA (Jacobs, Kelly, and Sobolewski, 2007). On average, US citizens spend about 90% of their time indoors (Jacobs, Kelly, and Sobolewski, 2007). Much of that time is spent at home, thus housing is a key factor in health (Chapman et al., 2009). Chronic exposure to allergens such as dustmites, mold, and pollen is associated with asthma, and a growing body of evidence suggests that allergens and other chemicals in the home contribute to both sensitizing children and triggering attacks (Jacobs, Kelly, and Sobolewski, 2007). One recommendation from health organizations is to improve indoor air quality by removing carpet (Agency for Toxic Substances and Disease Registry, 2007). In practice, many organizations performing green upgrades replaced carpet with fiber-free flooring (such as bamboo or natural linoleum) as a green upgrade, and took additional precautions by avoiding VOCs (volatile organic compounds) in paint, stains, and finishing materials (Bradshaw et al., 2005, p. 127). Non-profits “identified improved health of residents such as reduced exposure to toxics and reduced incidence of asthma” from to these upgrades, as documented in Bradshaw et al., 2005, (p. 37).

In other instances, health benefits result from more easily achieved indoor warmth. The general effect of greater warmth and dryness is improved respiratory health (Chapman et al., 2009). Heat retention and draft reduction can be accomplished through greening measures such as insulation, weatherstripping, and caulking, which reduce the amount of energy required to maintain a given indoor/outdoor temperature difference (Milne and Boadman, 2000). One study found a 38% reduction in overnight hospital stays of residents 65 years and older whose homes had been better insulated (Chapman, 2009, p. 274).

Environmental Benefits

Higher energy efficiency reduces demand for electricity, in turn reducing environmental impacts of electricity generated with fossil fuels such as coal. Fossil fuels (coal, oil, and natural gas) are the principal fuels of electricity generation in the United States, largely due to their low costs and ready availability of coal (EPA, 2010e). As of 2010, 48% of US power was generated with coal (Hong and Stlatick, 1994; Lomax , 2010). Reduced coal mining due to lower electricity demand would result in less impact to landscapes from coal mining and reduced incidence of acid rain and poor air quality in the vicinity of the coal-fired power plants. Mining degrades water quality when the zinc, sodium, selenium, sulfate it unearths washes into streams (EPA, 2010f). Mountaintop removal mining, which impacts 12 million acres in the Appalachian region of the US, could also be reduced with higher energy efficiency (EPA, 2010f). Mountaintop removal mining a coal extraction method which denudes vast areas of landscapes rock to expose seams of coal by removing all vegetation, layers and dirt, thereby causing considerable habitat and wildlife loss (EPA, 2010f; EPA 2010g). Acid rain is another affect of energy generation, occurring when sulfur dioxide and nitrogen oxides from burning fossil fuels such as coal react with water, oxygen, and fall to the earth, causing acidification of lakes and streams, damaging trees, crops, and even historic monuments (EPA, 2008b). Coal- and oil-fired power plants and industry are also the largest sources of sulfur dioxide, which at high concentrations, reduce air quality and

aggravate existing conditions of sensitive individuals with asthma, bronchitis, and emphysema (especially children and the elderly) (EPA, 2010e).

Environmental Benefits – Greenhouse Gas Reduction

North America is susceptible to most of the serious threats of climate change, such as sea level rise, precipitation and temperature regime change, increased fires and droughts, and severe storms (Henson, 2008). Some of these changes are already being seen. For instance, there has been “a clear ramp-up in precipitation intensity for the US, especially since 1970s (Henson, 2008, p. 59).” Of all greenhouse gases, carbon dioxide is the most abundant in the atmosphere, and has increased 40% from pre-Industrial Revolution concentrations (Henson, 2008, p. 25). Failing to curb emissions to lessen climate change will lead to more severe consequences for people and property.

In the United States, electricity production is the single largest source of carbon dioxide emissions, representing 41% of all carbon dioxide emissions (EPA, 2010h). The majority of US electricity generation has historically been from coal, and as of 2010, coal was burned to generate 48% of US electricity (Hong, and Stlatick, 1994; Lomax, 2010). Coal-fired power plants generally cause more pollution, such as sulfur dioxide and nitrous oxides, per unit of electricity than any other fuel. In addition, combustion of coal for energy generation contributes significantly to climate change because every 1 pound of coal completely combusted produces 2.86 pounds of carbon dioxide (Hong and Stlatick, 1994). The importance of reducing GHG emission and their direct relationship to energy is explained as follows:

Emissions of greenhouse gases must be curtailed if we hope to minimize the extent and impact of climate change. The majority of GHG emissions come from combustion of fossil fuels for energy and transportation.” (CAPCOA [California Air Pollution Control Officers Association], 2009, p. 1).

Reducing energy demand through improving the energy efficiency of homes, as explored in this project, has climate change co-benefits. The EPA estimates that, for example, if home energy usage across the US were reduced by 10%, at least 40 power plants would be unneeded, and the resulting carbon emissions reduction would be equivalent to removing 25 million vehicles from the roads (Partnerships for Home Energy Efficiency, 2007).

Case studies of greened affordable housing were projected to use between 13% to 76% less energy than prior to upgrades, with an average of 30% in energy savings across non-profit projects and federally-funded weatherization projects (see Table 8.1 and Table 8.2). This finding indicates that the 10% energy reduction per dwelling target is theoretically achievable.

Environmental Benefits – Water Conservation

Beyond the demonstrated direct monetary benefits to the resident, reducing water consumption by retrofitting water fixtures of existing homes has positive repercussions for the environment and society. The environmental and societal benefits gained through water conservation stem from avoiding construction of new dams and from slowing or halting increases in water diversion, thereby preserving high quality habitat for fish, birds, and other wildlife, and saving hundreds of millions of public dollars for other uses (EPA, 2010i).

In California, surface water (typically from rivers) makes up 61-79% of water used for agriculture and urban purposes in a given year, averaging 75 acre feet in a wet year (California Legislative Analyst Office [CaLAO], 2008). (In contrast, ground water comprises up to 21-39% of the state water supply, averaging 41 acre feet in a dry year [CaLAO, 2008].) River systems are obviously essential habitat for fish and life forms that live within the water itself (aquatic habitat), but they are also essential to numerous wildlife species dependant upon the vegetation developed at the edges (riparian habitat). A river's riparian floodplain, freshwater wetlands, and oak forests are some of the most productive and diverse habitats and can support hundreds of migratory bird species and other wildlife (The Nature Conservancy, 2010).

Dams are barriers constructed, by intention, to change natural flow rates of rivers to store water for release at will. Dams spoil the integrity of riparian and aquatic habitat. The stored water inundates the upstream area, completely eliminating large areas of mature, intact riparian forest and wetlands, and causes a build up sediment behind the barrier. Meanwhile lower reaches experience rises in temperature, reduction in dissolved oxygen, and changes in chemistry (pH) that leads to changes in food webs and reduced biodiversity (West Virginia Conservation Agency [WVCA], 2003). Perhaps most dramatically, dams cut salmon and other migrating fish off from their native spawning grounds and reduce egg viability, decimating commercially and recreationally important fish populations (Moyle, Israel, and Purdy, 2008, p. 27, 50, and 64). From a societal benefit perspective, development and operation of additional surface water (or ground water) supplies costs hundreds of millions of public dollars that could be spent on many other important public services. Dams also increase the need to construct additional water supply treatment and wastewater facilities (Utah Division of Water Resources, n.d).

Water conservation eliminates waste and curtails the need for increased water diversion of rivers already modified with dams. It also makes new dams on the few remaining wild rivers unnecessary. Damming and diversion have severely degraded most California rivers, and only one river, the Cosumnes River, remains undammed on the California side of the Sierra Nevada (Center for Watershed Science, 2010; The Nature Conservancy, 2010). Other unique California natural monuments, such as Mono Lake, have been devastated by water diversions which drastically affected its ecology (Mono Lake Committee, 2010; The Nature Conservancy, 2010; The Trailmaster, 2007; Knudson, 2010).

Low-flow devices are an important component of an indoor water conservation program, stretching existing supplies of water farther by lowering the flow rate at bath and kitchen faucets, toilets, showerheads, while still satisfying the needs current users (West Virginia Conservation Agency [WVCA], 2003). Water conservation on a mass scale is possible and

can be highly successful. Conservation has made it possible for the city of Los Angeles to grow by 1 million people since the 1970s, but not increase its water usage (LADWP, 2010). During periods of drought, which are more likely to occur with climate change, meeting minimal needs of all users (urban, agriculture, and wildlife) will be very difficult (Henson, 2008, p.13, 69; WVCA, 2003). Eliminating waste and reducing excessive use should be a central main water management goal, and an important component of this effort should be installation of household water conservation devices.

Value of Co-benefits

Researchers Schweitzer and Tonn have attempted to quantify the health, safety, and indirect environmental benefits accrued from weatherization (Schweitzer and Tonn, 2003). According to their 2003 study, each weatherized household experiences an additional net present value of \$156 (2010 dollars, total for 30 years) in health and safety benefits due to decreased illnesses and risk of fires (due to combustion equipment repair or replacement). When less electricity is generated and consumers burn less natural gas, the environmental benefit is improved air quality from less particulate matter and heavy metals released into the air. Schweitzer and Tonn valued these air quality benefits at \$500 (2010 dollars, for 30 years) per weatherized home. Another interesting figure was the estimated value of low-flow showerheads and faucet aerators, commonly provided alongside weatherization service, provided an estimated net present value of \$336 alone (2010 dollars) per weatherized household (2003, p. 327).

California law now mandates that Greenhouse gas emissions must be reduced in accordance with AB 32 (2006), as a mitigation measure for climate change. The researchers monetized the avoided greenhouse gas emissions at \$1,577 (2010 dollars, for 30 years) per weatherized dwelling from reduced electricity generation and natural gas combustion. As shown in Chapter 7 in Table 7.2, this study found that the alternative upgrades would deliver a projected annual savings of 2,728 pounds of carbon annually. This savings would occur for an upfront cost of \$10,745.27, which is a cost of \$1 per pound for 4 years, and subsequent annual savings would be incurred at no cost.

Chapter 10.0 – Policy Implications

The final chapter of this study reflects on the preceding cost-benefit analysis findings and commentary from researchers in affordable housing to evaluate the policy of greening affordable homes. The evaluation specifically addresses the new HUD policy of adding green upgrades to homes rehabilitated and sold as affordable single-family homes through the second iteration of the Neighborhood Stabilization Program, NSP2. It also discusses how HUD could improve its greening guidance in its future notifications. The chapter concludes with an assessment of particular greening strategies and objectives, and offers recommendations for formulating cost-effective green upgrade programs in the future.

General Principles

Most low-income people live in older, drafty homes with little insulation that were built during the ‘cheap energy era’ (Brown and Berry, 1995). This is evidenced by the fact that 39% of the homes repaired through the weatherization program (from inception until 2005) were built before 1955. Even California state government, considered a leader in environmental regulations, did not include energy efficiency standards in its building code (Title 24, Part 6) until 1978. By this point, 65% percent of US housing stock that existed in 2009 had already been built (Brown and Berry 1995; Census, 2008, p. 1;EDAW, 2008)³. While many pre-Title 24 homes in California and elsewhere wasted energy from the time of first commissioning, “invariably” aging makes these structures even more cold, inefficient, and more expensive to heat (Brown and Berry, 1995).

Until recently, green building features were not typically incorporated into affordable housing, as these features are associated with high cost (Stawitz et al.. 2008; Bradshaw et al., 2005, p. 9). However, utility bills typically comprise a much larger percentage of household budgets for lower-income families; low-income households typically spend 17% of their total

³ Also of 2009, the median aged housing unit in the US was built in 1974 (US Census Bureau, 2010).

income on energy compared to 4% for other households (Reamy and Gates, 2009). It is not unheard of for some low-income households to face the hardships of choosing between heat and other basic necessities (Brown and Berry, 1995). Thus despite the higher upfront cost, investment in green features immediately reduces utility usage and results in long-term savings, which has a greater relative benefit to low-income households than to mid- and high-income households.

There are several meaningful co-benefits to green affordable housing, including a tighter building envelope that creates more warmth using less energy, and thereby makes indoor comfort less expensive. Lowering the energy and water demands of a home through green upgrades also reduces a household's vulnerability to increases in energy and water prices (Gether et al., 2005 in Sunikka, 2006). Greening existing homes also meets the dual environmental goals of increased water and energy conservation. By saving energy, retrofitted homes decrease carbon dioxide emissions to the environment and lessen one of the central causes of global warming, a very serious threat to all parts of the world (Foster, Tramba, and MacDonald 2008). A significant proportion of carbon dioxide emissions reduction policies in developed countries target only new buildings, and government bodies have to date done little to upgrade existing buildings (Sunikka, 2006, p. 522). Greening of existing affordable housing is one important policy step that addresses this key sector. Greening may also include indoor air quality improvement measures, for instance replacing carpets with natural, renewable, low-VOC, non-allergen accumulating flooring such as natural linoleum or renewable bamboo. These measures are believed to improve health, particularly of those with respiratory ailments. (Health and the environmental co-benefits of green upgrades are discussed in Chapter 9.)

Due to the short and long-term benefits to low-income residents and the environment, the greening of affordable housing through the NSP2 program is both merited and endorsed. By allocating budget dollars towards greening project homes, a tradeoff is made. Greening

adds an additional cost per home, thereby reducing the total number of homes that can be made available through the NSP2 program. However, based on this study and other cases, operating costs of the green homes are likely to be 20% to 40% lower for the residents, helping which helps improve affordability. The green features also allow for affordable warmth, which may mean fewer respiratory illnesses and potentially fewer asthma attacks, benefiting the household with better health, another valuable benefit enjoyed. The environmental benefits are also immediate, which includes lower demand for water and electricity, which means a decelerated demand for additional dams and fossil fuel extraction, which means decelerated destruction of habitat and reduced carbon dioxide emissions. Further, the social benefit is multiplied if the labor to conduct the green the units is provided in part by apprentices in workforce development programs (for the work that does not require a licensed electrician, such as installing clotheslines and showerheads), creating green jobs and providing training. Greening affordable housing essentially generates multiple benefits from the same tax dollar, and was thereby a sensible addition to the Neighborhood Stabilization Program.

Limited Data

While the social objectives behind green affordable housing are not likely to be controversial, two significant obstacles to widespread incorporation of green building features into affordable housing has been lack of has been upfront cost and long-term savings data for implementation (Bradshaw et al., 2005, p. 172). In searching for documented cases of affordable housing improved with green upgrades, few case studies could be found. The best resource discovered was Bradshaw et al.'s 2005 collection of case studies which documented 16 projects which provided housing for households earning between 80%-120% of area median income, at a cost of less than 30% of their income (in compliance with HUD's affordability definition) (Bradshaw et al., 2005, p. 16). However, only five of Bradshaw et al.'s cases were rehabilitation projects (not newly built housing units),

thus only those five were relevant to the NSP2 upgrade efforts. And of these five projects, only Johnson Street in Oregon units were detached greened existing affordable dwelling units, making this project the most comparable to NSP2 efforts to rehabilitate existing single-family homes (Bradshaw et al., 2005, p. 41). (Review of these cases is provided in Chapter 8.) Within this larger context of limited data on greening of existing affordable homes, the value of the hypothetical Montalvin case study created for this study—based on genuine floor plans and redevelopment planner insight—is put in perspective.

Alternative Set of Upgrades Found Superior

Another significant obstruction to non-profit groups and government agencies incorporating green features into affordable housing has been the lack of clear guidance as to which specific green building upgrade measures are financially feasible under tight budgets, and ultimately most cost-effective (HUD, 2008, p. 80). The Contra Costa County planners formulating the NSP2 grant proposal/application struggled with a lack of clear direction on which specific green measures would be affordable and cost effective. The original upgrade set, devised under the aforementioned circumstances of limited cost and benefit data, were found in this study to cost over 60% more than anticipated (\$24,501 instead of \$15,000), and were determined to include some features (specifically dual pane windows) which green building professionals and research literature regard as lower-performing and less cost effective than alternatives (specifically ceiling insulation) (Di Santo, T., personal communication, April 9, 2010; HUD, 2008, p. 62; Brown and Berry, 1995, p. 729). If the original upgrades had been implemented as proposed, this difference of \$9,501 in the budget would have meant a reduced cap on the home purchase price to \$126,749, or a financial assistance package reduced by the same amount. The financial assistance package (typically a grant for qualifying households) is an important component in making homeownership financially feasible for first-time or low-income households by

lowering or eliminating down payment and mortgage closing costs (Darrensburg, L. personal communication, July 3, 2009).

The alternative set of upgrades created for this study were formulated to meet the NSP2 objectives, but aimed to do so at a lower cost (see Appendix 2 for a detailed product listing). The alternative set was estimated to cost \$4,133.50 less upfront than the original upgrades at \$20,367, and to save the household an additional \$223 than the original upgrades. This brought annual household utility savings to \$740 over the baseline home, reducing utility costs by 28%. Thus the alternative upgrades were superior in cost-effectiveness overall, and future upgrade programs upgrade measures should more closely resemble the alternative set of measures than the original upgrades set. Details of the alternative upgrades are described in Chapters 6 and 7.

Cost-Effective Upgrade Measures

The following provides recommendations to planners and others for formulating a cost-effective set of greening measures for existing homes, based on findings from the Montalvin theoretical case study. The NSP2 green upgrade measures were intended to address three areas (or sectors) of greening: indoor air quality, water conservation, and energy conservation. Between the two sets of upgrades analyzed, the alternative green upgrades performed better than the original upgrades, as a whole. (Details of the alternative upgrades are in Appendix 2.) Within this group of alternative upgrades, some measures performing better than others. When broken up across to these sectors and analyzed for costs and benefits, the payback rates for the alternative upgrades were found to be significantly different for water, energy, and air quality sectors. As shown in Chapter 7, Table 7.3, the alternative water conservation upgrades were estimated to have the shortest payback period, paying for themselves in approximately 6.4 years through utility savings. This is significantly shorter than the 21.8 years for the alternative energy upgrades. The shorter payback for the water conservation upgrades period was mostly due to their lower upfront

costs. The quick payback period of the water upgrades makes them the “low hanging fruit” of green home retrofitting—a colloquial phrase for easily achieved goals. Conversely, the alternative energy upgrades took decades to payback and had an upfront cost of \$9,557. This cost is nearly three times higher the federal weatherization work done in Contra Costa County, priced at \$3,500 for fiscal year 2008-2009 (see Chapter 8, Table 8.2). Coupled with the fact that weatherization upgrades save participating California homeowners \$418 annually in energy savings, these figures clearly indicate that techniques and upgrade measures used by the weatherization program are more cost-effective, and thus superior to the alternative energy upgrades (see Chapter 8, Table 8.2). Therefore future green retrofitting programs should model their energy efficiency measures closely after the federal weatherization program approach, and not those of either the original or alternative upgrade sets explored in this study.

The two air quality improvement measures studied as a part of the original and alternative upgrades were 1) painting all surfaces with zero-VOC paint, and 2) replacing existing flooring (including carpet) with quickly renewable natural bamboo. These were two of the costliest individual upgrade measures, and compounded by the fact they are not directly associated with any monetary savings, their cost-effectiveness is uncertain. These indoor air quality upgrades are presumed to provide health benefits (see Chapter 9) especially for children with asthma and others with various respiratory conditions, which is particularly important among lower income neighborhoods near industrial plants and freeways (Kleffman and Bohan, 2010). Due to the cost constraints typical of affordable housing endeavors, and limited data, a search for equally or more effective but less costly materials is recommended. If this proves difficult, then perhaps use of VOC concentration tests, such as canister air collection analysis offered by Closer Look Inspections, coupled with a scientifically-established threshold concentration of concern should be used to determine whether the replacement is appropriate or unnecessary (Closer Look Inspections,

2010). Of course, in the instance that residents suffer from respiratory illness or compromised immune systems, or the homes are located in areas with poor air quality, then regardless of relatively high prices, upgrades that improve indoor air quality are warranted.

Improving HUD Greening Guidance

The preceding recommends specific measures as cost-effective green upgrades appropriate for formulating a low-cost home greening program. HUD could improve its greening guidance by promoting those particular upgrades and providing . In addition to promoting the aforementioned cost-effective upgrades, HUD could improve its greening guidance with leadership on four specific issues not addressed by the NSP2 notification. These four issues are:

- 1) incorporating weatherization methods
- 2) involving workforce development organizations in project labor
- 3) providing guidance and pre-negotiation for rebates and tax credits
- 4) incorporating affordable rentals

Providing direction and leadership on these issues could have aided organizations in formulating their approach to the NSP2 green element, and could have widened the beneficial social impacts of the program for the reasons are provided.

Weatherization Methods

Weatherization is a federal program of the US Department of Energy with a documented history of affordably increasing the energy efficiency of homes. (See Chapter 8 for greater detail.) Its methods and institutional knowledge in strategically upgrading homes would be an ideal resource to couple with HUD programs such as NSP which seek to improve the energy efficiency of existing homes. In future programs, HUD should encourage jurisdictions to incorporate input from local or state weatherization agencies on how to approach the energy saving upgrades. This takes advantage of decades of local expertise, which would be superior to simply referencing documents that describe or list upgrades but lack information on efficacy or cost guidance.

Workforce Development Agreements

Labor was determined to comprise half to two-thirds of the cost to implement the series of upgrades for the home model in this study. Once again, weatherization offers a cost-effective, low-cost method. In many instances, weatherization is implemented by Community Action Partnership Network members and other groups which provide workforce development program for those seeking new job skills (California Department of Community Service and Development [CSD], 2010; Community Action Partnership Network, n.d.). Contracting labor through these job skill programs to provide a portion of greening labor would mean a reduced labor cost for appropriate greening tasks, such as installing clotheslines and faucet aerators. By using workforce development program labor, future HUD-funded greening programs will have reduced labor costs. These savings could be allocated towards greening measures that might not have been possible under the tighter budget constraints, such as planting fruit or shade trees, creating raised vegetable beds of clean soil, or simply serving additional households. By encouraging involvement of workforce development programs in future greening projects, HUD would help facilitate a wider distribution of jobs. HUD would be seizing the opportunity to multiply the social benefit potential of federal grant dollars by providing work to not only established contractors and subcontractors, but also to those training for new careers. In future programs, It would be important for HUD to advise jurisdictions to create work agreements that clearly differentiate between “low skilled work” such as installing clotheslines and aerators, from work that should only be done by licensed electricians, such as wiring and replacing lighting fixtures. Also, to create an incentive to arrange labor through workforce development organizations, future HUD programs should award additional ranking points to jurisdictions that commit to making work available to workforce development organizations.⁴

⁴ In competitive grant competition such as HUD's NSP2, applicants with the highest number of ranking points earn funding.

Rebate Guidance

Numerous entities providing green affordable housing documented in Bradshaw et al. reported that rebates and tax credits from utility companies, the federal Energy Star program, and other sources provided a portion of project funding (Bradshaw et al., 2005, p. 174, 175). These credits and rebates were earned on a wide range of green measures from appliances to ceiling insulation and windows. Community development corporations (CDCs) in the Seattle, Portland, Boston, and southern California metro areas that developed green affordable housing were able to take advantage these tax and rebate benefits. However, the Santa Clara and Contra Costa County public affordable housing agencies indicated they were not attempting to use efficiency-related tax credits or rebates for their NSP2 programs, despite the fact that these agencies had the capacity to use traditional affordable tax credits (LIHTC) (Lachman, D., personal communication, May 24, 2010). In making phone calls and searching websites, it was found that eligibility and redemption terms for rebates and tax credits for public agencies could not be readily determined for rebates or tax credits of either the federal Energy Star program or the PGE corporation. (Only the local water provided, EBMUD, readily agreed to provide water saving devices to any County employee bearing a title for a home in their service area and their employee identification badge.)

Due to the potential for rebates and tax credits to produce savings that can fund pursuit of additional green upgrades (such as photovoltaic panels), these financial tools should not be disregarded. Two potential solutions are as follows. Ahead of rollout of greening programs such as NSP, HUD could collaborate with the DoE Energy Star division and/or the IRS to create a central resource (i.e., website) that aims to provide enough guidance for those with experience in low-income housing tax credits (LIHTC), such as housing authorities, to be able to apply for Energy Star credits. A parallel recommendation is for HUD

to assign state departments of housing the responsibility to pre-negotiate rebate terms with the largest energy utilities in the state, on behalf of housing authorities state wide. For instance, HCD in California would pre-negotiate rebate terms with PG&E and Southern California Edison, and local jurisdictions seeking rebates would have clear forms and instructions.

Incorporating Affordable Rentals

Finally, any policy recommendations for HUD would be remiss if it they did not include commentary on homeownership. Home ownership has been the central affordable housing solution for most of the past decade (Mallarch, 2009). HUD's NSP2 and other ownership-focused programs provide for-sale units, which address the needs of households in certain income ranges (near 80% of area media income)—households with income low enough to qualify for assistance, but not so low that they cannot afford mortgage payments. However, homes for purchase do little to address one of the greatest affordable housing problems of the US—the limited supply of new, modest, affordable rental housing, like garden apartments of the 50s and 60s (Mallarch, 2009). As stated by affordable housing specialist Alan Mallarch, “[h]ome ownership for lower income people is an inherently risky proposition.” Homeownership is not the panacea for all households facing the affordable housing struggle, as demonstrated by the waves of foreclosures associated with the Great Recession, beginning in year 2007. There are merits to homeownership, perhaps chief among them that lower-income homeowners are spared the victimized by “slumlords,” as the lower-income owners have the opportunity to take charge of their home's condition. Another important benefit of ownership is that mortgage payments earn the lower-income owners equity that is

forfeited in rent payments. However, there are a number of benefits to renting not found in ownership:

- lower monthly payments than mortgages (typically)
- can afford to rent in a wider range of neighborhoods than can buy into
- can more easily adapt with changing financial or life situation (moving to a larger or smaller unit, another complex or neighborhood)
- can move closer to a job site to shorten commute length, saving time and fuel
- can take advantage better rental opportunities if they arise
- landlords are responsible for unit repairs, and sometimes utilities and/or laundry machines

In fact, to meet the HUD affordability requirement to serve low-income populations at 50% area median income (AMI), Contra Costa County added apartment rentals/leases to the proposal, otherwise it faced the slim proposition of being able to serve families in the lowest income categories with purchased housing (CCC, 2009, p. 22, 24). Hence, planners in the field recognize that the homeownership approach falls short in accommodating the poorest families. This study encourages HUD to recommit to closing this critical gap by renewing its role with policies that expand its facilitation of construction and rehabilitation of modest apartment complexes.

REFERENCES

- Alliance For Water Efficiency (2010). *Toilet retrofit devices introduction*. Retrieved August 12, 2010 from: http://www.allianceforwaterefficiency.org/Toilet_Retrofit_Devices.aspx
- Agency for Toxic Substances and Disease Registry (ATSDR) (2007). *Case studies in environmental medicine (csem): environmental triggers of asthma*. Retrieved July 29, 2010 from: <http://www.atsdr.cdc.gov/csem/asthma/envfactors.html>
- Best Buy (2007). *Guides and Resources: Washer buying guide*. Retrieved May 23, 2010 from: <http://www.bestbuy.com/site/olspage.jsp?guideID=1043363100291&type=page&id=c at12077>
- Bradshaw, W., Connelly, E. F., Cook, M.F., Goldstein, J., and Pauly, J. (2005). *The costs and benefits of green affordable housing*. Retrieved February 5, 2010 from: <http://www.housingtrustonline.org/download/GreenAffordableHousing.pdf>
- Brown, M. A. and Berry, L. G. (1995). Determinants of program effectiveness: results of the national weatherization evaluation. *Energy*, 20 (8):729-743
- BuilditGreen (2007). *Greenpoint Rated existing home checklist v1.2 [Spreadsheet]*. Retrieved June 13, 2009 from: <http://www.builditgreen.org/guidelines--checklists/>
- California Air Pollution Control Officers Association(CAPCOA) (2009). *Model Policies for Greenhouse gases in general plans..* Retrieved May 23, 2010 from: http://www.ca-ilg.org/sites/ilgbackup.org/files/resources/CAPCOA_Model_Policies_for_Greenhouse_Gases_in_General_Plans_-_June_2009.pdf
- California Department of Community Service and Development (CSD) (2007). *Income Guidelines for the Low-Income Home Energy Assistance Program (LIHEAP)*. Retrieved August 14, 2010 from: <http://www.csd.ca.gov/Programs/EnergyIncomeGuidelines.aspx>
- California Department of Community Service and Development (CSD) (2008). *CSD Helps low-income families manage and reduce enegy costs*. Retrieved August 14, 2010 from: [http://www.csd.ca.gov/Contractors/documents/Energy%20tab/LIHEAP-DOE%20Fact%20Sheet%20\(2008\).pdf](http://www.csd.ca.gov/Contractors/documents/Energy%20tab/LIHEAP-DOE%20Fact%20Sheet%20(2008).pdf)
- California Department of Community Service and Development (CSD) (2010). *Weatherization Assistance Program for Low-Income Persons:2009 State Plan and Application to the Department of Energy*. Retrieved June 12, 2010 from: <http://www.csd.ca.gov/Contractors/documents/Energy%20tab/State%20Plans/2009%20DOE%20Standard%20State%20Plan%20rev%206%2016.pdf>
- California Energy Commission (2006). *Consumer energy center: Thermostats*. Retrieved July 22, 2010 from: http://www.consumerenergycenter.org/home/heating_cooling/thermostats.html

- California Energy Commission (2010a). *Consumer energy center: Water Heaters*. Retrieved July 22, 2010 from:
<http://www.consumerenergycenter.org/home/appliances/dryers.html>
- California Energy Commission (2010b). *Consumer energy center: Water Heaters*. Retrieved July 22, 2010 from:
<http://www.consumerenergycenter.org/home/appliances/waterheaters.html>
- California Legislative Analyst Office [CaLAO] (2008). *California's Water: An LAO Primer*. Retrieved July 27, 2010 from:
http://www.lao.ca.gov/2008/rsrc/water_primer/water_primer_102208.aspx
- Campanella, L. Annual accounting reports for Contra Costa. July 1, 2008 to June 30, 2009. Personal communication, California Department of Community Services & Development, Energy and Environmental Services Division.
- Center for Watershed Sciences (2010). *Watershed restoration*. Retrieved July 30, 2010 from: <http://watershed.ucdavis.edu/research/restoration.html>
- CFBT-US, LLC. (n.d.). *Contra Costa County LODD*. Retrieved May 9, 2010 from: <http://cfbt-us.com/wordpress/?p=497>
- Chapman, R., Howden-Chapman, P., Viggers, H., O'dea, D., and Kennedy, M. (2009). Retrofitting houses with insulation: a cost-benefit analysis of randomised community trial. *Journal Of Epidemiological Community Health*, 63:271-277
- City of Roseville (n.d.). *HET Toilet rebate application* (Form # 08433-2). Retrieved from:
<http://www.roseville.ca.us/civica/filebank/blobdload.asp?BlobID=11672>
- City of Tampa (2010). *Water use calculator* [Online calculator]. Retrieved April 26, 2010.
http://www.tampagov.net/dept_water/information_resources/Saving_water/Water_use_calculator.asp
- Closer Look inspection Group, LLC. (2010). *What Are VOCs?* Retrieved July 22, 2010 from:
<http://www.closerlookinspection.com/vocs.htm>
- Community Action Partnership Network, (n.d). *About CAAS*. Retrieved August 5, 2010 from: http://www.communityactionpartnership.com/index.php?option=com_content&task=view&id=21&Itemid=50
- Contra Costa Consortium (CCC) (2009). *HUD Neighborhood Stabilization Program 2 Application* (Application ID # 388071984).
- EBMUD (n.d.). *Water rates and service charges effective July 1, 2010*. Retrieved July 20, 2010 from <http://www.ebmud.com/for-customers/account-information/water-rates-service-charges>
- EDAW (2008). *Case Study: California Title 24 energy code*. Retrieved June 13, 2010 from: http://www.cityofseattle.net/environment/documents/GBTF_NewBldg_Title24_Case_Study.pdf

- Efficiency Partnership (2010a). *Flex your power: product guides*. Retrieved July 12, 2010 from: http://www.fypower.org/res/tools/products_results.html?id=100160
- Efficiency Partnership (2010c). *Flex your power: water heaters*. Retrieved August 15, 2010 from: http://www.fypower.org/res/tools/products_results.html?id=100215
- Efficiency Partnership (2010b). *Energy saving tips: free and low cost recommendations*. Retrieved May 29, 2010 from: http://www.fypower.org/res/tools/energy_tips.html
- Efloors.com (n.d). *How much laminate flooring will you need?* Retrieved March 29, 2010 from: http://www.efloors.com/laminate_flooring_estimating.asp
- Energy Star (n.d.a). *How a product earns the energy star label*. Retrieved July 30, 2010 from: http://www.energystar.gov/index.cfm?c=products.pr_how_earn
- Energy Star (n.d.b). *Ceiling fan basics*. Retrieved July 14, 2010 from: http://www.energystar.gov/index.cfm?c=ceiling_fans.pr_ceiling_fans_basics
- Energy Star (n.d.c). *What about clothes dryers?* Retrieved July 9, 2010 from: http://energystar.custhelp.com/cgibin/energystar.cfg/php/enduser/std_adp.php?p_faqid=2984&p_created=1171989382
- Energy Star (n.d.d). *water heater, high efficiency gas storage for consumers*. Retrieved July 10, 2010 from: http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=WGS
- Enterprise (2008). *Green single family rehabilitation specifications*. Retrieved June 13, 2009 from: http://www.greencommunitiesonline.org/tools/resources/green_rehab_specs_gci_2008_criteria_final.pdf
- Foster, S. C., Tramba, A.V., and MacDonald, L.J. (2008). *ecoMOD: analyzing energy efficiency in affordable housing. Proceedings of the 2008 Systems and Information Engineering Design Symposium*. Charlottesville: University of Virginia.
- Henson, R. (2008). *The rough guide to climate change*. New York: Rough Guides (Distributed by Penguin Books)
- Home Depot (2010). *Buying guide: refrigerators*. Retrieved May 5, 2010 from: <http://www.homedepot.com/webapp/wcs/stores/servlet/ContentView?pn=Refrigerators&langId=1&storeId=10051&catalogId=10053&locStoreNum=1017&marketID=21>
- Hong, B.D., and Stlatick, E.R. (1994, January-April). Carbon dioxide emission factors for coal. *Quarterly Coal Report*, 1-8. Retrieved July 18, 2010 from: http://www.eia.doe.gov/cneaf/coal/quarterly/co2_article/co2.html
- Investopedia ULC. (2010) *Dollartimes: the net present value (npv) calculator* [Online calculator]. Retrieved June 27, 2010 from: <http://www.investopedia.com/calculator/NetPresentValue.aspx>

- Jacobs, D.E., Kelly, T., and Sobolewski, J. (2007). Linking public health, housing, and indoor environmental policy: successes and challenges at the local and federal agencies in the United States. *Environmental Health Perspectives*, 115 (6): 976-982
- Kaiser, M.J., and Pulsipher, A.G. (2004) WAP explained. *Energy Policy*, 32: 1843-1860
- Kleffman, S. and Bohan, S. (2010, January 26). Day II: Health problems persist when options are limited . East Bay ZIP codes lacking middle-class amenities have higher rates of asthma, heart disease and cancer. *Contra Costa Times*. Retrieved August 1, 2010 from: http://www.contracostatimes.com/top-stories/ci_13919582
- Knudson, T. (2010, April 4). The public eye: Mono Lake's unhealthy dust. *The Sacramento Bee*. Retrieved July 28, 2010 from: <http://www.sacbee.com/2010/03/11/2598405/public-eye-mono-lakes-unhealthy.html>
- Lawrence Berkeley National Laboratories (LBNL). (2010). *Home Energy Savings* [Online calculator]. Retrieved June 12, 2010 from: <http://hes.lbl.gov/consumer/>
- Lemus, G. (2006). *Montalvin Manor redevelopment area: staff study for the purpose of creating an amnesty program for undocumented construction*. Martinez: Contra Costa County.
- Lomax, S. (2010, July 16). Climate bill would reduce U.S. GDP by \$452 billion, energy department says. *Bloomberg*. Retrieved August 2, 2010 from: <http://www.bloomberg.com/news/2010-07-16/climate-bill-would-reduce-u-s-gdp-by-452-billion-energy-department-says.html>
- Los Angeles Department of Water and Power. (LAWPD) (2010, April 13). *LADWP Applauds its Customers February Marks Lowest Recorded Water Use in 32 Years*. Retrieved July 28, 2010 from: <http://www.ladwpnews.com/go/doc/1475/499743/>
- Mallach, A. (2009). The case for affordable housing. *Planning*, 75 (3) : 31-36
- Milne, G. and Boardman, B. (2000). Making cold homes warmer: the effect of energy efficiency improvements in low-income homes. *Energy Policy*, (28):411-424
- Mono Lake Committee. (2010). *Water conservation: why conserve?* Retrieved August 5, 2010 from: <http://www.monolake.org/about/waterconservation#whyconserve>
- Moyle, P.B., Israel, J.A. and Purdy, S.E. (2008). *Salmon, Steelhead, and Trout in California: Status of an emblematic fauna*. Retrieved August 21, 2010 from: <http://www.caltrout.org/SOS-Californias-Native-Fish-Crisis-Final-Report.pdf>
- National Oceanic and Atmospheric Administration (NOAA). (2004). *Climatology of the United States, Station: Richmond, CA, 1971-2000 (No. 20)*. Retrieved April 29, 2010 from: <http://cdo.ncdc.noaa.gov/climatenormals/clim20/ca/047414.pdf>
- Partnerships for Home Energy Efficiency (2007). *An overview*. Retrieved July 21, 2010 from: http://www.energystar.gov/ia/home_improvement/PHEE_Overview_final.pdf

- Reamy, G. and Gates, C. (2009, June). What is weatherization? Presentation at the 2009 National Weatherization Training Conference of the US Department of Energy, Indianapolis, Indiana.
- Retzlaff, R. C. (2009). The use of LEED in Planning and Development Regulation: An exploratory analysis. *Journal of Planning Education and Research*, 29:67-77
- Rheem Manufacturing Company (2006). *Use and care manual with instructions for the installer* (Document no. AP 13787). Retrieved June 14, 2010 from: <http://products.geappliances.com/MarketingObjectRetrieval/Dispatcher?RequestType=PDF&Name=AP13787%20GE%20US%20Power%20Vent.pdf>
- Schweitzer, M. and Tonn, B. (2003). Non-energy Benefits of the US Weatherization Assistance Program: A summary of their scope and magnitude. *Applied Energy*, 76:321-335.
- Sparks, C.W. (2007). *Greening Affordable Housing: An Assessment of Housing under the Community Development Block Grant and HOME Investment Partnership Programs*. Master's thesis. Texas State University- San Marcos. Retrieved December 29, 2009 from: <http://ecommons.txstate.edu/arp/251>
- Stawitz, C., McGehee, H., Devlin, C.M., Tan, F., and Wong, S. (2008). Increasing awareness of residential energy consumption: data analysis and presentation for EcoMod, a sustainable housing initiative. *Proceedings of the 2008 Systems and Information Engineering Design Symposium*. Charlottesville: University of Virginia.
- Sunikka, M. (2006). Energy efficiency and low-carbon technologies in urban renewal. *Building Research & Information*. 34(6): 521-533
- The Nature Conservancy (TNC) (2010). *Cosumnes River*. Retrieved July 18, 2010 from: <http://www.nature.org/wherewework/northamerica/states/california/preserves/art6318.html>
- The Trailmaster, Inc. (2007). Mono Lake Tufa State Reserve: South Tufa Trail. Sacramento: California Department of Parks and Recreation Retrieved July 22, 2010 from: http://www.parks.ca.gov/default.asp?page_id=25164
- Tonn, B., Schmoyer, R., and Wagner, S. (2003). Weatherizing the homes of low-income energy assistance program clients: a programmatic assessment. *Energy Policy*, 31: 735-744
- US Census Bureau, (n.d.) 2000 Census Summary File 3, Matrices H7, H74, H76, H80, and HCT28 for Census Tract 3604.01; Retrieved March 25, 2010 from: http://factfinder.census.gov/home/saff/main.html?_lang=en
- US Census Bureau. (2008). *American Housing Survey for the United States: 2007*. Retrieved May 12, 2009 from: <http://www.census.gov/prod/2008pubs/h150-07.pdf>
- US Census Bureau. (2010). 2009 American Housing Survey National detailed tables - introductory characteristics- Table 1-1 [Spreadsheet]. Retrieved May 12, 2009 from: <http://www.census.gov/hhes/www/housing/ahs/ahs09/ahs09.html>

- US Department of Energy (DoE) (2001). *Weatherize your home-caulk and weather strip*. Retrieved March 22, 2010 from: <http://www1.eere.energy.gov/library/pdfs/28039.pdf>
- US Department of Energy (DoE) (2009a). *Energy savers: weatherstripping*. Retrieved March 24, 2010 from: http://www.energysavers.gov/your_home/insulation_airsealing/index.cfm/mytopic=11280
- US Department of Energy (DoE) (2009b). *Energy savers: air conditioning*. Retrieved July 11, 2010 from: http://www.energysavers.gov/your_home/space_heating_cooling/index.cfm/mytopic=12370
- US Department of Energy (DoE) (2009c). *Energy savers: sizing storage and heat pump (with tank) water heaters*. Retrieved August 9, 2010 from: http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=12990
- US Department of Energy (DoE) (2010a). *Energy savers: ceiling fans and other circulating fans*. Retrieved July 9, 2010 from: http://www.energysavers.gov/your_home/space_heating_cooling/index.cfm/mytopic=12355
- US Department of Energy (DoE) (2010b). *Energy savers: thermostats and control systems*. Retrieved July 10, 2010 from: http://www.energysavers.gov/your_home/space_heating_cooling/index.cfm/mytopic=12720
- US Environmental Protection Agency (EPA) (2008a). *National efficiency standards and specifications for residential and commercial water-using fixtures and appliances*. Retrieved June 22, 2010 from: <http://www.epa.gov/WaterSense/docs/matrix508.pdf>
- US Environmental Protection Agency (EPA) (2008b). *Acid rain*. Retrieved August 10, 2010 from: <http://www.epa.gov/acidrain/>
- US Environmental Protection Agency (EPA) (2010a). *Green building: frequent questions. What is green building?* Retrieved August 8, 2010 from: <http://www.epa.gov/greenbuilding/pubs/faqs.htm#1>
- US Environmental Protection Agency (EPA) (2010b). *An introduction to indoor air quality: volatile organic compounds (VOCs)*. Retrieved August 2, 2010 from: <http://www.epa.gov/iaq/voc.html#Health Effects>
- US Environmental Protection Agency (EPA) (2010c). *Watersense. Indoor water use in the United States*. Retrieved July 22, 2010 from: <http://www.epa.gov/WaterSense/pubs/indoor.html>

- US Environmental Protection Agency (EPA) (2010d). *Lead in paint, dust, and soil. Renovation, Repair and Painting (RRP)*. Retrieved August 15, 2010 from: <http://www.epa.gov/lead/pubs/renovation.htm>
- US Environmental Protection Agency (EPA) (2010e). *Human-related sources and sinks of carbon dioxide*. Retrieved August 11, 2010 from: http://www.epa.gov/climatechange/emissions/co2_human.html
- US Environmental Protection Agency (EPA) (2010f). *Mid-Atlantic Mountaintop Mining*. Retrieved August 8, 2010 from: <http://www.epa.gov/region3/mtntop/>
- US Environmental Protection Agency (EPA) (2010g). *EPA greening glossary*. <http://www.epa.gov/oaintrnt/glossary.htm>
- US Environmental Protection Agency (EPA) (2010h). *Effects of climate change and greenhouse gas mitigation strategies on air quality*. Retrieved August 11, 2010 from: http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/9066/report/0
- US Environmental Protection Agency (EPA) (2010i). *Watersense: what are the environmental benefits of water efficiency?* Retrieved August 9, 2010 from: http://www.epa.gov/WaterSense/water_efficiency/environmental_benefits.html
- US Department of Housing and Urban Development (HUD) (2005). *ECM: Domestic water-heating systems*. Retrieved July 1, 2010 from : http://www.hud.gov/offices/pih/programs/ph/phecc/strat_w1.cfm
- US Department of Housing and Urban Development (HUD) (2008). *Building Energy Star qualified homes and incorporating energy efficiency and green building into HOME-funded affordable homes*.
- US Department Of Housing And Urban Development (HUD). (2009a). *Notice of fund availability (nofa) for the Neighborhood Stabilization Program 2 under the American Recovery and Reinvestment Act, 2009* (Docket No. FR-5321-N-01). Washington, D.C.:Author. Retrieved June 12, 2009 from: http://www.hud.gov/offices/cpd/communitydevelopment/programs/neighborhoodspg/pdf/nsp2_nofa.pdf
- US Department of Housing and Urban Development (HUD) (2009b). *CPD implementation guidance for the buy American requirement of the American Recovery and Reinvestment Act of 2009 including the exception process* (Notice no. CPD-09-05). Retrieved March 27, 2010 from: www.hud.gov/offices/adm/hudclips/notices/cpd/files/09-05cpdn.doc
- Utah Divison of Water Resources (n.d.) *Water education: municipal drinking water*. Retrieved August 9, 2010 from: <http://www.watereducation.utah.gov/WaterInUtah/Municipal/default.asp>
- West Virginia Conservation Agency (WVCA) (2003). *Interaction of competing uses of water*. Retrieved August 8, 2010 from: <http://www.wvca.us/envirothon/a8.html>

APPENDIX A1 : List of Material and Labor Costs for Green Upgrades and Conventional Equivalents

ITEMS	Version	Brief Description	Cost L + M	Cost - Material	Cost - Labor	Product Details (Brand, Model, Specifications and Home Depot SKU#)	Green - Conv. Difference
Appliance - Clothes Washer	Conv.	Economy model, over 3 cubic feet	\$559.00	\$359.00	\$200.00	GE, 3.2 Cu. Ft. Super Capacity Washer Model # WHDSR209GWW, Store SKU # 626-227	\$289.00
	Green	EnergyStar rated economy model, over 3 cubic feet	\$848.00	\$448.00	\$400.00	LG Electronics, 3.5 Cu. Ft. Large Capacity Front Load Model # WM2010CW Store SKU # 238606	
Appliance - Dishwasher	Conv.	Economy model	\$669.00	\$219.00	\$450.00	Americana, 24 In. Built-In Model # ADW1100NWW, Store SKU # 975-171	\$180.00
	Green	EnergyStar rated economy, water efficient model	\$849.00	\$399.00	\$450.00	Maytag, JetClean® Plus, 24 In. Model # MDBH949AWW Store SKU # 549-097	
Appliance - Refrigerator	Conv.	Economy model, over 25 cubic sq. feet	\$959.00	\$899.00	\$60.00	Maytag 25.2 Cu. Ft. Side-by-Side Refrigerator Model # MSD2572VEW Internet # 100663233 Store SKU # 301408 Store SO SKU # 301408	-\$100.00
	Green	EnergyStar rated, over 25 cubic sq. feet, economy model	\$859.00	\$799.00	\$60.00	Amana, 25.1 Cu. Ft. Side-by-Side Refrigerator Model # ASD2522WRW, Store SKU # 187561	
Flooring	Conv.	Laminate flooring	\$3,375.12	\$1,225.12	\$2,150.00	Home Legend, Tacoma Oak, 7mm T x 7 9/16 In. W x 50 5/8 In. L Laminate Click Lock Flooring (23.93 sq. ft./Case) Model # HL85 Internet/Catalog # 100671872 Store SKU # 278587 \$23.69/CA (\$0.99/sqft in boxes of in boxes of 23.6 , 52 boxes of 23.5 = 1113 sqft + 10% extra)	\$2,297.12
	Green	Bamboo flooring	\$5,672.24	\$3,672.24	\$2,000.00	Home Legend, Horizontal Natural, 5/8 In. T x 3 3/4 In. W x 37 3/4 In. L Solid Bamboo Flooring Model # BAFL24NA Internet/Catalog # 100497047 Price includes shipping \$70.62/CA-Case Covers 23.59sqft (\$2.99/sqfoot in boxes of 23.6 , 52 boxes of 23.5 = 1113 sqft + 10% extra)	
Lights and Fan for Bathroom	Conv.	Economy model	\$821.00	\$176.00	\$645.00	(2) NuTone 70 CFM Fluorescent Fan/LighModel # 769RFT, Store SKU # 380790 (2)Hampton Bay, Brushed Nickel Finish 4-Light Bath Bar Model # HB2051-35 Internet/Catalog # 202022451 Store SKU # 108898 \$12.97/EA plus GE Crystal Clear Double Life 40-Watt Globe G25 (2 per Pack) Model # 40G25C/2L-TP2/6 Store SKU # 661639 \$4.77/EA	\$423.00
	Green	EnergyStar rated economy model	\$1,244.00	\$344.00	\$900.00	(2)NuTone Recessed Fan/light, Energy Star, 70 CFM, 1.5 Sones, 6 In. White Trim, Model # 744FLNT, SKU # 148-633 (online only) \$129/EA (2)Green Matters, Light Brushed Nickel 18 In. Vanity Racetrack Style 15W Bulbs Included Model # HD-3301 Internet/Catalog # 202054182 \$43/EA	
Lighting for Other Rooms and Outdoors	Conv.	Economy single bulb fixtures and motion sensor lights	\$1,646.93	\$194.43	\$1,452.50	INDOOR: (9) Hampton Bay, Flushmount in Antique Brass Finish with White Opal Glass Model # JO106H Store SKU # 287958 \$9.47/EA + \$3.87 (2 light bulbs per pack, 60 watt, SKU#206767) OUTDOOR: (5) Heath Zenith, 150 Deg., 120W White Motion Sensor Security Light Model # SL-5411-WH Internet/Catalog # 100014085 Store SKU # 408693 \$17.97/EA	\$717.42
	Green	EnergyStar rated economy single bulb fixtures and motion sensor lights	\$2,364.35	\$251.85	\$2,112.50	INDOOR: (9) Green Matters, Light Brushed Nickel Fluorescent 6 In. Ceiling Mount w/ Alabaster Glass with 13W CFL Bulb Included Model # HD-3189 Internet/Catalog # 202054154 \$18.00/EA OUTDOOR: (5) Heath Zenith, 150 Deg., 120W White Motion Sensor Security Light Model # SL-5411-WH Internet/Catalog # 100014085 Store SKU # 408693 \$17.97/EA	
Paint	Conv.	Economy paint	\$3,115.72	\$265.72	\$2,850.00	Glidden 1 Gal. Eggshell Light Colors Interior Latex Paint (13 gallons) with 350 sqft/gallon Model # GL6011-01 Store SKU # 308545 \$20.47/GA	\$86.32
	Green	Zero VOC from local company	\$3,202.04	\$352.04	\$2,850.00	Kelly-Moore, Green Coat. 0 VOCs. (13 gallons) with 350 sqft/gallon (20.47 per gallon)	
Water Fixture - Bath Faucets	Conv.	Economy faucet model	\$196.00	\$46.00	\$150.00	MOEN Touch Control Bath Faucet in Chrome, 2.2 gpm Model # CA84403 Store SKU # 790938 \$46.00/EA	\$320.00
	Green	WaterSense low-flow	\$516.00	\$116.00	\$400.00	Price Pfister Pasadena 4 In. Bath in Polished Chrome 1.5 gpm, Model # F-048-PDCC Store SKU # 582801 \$58.00/EA	
Water Fixture - Kitchen Faucet	Conv.	Economy faucet model	\$150.00	\$30.00	\$120.00	Glacier Bay Two Handle Kitchen Faucet in Chrome Model # 67099-0001 Internet/Catalog # 202043831 Store SKU # 839256 \$29.98/EA 2.2gpm flowrate	\$36.00
	Green	Conventional economy model plus aerator	\$186.00	\$36.00	\$150.00	Average aerator cost \$6.00; WaterSense does not label kitchen faucets.	
Water Fixture - Showerhead	Conv.	Standard	\$54.85	\$4.85	\$50.00	American Standard Easy Clean Showerhead- 2.5 gpm Polished Chrome Model # 8888.075.002 Internet/Catalog # 100079217 \$16.25/EA	\$33.02
	Green	WaterSense low-flow	\$87.87	\$12.87	\$75.00	Delta 1.5 GPM Water-Amplifying Shower Head in Chrome, Model # 75153, Store SKU # 725532, \$12.87/EA	
Water Fixture - Toilets	Conv.	Standard, Single flush	\$537.00	\$187.00	\$350.00	Glacier Bay All In One White Toilet Model # TG-4200-W 1.6 GPF SKU # 303635.	\$49.00
	Green	WaterSense, Dual flush	\$586.00	\$236.00	\$350.00	Glacier Bay Elongated Dual Flush High Efficiency 1.1/1.6 GPF All-in-One Toilet, Model # N2316, Store SKU # 215583, \$118.00/EA	
Weatherstripping	Conv.	none (no equivalent)	\$0.00				0
	Green	Door sweeps and silicon tubing	\$110.72	\$35.72	\$75.00	(2) MD Building Products 17 Ft. White All Climate Thermalblend® Silicone Blend Weatherseal Model # 43846 Store SKU # 435400 \$9.89/EA PLUS MD Building Products 36 In. Premium Aluminum and Vinyl Door Sweep Aluminum Model # 05389 Store SKU # 625000 \$7.97/EA	
Windows	Conv.	Single paned	\$7,588.13	\$2,188.13	\$5,400.00	Jeld-Wen, 600 Series, single pane, vinyl frame, EZ Frame.	\$387.37
	Green	Dual paned	\$7,975.50	\$2,775.50	\$5,200.00	Milgard, Classics series, low emissivity, 0.30 U solar gain, double paned windows with expanding foam.	
TOTAL	Conv.	ALL	\$19,671.75	\$5,794.25	\$13,877.50	ALL	\$4,718.25
TOTAL	Green	ALL	\$24,500.72	\$9,478.22	\$15,022.50	ALL	
GREEN Labor + Materials Costs: \$24,501						L + M	
CONVENTIONAL Labor + Material Costs: \$19,671						L + M	

APPENDIX A2 – Labor and material costs for alternative upgrades cost, with product details.

ITEM	Cost L + M	Cost - Material	Cost - Labor	Product Details (Brand, Model, Specifications and Home Depot SKU#)
Appliance - Clothes Washer	\$848.00	\$448.00	\$400.00	LG Electronics, 3.5 Cu. Ft. Large Capacity Front Load Model # WM2010CW Store SKU # 238606
Appliance - Dishwasher	\$849.00	\$399.00	\$450.00	Maytag, JetClean® Plus, 24 In. Model # MDBH949AWW Store SKU # 549-097
Appliance - Refrigerator	\$758.00	\$698.00	\$60.00	Amana, 25.1 Cu. Ft. Side-by-Side Refrigerator Model # ASD2522WRW, Store SKU # 187561
Ceiling Fans (with lights)	\$1,222.85	\$247.85	\$975.00	(4) #1: Hampton Bay 36" Minuet III Fan Model AG806C-WH Store SKU # 164352 (\$47.97) (1) #2: Hampton Bay 44" Hawkins Fan Model YG204-WH. Store SKU # 117391 (\$49.97)
Ceiling Insulation	\$2,782.50	\$2,782.50	\$0.00	Flat roof insulation at 2.50 per square foot, for 1,113 square feet. (Per contractor Bay Valley Inc.)
Clothesline	\$143.88	\$53.88	\$90.00	(3) Lehigh 40 Ft. Retractable Clothesline Model # RC40 Store SKU # 386259 \$17.96/EA
Digital Thermostat	\$109.00	\$39.00	\$70.00	RiteTemp Flush Mount 7 Day Programmable Back Lit Touch Screen Thermostat for 1 Or 2 Stage Systems Model # 6036 Store SKU # 474235 \$39.00/EA
Flooring	\$5,672.24	\$3,672.24	\$2,000.00	Home Legend, Horizontal Natural, 5/8 In. T x 3 3/4 In. W x 37 3/4 In. L Solid Bamboo Flooring Model # BAFL24NA Internet/Catalog # 100497047 Price includes shipping \$70.62/CA-Case Covers 23.59sqft (\$2.99/sqfoot in boxes of 23.6 , 52 boxes of 23.5 = 1113 sqft + 10% extra)
Lights & Fans with Lights for Bathrooms	\$1,244.00	\$344.00	\$900.00	(2)NuTone Recessed Fan/light, Energy Star, 70 CFM, 1.5 Sones, 6 In. White Trim, Model # 744FLNT, SKU # 148-633 (online only) \$129/EA (2)Green Matters, Light Brushed Nickel 18 In. Vanity Racetrack Style 15W Bulbs Included Model # HD-3301 Internet/Catalog # 202054182 \$43/EA
Lighting - Indoor & Outdoor (excludes bathrooms)	\$1,314.35	\$161.85	\$1,152.50	INDOOR: (4) Green Matters, Light Brushed Nickel Fluorescent 6 In. Ceiling Mount w/ Alabaster Glass with 13W CFL Bulb Included Model # HD-3189 Internet/Catalog # 202054154 \$18.00/EA -- NOTE: ceiling fans provide 5 lights. OUTDOOR: (5) Heath Zenith, 150 Deg., 120W White Motion Sensor Security Light Model # SL-5411-WH Internet/Catalog # 100014085 Store SKU # 408693 \$17.97/EA
Paint	\$3,202.04	\$352.04	\$2,850.00	Kelly-Moore, Green Coat. 0 VOCs. (13 gallons) with 350 sqft/gallon (\$20.47 per gallon)
Water Fixture - Bath Faucets	\$516.00	\$116.00	\$400.00	Price Pfister Pasadena 4 In. Bath in Polished Chrome 1.5 gpm, Model # F-048-PDCC Store SKU # 582801 \$58.00/EA
Water Fixture - Kitchen Faucet Aerator	\$36.00	\$6.00	\$30.00	Average aerator cost \$6.00. (WaterSense does not label kitchen faucets.)
Water Fixture - Showerhead	\$87.87	\$12.87	\$75.00	Delta 1.5 GPM Water-Amplifying Shower Head in Chrome, Model # 75153, Store SKU # 725532, \$12.87/EA
Water Fixture - Toilets Tank Bag	\$67.98	\$7.98	\$60.00	New Resources Group Toilet FlushLess water displacement blatter bag. 2.5 quarts displaced per bag. Amazon.com Item #: B002ED3J4K \$3.99/EA
Waterheater	\$1,403.04	\$603.04	\$800.00	GE Energy Star 50 Gallon Natural Gas Storage Water Heater, 36K BTU, Ultra Low Nox, E =0.62 Model # SG50T12TXK00 , Store SKU # 170910, \$568.00/EA, SEISMIC STRAP Spacemaker Water Heater Earthquake Restraining Straps Model # E-75 Internet/Catalog # 100067210 Store SKU # 495011 \$13.47/EA
Weather-stripping	\$110.72	\$35.72	\$75.00	(2) MD Building Products 17 Ft. White All Climate Thermalblend® Silicone Blend Weatherseal Model # 43846 Store SKU # 435400 \$9.89/EA PLUS MD Building Products 36 In. Premium Aluminum and Vinyl Door Sweep Aluminum Model # 05389 Store SKU # 625000 \$7.97/EA
TOTAL	\$20,367	\$9,980	\$10,388	Alternative Upgrades Total Costs = \$20,367

Note: Original Upgrades included windows, Alternative Upgrades drops window upgrades, and instead improves ceiling insulation. Using laminate flooring instead of bamboo brings to total cost to \$18,740 while still improving indoor air quality.

Appendix B: Calculations & Industry Recommendations for Materials Sizing

Ceiling Fan Sizing :

Energy Star (n.d.) *Ceiling fan basics*. Retrieved July 14, 2010 from:
http://www.energystar.gov/index.cfm?c=ceiling_fans.pr_ceiling_fans_basics

living room		small bedroom	
12.2	22.4	11.5	8.10
146	268	137	106
	39128		14522
	271.7222222		100.8472222
78%	211.9433333	78%	78.66083333
44" diameter		36" diameter	
kitchen		master bedroom	
9.3	20.8	15.11	13.8
111	248	191	164
	27528		31324
	191.1666667		217.5277778
78%	149.11	78%	169.6716667
44" diameter		44" diameter	
converted bedroom			
10.2	20.8		
122	248		
	30256		
	210.1111111		
78%	163.8866667		
44" diameter			
(will also require wiring to install)			

Flooring sizing:

$1427 * 78\% = 1,113 \text{ sq ft}$

(The Karen Rd home floor plans were scaled down to 1,113 sq. ft. to represent the typical home per the research. See Chapter 3.)

Lighting

NOTE: 10 fixtures, 1 of which is the laundry room. This bulb remains in baseline configuration. Thus, effectively, there are only 9 places lights (or fans) are installed. Of the 9 fixtures that are modified (in conventional configuration, original & alternative upgrades), one need wiring (garage bedroom). In all instances, 8 are regular installs, and 1 is a newly wired.

HOUSE LIGHTS + FANS (Conventional)		
Conventional Equiv.	Labor	Materials
8 regular single bulb fixtures		
1 newly wired single bulb (all Non-Energy Star)	\$940	\$105
OUTDOOR LIGHTS (Conventional) (non energystar)		
	Labor	Materials
5 motion sensors	\$512.50	\$89.85
BATH LIGHTS + FANS (Conventional)		
2 Strips	\$120.00	\$45.02
2 Fans	\$525.00	\$130.98
bulbs - non Energy Star		

HOUSE LIGHTS (Original)		
Original	Labor	Materials
8 regular single bulb Energy Star fixtures	\$1,280.00	
1 newly wired single bulb* (All Energy Star)	\$320.00	\$162.00
OUTDOOR LIGHTS (Original) (non energystar)		
	Labor	Materials
5 motion sensors	\$512.50	\$89.85
BATH LIGHTS + FANS (Original)		
2 Strips - ES	\$375.00	\$86.00
2 Fans - ES. (come with ES bulbs)	\$525.00	\$258.00

HOUSE LIGHTS + FANS (Alternative)		
Alternative	Labor	Materials
4 regular single bulb, Energy Star fixtures	\$640.00	\$72.00
5 ceiling fans; 1 newly wired	\$975.00	\$247.85
<<ceiling fans are NOT included in the LIGHTING costing portion ; seperately accounted.		
OUTDOOR LIGHTS (Alternative) (non energystar)		
	Labor	Materials
5 motion sensors	\$512.50	\$89.85
BATH LIGHTS + FANS (Alternative)		
2 Strips - ES	\$375.00	\$86.00
2 Fans - ES. (come with ES bulbs)	\$525.00	\$258.00

Paint Volume Calculation

Rob Kimball at Kelly-Moore, San Luis Obispo, CA. (805)541-5116. March 22, 2010. Personal communication..

	width	inches	height	inches	
bedroom 1:	740		96	71040	
master	710		96	68160	
bedroom 2:	486		96	46656	
kitchen:	1198		96	115008	
living rm :	828		96	79488	
hall	338		96	32448	
mas. Bath	332		96	31872	
other bath	292		96	28032	
laundry	296		96	28416	
closet1	376		96	36096	
closet2	114		96	10944	
closet3	178		96	17088	
closet4	178		96	17088	
closet5	94		96	9024	
closet6	296		96	28416	4304
ceiling				205488	
sum				5731	
78%				4470.18	square feet of paint at 350 sqft/gallon 12.77194 Gallons of Paint
				13 gallons of Paint	

Perimeter of Walls (for insulation)

Rates Guy Roth of Bay Valley, Inc. personal communication.
Bay Valley Insulation, Fremont, CA. (510) 791-5535. May 5, 2010.

Walls	ft.in.	feet*12	inches	
20.8	20	240	8	
10.2	10	120	2	
9.3	9	108	3	
12.2	12	144	2	
22.4	22	264	4	
5.4	5	60	4	
7	7	84	0	
13.8	13	156	8	
13.8	13	156	8	
15.11	15	180	11	
8	8	96	0	
6	6	72	0	
sum			1730	
78%			1349.4	
feet			112.45	PERMITER of MODEL HOUSE
				feet of foam insulation needed

Water Heater Sizing

US Department of Energy (2009). *Sizing storage and heat pump (with tank) water heaters.*

Accessed June 17, 2010 from:

http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=12990

Hot water needed	Water Usage	Times per one hour	Hot H2O (in gallons)
12	Shower	1	12
9	Bath	0	0
2	Shaving	0	0
4	Hands & face washing	5	20
4	Hair shampoo	1	4
4	Hand dishwashing	0	0
14	Automatic dishwasher	0	0
5	Food preparation	0	0
26	Wringer clothes washer	0	0
32	Automatic clothes washer	0.5	16
		SUM	52

Window Size Calculation

Home Depot Store #1052, San Luis Obispo, CA (805) 596-0857. March 24, 2010.

Scaled Windows	Milgard Windows - Tuscany Model		WIDTH	HEIGHT	TYPE
	Width (in)	Height (in)	feet/inch	feet/inch	
3*	19	19	1' 7"	1' 7"	Crank (or Fixed)
1	36	28	3'	2' 4"	SingleHung
1	28	37	2' 4"	3'	SingleHung
1	37	41.5"	3'1"	3' 5.5"	SingleHung
1	37	49"	3'1"	4'1"	SingleHung
1	37	39	3'1"	3'3"	SingleHung
2	37.5	56	4'8"	3' 1.5"	Picture
1	54.5	26.5	4' 6.5"	2' 2.5"	Picture
1	standard	83	standard	6' 11"	Slider

12

*1: Privacy + Tempered, 2: Privacy, 3: Nothing

APPENDIX C: Labor Solicitation Spreadsheet for Green and Conventional Upgrades

ESTIMATE 1 - ITEMS				
1	COMFORT/TEMP	SKU at HOMEDEPOT	YOUR LABOR PRICE EST.	
	WINDOWS - 12 Single Pane: (600 Series or by JeldWen) EZ-Frame 5 Single Hung, 3 Casement, 3 Picture, & 1 Sliding Door	Special Order to Spec	5200	70
	Thermostat -RiteTemp Manual for most 24 Volt Systems	# 460822	60	1
	SWAMP COOLER Unit (2) - Living and Masterbedroom LG Electronics 18000 and 12000 btu "window coolers"	# 125399 and # 851103	1650	22
	WALL FURNACE Williams Furnace Co. 35,0000 BTUs - Top Vent w/thermostat	# 861154	1800	24
2	APPLIANCE REPLACEMENT			
	Clothes dryer - GE Size: 5.8 Cu. Ft.	# 627337	200	2.5
	Clothes washer - GE 3.2 Cu. Ft.,	# 626227	200	2.5
	Dishwasher - Americana 24 In.	#975171	450	6
	Kitchen hood - Maytag 30 In. Vented Under-Cabinet Range Hood	#124079	600	8
	Refrigerator - Hotpoint 25.0 Cu. Ft. Side-by-Side	# 568427	60	1
3	WATER FIXTURE REPLACEMENTS			
	Kitchen Faucet - Glacier Bay Two Handle Kitchen Faucet	#839256	120	1.6
	Bath Faucets (2) - MOEN Touch Control Bath Faucet	# 790938	150	2
	Showerhead (1) - American Standard Easy Clean	# 100079217	50	1
4	LIGHTING and FANS			
	Room Lights (replace 8 prewired, 1 needs wiring) Hampton Bay Flushmount (9 total) Bedroom, Living, Kitchen	# 287958	940	12.5
	Bathroom Fan w/ Light (2) - NuTone 70 CFM Fluorescent Fan/Light (Same switchfor light and fan)	# 380790	525	7
	Bath (2)- Hampton Bay 4-Light Bar (replace, both prewired)	# 108898	120	2.1
5	OTHER			
	Water Heater - GE 50 Gallon Electric 6YR 4500 Watt	# 487776	850	11.3
	Paint interior - no color change, no primer needed (except for ceiling) Glidden 1 Gal. Eggshell Latex Paint	# 859969	2250	30
	Flooring Laminate Click Lock Flooring dispose of old carpet (recycle as much as possible)	# 278587	2150	28.6
* Any item number longer than 6 digits is ordered online				

ESTIMATE 2 - ITEMS				
		SKU at HOMEDEPOT	YOUR LABOR PRICE EST.	
1	COMFORT/TEMP			
	WINDOWS - 12 DUAL Pane: (Milgard Styline, Z-Bar) 5 Single Hung, 3 Casement, 3 Picture, & 1 Sliding Door Weatherstripping - Vinyl strips for 2 outer doors, install door sweeps. Thermostat -RiteTemp Flush Mount Touch Screen, 1 or 2 Stage system	Special Ordered #625000 and #435400 #474235	5400 75 70	72 1 1
	INSULATION			
Provide own materials	1a: UltraTouch* Batt Insulation - R-13 (2x4) Wall, R-38 Ceiling (no attic) 1b: Remove and Replace Dry Wall (Two Subcontractors OK)	n/a	1500 8200	20 109
Provide own materials	2: Blown in Cellulose - R-13 wall (min), R-38 ceiling (no attic) (One Subcontractor OK)	n/a	2600	34.6
Specs:	Net wall area: 717square feet, Ceiling: 1113 sqft Studs are 2x4, no current insulation, Knob&Tube Wiring			
2	APPLIANCE REPLACEMENT etc.			
	Install Three 40 foot retractable clotheslines for maximum sun.	# 386259	90	2
	Clothes washer - LG 3.5 Cu. Ft. Front Load	# 238606	400	5.3
	Dishwasher - Maytag JetClean® Plus 24 In.	# 549097	450	6
	Kitchen hood - Air King 30-Inch Range Hood	LOWES Item #: 39621	600	8
	Refrigerator - Amana 25.1 Cu. Ft. Side-by-Side	# 187561	60	1
3	WATER FIXTURE REPLACEMENTS			
	Kitchen Faucet - insert an aerator (will be provided)	none	30	0.5
	Bath Faucets (2) - Price Pfister 4 In.	# 582801	400	5.3
	Showerhead (1) - Delta Water-Amplifying	# 725532	75	1
4	LIGHTING and FANS			
	Ceiling Fans (5) -replace 4 lights with fans. 1 room needs to be wired. 36" Minuet III (4) and 44" Hawkins Fan (1) - both Hampton Bay	#164352 and #117391	975	13
	Overhead Lights - replace fixtures Fluorescent 6 In. Ceiling Mount (5 total) Bedroom, Living, Kitchen	# 202054154	800	10.6
	Bathroom Fan w/ Light (2) - NuTone Recessed Fan/light, Energy Star (Same switchfor light and fan)	#148633	525	7
	Bath (2) - 3 Light 18 In. Racetrack - (replace, both prewired)	# 202054182	375	5
	Outdoor Lights - (4) - replace four lights with motion-detection lights.	# 408693	410	5.4
5	OTHER			
	Water Heater - GE Energy Star 50 Gall. Nat. Gas 36K BTU, Low Nox	# 170910	800	10.6
	Paint interior - no color change, no primer needed (except for ceiling) Kelly-Moore Green Coate	n/a	2250	30
	Flooring Solid Bamboo Flooring - install 1113sqft (dispose of old carpet & vinyl, recycle as much as possible)	# 100497047	2000	26.6

Note: Any item number longer than 6 digits is ordered online
* Ultratouch is recycled blue jeans, formaldehyde free

6 OTHER
ELECTRICAL (Re-wire, Subpanel, Meter)

7800 80

HOME ENERGY SAVER™

HOME ENERGY SAVER REPORT

Prepared by:

Delilah Z. Leval Base Home Model

This report is generated by the Home Energy Saver web-based energy audit tool, developed by the U.S. Department of Energy's Lawrence Berkeley National Laboratory, and can be reached at <http://hes.lbl.gov>

[illegible]

Doors Windows

Attic Roof

Ducts Pipes

Thermostat

97

Time : **17**; Temperature setting - Heating temperature : **8**; Temperature setting - Cooling temperature : **8**; Weekdays Heating Wake degrees : **68**; Weekdays Heating Wake Time : **7**; Weekdays Heating Away degrees : **64**; Weekdays Heating Away Time : **9**; Weekdays Heating Evening degrees : **68**; Weekdays Heating Evening Time : **19**; Weekdays Heating Sleep degrees : **64**; Weekdays Heating Sleep Time : **23**; Weekdays Cooling Wake degrees : **78**; Weekdays Cooling Wake Time : **7**; Weekdays Cooling Away degrees : **81**; Weekdays Cooling Away Time : **9**; Weekdays Cooling Evening degrees : **78**; Weekdays Cooling Evening Time : **19**; Weekdays Cooling Sleep degrees : **81**; Weekdays Cooling Sleep Time : **23**; Weekend/Holiday Heating Wake degrees : **68**; Weekend/Holiday Heating Wake Time : **8**; Weekend/Holiday Heating Away degrees : **64**; Weekend/Holiday Heating Away Time : **11**; Weekend/Holiday Heating Evening degrees : **68**; Weekend/Holiday Heating Evening Time : **19**; Weekend/Holiday Heating Sleep degrees : **64**; Weekend/Holiday Heating Sleep Time : **23**; Weekend/Holiday Cooling Wake degrees : **78**; Weekend/Holiday Cooling Wake Time : **8**; Weekend/Holiday Cooling Away degrees : **81**; Weekend/Holiday Cooling Away Time : **11**; Weekend/Holiday Cooling Evening degrees : **78**; Weekend/Holiday Cooling Evening Time : **19**; Weekend/Holiday Cooling Sleep degrees : **81**; Weekend/Holiday Cooling Sleep Time : **23**;

Heating Equipment

Type of heating system : **Room (through-the-wall) gas furnace**; Heating system capacity : **60000**; Heating system efficiency : **50.00**; Year heating system installed : **1970**; Percentage of the house's floor area heated by a central or room heating system : **19**; Percentage of the house's heating needs supplied by a wood burning stove or portable heater : **37**;

Cooling Equipment

Type of cooling system : **No Cooling Equipment**; Cooling system capacity : **0**; Cooling system efficiency : **0.00**; Year cooling system installed : **1970**; Percentage of the house's floor area cooled by the cooling system : **100**; Hours room air conditioner is on during an average day in the cooling season : **None**; Number of months room air conditioner is on during an average cooling season ? : **None**; Does the house have ceiling fans? : **Yes**; Number of ceiling fans : **2**; Does the house have a whole-house fan? : **No**; Hours per day the whole-house fan is used : **0**; Months per year the whole-house fan is used : **0**; Does the house have portable fans? : **Yes**; Number of portable fans : **1**;

Water Heating

Water heater fuel : **Piped Natural Gas**; Year purchased : **1972**; Does occupant pay for water heater fuel? : **Yes**; Is an adult at home on weekdays? : **Yes**; Energy Factor : **0.47**; Recovery Efficiency : **0.76**; Rated Input : **38000.00**; Storage tank capacity (gallons) : **40**; Temperature Setting : **Medium-Low**; Water heater location : **Outdoors**;

Lighting

Kitchen : **2**; Kitchen Bulb Type : **Halogen Tochiere**; Kitchen Number of bulbs in fixture : **1^1;2^1**; Kitchen Sum of wattages for all bulbs in fixture : **1^95;2^95**; Kitchen Usage (Hrs/day) : **1**; Dining Room : **0**; Dining Room Bulb Type : ; Dining RoomNumber of bulbs in fixture : ; Dining RoomSum of wattages for all bulbs in fixture : ; Dining RoomUsage (Hrs/day) : ; Living Room : **3**; Living Room Bulb Type : **Halogen Tochiere**; Living Room Number of bulbs in fixture : **1^1;2^1;3^1**; Living Room Sum of wattages for all bulbs in fixture : **1^124;2^124;3^124**; Living Room Usage (Hrs/day) : **1**; Family Room : **0**; Family Room Bulb Type : ; Family Room Number of bulbs in fixture : ; Family Room Sum of wattages for all bulbs in fixture : ; Family Room Usage (Hrs/day) : ; Master Bedroom : **3**; Master Bedroom Bulb Type : **Halogen Tochiere**; Master Bedroom Number of bulbs in fixture : **1^1;2^1;3^1**; Master BedroomSum of wattages for all bulbs in fixture : **1^93;2^93;3^93**; Master Bedroom Usage (Hrs/day) : **1**; Hall : **0**; Hall Bulb Type : ; Hall Number of bulbs in fixture : ; Hall Sum of wattages for all bulbs in fixture : ; Hall Usage (Hrs/day) : ; All Bedrooms : **1**; All Bedrooms Bulb Type : **Halogen Tochiere**; All Bedrooms Number of bulbs in fixture : **1^1**; All Bedrooms Sum of wattages for all bulbs in fixture : **1^94**; All Bedrooms Usage (Hrs/day) : **1**; All Bathrooms : **4**; All Bathrooms Bulb Type : **Halogen Tochiere**; All Bathrooms Number of bulbs in fixture : **1^1;2^1;3^1;4^1**; All Bathrooms Sum of wattages for all bulbs in fixture : **1^138;2^138;3^138;4^138**; All Bathrooms Usage (Hrs/day) : **1**; All Closets : **0**; All Closets Bulb Type : ; All Closets Number of bulbs in fixture : ; All Closets Sum of wattages for all bulbs in fixture : ; All Closets Usage (Hrs/day) : ; Utility Room : **1**; Utility Room Bulb Type : ; Utility Room Number of bulbs in fixture : ; Utility Room Sum of wattages for all bulbs in fixture : ; Utility Room Usage (Hrs/day) : ; Garage : **0**; Garage Bulb Type : ; Garage Number of bulbs in fixture : ; Garage Sum of wattages for all bulbs in fixture : ; Garage Usage (Hrs/day) : ; Outdoor Lighting : **5**; Outdoor Lighting Bulb Type : **Halogen Tochiere**; Outdoor Lighting Number of bulbs in fixture : **1^1;2^1;3^1;4^1;5^1**; Outdoor Lighting Sum of wattages for all bulbs in fixture : **1^110;2^110;3^110;4^110;5^110**; Outdoor Lighting Usage (Hrs/day) : **1**; Other : **0**; Other Bulb Type : ; Other Number of bulbs in fixture : ; Other Sum of wattages for all bulbs in fixture : ; Other Usage (Hrs/day) : ;

Refrigerators Freezers

Year made : **1972**; Size : **Large (19-21 cu ft)**; Type : **Large (19-21 cu ft)**; Energy Star : **No**; Year made : **present**; Size : **present**; Type : **present**; Energy Star : **No**; Year made : **present**; Size : **present**; Type : **present**; Energy Star : **No**; Year made : **present**; Size : **present**; Type : **present**; Year made : **present**; Size : **present**; Type : **present**; Year made : **present**; Size : **present**; Type : **present**;

Cooking Dishwashing

Stove fuel : **Natural Gas or Propane**; hours per day stove used : **1 hour**; Pilot Light : **No**; Oven fuel : **Natural Gas or Propane**; Hours per week oven used : **2 hours**; Pilot Light : **No**; Does house have/use a dishwasher : **Yes**; Energy Start Qualified : **No**; Loads washed per week : **4**;

Laundry

Does house have/use a clothes washer? : **Yes**; ENERGY STAR Qualified : **No**; Hot/Warm : **2**; Hot/Cold : **0**; Warm/Warm : **3**; Warm/Cold : **2**; Cold/Cold : **0**; Dryer fuel : **Electricity**; Number of loads dried per week : **7**;

HotTubs Spas Pumps

How many hours/day does the pool pump run? : **House doesn't have a pool pump**; How many months of the year does the pool pump run? : **0**; Is there a pool heater? : **No**; How is the spa heated? : **House doesn't have a spa/hot tub**; If spa is heated only when it is being used, how many hours per week is it used?" **6** major_appliance_input sumpPumpSize Detailed HotTubs-Spas-Pumps sumpPumpSize sump-pump-size 0 values:1-4 What is the size of the sump pump? **7** major_appliance_input : **0**; What is the size of the sump pump? : **House doesn't have a sump/sewage pump**; How many hours/year does the sump operate? : **5 hours/year**; Indicate the vertical distance that water is lifted. : **House doesn't have a well pump**; Combined pump and motor efficiency : **Typical - 40%**; Is house water pressure provided by gravity or pump? : **Pump**; How much water is used outdoors? : **Roughly 5 min/day with garden hose**;

Entertainment

Number of Units : **1**; Average Per-unit Use : **2**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Energy Star? : **No**; Number of Units : **0**; Average Per-unit Use : **2**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **2**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **2**; Unit of Time : **2**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **2**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **1**; Average Per-unit Use : **4**; Unit of Time : **Hours**; Unit of Calendar : **Week**; Energy Star? : **No**; Number of Units : **1**; Average Per-unit Use : **2**; Unit of Time : **Hours**; Unit of Calendar : **Week**; Energy Star? : **No**; Number of Units : **1**; Average Per-unit Use : **1**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Number of Units : **1**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **1**; Average Per-unit Use : **2**; Unit of Time : **Hours**; Unit of Calendar : **Week**; Number of Units : **1**; Average Per-unit Use : **30**; Unit of Time : **Minutes**; Unit of Calendar : **Week**; Number of Units : **1**; Average Per-unit Use : **30**; Unit of Time : **Minutes**; Unit of Calendar : **Week**; Energy Star : **No**; Number of Units : **1**; Average Per-unit Use : **2**; Unit of Time : **Hours**; Unit of Calendar : **Week**;

Home Office

Number of Units : **1**; Average Per-unit Use : **5**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **1**; Average Per-unit Use : **5**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **0**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Week**; Number of Units : **1**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Week**; Number of Units : **1**; Average Per-unit Use : **5**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **1**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Energy Star : **No**; Number of Units : **0**; Average Per-unit Use : **4**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **30**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Average Per-unit Use : **0**; Unit of Time : **Hours**; Unit of Calendar : **Day**;

Other Appliances

House Shape Size

Skylights

HOME ENERGY SAVER™

YEARLY ENERGY COSTS

Providing more details will make your results more accurate.

	Total	Heating	Cooling	Hot Water	Large Appliances	Small Appliances	Lighting
Existing Home	\$1,470	\$145	\$11	\$268	\$587	\$215	\$244
With Upgrades	\$1,627	\$682	\$11	\$204	\$397	\$215	\$118
Savings	\$-157	\$-537	\$0	\$64	\$190	\$0	\$126

Important Note: These are initial estimates only, and results may vary. If the owner has not already done so, we strongly recommend that they retain a professional energy auditor to develop a detailed work scope and budget for improving the home. We also recommend the Home Performance with ENERGY STAR program when considering home improvements.

[Comparing Results to Home's Utility Bill](#)

HOME ENERGY SAVER™

YEARLY WHOLE HOUSE RESULTS

		Existing Home	With Upgrades	Savings	Percentage Reductions
Whole House	Energy Bill	\$1,470	\$1,627	-\$157	-10.7%
	Electricity	5837 kWh	3346 kWh	2491 kWh	42.7%
	Natural Gas	495 Therms	948 Therms	-453 Therms	-91.5%
	Emissions	8695 CO ₂	12744 CO ₂	-4049 lb. CO₂	-46.6%
Heating	Energy Bill	\$145	\$682	-\$537	-370.3%
	Natural Gas	114 Therms	537 Therms	-423 Therms	-371.1%
	Emissions	1332 lb. CO ₂	6274 lb. CO ₂	-4942 lb. CO₂	-371%
Cooling	Energy Bill	\$11	\$11	\$0	0%
	Electricity	75 kWh	75 kWh	0 kWh	0%
	Emissions	37 lb. CO ₂	37 lb. CO ₂	0 lb. CO₂	0%
Hot Water	Energy Bill	\$268	\$204	\$64	23.9%
	Natural Gas	211 Therms	161 Therms	50 Therms	23.7%
	Emissions	2465 lb. CO ₂	1880 lb. CO ₂	585 lb. CO₂	23.7%
Large Appliances	Energy Bill	\$587	\$397	\$190	32.4%
	Electricity	2574 kWh	957 kWh	1617 kWh	62.8%
	Natural Gas	170 Therms	250 Therms	-80 Therms	-47.1%
	Emissions	3270 lb. CO ₂	3398 lb. CO ₂	-128 lb. CO₂	-3.9%
Small Appliances	Energy Bill	\$215	\$215	\$0	0%
	Electricity	1493 kWh	1493 kWh	0 kWh	0%
	Emissions	745 lb. CO ₂	745 lb. CO ₂	0 lb. CO₂	0%
Lighting	Energy Bill	\$244	\$118	\$126	51.6%
	Electricity	1695 kWh	821 kWh	874 kWh	51.6%
	Emissions	846 lb. CO ₂	410 lb. CO ₂	436 lb. CO₂	51.5%

Heating electricity values include fan or pumping energy for homes that have forced-air or water-based heating systems powered by circulation pumps. The values for Hot Water include taps and faucets only; the energy consumed by the water heater to supply hot water for appliances such as clothes washers and dishwashers is included instead in the rows for those appliances.

HOME ENERGY SAVER™

YEARLY HEATING AND COOLING RESULTS

[Show Details](#)

Total Cost	
Cost	\$156
Heating	\$145
Cooling	\$11

Total Energy	
Energy Use	114 therms75 kWh
Heating	114 therms
Cooling	75 kWh

Notes: this house is 37% heated by wood fuel.
19% of the floor area is heated and 100% cooled.

Heating electricity values include fan or pumping energy for homes that have forced-air or water-based heating systems powered by circulation pumps.

[What if my results don't match my energy bill?](#)

HOME ENERGY SAVER™

YEARLY LARGE APPLIANCES AND WATER HEATING RESULTS

[Show Details](#)

Appliance	Total Cost
First Refrigerator	\$124
Stove	\$42
Oven	\$14
Clotheswasher	\$139
Clothesdryer	\$210
Dishwasher	\$59
Hot Water: Taps and Faucets	\$268
Totals	\$855

Equipment energy is the energy used by motors, heating elements, and burners inside your appliances. This number excludes the energy consumed by your water heater to supply hot water for appliances such as clothes washers and dishwashers (which is included instead in the rows for those appliances).

[What if my results don't match my energy bill?](#)

HOME ENERGY SAVER™

YEARLY SMALL APPLIANCES RESULTS

[Show Details](#) ?

Category	Energy Use	Energy Costs
Entertainment	345 kWh	\$50
HomeOffice	361 kWh	\$52
Kitchen	470 kWh	\$68
Other	285 kWh	\$41

[What if my results don't match my energy bill?](#)

HOME ENERGY SAVER™

YEARLY LIGHTING RESULTS

Here is the calculated Yearly lighting bill based on the inputs you provided:

[Show Details](#) ?

Room	Energy Use	Energy Costs
All Bathrooms	404 kwh	\$58
All Bedrooms	34 kwh	\$5
Kitchen	208 kwh	\$30
Living Room	273 kwh	\$39
Master Bedroom	102 kwh	\$15
Outdoor Lighting	600 kwh	\$86
Utility Room	74 kwh	\$11

[What if my results don't match my energy bill?](#)

UPGRADE RECOMMENDATIONS SUMMARY

Visit [Recommendations](#) to see more information on each upgrade.

	Yearly Savings	Estimated Added Cost	How Much is Too Much?	Simple Payback Time	Estimated ROI	Emissions (lbs. CO₂)
Total for recommended upgrades	\$385	\$409	\$9625	-3	10000%	-4049

Important Note: These are initial estimates only, and results may vary. If the owner has not already done so, we strongly recommend that they retain a professional energy auditor to develop a detailed work scope and budget for improving the home. We also recommend the Home Performance with ENERGY STAR program when considering home improvements.

Upgrades Requiring Investment

1. Indoor lights
2. Electric clothes dryer
3. Clothes washer
4. Refrigerator
5. Ceiling fan
6. Gas water heater
7. Well pump
8. Dishwasher

Other benefits that often come along with these energy-saving upgrades

- Fluorescent lamps last several times longer than ordinary incandescent bulbs, which saves you the time and expense of replacing bulbs when they burn out.
- Natural gas clothes dryers reduce your home's peak load on the power grid compared to an electric dryer.
- ENERGY STAR® clothes washers can reduce water use significantly, leave the clothes drier thus reducing drying time and energy consumption, and reduce wear and tear on clothes.
- Energy-efficient refrigerators are quieter, run less often, release less heat into your kitchen, and keep their contents cool longer during power outages.
- Ceiling fans mix the air in your home more effectively, creating more even temperatures and a more comfortable home. During the cooling season, ceiling fans create air movement that makes you feel cooler, which in turn allows you to raise your air conditioner thermostat setting, reducing your cooling bill. Energy efficient ceiling fans add less heat to the inside of your home during the cooling season.
- Efficient gas-fired water heaters may hold their temperature longer following power interruptions and operate more safely.
- None available.
- Some ENERGY STAR dishwashers reduce water use and/or have shorter run times.

HOME ENERGY SAVER™

UPGRADE RECOMMENDATIONS ?

What efficiency level would you like to model for the initial selection of upgrades? ?

EnergyStar

What simple payback period would you like to use for selecting upgrades?

10

RECALCULATE Rows that are dimmed are not included in the calculated values for the retrofit package. To include them check their boxes and recalculate.

Add/ Remove	Upgrade	Upgrade Choice & Description	Yearly Savings	Estimated Added Cost	How Much is Too Much?	Simple Payback Time	Estimated Return on Investment	Emissions (lbs. CO ₂)
☐	Check/Uncheck All Upgrades	Total for Selected Upgrades:	385	409	9625	-3	10000%	-4049
☒	Indoor lights	CFLs in high-use fixtur	\$118	\$ 66 ?	2950	1	177%	436
☒	Electric clothes dryer	Switch to gas dryer	\$114	\$? ?	2850	1	5000%	-250
☒	Clothes washer	MEF=1.42 WF=9.5 EN	\$69	\$ 180 ?	1725	3	38%	322
☒	Refrigerator	15% better than standa	\$8	\$ 87 ?	200	11	8%	29
☐	Windows	2-pane/solar-control lo	(\$537)	\$ 471 ?	-13425	upgrade increases energy use		-4942
☒	Ceiling fan	ENERGY STAR-label	\$1	\$ 1 ?	25	1	NCE	4
☒	Gas water heater	EF=0.62	\$48	\$ 48 ?	1200	1	28%	444
☒	Well pump	60% combined pump a	\$6	\$ 6 ?	150	1	4%	22
☒	Dishwasher	EF=0.58 ENERGY ST.	\$21	\$ 21 ?	525	17	NCE	135
☐	Attic insulation	R-30	(\$410)	\$ -410 ?	-10250	upgrade increases energy use		-3774
☐	Cool roof	Solar reflectance = 0.5	(\$649)	\$ -649 ?	-16225	upgrade increases energy use		-5970
☐	Slab insulation	R-5 slab edge	(\$583)	\$ -583 ?	-14575	upgrade increases energy use		-5363
☐	Air sealing	25% air leakage reduc	(\$551)	\$ -551 ?	-13775	upgrade increases energy use		-5070
☐	Thermostat	ENERGY STAR-label	(\$483)	\$ -483 ?	-12075	upgrade increases energy use		-4440
☐	Wall insulation	R-11 wall cavity	(\$516)	\$ -516 ?	-12900	upgrade increases energy use		-4743

Important Note: These are initial estimates only, and results may vary. If the owner has not already done so, we strongly recommend that they retain a professional energy auditor to develop a detailed work scope and budget for improving the home. We also recommend the Home Performance with ENERGY STAR program when considering home improvements.

NCE = Not Cost Effective. This upgrade will not pay for itself in your situation. There may be other reasons, such as improved comfort, to implement the upgrade, or it could be made more cost-effective if the investment cost is reduced.

Note: Each of the upgrades in the table above are evaluated in isolation from the others. If the efficiency level is changed for one upgrade, its potential impact on other upgrades will not be counted in the row-by-row estimates. However, these kinds of interactions are included in the "package" totals associated with the whole-house totals and chart at the top of the page, for the upgrades selected as part of the package. For example, if the furnace efficiencies are raised, the energy savings from wall insulation will not change in the row estimate, but the incremental savings from including insulation in the package will be less due to the more efficient furnace's impact on reducing the energy required to make up heat losses through the wall (there is less energy being used, so less to save).

DETAILED UPGRADE RECOMMENDATIONS REPORT

This is a printable report of the upgrades selected for the home. These upgrades have the potential to save \$-157 each year on the utility bill.

Upgrade Package Summary:

Estimate Yearly Bill Savings:	\$-157	?
Estimated Lifetime Energy Savings:	\$-2,512	?
Estimated Added Cost:	\$161	?
Maximum Price for 10 Year Payback:	\$-2,412	?
Return on Investment:	10,000%	?
Upgrade Pays for Itself in:	-3 years	?

You selected the following upgrades:

- [Replace high use incandescent lamps with compact fluorescent lamps](#)
- [When replacing your electric clothes dryer, switch to natural gas model](#)
- [When replacing your clothes washer, choose an ENERGY STAR-labeled model](#)
- [When replacing your main refrigerator, choose an ENERGY STAR-labeled model](#)
- [When replacing your ceiling fan, choose an ENERGY STAR-labeled model](#)
- [When replacing your gas water heater, choose an energy efficient model](#)
- [When replacing your well pump, choose an energy efficient model](#)
- [When replacing your dishwasher, choose an ENERGY STAR-labeled model](#)

Note: The economic benefits for each of the upgrades below are evaluated in isolation from the other upgrades. If the efficiency level is changed for one upgrade, its potential impact on other upgrades will not be counted in the individual upgrade estimates. However, these kinds of interactions are included in the "package" totals associated with the whole-house totals and chart at the top of the page (above). For example, if the furnace efficiency is increased, the energy savings from wall insulation will not change in the table below, but the incremental savings from including insulation in the package will be less due to the more efficient furnace's impact on reducing the energy required to make up heat losses through the wall (there is less energy being used, so less to save).

Replace high use incandescent lamps with compact fluorescent lamps

Economic Benefits:

Estimate Yearly Bill Savings:	\$118
Estimated Lifetime Energy Savings:	\$1,888
Estimated Added Cost:	\$66
Maximum Price for 10 Year Payback:	\$2,950
Return on Investment:	177%
Upgrade Pays for Itself in:	1 year

Additional Benefits:

Fluorescent lamps last several times longer than ordinary incandescent bulbs, which saves you the time and expense of replacing bulbs when they burn out.

Upgrade Description:

Replace high-use incandescent lamps with compact fluorescent lamps. These units can save up to 75% of the energy used by an ordinary incandescent bulb.

Purchasing Tips:

- Compare the light output in Lumens of the bulb you are replacing to ensure you are using the appropriate CFL. Most CFLs list their light output and equivalent incandescent wattage on their package.
- CFLs are available in many shapes and sizes, which will allow replacing nearly any incandescent bulb.
- When buying new light fixtures, look for ENERGY STAR qualified models.
- CFLs are a good investment for lights that are used 2-3 hours per day on average or more.

More Information:

- [ENERGY STAR qualifying lighting product list](#)
- [General information about lighting from DOE](#)

[\[Return to upgrades list\]](#)

When replacing your electric clothes dryer, switch to natural gas model

Economic Benefits:

Estimate Yearly Bill Savings:	\$114
Estimated Lifetime Energy Savings:	\$1,824
Estimated Added Cost:	\$0
Maximum Price for 10 Year Payback:	\$2,850
Return on Investment:	5,000%
Upgrade Pays for Itself in:	1 year

Additional Benefits:

Natural gas clothes dryers reduce your home's peak load on the power grid compared to an electric dryer.

Upgrade Description:

When replacing your electric clothes dryer, select a natural gas model. In many situations, this will reduce your overall energy bill because natural gas tends to cost less than electricity, for the same heating value.

Note: Our calculations bill savings, typical upgrade costs, and cost-effectiveness are for a minimum-efficiency natural gas dryer model. The default upgrade cost provided here assumes that a natural gas connection is available at your clothes dryer. If this is not the case, be sure to include the cost of extending

Purchasing Tips:

- To use a gas dryer, your laundry room must have a gas hookup, with proper connections and safe venting of the gas's exhaust, in addition to an electrical outlet
- Look for a dryer with a moisture sensor, and use the dryness settings rather than timed drying.
- When replacing your clothes washer, choose a model with high-speed spin cycles. This feature removes more water from clothes, which reduces the energy and time required for drying.

More Information:

- [General Information from DOE](#)
- [Laundry tips from ACEEE](#)
- [Information from the California Energy Commission](#)

[\[Return to upgrades list\]](#)

When replacing your clothes washer, choose an ENERGY STAR-labeled model

Economic Benefits:

Estimate Yearly Bill Savings:	\$69
Estimated Lifetime Energy Savings:	\$1,104
Estimated Added Cost:	\$180
Maximum Price for 10 Year Payback:	\$1,725
Return on Investment:	38%
Upgrade Pays for Itself in:	3 years

Additional Benefits:

ENERGY STAR® clothes washers can reduce water use significantly, leave the clothes drier thus reducing drying time and energy consumption, and reduce wear and tear on clothes.

Upgrade Description:

When replacing your clothes washer, choose an ENERGY STAR-labeled model. ENERGY STAR clothes washers can reduce energy consumption by up to 70% and are available in top-loading and front-loading designs. Some ENERGY STAR models use up to 50% less water in addition to saving energy.

Note: Our calculations bill savings, typical upgrade costs, and cost-effectiveness are for a model with the lowest efficiency that qualifies for the ENERGY STAR label.

Purchasing Tips:

- Choose a clothes washer with high-speed spin cycles. This feature removes more water from clothes, which reduces the energy and time required for drying.
- Select a low water-use, high efficiency washer. Front-loading tumble-action washers can cut energy use by up to 70 percent, reduce water consumption significantly, and may actually get clothes cleaner. ¹
- Look for pre-soaking and/or "suds saver" options which conserve energy.
- Clothes washers come with [EnergyGuide](#) yellow and black labels. Use these labels to select the most efficient model for the capacity you have chosen.

More Information:

- [ENERGY STAR clothes washer product list](#)
- [General Information from DOE](#)
- [Top-Rated Energy-Efficient Clothes Washers from ACEEE](#)

[\[Return to upgrades list\]](#)

When replacing your main refrigerator, choose an ENERGY STAR-labeled model

Economic Benefits:

Estimate Yearly Bill Savings:	\$8
Estimated Lifetime Energy Savings:	\$128
Estimated Added Cost:	\$87
Maximum Price for 10 Year Payback:	\$200
Return on Investment:	8%
Upgrade Pays for Itself in:	11 years

Additional Benefits:

Energy-efficient refrigerators are quieter, run less often, release less heat into your kitchen, and keep their contents cool longer during power outages.

Upgrade Description:

When replacing your main refrigerator, choose an ENERGY STAR®-labeled model. ENERGY STAR refrigerators must exceed federal efficiency standards by at least 15%. Models that are up to 40% more efficient than the federal standards are available.

Note: Our calculations bill savings, typical upgrade costs, and cost-effectiveness are for a model with the lowest efficiency that qualifies for the ENERGY STAR label.

Purchasing Tips:

- Be especially careful in choosing a refrigerator because it will use more energy than any other kitchen appliance.
- Refrigerators with the freezer on the bottom or the top are the most efficient. Bottom-mounted freezer models use about 16% less energy than side-by-side models. Top-mounted freezer models use about 13% less energy than a side-by side. ¹
- Through-the-door icemakers and water dispensers are convenient and reduce the need to open the door, which helps maintain a more constant temperature. However, these convenient items will increase your refrigerator's energy use by 14 to 20%. ¹
- Too large a refrigerator wastes space and energy. One that is too small can mean extra trips to the grocery store. Decide which size fits your needs, then compare the [EnergyGuide](#) yellow and black label on each so you can purchase the most energy efficient make and model. The most efficient refrigerator size is 16-20 cubic feet. ^{1,2}

More Information:

- [ENERGY STAR refrigerator product list](#)
- [Consortium for Energy Efficiency refrigerator product list](#)
- [Top-Rated Refrigerators from ACEEE](#)
- [Energy Saving Tips for refrigerators from "Energy Savers"](#)

[\[Return to upgrades list\]](#)

When replacing your ceiling fan, choose an ENERGY STAR-labeled model

Economic Benefits:

Estimate Yearly Bill Savings:	\$1
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Estimated Lifetime Energy Savings:	\$16
Estimated Added Cost:	\$1
Maximum Price for 10 Year Payback:	\$25
Return on Investment:	-16%
Upgrade Pays for Itself in:	1 year

Additional Benefits:

Ceiling fans mix the air in your home more effectively, creating more even temperatures and a more comfortable home. During the cooling season, ceiling fans create air movement that makes you feel cooler, which in turn allows you to raise your air conditioner thermostat setting, reducing your cooling bill. Energy efficient ceiling fans add less heat to the inside of your home during the cooling season.

Upgrade Description:

When buying a new ceiling fan, choose an ENERGY STAR-labeled model. An ENERGY STAR-labeled fan/light combination unit can save about 50% of the energy use of a typical-efficiency unit.

Purchasing Tips:

- If your ceiling fan includes lights, most of your energy savings will come from buying a ceiling fan with an ENERGY STAR-qualified light kit.
- It's important to buy the right size fan for your space and install it properly. The ENERGY STAR link below provides more details.

More Information:

- [ENERGY STAR qualifying ceiling fan product list](#)

[\[Return to upgrades list\]](#)

When replacing your gas water heater, choose an energy efficient model

Economic Benefits:

Estimate Yearly Bill Savings:	\$48
Estimated Lifetime Energy Savings:	\$768
Estimated Added Cost:	\$48
Maximum Price for 10 Year Payback:	\$1,200
Return on Investment:	28%
Upgrade Pays for Itself in:	1 year

Additional Benefits:

Efficient gas-fired water heaters may hold their temperature longer following power interruptions and operate more safely.

Upgrade Description:

When replacing your gas water heater, choose an energy-efficient model with an Energy Factor of 0.62 or higher.

Note: Our calculations bill savings, typical upgrade costs, and cost-effectiveness assume the efficient water heater has an energy factor of 0.62 and recovery efficiency of 0.76. Higher efficiency units are available, and would provide additional energy savings.

Purchasing Tips:

- The most important measure of efficiency for water heaters is the Energy Factor EF. The higher the EF, the more efficient the water heater.
- Purchase a water heater whose tank is internally insulated with at least R-16. [5](#)
- A water heater that is too large for your home not only has a higher purchase cost but will increase your energy costs due to excessive cycling and standby losses. The resources below provide good, simple guidance on proper sizing of water heaters. The size, or "capacity", of a fuel-fired water heater should be judged by its first hour rating FHR, not its tank size. Due to larger burners, some gas water heaters with smaller tanks actually have higher capacities FHRs than models with larger tanks.
- Many types of water heaters are now available, such as "demand" tankless, "indirect" or "integrated", and solar-assisted water heaters. [More Information](#)
- New and/or efficient gas water heaters may have different venting and flue requirements. When replacing your water heater make sure your contractor assesses your existing flue, follows new code requirements for venting water heaters, and obtains necessary permits and inspections. [3](#)

More Information:

- [General Information from DOE](#)
- [DOE Water Heating fact sheet](#)

- [Top-Rated Energy-Efficient Water Heaters from ACEEE](#)
- [GAMA consumer's directory click on "Consumers"](#)
- [How to prevent health and safety problems with combustion equipment](#)

[\[Return to upgrades list\]](#)

When replacing your well pump, choose an energy efficient model

Economic Benefits:

Estimate Yearly Bill Savings:	\$6
Estimated Lifetime Energy Savings:	\$96
Estimated Added Cost:	\$6
Maximum Price for 10 Year Payback:	\$150
Return on Investment:	4%
Upgrade Pays for Itself in:	1 year

Additional Benefits:

None available.

Upgrade Description:

When buying a new water well pump, choose an energy efficient model. These units can save up to one-third of the energy use of a typical well pump.

Note: Our calculations bill savings, typical upgrade costs, and cost-effectiveness are for a well pump and motor with a combined 60% efficiency.

Purchasing Tips:

- Well pump/motor efficiency measures how much of the electrical energy is converted to useful work to move water. The efficiency is usually not a published value, but it can be calculated based on the manufacturer's published performance data. Ask your pump dealer for help, or use the links below for guidance.
- The most energy efficient well pumps are those designed to be powered by solar power systems.
- One of the best ways to reduce well-pump energy use is to reduce water use, particularly outdoor use. To reduce water use, install low-flow plumbing fittings, low-flush toilets, and water-efficient irrigation equipment e.g., timers or drip irrigation.

More Information:

- [Irrigation pumping systems](#)
- [Irrigation water pumps North Dakota Extension Service](#)
- [Home Energy Magazine](#)

[\[Return to upgrades list\]](#)

When replacing your dishwasher, choose an ENERGY STAR-labeled model

Economic Benefits:

Estimate Yearly Bill Savings:	\$21
Estimated Lifetime Energy Savings:	\$336
Estimated Added Cost:	\$21
Maximum Price for 10 Year Payback:	\$525
Return on Investment:	-2%
Upgrade Pays for Itself in:	17 years

Additional Benefits:

Some ENERGY STAR dishwashers reduce water use and/or have shorter run times.

Upgrade Description:

When replacing your dishwasher, choose an ENERGY STAR- labeled model. ENERGY STAR dishwashers must be at least 15% more efficient than federal efficiency standards. Models are available that are over twice as efficient as a standard new dishwasher. Many ENERGY STAR models reduce water consumption in addition to saving energy. Note: Our calculations bill savings, typical upgrade costs, and cost-effectiveness are for a model with the lowest efficiency that qualifies for the ENERGY STAR label.

Purchasing Tips:

- Choose a dishwasher that allows you the option of air drying rather than heat drying. Air drying uses much less energy than heat drying. ¹
- Look for models with internal "booster heaters" which permit lower water heater temperature settings.
- Choose a dishwasher that provides several wash cycle options, such as "energy-saving" or "short wash" cycles. These features reduce energy and water consumption.
- Select a dishwasher with the appropriate capacity for your needs. Dishwashers are classified as either compact or standard capacity. Compact models use less energy but also hold fewer dishes. If you have to run the compact dishwasher more often, you could actually use more energy than with a standard capacity dishwasher. ¹
- Dishwashers come with [EnergyGuide](#) yellow and black labels. Use these labels to select the most efficient model for the capacity you have chosen.

More Information:

- [ENERGY STAR dishwasher product list](#)
- [Top-Rated Energy-Efficient Dishwashers from ACEEE](#)
- [Tips for Lowering Your Dishwasher Energy Usage from DOE](#)

[\[Return to upgrades list\]](#)

HOME ENERGY SAVER™

ROADMAP TO RESULTS

Ease into the process of making your home more efficient. If you're new to this, or you're on a very tight budget, start with the [lowest-hanging fruit](#) like double-checking your water heater's temperature setting.

The next easy steps are simple things that will fit into your shopping basket: maybe a few compact fluorescent lamps or a roll of weatherstripping.

When it's time to replace that old fridge, or other appliances, take time to shop smart. At a minimum, look for the ENERGY STAR rating. There are detailed lists of products that will take you even farther. Remember: you're not simply spending money, you're [investing for profit and comfort](#).

Redoing your kitchen? New roof? Finally adding that in-law unit? [Creating successful projects](#) can take some work. Take the time to find a home performance specialist to help you think thru all the options ahead of time, and then [find the right contractor](#) with the skills to do the job right.

Not only will these upgrades pay for themselves many times over, there are all kinds of [financial incentives](#) to help you trim the cost. And many of the "[non-energy benefits](#)" will be worth more than money can buy.

And, don't forget about saving [water](#) (which also saves energy).

Stumped? [Ask an expert](#).

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HOME ENERGY SAVER™

HOME ENERGY SAVER REPORT

Prepared by:

Delilah Z. Leval Upgraded Home Model

This report is generated by the Home Energy Saver web-based energy audit tool, developed by the U.S. Department of Energy's Lawrence Berkeley National Laboratory, and can be reached at <http://hes.lbl.gov>

[illegible]

Doors Windows

Attic Roof

Ducts Pipes

Thermostat

Settings changed during the day and evening: **No Change**; Standard or Programmable Thermostat : **standard**; Temperature setting - Heating temperature : **64**;
 Temperature setting - Cooling temperature : **81**; Weekdays Heating Day Degrees : **64**; Weekdays Heating Day Time : **8**; Weekdays Heating Night Degrees : **68**; Weekdays
 Heating Night Time : **17**; Weekdays Cooling Day Degrees : **81**; Weekdays Cooling Day Time : **8**; Weekdays Cooling Night Degrees : **78**; Weekdays Cooling Night Time : **17**;
 Weekend/Holiday Heating Day Degrees : **64**; Weekend/Holiday Heating Day Time : **115**; Weekend/Holiday Heating Night Degrees : **68**; Weekend/Holiday Heating Night Time :

17; Weekend/Holiday Cooling Day Degrees : **81**; Weekend/Holiday Cooling Day Time : **8**; Weekend/Holiday Cooling Night Degrees : **78**; Weekend/Holiday Cooling Night Time : **17**; Temperature setting - Heating temperature : **8**; Temperature setting - Cooling temperature : **8**; Weekdays Heating Wake degrees : **68**; Weekdays Heating Wake Time : **7**; Weekdays Heating Away degrees : **64**; Weekdays Heating Away Time : **9**; Weekdays Heating Evening degrees : **68**; Weekdays Heating Evening Time : **19**; Weekdays Heating Sleep degrees : **64**; Weekdays Heating Sleep Time : **23**; Weekdays Cooling Wake degrees : **78**; Weekdays Cooling Wake Time : **7**; Weekdays Cooling Away degrees : **81**; Weekdays Cooling Away Time : **9**; Weekdays Cooling Evening degrees : **78**; Weekdays Cooling Evening Time : **19**; Weekdays Cooling Sleep degrees : **81**; Weekdays Cooling Sleep Time : **23**; Weekend/Holiday Heating Wake degrees : **68**; Weekend/Holiday Heating Wake Time : **8**; Weekend/Holiday Heating Away degrees : **64**; Weekend/Holiday Heating Away Time : **11**; Weekend/Holiday Heating Evening degrees : **68**; Weekend/Holiday Heating Evening Time : **19**; Weekend/Holiday Heating Sleep degrees : **64**; Weekend/Holiday Heating Sleep Time : **23**; Weekend/Holiday Cooling Wake degrees : **78**; Weekend/Holiday Cooling Wake Time : **8**; Weekend/Holiday Cooling Away degrees : **81**; Weekend/Holiday Cooling Away Time : **11**; Weekend/Holiday Cooling Evening degrees : **78**; Weekend/Holiday Cooling Evening Time : **19**; Weekend/Holiday Cooling Sleep degrees : **81**; Weekend/Holiday Cooling Sleep Time : **23**;

Heating Equipment

Type of heating system : **Room (through-the-wall) gas furnace**; Heating system capacity : **60000**; Heating system efficiency : **50.00**; Year heating system installed : **1970**; Percentage of the house's floor area heated by a central or room heating system : **19**; Percentage of the house's heating needs supplied by a wood burning stove or portable heater : **37**;

Cooling Equipment

Type of cooling system : **No Cooling Equipment**; Cooling system capacity : **0**; Cooling system efficiency : **0.00**; Year cooling system installed : **1970**; Percentage of the house's floor area cooled by the cooling system : **100**; Hours room air conditioner is on during an average day in the cooling season : **None**; Number of months room air conditioner is on during an average cooling season ? : **None**; Does the house have ceiling fans? : **Yes**; Number of ceiling fans : **2**; Does the house have a whole-house fan? : **No**; Hours per day the whole-house fan is used : **0**; Months per year the whole-house fan is used : **0**; Does the house have portable fans? : **Yes**; Number of portable fans : **1**;

Water Heating

Water heater fuel : **Piped Natural Gas**; Year purchased : **1972**; Does occupant pay for water heater fuel? : **Yes**; Is an adult at home on weekdays? : **Yes**; Energy Factor : **0.47**; Recovery Efficiency : **0.76**; Rated Input : **38000.00**; Storage tank capacity (gallons) : **40**; Temperature Setting : **Medium-Low**; Water heater location : **Garage**;

Lighting

Kitchen : **2**; Kitchen Bulb Type : **Halogen Tochiere**; Kitchen Number of bulbs in fixture : **1^1;2^1**; Kitchen Sum of wattages for all bulbs in fixture : **1^60;2^60**; Kitchen Usage (Hrs/day) : **1**; Dining Room : **0**; Dining Room Bulb Type : ; Dining RoomNumber of bulbs in fixture : ; Dining RoomSum of wattages for all bulbs in fixture : ; Dining RoomUsage (Hrs/day) : ; Living Room : **3**; Living Room Bulb Type : **Halogen Tochiere**; Living Room Number of bulbs in fixture : **1^1;2^1;3^1**; Living Room Sum of wattages for all bulbs in fixture : **1^60;2^60;3^60**; Living Room Usage (Hrs/day) : **1**; Family Room : **0**; Family Room Bulb Type : ; Family Room Number of bulbs in fixture : ; Family Room Sum of wattages for all bulbs in fixture : ; Family Room Usage (Hrs/day) : ; Master Bedroom : **3**; Master Bedroom Bulb Type : **Halogen Tochiere**; Master Bedroom Number of bulbs in fixture : **1^1;2^1;3^1**; Master BedroomSum of wattages for all bulbs in fixture : **1^65;2^65;3^65**; Master Bedroom Usage (Hrs/day) : **1**; Hall : **0**; Hall Bulb Type : ; Hall Number of bulbs in fixture : ; Hall Sum of wattages for all bulbs in fixture : ; Hall Usage (Hrs/day) : ; All Bedrooms : **1**; All Bedrooms Bulb Type : **Halogen Tochiere**; All Bedrooms Number of bulbs in fixture : **1^1**; All Bedrooms Sum of wattages for all bulbs in fixture : **1^60**; All Bedrooms Usage (Hrs/day) : **1**; All Bathrooms : **4**; All Bathrooms Bulb Type : **Halogen Tochiere**; All Bathrooms Number of bulbs in fixture : **1^1;2^1;3^1;4^1**; All Bathrooms Sum of wattages for all bulbs in fixture : **1^60;2^60;3^14;4^14**; All Bathrooms Usage (Hrs/day) : **1**; All Closets : **0**; All Closets Bulb Type : ; All Closets Number of bulbs in fixture : ; All Closets Sum of wattages for all bulbs in fixture : ; All Closets Usage (Hrs/day) : ; Utility Room : **1**; Utility Room Bulb Type : ; Utility Room Number of bulbs in fixture : ; Utility Room Sum of wattages for all bulbs in fixture : ; Utility Room Usage (Hrs/day) : ; Garage : **0**; Garage Bulb Type : ; Garage Number of bulbs in fixture : ; Garage Sum of wattages for all bulbs in fixture : ; Garage Usage (Hrs/day) : ; Outdoor Lighting : **5**; Outdoor Lighting Bulb Type : **Halogen Tochiere**; Outdoor Lighting Number of bulbs in fixture : **1^1;2^1;3^1;4^1;5^1**; Outdoor Lighting Sum of wattages for all bulbs in fixture : **1^120;2^120;3^120;4^120;5^120**; Outdoor Lighting Usage (Hrs/day) : **1**; Other : **0**; Other Bulb Type : ; Other Number of bulbs in fixture : ; Other Sum of wattages for all bulbs in fixture : ; Other Usage (Hrs/day) : ;

Refrigerators Freezers

Year made : ; Size : **Large (19-21 cu ft)**; Type : **Large (19-21 cu ft)**; Energy Star : **Yes**; Year made : **present**; Size : **present**; Type : **present**; Energy Star : **No**; Year made : **present**; Size : **present**; Type : **present**; Energy Star : **No**; Year made : **present**; Size : **present**; Type : **present**; Year made : **present**; Size : **present**; Type : **present**;

Cooking Dishwashing

Stove fuel : **Natural Gas or Propane**; hours per day stove used : **1 hour**; Pilot Light : **No**; Oven fuel : **Electricity**; Hours per week oven used : **2 hours**; Pilot Light : **No**; Does house have/use a dishwasher : **Yes**; Energy Start Qualified : **Yes**; Loads washed per week : **4**;

Laundry

Does house have/use a clothes washer? : **Yes**; ENERGY STAR Qualified : **Yes**; Hot/Warm : **2**; Hot/Cold : **0**; Warm/Warm : **3**; Warm/Cold : **2**; Cold/Cold : **0**; Dryer fuel : **Electricity**; Number of loads dried per week : **7**;

HotTubs Spas Pumps

How many hours/day does the pool pump run? : **House doesn't have a pool pump**; How many months of the year does the pool pump run? : **0**; Is there a pool heater? : **No**; How is the spa heated? : **House doesn't have a spa/hot tub**; If spa is heated only when it is being used, how many hours per week is it used?" **6** major_appliance_input sumpPumpSize Detailed HotTubs-Spas-Pumps sumpPumpSize sump-pump-size 0 values:1-4 What is the size of the sump pump? **7** major_appliance_input : **0**; What is the size of the sump pump? : **House doesn't have a sump/sewage pump**; How many hours/year does the sump operate? : **5 hours/year**; Indicate the vertical distance that water is lifted. : **House doesn't have a well pump**; Combined pump and motor efficiency : **Typical - 40%**; Is house water pressure provided by gravity or pump? : **Pump**; How much water is used outdoors? : **Roughly 5 min/day with garden hose**;

Entertainment

Number of Units : **1**; Average Per-unit Use : **2**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Energy Star? : **No**; Number of Units : **0**; Average Per-unit Use : **2**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **2**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **2**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **1**; Average Per-unit Use : **4**; Unit of Time : **Hours**; Unit of Calendar : **Week**; Energy Star? : **No**; Number of Units : **1**; Average Per-unit Use : **2**; Unit of Time : **Hours**; Unit of Calendar : **Week**; Energy Star? : **No**; Number of Units : **1**; Average Per-unit Use : **1**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **0**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Number of Units : **1**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **1**; Average Per-unit Use : **2**; Unit of Time : **Hours**; Unit of Calendar : **Week**; Number of Units : **1**; Average Per-unit Use : **30**; Unit of Time : **Minutes**; Unit of Calendar : **Week**; Number of Units : **1**; Average Per-unit Use : **30**; Unit of Time : **Minutes**; Unit of Calendar : **Week**; Energy Star : **No**; Number of Units : **1**; Average Per-unit Use : **2**; Unit of Time : **Hours**; Unit of Calendar : **Week**;

Home Office

Number of Units : **1**; Average Per-unit Use : **5**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **1**; Average Per-unit Use : **5**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **0**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Week**; Number of Units : **1**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Week**; Number of Units : **1**; Average Per-unit Use : **5**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **4**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **30**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Average Per-unit Use : **0**; Unit of Time : **Hours**; Unit of Calendar : **Day**;

Miscellaneous Kitchen Equipment

Bottled Water (With heating or chilling ability) : **Day**; Energy Star Qualified : **No**; Instant Hot Water : **No**; Number of Units : **0**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Week**; Number of Units : **1**; Average Per-unit Use : **30**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **30**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **0**; Unit of Time : **Minutes**; Unit of Calendar : **Week**; Number of Units : **0**; Average Per-unit Use : **0**; Unit of Time : **Hours**; Unit of Calendar : **Month**; Number of Units : **0**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Week**; Number of Units : **1**; Average Per-unit Use : **1**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **0**; Unit of Time : **Hours**; Unit of Calendar : **Week**; Number of Units : **1**; Average Per-unit Use : **6**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **4**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Average Per-unit Use : **Day**; Unit of Time : **Minutes**; Unit of Calendar : **Day**;

Other Appliances

Number of Units : **0**; Number of Units : **0**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Week**; Number of Units : **1**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Week**; Number of Units : **0**; Average Per-unit Use : **24**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Months in the year : **4**; Number of Units : **2**; Number of Units : **0**; Average Per-unit Use : **24**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Energy Star : **No**; Number of Units : **1**; Average Per-unit Use : **5**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Months in year : **4**; Number of Units : **0**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Months in year : **4**; Number of Units : **0**; Average Per-unit Use : **24**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Energy Star : **No**; Number of Units : **0**; Average Per-unit Use : **8**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Number of Units : **1**; Average Per-unit Use : **7**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Months in year : **4**; Number of Units : **0**; Average Per-unit Use : **24**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **1**; Average Per-unit Use : **20**; Unit of Time : **Minutes**; Unit of Calendar : **Week**; Number of Units : **0**; Average Per-unit Use : **2**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Months in year : **4**; Number of Units : **0**; Number of Units : **0**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Months in year : **4**; Number of Units : **0**; Average Per-unit Use : **6**; Unit of Time : **Hours**; Unit of Calendar : **Week**; Number of Units : **0**; Name : ; Average Per-unit Use : **0**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Watts : ; Number of Units : **0**; Name : ; Average Per-unit Use : **0**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Watts : ; Number of Units : **0**; Name : ; Average Per-unit Use : **0**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Watts : ; Number of Units : **0**; Name : ; Average Per-unit Use : **0**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Watts : ;

House Shape Size

Conditioned floor area (all stories combined) ? : **1113**; Direction faced by front of house : **North**; Stories above ground level : **1**; Interior floor-to-ceiling height : **8 feet**; Rectangle : ; L-Shape : ; Front S-Shape : ; Back S-Shape : ; T-Shape : ; U-Shape : ; Split- or Tri- Level : ; Townhouse : ; Front door is on Top Side : ; Front door is on Right Side : ; Front door is on Bottom Side : ; Front door is on Left Side : ; Length of the house (from front to back)\r : **25.84**; Width of the house (from left to right)\r : **43.07**; Front door is on Top Side : ; Front door is on Right Side : ; Front door is on Bottom Side : ; Front door is on Left Side : ; Side 1 Dimension : **10.00**; Side 2 Dimension : **10.00**; Side 3 Dimension : **43.07**; Side 4 Dimension : **25.84**; Front door is on Top Side : ; Front door is on Right Side : ; Front door is on Bottom Side : ; Front door is on Left Side : ; Side 1 Dimension : **10.00**; Side 2 Dimension : **10.00**; Side 3 Dimension : **10.00**; Side 4 Dimension : **10.00**; Side 3 Dimension : **43.07**; Side 4 Dimension : **25.84**; Front door is on Top Side : ; Front door is on Right Side : ; Front door is on Bottom Side : ; Front door is on Left Side : ; Side 1 Dimension : **10.00**; Side 2 Dimension : **10.00**; Side 3 Dimension : **10.00**; Side 4 Dimension : **10.00**; Side 3 Dimension : **43.07**; Side 4 Dimension : **25.84**; Front door is on Top Side : ; Front door is on Right Side : ; Front door is on Bottom Side : ; Front door is on Left Side : ; Side 1 Dimension : **10.00**; Side 2 Dimension : **10.00**; Side 3 Dimension : **10.00**; Side 4 Dimension : **43.07**; Side 3 Dimension : **25.84**; Side 4 Dimension : **10.00**; Front door is on Top Side : ; Front door is on Right Side : ; Front door is on Bottom Side : ; Front door is on Left Side : ; Side 1 Dimension : **10.00**; Side 2 Dimension : **10.00**; Side 3 Dimension : **43.07**; Side 4 Dimension : **25.84**; Front door is on Top Side : ; Front door is on Right Side : ; Front door is on Bottom Side : ; Front door is on Left Side : ; Length of the house (from front to back)\r : **25.84**; Width of the house (from left to right)\r : **43.07**;

Skylights

Single-pane, clear : ; Single-pane, tinted : ; Double-pane, clear : ; Double-pane, tinted : ; Double-pane, solar-control low-E : ; Double-pane, clear : ; Double-pane, tinted : ; Double-pane, solar-control low-E : ; Double-pane, insulating low-E, argon gas fill : ; Single-pane, clear : ; Double-pane, clear : ; Double-pane, tinted : ; Double-pane, solar-control low-E : ; Double-pane, solar-control low-E, argon gas fill : ; Double-pane, insulating low-E : ; Double-pane, insulating low-E, argon gas fill : ; Triple-pane, insulating low-E, argon gas fill : ; Skylight U-Factor : **0.00**; Skylight Solar heat gain coefficient : **0.00**; Enter the R-value of movable skylight insulation : **0.00**; Select the type of movable interior skylight shades : **None**; Skylight size : **0.00**;

HOME ENERGY SAVER™

YEARLY ENERGY COSTS

Providing more details will make your results more accurate.

Existing Home	\$1,255	
With Upgrades	\$903	

	<u>Total</u>	<u>Heating</u>	<u>Cooling</u>	<u>Hot Water</u>	<u>Large Appliances</u>	<u>Small Appliances</u>	<u>Lighting</u>
Existing Home	\$1,255	\$117	\$11	\$268	\$532	\$229	\$98
With Upgrades	\$903	\$117	\$11	\$79	\$369	\$229	\$98
Savings	\$352	\$0	\$0	\$189	\$163	\$0	\$0

Important Note: These are initial estimates only, and results may vary. If the owner has not already done so, we strongly recommend that they retain a professional energy auditor to develop a detailed work scope and budget for improving the home. We also recommend the Home Performance with ENERGY STAR program when considering home improvements.

[Comparing Results to Home's Utility Bill](#)

HOME ENERGY SAVER™

YEARLY WHOLE HOUSE RESULTS

		Existing Home	With Upgrades	Savings	Percentage Reductions
Whole House	Energy Bill	\$1,255	\$903	\$352	28%
	Electricity	5111 kWh	3552 kWh	1559 kWh	30.5%
	Natural Gas	409 Therms	305 Therms	104 Therms	25.4%
	Emissions	7328 CO ₂	5333 CO ₂	1995 lb. CO₂	27.2%
Heating	Energy Bill	\$117	\$117	\$0	0%
	Natural Gas	92 Therms	92 Therms	0 Therms	0%
	Emissions	1075 lb. CO ₂	1075 lb. CO ₂	0 lb. CO₂	0%
Cooling	Energy Bill	\$11	\$11	\$0	0%
	Electricity	75 kWh	75 kWh	0 kWh	0%
	Emissions	37 lb. CO ₂	37 lb. CO ₂	0 lb. CO₂	0%
Hot Water	Energy Bill	\$268	\$79	\$189	70.5%
	Natural Gas	211 Therms	62 Therms	149 Therms	70.6%
	Emissions	2465 lb. CO ₂	724 lb. CO ₂	1741 lb. CO₂	70.6%
Large Appliances	Energy Bill	\$532	\$369	\$163	30.6%
	Electricity	2763 kWh	1204 kWh	1559 kWh	56.4%
	Natural Gas	106 Therms	151 Therms	-45 Therms	-42.5%
	Emissions	2617 lb. CO ₂	2362 lb. CO ₂	255 lb. CO₂	9.7%
Small Appliances	Energy Bill	\$229	\$229	\$0	0%
	Electricity	1590 kWh	1590 kWh	0 kWh	0%
	Emissions	793 lb. CO ₂	793 lb. CO ₂	0 lb. CO₂	0%
Lighting	Energy Bill	\$98	\$98	\$0	0%
	Electricity	683 kWh	683 kWh	0 kWh	0%
	Emissions	341 lb. CO ₂	341 lb. CO ₂	0 lb. CO₂	0%

Heating electricity values include fan or pumping energy for homes that have forced-air or water-based heating systems powered by circulation pumps. The values for Hot Water include taps and faucets only; the energy consumed by the water heater to supply hot water for appliances such as clothes washers and dishwashers is included instead in the rows for those appliances.

HOME ENERGY SAVER™

YEARLY HEATING AND COOLING RESULTS

[Show Details](#)

Total Cost	
Cost	\$128
Heating	\$117
Cooling	\$11

Total Energy	
Energy Use	92 therms75 kWh
Heating	92 therms
Cooling	75 kWh

Notes: this house is 37% heated by wood fuel.
19% of the floor area is heated and 100% cooled.

Heating electricity values include fan or pumping energy for homes that have forced-air or water-based heating systems powered by circulation pumps.

[What if my results don't match my energy bill?](#)

HOME ENERGY SAVER™

YEARLY LARGE APPLIANCES AND WATER HEATING RESULTS

[Show Details](#)

Appliance	Total Cost
First Refrigerator	\$124
Stove	\$42
Oven	\$34
Clotheswasher	\$134
Clothesdryer	\$210
Dishwasher	\$56
Hot Water: Taps and Faucets	\$268
Totals	\$800

Equipment energy is the energy used by motors, heating elements, and burners inside your appliances. This number excludes the energy consumed by your water heater to supply hot water for appliances such as clothes washers and dishwashers (which is included instead in the rows for those appliances).

[What if my results don't match my energy bill?](#)

HOME ENERGY SAVER™

YEARLY SMALL APPLIANCES RESULTS

[Show Details](#) ?

Category	Energy Use	Energy Costs
Entertainment	345 kWh	\$50
HomeOffice	361 kWh	\$52
Kitchen	470 kWh	\$68
Other	382 kWh	\$55

[What if my results don't match my energy bill?](#)

HOME ENERGY SAVER™

YEARLY LIGHTING RESULTS

Here is the calculated Yearly lighting bill based on the inputs you provided:

[Show Details](#) ?

Room	Energy Use	Energy Costs
All Bathrooms	108 kwh	\$16
All Bedrooms	22 kwh	\$3
Kitchen	132 kwh	\$19
Living Room	132 kwh	\$19
Master Bedroom	72 kwh	\$10
Outdoor Lighting	143 kwh	\$21
Utility Room	74 kwh	\$11

[What if my results don't match my energy bill?](#)

UPGRADE RECOMMENDATIONS SUMMARY

Visit [Recommendations](#) to see more information on each upgrade.

	Yearly Savings	Estimated Added Cost	How Much is Too Much?	Simple Payback Time	Estimated ROI	Emissions (lbs. CO₂)
Total for recommended upgrades	\$316	\$510	\$3160	2	59%	1995

Important Note: These are initial estimates only, and results may vary. If the owner has not already done so, we strongly recommend that they retain a professional energy auditor to develop a detailed work scope and budget for improving the home. We also recommend the Home Performance with ENERGY STAR program when considering home improvements.

Upgrades Requiring Investment

1. Indoor lights
2. Electric clothes dryer
3. Clothes washer
4. Gas water heater

Other benefits that often come along with these energy-saving upgrades

- Fluorescent lamps last several times longer than ordinary incandescent bulbs, which saves you the time and expense of replacing bulbs when they burn out.
- Natural gas clothes dryers reduce your home's peak load on the power grid compared to an electric dryer.
- ENERGY STAR® clothes washers can reduce water use significantly, leave the clothes drier thus reducing drying time and energy consumption, and reduce wear and tear on clothes.
- Efficient gas-fired water heaters may hold their temperature longer following power interruptions and operate more safely.

HOME ENERGY SAVER™

UPGRADE RECOMMENDATIONS ?

What efficiency level would you like to model for the initial selection of upgrades? ?

EnergyStar

What simple payback period would you like to use for selecting upgrades?

10

RECALCULATE

Rows that are dimmed are not included in the calculated values for the retrofit package.
To include them check their boxes and recalculate.

Add/ Remove	Upgrade	Upgrade Choice & Description	Yearly Savings	Estimated Added Cost	How Much is Too Much?	Simple Payback Time	Estimated Return on Investment	Emissions (lbs. CO ₂)
☐	Check/Uncheck All Upgrades	Total for Selected Upgrades:	316	510	3160	2	59%	1995
☒	Indoor lights	CFLs in high-use fixtur	\$98	\$ 0 ?	980	0	NCE	0
☒	Electric clothes dryer	Switch to gas dryer	\$114	\$ 160 ?	1140	1	71%	-250
☒	Clothes washer	MEF=1.42 WF=9.5 EN	\$56	\$ 180 ?	560	3	30%	207
☒	Gas water heater	EF=0.62	\$48	\$ 170 ?	480	4	28%	444
☐	Refrigerator	15% better than standa	\$8	\$ 87 ?	80	11	8%	29
☐	Well pump	60% combined pump a	\$6	\$ 110 ?	60	18	4%	22
☐	Dishwasher	EF=0.58 ENERGY ST.	\$20	\$ 360 ?	200	18	NCE	121
☐	Ceiling fan	ENERGY STAR-label	\$1	\$ 60 ?	10	60	NCE	4
☐	Attic insulation	R-30	(\$295)	\$ 0 ?	0	upgrade increases energy use		-2710
☐	Cool roof	Solar reflectance = 0.5	(\$537)	\$ 115 ?	0	upgrade increases energy use		-4942
☐	Slab insulation	R-5 slab edge	(\$469)	\$ 386 ?	0	upgrade increases energy use		-4311
☐	Air sealing	25% air leakage reduc	(\$470)	\$ 850 ?	0	upgrade increases energy use		-4323
☐	Thermostat	ENERGY STAR-label	(\$396)	\$ 320 ?	0	upgrade increases energy use		-3645
☐	Wall insulation	R-11 wall cavity	(\$399)	\$ 367 ?	0	upgrade increases energy use		-3668
☐	Windows	2-pane/solar-control lo	(\$500)	\$ 471 ?	0	upgrade increases energy use		-4603

Important Note: These are initial estimates only, and results may vary. If the owner has not already done so, we strongly recommend that they retain a professional energy auditor to develop a detailed work scope and budget for improving the home. We also recommend the Home Performance with ENERGY STAR program when considering home improvements.

NCE = Not Cost Effective. This upgrade will not pay for itself in your situation. There may be other reasons, such as improved comfort, to implement the upgrade, or it could be made more cost-effective if the investment cost is reduced.

Note: Each of the upgrades in the table above are evaluated in isolation from the others. If the efficiency level is changed for one upgrade, its potential impact on other upgrades will not be counted in the row-by-row estimates. However, these kinds of interactions are included in the "package" totals associated with the whole-house totals and chart at the top of the page, for the upgrades selected as part of the package. For example, if the furnace efficiencies are raised, the energy savings from wall insulation will not change in the row estimate, but the incremental savings from including insulation in the package will be less due to the more efficient furnace's impact on reducing the energy required to make up heat losses through the wall (there is less energy being used, so less to save).

DETAILED UPGRADE RECOMMENDATIONS REPORT

This is a printable report of the upgrades selected for the home. These upgrades have the potential to save \$352 each year on the utility bill.

Upgrade Package Summary:

Estimate Yearly Bill Savings:	\$352	?
Estimated Lifetime Energy Savings:	\$4,224	?
Estimated Added Cost:	\$128	?
Maximum Price for 10 Year Payback:	\$1,020	?
Return on Investment:	59%	?
Upgrade Pays for Itself in:	2 years	?

You selected the following upgrades:

- [Replace high use incandescent lamps with compact fluorescent lamps](#)
- [When replacing your electric clothes dryer, switch to natural gas model](#)
- [When replacing your clothes washer, choose an ENERGY STAR-labeled model](#)
- [When replacing your gas water heater, choose an energy efficient model](#)

Note: The economic benefits for each of the upgrades below are evaluated in isolation from the other upgrades. If the efficiency level is changed for one upgrade, its potential impact on other upgrades will not be counted in the individual upgrade estimates. However, these kinds of interactions are included in the "package" totals associated with the whole-house totals and chart at the top of the page (above). For example, if the furnace efficiency is increased, the energy savings from wall insulation will not change in the table below, but the incremental savings from including insulation in the package will be less due to the more efficient furnace's impact on reducing the energy required to make up heat losses through the wall (there is less energy being used, so less to save).

Replace high use incandescent lamps with compact fluorescent lamps

Economic Benefits:

Estimate Yearly Bill Savings:	\$98
Estimated Lifetime Energy Savings:	\$1,176
Estimated Added Cost:	\$0
Maximum Price for 10 Year Payback:	\$980
Return on Investment:	0%
Upgrade Pays for Itself in:	Under 1 year

Additional Benefits:

Fluorescent lamps last several times longer than ordinary incandescent bulbs, which saves you the time and expense of replacing bulbs when they burn out.

Upgrade Description:

Replace high-use incandescent lamps with compact fluorescent lamps. These units can save up to 75% of the energy used by an ordinary incandescent bulb.

Purchasing Tips:

- Compare the light output in Lumens of the bulb you are replacing to ensure you are using the appropriate CFL. Most CFLs list their light output and equivalent incandescent wattage on their package.
- CFLs are available in many shapes and sizes, which will allow replacing nearly any incandescent bulb.
- When buying new light fixtures, look for ENERGY STAR qualified models.
- CFLs are a good investment for lights that are used 2-3 hours per day on average or more.

More Information:

- [ENERGY STAR qualifying lighting product list](#)

When replacing your electric clothes dryer, switch to natural gas model

Economic Benefits:

Estimate Yearly Bill Savings:	\$114
Estimated Lifetime Energy Savings:	\$1,368
Estimated Added Cost:	\$160
Maximum Price for 10 Year Payback:	\$1,140
Return on Investment:	71%
Upgrade Pays for Itself in:	1 year

Additional Benefits:

Natural gas clothes dryers reduce your home's peak load on the power grid compared to an electric dryer.

Upgrade Description:

When replacing your electric clothes dryer, select a natural gas model. In many situations, this will reduce your overall energy bill because natural gas tends to cost less than electricity, for the same heating value.

Note: Our calculations bill savings, typical upgrade costs, and cost-effectiveness are for a minimum-efficiency natural gas dryer model. The default upgrade cost provided here assumes that a natural gas connection is available at your clothes dryer. If this is not the case, be sure to include the cost of extending

Purchasing Tips:

- To use a gas dryer, your laundry room must have a gas hookup, with proper connections and safe venting of the gas's exhaust, in addition to an electrical outlet
- Look for a dryer with a moisture sensor, and use the dryness settings rather than timed drying.
- When replacing your clothes washer, choose a model with high-speed spin cycles. This feature removes more water from clothes, which reduces the energy and time required for drying.

More Information:

- [General Information from DOE](#)
- [Laundry tips from ACEEE](#)
- [Information from the California Energy Commission](#)

When replacing your clothes washer, choose an ENERGY STAR-labeled model

Economic Benefits:

Estimate Yearly Bill Savings:	\$56
Estimated Lifetime Energy Savings:	\$672
Estimated Added Cost:	\$180
Maximum Price for 10 Year Payback:	\$560
Return on Investment:	30%
Upgrade Pays for Itself in:	3 years

Additional Benefits:

ENERGY STAR® clothes washers can reduce water use significantly, leave the clothes drier thus reducing drying time and energy consumption, and reduce wear and tear on clothes.

Upgrade Description:

When replacing your clothes washer, choose an ENERGY STAR-labeled model. ENERGY STAR clothes washers can reduce energy consumption by up to 70% and are available in top-loading and front-loading designs. Some ENERGY STAR models use up to 50% less water in addition to saving energy.

Note: Our calculations bill savings, typical upgrade costs, and cost-effectiveness are for a model with the lowest efficiency that qualifies for the ENERGY STAR label.

Purchasing Tips:

- Choose a clothes washer with high-speed spin cycles. This feature removes more water from clothes, which reduces the energy and time required for drying.
- Select a low water-use, high efficiency washer. Front-loading tumble-action washers can cut energy use by up to 70 percent, reduce water consumption significantly, and may actually get clothes cleaner. [1](#)
- Look for pre-soaking and/or "suds saver" options which conserve energy.
- Clothes washers come with [EnergyGuide](#) yellow and black labels. Use these labels to select the most efficient model for the capacity you have chosen.

More Information:

- [ENERGY STAR clothes washer product list](#)
- [General Information from DOE](#)
- [Top-Rated Energy-Efficient Clothes Washers from ACEEE](#)

[\[Return to upgrades list\]](#)

When replacing your gas water heater, choose an energy efficient model

Economic Benefits:

Estimate Yearly Bill Savings:	\$48
Estimated Lifetime Energy Savings:	\$576
Estimated Added Cost:	\$170
Maximum Price for 10 Year Payback:	\$480
Return on Investment:	28%
Upgrade Pays for Itself in:	4 years

Additional Benefits:

Efficient gas-fired water heaters may hold their temperature longer following power interruptions and operate more safely.

Upgrade Description:

When replacing your gas water heater, choose an energy-efficient model with an Energy Factor of 0.62 or higher.

Note: Our calculations bill savings, typical upgrade costs, and cost-effectiveness assume the efficient water heater has an energy factor of 0.62 and recovery efficiency of 0.76. Higher efficiency units are available, and would provide additional energy savings.

Purchasing Tips:

- The most important measure of efficiency for water heaters is the Energy Factor EF. The higher the EF, the more efficient the water heater.
- Purchase a water heater whose tank is internally insulated with at least R-16. [5](#)
- A water heater that is too large for your home not only has a higher purchase cost but will increase your energy costs due to excessive cycling and standby losses. The resources below provide good, simple guidance on proper sizing of water heaters. The size, or "capacity", of a fuel-fired water heater should be judged by its first hour rating FHR, not its tank size. Due to larger burners, some gas water heaters with smaller tanks actually have higher capacities FHRs than models with larger tanks.
- Many types of water heaters are now available, such as "demand" tankless, "indirect" or "integrated", and solar-assisted water heaters. [More Information](#)
- New and/or efficient gas water heaters may have different venting and flue requirements. When replacing your water heater make sure your contractor assesses your existing flue, follows new code requirements for venting water heaters, and obtains necessary permits and inspections. [3](#)

More Information:

- [General Information from DOE](#)
- [DOE Water Heating fact sheet](#)
- [Top-Rated Energy-Efficient Water Heaters from ACEEE](#)
- [GAMA consumer's directory click on "Consumers"](#)
- [How to prevent health and safety problems with combustion equipment](#)

[\[Return to upgrades list\]](#)

HOME ENERGY SAVER™

ROADMAP TO RESULTS

Ease into the process of making your home more efficient. If you're new to this, or you're on a very tight budget, start with the [lowest-hanging fruit](#) like double-checking your water heater's temperature setting.

The next easy steps are simple things that will fit into your shopping basket: maybe a few compact fluorescent lamps or a roll of weatherstripping.

When it's time to replace that old fridge, or other appliances, take time to shop smart. At a minimum, look for the ENERGY STAR rating. There are detailed lists of products that will take you even farther. Remember: you're not simply spending money, you're [investing for profit and comfort](#).

Redoing your kitchen? New roof? Finally adding that in-law unit? [Creating successful projects](#) can take some work. Take the time to find a home performance specialist to help you think thru all the options ahead of time, and then [find the right contractor](#) with the skills to do the job right.

Not only will these upgrades pay for themselves many times over, there are all kinds of [financial incentives](#) to help you trim the cost. And many of the "[non-energy benefits](#)" will be worth more than money can buy.

And, don't forget about saving [water](#) (which also saves energy).

Stumped? [Ask an expert](#).

HOME ENERGY SAVER™

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HOME ENERGY SAVER™

HOME ENERGY SAVER REPORT

Prepared by:

This report is generated by the Home Energy Saver
web-based energy audit tool, developed by
the U.S. Department of Energy's
Lawrence Berkeley National Laboratory,
and can be reached at <http://hes.lbl.gov>

[illegible]

Doors Windows

Attic Roof

Ducts Pipes

Thermostat

130

Time : **17**; Temperature setting - Heating temperature : **8**; Temperature setting - Cooling temperature : **8**; Weekdays Heating Wake degrees : **68**; Weekdays Heating Wake Time : **7**; Weekdays Heating Away degrees : **64**; Weekdays Heating Away Time : **9**; Weekdays Heating Evening degrees : **68**; Weekdays Heating Evening Time : **19**; Weekdays Heating Sleep degrees : **64**; Weekdays Heating Sleep Time : **23**; Weekdays Cooling Wake degrees : **78**; Weekdays Cooling Wake Time : **7**; Weekdays Cooling Away degrees : **81**; Weekdays Cooling Away Time : **9**; Weekdays Cooling Evening degrees : **78**; Weekdays Cooling Evening Time : **19**; Weekdays Cooling Sleep degrees : **81**; Weekdays Cooling Sleep Time : **23**; Weekend/Holiday Heating Wake degrees : **68**; Weekend/Holiday Heating Wake Time : **8**; Weekend/Holiday Heating Away degrees : **64**; Weekend/Holiday Heating Away Time : **11**; Weekend/Holiday Heating Evening degrees : **68**; Weekend/Holiday Heating Evening Time : **19**; Weekend/Holiday Heating Sleep degrees : **64**; Weekend/Holiday Heating Sleep Time : **23**; Weekend/Holiday Cooling Wake degrees : **78**; Weekend/Holiday Cooling Wake Time : **8**; Weekend/Holiday Cooling Away degrees : **81**; Weekend/Holiday Cooling Away Time : **11**; Weekend/Holiday Cooling Evening degrees : **78**; Weekend/Holiday Cooling Evening Time : **19**; Weekend/Holiday Cooling Sleep degrees : **81**; Weekend/Holiday Cooling Sleep Time : **23**;

Heating Equipment

Type of heating system : **Room (through-the-wall) gas furnace**; Heating system capacity : **60000**; Heating system efficiency : **50.00**; Year heating system installed : **1970**; Percentage of the house's floor area heated by a central or room heating system : **19**; Percentage of the house's heating needs supplied by a wood burning stove or portable heater : **37**;

Cooling Equipment

Type of cooling system : **No Cooling Equipment**; Cooling system capacity : **0**; Cooling system efficiency : **0.00**; Year cooling system installed : **1970**; Percentage of the house's floor area cooled by the cooling system : **100**; Hours room air conditioner is on during an average day in the cooling season : **None**; Number of months room air conditioner is on during an average cooling season ? : **None**; Does the house have ceiling fans? : **Yes**; Number of ceiling fans : **5**; Does the house have a whole-house fan? : **No**; Hours per day the whole-house fan is used : **0**; Months per year the whole-house fan is used : **0**; Does the house have portable fans? : **Yes**; Number of portable fans : **1**;

Water Heating

Water heater fuel : **Piped Natural Gas**; Year purchased : **Piped Natural Gas**; Does occupant pay for water heater fuel? : **Yes**; Is an adult at home on weekdays? : **Yes**; Energy Factor : **0.55**; Recovery Efficiency : **0.76**; Rated Input : **38000.00**; Storage tank capacity (gallons) : **50**; Temperature Setting : **Medium-Low**; Water heater location : **Outdoors**;

Lighting

Kitchen : **2**; Kitchen Bulb Type : **Halogen Tochiere**; Kitchen Number of bulbs in fixture : **1^1;2^1**; Kitchen Sum of wattages for all bulbs in fixture : **1^60;2^60**; Kitchen Usage (Hrs/day) : **1**; Dining Room : **0**; Dining Room Bulb Type : **;**; Dining RoomSum of wattages for all bulbs in fixture : **;**; Dining RoomUsage (Hrs/day) : **;**; Living Room : **3**; Living Room Bulb Type : **Halogen Tochiere**; Living Room Number of bulbs in fixture : **1^1;2^1;3^1**; Living Room Sum of wattages for all bulbs in fixture : **1^60;2^60;3^60**; Living Room Usage (Hrs/day) : **1**; Family Room : **0**; Family Room Bulb Type : **;**; Family Room Number of bulbs in fixture : **;**; Family Room Sum of wattages for all bulbs in fixture : **;**; Family Room Usage (Hrs/day) : **;**; Master Bedroom : **3**; Master Bedroom Bulb Type : **Halogen Tochiere**; Master Bedroom Number of bulbs in fixture : **1^1;2^1;3^1**; Master BedroomSum of wattages for all bulbs in fixture : **1^65;2^65;3^65**; Master Bedroom Usage (Hrs/day) : **1**; Hall : **0**; Hall Bulb Type : **;**; Hall Number of bulbs in fixture : **;**; Hall Sum of wattages for all bulbs in fixture : **;**; Hall Usage (Hrs/day) : **;**; All Bedrooms : **1**; All Bedrooms Bulb Type : **Halogen Tochiere**; All Bedrooms Number of bulbs in fixture : **1^1**; All Bedrooms Sum of wattages for all bulbs in fixture : **1^60**; All Bedrooms Usage (Hrs/day) : **1**; All Bathrooms : **4**; All Bathrooms Bulb Type : **Halogen Tochiere**; All Bathrooms Number of bulbs in fixture : **1^1;2^1;3^1;4^1**; All Bathrooms Sum of wattages for all bulbs in fixture : **1^60;2^60;3^14;4^14**; All Bathrooms Usage (Hrs/day) : **1**; All Closets : **0**; All Closets Bulb Type : **;**; All Closets Number of bulbs in fixture : **;**; All Closets Sum of wattages for all bulbs in fixture : **;**; All Closets Usage (Hrs/day) : **;**; Utility Room : **1**; Utility Room Bulb Type : **;**; Utility Room Number of bulbs in fixture : **;**; Utility Room Sum of wattages for all bulbs in fixture : **;**; Utility Room Usage (Hrs/day) : **;**; Garage : **0**; Garage Bulb Type : **;**; Garage Number of bulbs in fixture : **;**; Garage Sum of wattages for all bulbs in fixture : **;**; Garage Usage (Hrs/day) : **;**; Outdoor Lighting : **5**; Outdoor Lighting Bulb Type : **Halogen Tochiere**; Outdoor Lighting Number of bulbs in fixture : **1^1;2^1;3^1;4^1;5^1**; Outdoor Lighting Sum of wattages for all bulbs in fixture : **1^120;2^120;3^120;4^120;5^120**; Outdoor Lighting Usage (Hrs/day) : **1**; Other : **0**; Other Bulb Type : **;**; Other Number of bulbs in fixture : **;**; Other Sum of wattages for all bulbs in fixture : **;**; Other Usage (Hrs/day) : **;**;

Refrigerators Freezers

Year made : **;**; Size : **Large (19-21 cu ft)**; Type : **Large (19-21 cu ft)**; Energy Star : **Yes**; Year made : **present**; Size : **present**; Type : **present**; Energy Star : **No**; Year made : **present**; Size : **present**; Type : **present**; Energy Star : **No**; Year made : **present**; Size : **present**; Type : **present**; Year made : **present**; Size : **present**; Type : **present**;

Cooking Dishwashing

Stove fuel : **Natural Gas or Propane**; hours per day stove used : **1 hour**; Pilot Light : **No**; Oven fuel : **Electricity**; Hours per week oven used : **2 hours**; Pilot Light : **No**; Does house have/use a dishwasher : **Yes**; Energy Start Qualified : **Yes**; Loads washed per week : **4**;

Laundry

Does house have/use a clothes washer? : **Yes**; ENERGY STAR Qualified : **Yes**; Hot/Warm : **2**; Hot/Cold : **0**; Warm/Warm : **3**; Warm/Cold : **2**; Cold/Cold : **0**; Dryer fuel : **Electricity**; Number of loads dried per week : **3**;

HotTubs Spas Pumps

How many hours/day does the pool pump run? : **House doesn't have a pool pump**; How many months of the year does the pool pump run? : **0**; Is there a pool heater? : **No**; How is the spa heated? : **House doesn't have a spa/hot tub**; If spa is heated only when it is being used, how many hours per week is it used?" **6** major_appliance_input sumpPumpSize Detailed HotTubs-Spas-Pumps sumpPumpSize sump-pump-size 0 values:1-4 What is the size of the sump pump? **7** major_appliance_input : **0**; What is the size of the sump pump? : **House doesn't have a sump/sewage pump**; How many hours/year does the sump operate? : **5 hours/year**; Indicate the vertical distance that water is lifted. : **House doesn't have a well pump**; Combined pump and motor efficiency : **Typical - 40%**; Is house water pressure provided by gravity or pump? : **Pump**; How much water is used outdoors? : **Roughly 5 min/day with garden hose**;

Entertainment

Number of Units : **1**; Average Per-unit Use : **2**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Energy Star? : **No**; Number of Units : **0**; Average Per-unit Use : **2**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **2**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **2**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **1**; Average Per-unit Use : **4**; Unit of Time : **Hours**; Unit of Calendar : **Week**; Energy Star? : **No**; Number of Units : **1**; Average Per-unit Use : **2**; Unit of Time : **Hours**; Unit of Calendar : **Week**; Energy Star? : **No**; Number of Units : **1**; Average Per-unit Use : **1**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **4**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **1**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **1**; Average Per-unit Use : **2**; Unit of Time : **Hours**; Unit of Calendar : **Week**; Number of Units : **1**; Average Per-unit Use : **30**; Unit of Time : **Minutes**; Unit of Calendar : **Week**; Number of Units : **1**; Average Per-unit Use : **30**; Unit of Time : **Minutes**; Unit of Calendar : **Week**; Energy Star : **No**; Number of Units : **1**; Average Per-unit Use : **2**; Unit of Time : **Hours**; Unit of Calendar : **Week**;

Home Office

Number of Units : **1**; Average Per-unit Use : **5**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **1**; Average Per-unit Use : **5**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **0**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Week**; Number of Units : **1**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Week**; Number of Units : **1**; Average Per-unit Use : **5**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **4**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **30**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Average Per-unit Use : **0**; Unit of Time : **Hours**; Unit of Calendar : **Day**;

Miscellaneous Kitchen Equipment

Bottled Water (With heating or chilling ability) : **Day**; Energy Star Qualified : **No**; Instant Hot Water : **No**; Number of Units : **0**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Week**; Number of Units : **1**; Average Per-unit Use : **30**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **30**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **0**; Unit of Time : **Minutes**; Unit of Calendar : **Week**; Number of Units : **0**; Average Per-unit Use : **0**; Unit of Time : **Hours**; Unit of Calendar : **Month**; Number of Units : **0**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Week**; Number of Units : **1**; Average Per-unit Use : **1**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **0**; Unit of Time : **Hours**; Unit of Calendar : **Week**; Number of Units : **1**; Average Per-unit Use : **6**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **4**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Average Per-unit Use : **Day**; Unit of Time : **Minutes**; Unit of Calendar : **Day**;

Other Appliances

Number of Units : **0**; Number of Units : **0**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Week**; Number of Units : **1**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Week**; Number of Units : **0**; Average Per-unit Use : **24**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Months in the year : **4**; Number of Units : **2**; Number of Units : **0**; Average Per-unit Use : **24**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Energy Star : **No**; Number of Units : **1**; Average Per-unit Use : **5**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Months in year : **4**; Number of Units : **0**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Months in year : **4**; Number of Units : **0**; Average Per-unit Use : **24**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Energy Star : **No**; Number of Units : **0**; Average Per-unit Use : **8**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Number of Units : **1**; Average Per-unit Use : **7**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Number of Units : **0**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Months in year : **4**; Number of Units : **0**; Average Per-unit Use : **24**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Number of Units : **1**; Average Per-unit Use : **20**; Unit of Time : **Minutes**; Unit of Calendar : **Week**; Number of Units : **0**; Average Per-unit Use : **2**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Months in year : **4**; Number of Units : **0**; Number of Units : **0**; Average Per-unit Use : **1**; Unit of Time : **Hours**; Unit of Calendar : **Day**; Months in year : **4**; Number of Units : **0**; Average Per-unit Use : **6**; Unit of Time : **Hours**; Unit of Calendar : **Week**; Number of Units : **0**; Name : ; Average Per-unit Use : **0**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Watts : ; Number of Units : **0**; Name : ; Average Per-unit Use : **0**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Watts : ; Number of Units : **0**; Name : ; Average Per-unit Use : **0**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Watts : ; Number of Units : **0**; Name : ; Average Per-unit Use : **0**; Unit of Time : **Minutes**; Unit of Calendar : **Day**; Watts : ;

House Shape Size

Conditioned floor area (all stories combined) ? : **1113**; Direction faced by front of house : **North**; Stories above ground level : **1**; Interior floor-to-ceiling height : **8 feet**; Rectangle : ; L-Shape : ; Front S-Shape : ; Back S-Shape : ; T-Shape : ; U-Shape : ; Split- or Tri- Level : ; Townhouse : ; Front door is on Top Side : ; Front door is on Right Side : ; Front door is on Bottom Side : ; Front door is on Left Side : ; Length of the house (from front to back)\r : **25.84**; Width of the house (from left to right)\r : **43.07**; Front door is on Top Side : ; Front door is on Right Side : ; Front door is on Bottom Side : ; Front door is on Left Side : ; Side 1 Dimension : **10.00**; Side 2 Dimension : **10.00**; Side 3 Dimension : **43.07**; Side 4 Dimension : **25.84**; Front door is on Top Side : ; Front door is on Right Side : ; Front door is on Bottom Side : ; Front door is on Left Side : ; Side 1 Dimension : **10.00**; Side 2 Dimension : **10.00**; Side 3 Dimension : **10.00**; Side 4 Dimension : **10.00**; Side 3 Dimension : **43.07**; Side 4 Dimension : **25.84**; Front door is on Top Side : ; Front door is on Right Side : ; Front door is on Bottom Side : ; Front door is on Left Side : ; Side 1 Dimension : **10.00**; Side 2 Dimension : **10.00**; Side 3 Dimension : **10.00**; Side 4 Dimension : **10.00**; Side 3 Dimension : **43.07**; Side 4 Dimension : **25.84**; Front door is on Top Side : ; Front door is on Right Side : ; Front door is on Bottom Side : ; Front door is on Left Side : ; Side 1 Dimension : **10.00**; Side 2 Dimension : **10.00**; Side 3 Dimension : **10.00**; Side 4 Dimension : **43.07**; Side 3 Dimension : **25.84**; Side 4 Dimension : **10.00**; Front door is on Top Side : ; Front door is on Right Side : ; Front door is on Bottom Side : ; Front door is on Left Side : ; Side 1 Dimension : **10.00**; Side 2 Dimension : **10.00**; Side 3 Dimension : **43.07**; Side 4 Dimension : **25.84**; Front door is on Top Side : ; Front door is on Right Side : ; Front door is on Bottom Side : ; Front door is on Left Side : ; Length of the house (from front to back)\r : **25.84**; Width of the house (from left to right)\r : **43.07**;

Skylights

Single-pane, clear : ; Single-pane, tinted : ; Double-pane, clear : ; Double-pane, tinted : ; Double-pane, solar-control low-E : ; Double-pane, clear : ; Double-pane, tinted : ; Double-pane, solar-control low-E : ; Double-pane, insulating low-E, argon gas fill : ; Single-pane, clear : ; Double-pane, clear : ; Double-pane, tinted : ; Double-pane, solar-control low-E : ; Double-pane, solar-control low-E, argon gas fill : ; Double-pane, insulating low-E : ; Double-pane, insulating low-E, argon gas fill : ; Triple-pane, insulating low-E, argon gas fill : ; Skylight U-Factor : **0.00**; Skylight Solar heat gain coefficient : **0.00**; Enter the R-value of movable skylight insulation : **0.00**; Select the type of movable interior skylight shades : **None**; Skylight size : **0.00**;

HOME ENERGY SAVER™

YEARLY ENERGY COSTS

Providing more details will make your results more accurate.

Existing Home	\$1,032
With Upgrades	\$812

	<u>Total</u>	<u>Heating</u>	<u>Cooling</u>	<u>Hot Water</u>	<u>Large Appliances</u>	<u>Small Appliances</u>	<u>Lighting</u>
Existing Home	\$1,032	\$57	\$11	\$237	\$400	\$229	\$98
With Upgrades	\$812	\$57	\$11	\$106	\$311	\$229	\$98
Savings	\$220	\$0	\$0	\$131	\$89	\$0	\$0

Important Note: These are initial estimates only, and results may vary. If the owner has not already done so, we strongly recommend that they retain a professional energy auditor to develop a detailed work scope and budget for improving the home. We also recommend the Home Performance with ENERGY STAR program when considering home improvements.

[Comparing Results to Home's Utility Bill](#)

HOME ENERGY SAVER™

YEARLY WHOLE HOUSE RESULTS

		Existing Home	With Upgrades	Savings	Percentage Reductions
Whole House	Energy Bill	\$1,032	\$812	\$220	21.3%
	Electricity	4279 kWh	3596 kWh	683 kWh	16%
	Natural Gas	328 Therms	229 Therms	99 Therms	30.2%
	Emissions	5967 CO ₂	4467 CO ₂	1500 lb. CO₂	25.1%
Heating	Energy Bill	\$57	\$57	\$0	0%
	Natural Gas	45 Therms	45 Therms	0 Therms	0%
	Emissions	526 lb. CO ₂	526 lb. CO ₂	0 lb. CO₂	0%
Cooling	Energy Bill	\$11	\$11	\$0	0%
	Electricity	75 kWh	75 kWh	0 kWh	0%
	Emissions	37 lb. CO ₂	37 lb. CO ₂	0 lb. CO₂	0%
Hot Water	Energy Bill	\$237	\$106	\$131	55.3%
	Natural Gas	187 Therms	84 Therms	103 Therms	55.1%
	Emissions	2185 lb. CO ₂	981 lb. CO ₂	1204 lb. CO₂	55.1%
Large Appliances	Energy Bill	\$400	\$311	\$89	22.3%
	Electricity	1931 kWh	1248 kWh	683 kWh	35.4%
	Natural Gas	96 Therms	100 Therms	-4 Therms	-4.2%
	Emissions	2085 lb. CO ₂	1788 lb. CO ₂	297 lb. CO₂	14.2%
Small Appliances	Energy Bill	\$229	\$229	\$0	0%
	Electricity	1590 kWh	1590 kWh	0 kWh	0%
	Emissions	793 lb. CO ₂	793 lb. CO ₂	0 lb. CO₂	0%
Lighting	Energy Bill	\$98	\$98	\$0	0%
	Electricity	683 kWh	683 kWh	0 kWh	0%
	Emissions	341 lb. CO ₂	341 lb. CO ₂	0 lb. CO₂	0%

Heating electricity values include fan or pumping energy for homes that have forced-air or water-based heating systems powered by circulation pumps. The values for Hot Water include taps and faucets only; the energy consumed by the water heater to supply hot water for appliances such as clothes washers and dishwashers is included instead in the rows for those appliances.

HOME ENERGY SAVER™

YEARLY HEATING AND COOLING RESULTS

[Show Details](#)

Total Cost	
Cost	\$68
Heating	\$57
Cooling	\$11

Total Energy	
Energy Use	45 therms75 kWh
Heating	45 therms
Cooling	75 kWh

Notes: this house is 37% heated by wood fuel.
19% of the floor area is heated and 100% cooled.

Heating electricity values include fan or pumping energy for homes that have forced-air or water-based heating systems powered by circulation pumps.

[What if my results don't match my energy bill?](#)

HOME ENERGY SAVER™

YEARLY LARGE APPLIANCES AND WATER HEATING RESULTS

[Show Details](#)

Appliance	Total Cost
First Refrigerator	\$124
Stove	\$42
Oven	\$34
Clotheswasher	\$117
Clothesdryer	\$90
Dishwasher	\$51
Hot Water: Taps and Faucets	\$237
Totals	\$637

Equipment energy is the energy used by motors, heating elements, and burners inside your appliances. This number excludes the energy consumed by your water heater to supply hot water for appliances such as clothes washers and dishwashers (which is included instead in the rows for those appliances).

[What if my results don't match my energy bill?](#)

HOME ENERGY SAVER™

YEARLY SMALL APPLIANCES RESULTS

[Show Details](#) ?

Category	Energy Use	Energy Costs
Entertainment	345 kWh	\$50
HomeOffice	361 kWh	\$52
Kitchen	470 kWh	\$68
Other	382 kWh	\$55

[What if my results don't match my energy bill?](#)

HOME ENERGY SAVER™

YEARLY LIGHTING RESULTS

Here is the calculated Yearly lighting bill based on the inputs you provided:

[Show Details](#) ?

Room	Energy Use	Energy Costs
All Bathrooms	108 kwh	\$16
All Bedrooms	22 kwh	\$3
Kitchen	132 kwh	\$19
Living Room	132 kwh	\$19
Master Bedroom	72 kwh	\$10
Outdoor Lighting	143 kwh	\$21
Utility Room	74 kwh	\$11

[What if my results don't match my energy bill?](#)

UPGRADE RECOMMENDATIONS SUMMARY

Visit [Recommendations](#) to see more information on each upgrade.

	Yearly Savings	Estimated Added Cost	How Much is Too Much?	Simple Payback Time	Estimated ROI	Emissions (lbs. CO₂)
Total for recommended upgrades	\$235	\$510	\$2350	2	45%	1500

Important Note: These are initial estimates only, and results may vary. If the owner has not already done so, we strongly recommend that they retain a professional energy auditor to develop a detailed work scope and budget for improving the home. We also recommend the Home Performance with ENERGY STAR program when considering home improvements.

Upgrades Requiring Investment

1. Indoor lights
2. Electric clothes dryer
3. Gas water heater
4. Clothes washer

Other benefits that often come along with these energy-saving upgrades

- Fluorescent lamps last several times longer than ordinary incandescent bulbs, which saves you the time and expense of replacing bulbs when they burn out.
- Natural gas clothes dryers reduce your home's peak load on the power grid compared to an electric dryer.
- Efficient gas-fired water heaters may hold their temperature longer following power interruptions and operate more safely.
- ENERGY STAR® clothes washers can reduce water use significantly, leave the clothes drier thus reducing drying time and energy consumption, and reduce wear and tear on clothes.

HOME ENERGY SAVER™

UPGRADE RECOMMENDATIONS ?

What efficiency level would you like to model for the initial selection of upgrades? ?

EnergyStar

What simple payback period would you like to use for selecting upgrades?

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RECALCULATE

Rows that are dimmed are not included in the calculated values for the retrofit package. To include them check their boxes and recalculate.

Add/ Remove	Upgrade	Upgrade Choice & Description	Yearly Savings	Estimated Added Cost	How Much is Too Much?	Simple Payback Time	Estimated Return on Investment	Emissions (lbs. CO ₂)
☐	Check/Uncheck All Upgrades	Total for Selected Upgrades:	235	510	2350	2	45%	1500
☒	Indoor lights	CFLs in high-use fixtur	\$98	\$ 0 ?	980	0	NCE	0
☒	Electric clothes dryer	Switch to gas dryer	\$48	\$ 160 ?	480	3	29%	-104
☒	Gas water heater	EF=0.62	\$48	\$ 170 ?	480	4	28%	444
☒	Clothes washer	MEF=1.42 WF=9.5 EN	\$41	\$ 180 ?	410	4	21%	145
☐	Refrigerator	15% better than standa	\$8	\$ 87 ?	80	11	8%	29
☐	Well pump	60% combined pump a	\$6	\$ 110 ?	60	18	4%	22
☐	Dishwasher	EF=0.58 ENERGY ST.	\$18	\$ 360 ?	180	20	NCE	107
☐	Ceiling fan	ENERGY STAR-label	\$1	\$ 60 ?	10	60	NCE	4
☐	Attic insulation	R-30	(\$229)	\$ 484 ?	0	upgrade increases energy use		-2103
☐	Cool roof	Solar reflectance = 0.5	(\$251)	\$ 115 ?	0	upgrade increases energy use		-2313
☐	Slab insulation	R-5 slab edge	(\$215)	\$ 386 ?	0	upgrade increases energy use		-1974
☐	Air sealing	25% air leakage reduc	(\$217)	\$ 850 ?	0	upgrade increases energy use		-1998
☐	Wall insulation	R-11 wall cavity	(\$249)	\$ 367 ?	0	upgrade increases energy use		-2290
☐	Windows	2-pane/solar-control lo	(\$225)	\$ 471 ?	0	upgrade increases energy use		-2068

Important Note: These are initial estimates only, and results may vary. If the owner has not already done so, we strongly recommend that they retain a professional energy auditor to develop a detailed work scope and budget for improving the home. We also recommend the Home Performance with ENERGY STAR program when considering home improvements.

NCE = Not Cost Effective. This upgrade will not pay for itself in your situation. There may be other reasons, such as improved comfort, to implement the upgrade, or it could be made more cost-effective if the investment cost is reduced.

Note: Each of the upgrades in the table above are evaluated in isolation from the others. If the efficiency level is changed for one upgrade, its potential impact on other upgrades will not be counted in the row-by-row estimates. However, these kinds of interactions are included in the "package" totals associated with the whole-house totals and chart at the top of the page, for the upgrades selected as part of the package. For example, if the furnace efficiencies are raised, the energy savings from wall insulation will not change in the row estimate, but the incremental savings from including insulation in the package will be less due to the more efficient furnace's impact on reducing the energy required to make up heat losses through the wall (there is less energy being used, so less to save).

DETAILED UPGRADE RECOMMENDATIONS REPORT

This is a printable report of the upgrades selected for the home. These upgrades have the potential to save \$220 each year on the utility bill.

Upgrade Package Summary:

Estimate Yearly Bill Savings:	\$220	?
Estimated Lifetime Energy Savings:	\$2,640	?
Estimated Added Cost:	\$128	?
Maximum Price for 10 Year Payback:	\$1,020	?
Return on Investment:	45%	?
Upgrade Pays for Itself in:	2 years	?

You selected the following upgrades:

- [Replace high use incandescent lamps with compact fluorescent lamps](#)
- [When replacing your electric clothes dryer, switch to natural gas model](#)
- [When replacing your gas water heater, choose an energy efficient model](#)
- [When replacing your clothes washer, choose an ENERGY STAR-labeled model](#)

Note: The economic benefits for each of the upgrades below are evaluated in isolation from the other upgrades. If the efficiency level is changed for one upgrade, its potential impact on other upgrades will not be counted in the individual upgrade estimates. However, these kinds of interactions are included in the "package" totals associated with the whole-house totals and chart at the top of the page (above). For example, if the furnace efficiency is increased, the energy savings from wall insulation will not change in the table below, but the incremental savings from including insulation in the package will be less due to the more efficient furnace's impact on reducing the energy required to make up heat losses through the wall (there is less energy being used, so less to save).

Replace high use incandescent lamps with compact fluorescent lamps

Economic Benefits:

Estimate Yearly Bill Savings:	\$98
Estimated Lifetime Energy Savings:	\$1,176
Estimated Added Cost:	\$0
Maximum Price for 10 Year Payback:	\$980
Return on Investment:	0%
Upgrade Pays for Itself in:	Under 1 year

Additional Benefits:

Fluorescent lamps last several times longer than ordinary incandescent bulbs, which saves you the time and expense of replacing bulbs when they burn out.

Upgrade Description:

Replace high-use incandescent lamps with compact fluorescent lamps. These units can save up to 75% of the energy used by an ordinary incandescent bulb.

Purchasing Tips:

- Compare the light output in Lumens of the bulb you are replacing to ensure you are using the appropriate CFL. Most CFLs list their light output and equivalent incandescent wattage on their package.
- CFLs are available in many shapes and sizes, which will allow replacing nearly any incandescent bulb.
- When buying new light fixtures, look for ENERGY STAR qualified models.
- CFLs are a good investment for lights that are used 2-3 hours per day on average or more.

More Information:

- [ENERGY STAR qualifying lighting product list](#)

When replacing your electric clothes dryer, switch to natural gas model

Economic Benefits:

Estimate Yearly Bill Savings:	\$48
Estimated Lifetime Energy Savings:	\$576
Estimated Added Cost:	\$160
Maximum Price for 10 Year Payback:	\$480
Return on Investment:	29%
Upgrade Pays for Itself in:	3 years

Additional Benefits:

Natural gas clothes dryers reduce your home's peak load on the power grid compared to an electric dryer.

Upgrade Description:

When replacing your electric clothes dryer, select a natural gas model. In many situations, this will reduce your overall energy bill because natural gas tends to cost less than electricity, for the same heating value.

Note: Our calculations bill savings, typical upgrade costs, and cost-effectiveness are for a minimum-efficiency natural gas dryer model. The default upgrade cost provided here assumes that a natural gas connection is available at your clothes dryer. If this is not the case, be sure to include the cost of extending

Purchasing Tips:

- To use a gas dryer, your laundry room must have a gas hookup, with proper connections and safe venting of the gas's exhaust, in addition to an electrical outlet
- Look for a dryer with a moisture sensor, and use the dryness settings rather than timed drying.
- When replacing your clothes washer, choose a model with high-speed spin cycles. This feature removes more water from clothes, which reduces the energy and time required for drying.

More Information:

- [General Information from DOE](#)
- [Laundry tips from ACEEE](#)
- [Information from the California Energy Commission](#)

When replacing your gas water heater, choose an energy efficient model

Economic Benefits:

Estimate Yearly Bill Savings:	\$48
Estimated Lifetime Energy Savings:	\$576
Estimated Added Cost:	\$170
Maximum Price for 10 Year Payback:	\$480
Return on Investment:	28%
Upgrade Pays for Itself in:	4 years

Additional Benefits:

Efficient gas-fired water heaters may hold their temperature longer following power interruptions and operate more safely.

Upgrade Description:

When replacing your gas water heater, choose an energy-efficient model with an Energy Factor of 0.62 or higher.

Note: Our calculations bill savings, typical upgrade costs, and cost-effectiveness assume the efficient water heater has an energy factor of 0.62 and recovery efficiency of 0.76. Higher efficiency units are available, and would provide additional energy savings.

Purchasing Tips:

- The most important measure of efficiency for water heaters is the Energy Factor EF. The higher the EF, the more efficient the water heater.

- Purchase a water heater whose tank is internally insulated with at least R-16. [5](#)
- A water heater that is too large for your home not only has a higher purchase cost but will increase your energy costs due to excessive cycling and standby losses. The resources below provide good, simple guidance on proper sizing of water heaters. The size, or "capacity", of a fuel-fired water heater should be judged by its first hour rating FHR, not its tank size. Due to larger burners, some gas water heaters with smaller tanks actually have higher capacities FHRs than models with larger tanks.
- Many types of water heaters are now available, such as "demand" tankless, "indirect" or "integrated", and solar-assisted water heaters. [More Information](#)
- New and/or efficient gas water heaters may have different venting and flue requirements. When replacing your water heater make sure your contractor assesses your existing flue, follows new code requirements for venting water heaters, and obtains necessary permits and inspections. [3](#)

More Information:

- [General Information from DOE](#)
- [DOE Water Heating fact sheet](#)
- [Top-Rated Energy-Efficient Water Heaters from ACEEE](#)
- [GAMA consumer's directory click on "Consumers"](#)
- [How to prevent health and safety problems with combustion equipment](#)

[\[Return to upgrades list\]](#)

When replacing your clothes washer, choose an ENERGY STAR-labeled model

Economic Benefits:

Estimate Yearly Bill Savings:	\$41
Estimated Lifetime Energy Savings:	\$492
Estimated Added Cost:	\$180
Maximum Price for 10 Year Payback:	\$410
Return on Investment:	21%
Upgrade Pays for Itself in:	4 years

Additional Benefits:

ENERGY STAR® clothes washers can reduce water use significantly, leave the clothes drier thus reducing drying time and energy consumption, and reduce wear and tear on clothes.

Upgrade Description:

When replacing your clothes washer, choose an ENERGY STAR-labeled model. ENERGY STAR clothes washers can reduce energy consumption by up to 70% and are available in top-loading and front-loading designs. Some ENERGY STAR models use up to 50% less water in addition to saving energy.

Note: Our calculations bill savings, typical upgrade costs, and cost-effectiveness are for a model with the lowest efficiency that qualifies for the ENERGY STAR label.

Purchasing Tips:

- Choose a clothes washer with high-speed spin cycles. This feature removes more water from clothes, which reduces the energy and time required for drying.
- Select a low water-use, high efficiency washer. Front-loading tumble-action washers can cut energy use by up to 70 percent, reduce water consumption significantly, and may actually get clothes cleaner. [1](#)
- Look for pre-soaking and/or "suds saver" options which conserve energy.
- Clothes washers come with [EnergyGuide](#) yellow and black labels. Use these labels to select the most efficient model for the capacity you have chosen.

More Information:

- [ENERGY STAR clothes washer product list](#)
- [General Information from DOE](#)
- [Top-Rated Energy-Efficient Clothes Washers from ACEEE](#)

[\[Return to upgrades list\]](#)

HOME ENERGY SAVER™

ROADMAP TO RESULTS

Ease into the process of making your home more efficient. If you're new to this, or you're on a very tight budget, start with the [lowest-hanging fruit](#) like double-checking your water heater's temperature setting.

The next easy steps are simple things that will fit into your shopping basket: maybe a few compact fluorescent lamps or a roll of weatherstripping.

When it's time to replace that old fridge, or other appliances, take time to shop smart. At a minimum, look for the ENERGY STAR rating. There are detailed lists of products that will take you even farther. Remember: you're not simply spending money, you're [investing for profit and comfort](#).

Redoing your kitchen? New roof? Finally adding that in-law unit? [Creating successful projects](#) can take some work. Take the time to find a home performance specialist to help you think thru all the options ahead of time, and then [find the right contractor](#) with the skills to do the job right.

Not only will these upgrades pay for themselves many times over, there are all kinds of [financial incentives](#) to help you trim the cost. And many of the "[non-energy benefits](#)" will be worth more than money can buy.

And, don't forget about saving [water](#) (which also saves energy).

Stumped? [Ask an expert](#).

HOME ENERGY SAVER™

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Baseline Water Usage

GENERAL QUESTIONS

1. Total number of people in your household. (Required)

INDOOR WATER USE

BATHROOM

1. How many showers are taken each day in your household?
 2. What is the average length (in minutes) of each shower.
 Enter 6.3 if you are unsure.
 3. What is the flow rate (gallons per minute) of your showerhead?
 Enter 5 for standard showerhead; 2 for low flow.
 4. Total number of baths taken each week by members of your household.

TOILETS

1. Average number of times each person flushes a toilet in your house per day.
 Enter 4 if you are unsure.
 2. How many gallons does your toilet use per flush?
 Enter 5 if you have a standard toilet; 1.6 if you have a low volume toilet.

FAUCETS

1. How many times each day does each household member use faucets to shave,
 brush teeth, wash hands and face?
 2. How many minutes does the water run during each use?

WASHING DISHES

1. How many times are dishes washed by hand each day?
 2. How many minutes does the water run during each wash?
 3. If you have a dishwasher, how many times is it used each week?
 4. The average dishwasher uses 15 gallons of water per load, change this number
 if yours is different.

LAUNDRY

1. How many loads of laundry are done by members of your household each week.
 2. The average washing machine uses 55 gallons of water per load, change this
 number if yours is different.

Press the Calculate button to compute your overall water use.

RESULTS			
PER CAPITA DAILY WATER USE IN YOUR HOUSEHOLD (gallons)			
INDOOR WATER USE		OUTDOOR WATER USE	
Bathroom	<input type="text" value="100"/>	Lawn Watering	<input type="text" value="0"/>
Toilets	<input type="text" value="20"/>	Other Outdoor Uses	<input type="text" value="0"/>
Faucets	<input type="text" value="60"/>	GENERAL WATER USE	
Laundry	<input type="text" value="10"/>		
Dishwasher	<input type="text" value="1"/>		
Hand Washing Dishes	<input type="text" value="8"/>		
Click one of the categories above to learn how to reduce your water usage.			

Monthly Use: 6,050 Annually Use: 72,635

Original Upgrades Water Usage

GENERAL QUESTIONS

1. Total number of people in your household. **(Required)**

INDOOR WATER USE

BATHROOM

1. How many showers are taken each day in your household?
2. What is the average length (in minutes) of each shower.
Enter **6.3 if you are unsure.**
3. What is the flow rate (gallons per minute) of your showerhead?
Enter **5 for standard showerhead; 2 for low flow.**
4. Total number of baths taken each week by members of your household.

TOILETS

1. Average number of times each person flushes a toilet in your house per day.
Enter **4 if you are unsure.**
2. How many gallons does your toilet use per flush?
Enter **5 if you have a standard toilet; 1.6 if you have a low volume toilet.**

FAUCETS

1. How many times each day does each household member use faucets to shave, brush teeth, wash hands and face?
2. How many minutes does the water run during each use?

WASHING DISHES

1. How many times are dishes washed **by hand** each day?
2. How many minutes does the water run during each wash?
3. If you have a dishwasher, how many times is it used each week?
4. The average dishwasher uses 15 gallons of water per load, change this number if yours is different.

LAUNDRY

1. How many loads of laundry are done by members of your household each week.
2. The average washing machine uses 55 gallons of water per load, change this number if yours is different.

OUTDOOR WATER USE

LAWN WATERING & OTHER USES

1. How many times is your lawn watered each week?
2. How many minutes is the lawn watered per watering?
3. Water is also used outdoors to wash cars, fill pools, rinse outdoor furniture and clean equipment. Estimate the average number of minutes water is used outdoors for purposes other than watering each week.

RESULTS

PER CAPITA DAILY WATER USE IN YOUR HOUSEHOLD (gallons)

INDOOR WATER USE

- Bathroom
- Toilets
- Faucets
- Laundry
- Dishwasher
- Hand Washing Dishes

OUTDOOR WATER USE

- Lawn Watering
- Other Outdoor Uses

GENERAL WATER USE

Click one of the categories above to learn how to reduce your water usage.

Monthly Use: 3,192 Annually Use: 38,325

Alternative Upgrades Water Usage

GENERAL QUESTIONS

1. Total number of people in your household. (Required)

INDOOR WATER USE

BATHROOM

1. How many showers are taken each day in your household?
2. What is the average length (in minutes) of each shower.
Enter **6.3 if you are unsure.**
3. What is the flow rate (gallons per minute) of your showerhead?
Enter **5 for standard showerhead; 2 for low flow.**
4. Total number of baths taken each week by members of your household.

TOILETS

1. Average number of times each person flushes a toilet in your house per day.
Enter **4 if you are unsure.**
2. How many gallons does your toilet use per flush?
Enter **5 if you have a standard toilet; 1.6 if you have a low volume toilet.**

FAUCETS

1. How many times each day does each household member use faucets to shave, brush teeth, wash hands and face?
2. How many minutes does the water run during each use?

WASHING DISHES

1. How many times are dishes washed **by hand** each day?
2. How many minutes does the water run during each wash?
3. If you have a dishwasher, how many times is it used each week?
4. The average dishwasher uses 15 gallons of water per load, change this number if yours is different.

LAUNDRY

1. How many loads of laundry are done by members of your household each week.
2. The average washing machine uses 55 gallons of water per load, change this number if yours is different.

OUTDOOR WATER USE

LAWN WATERING & OTHER USES

1. How many times is your lawn watered each week?
2. How many minutes is the lawn watered per watering?
3. Water is also used outdoors to wash cars, fill pools, rinse outdoor furniture and clean equipment. Estimate the average number of minutes water is used outdoors for purposes other than watering each week.

Press the Calculate button to compute your overall water use.

RESULTS			
PER CAPITA DAILY WATER USE IN YOUR HOUSEHOLD (gallons)			
INDOOR WATER USE		OUTDOOR WATER USE	
Bathroom	<input type="text" value="30"/>	Lawn Watering	<input type="text" value="0"/>
Toilets	<input type="text" value="18"/>	Other Outdoor Uses	<input type="text" value="0"/>
Faucets	<input type="text" value="60"/>	GENERAL WATER USE	
Laundry	<input type="text" value="2"/>		
Dishwasher	<input type="text" value="0"/>		
Hand Washing Dishes	<input type="text" value="8"/>		
Click one of the categories above to learn how to reduce your water usage.			

Monthly: 3,587 Annual: 43,070