Solving for Zero: Proving the Business Case for Net-Zero Housing in California

Jeff Sloan

60952140

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Abstract

Each year, building energy waste costs the United States $110 billion - more than the entire Gross Domestic Product of 130 nations around the globe (Statistics Times, 2017). The solution to this building energy waste issue lies in the adoption of energy efficient building design, yet this strategy is plagued by the perception that higher upfront costs make these strategies infeasible. This study tests the hypothesis that green buildings, and net-zero residential buildings specifically, are more expensive to build and operate than conventional buildings. The financial expenditures for code-compliant, net-zero ready, and net-zero building categories are comparatively analyzed. The research indicates that the additional capital expenditures for energy efficient enhancements related to the net-zero ready and net-zero building categories range from $9,937.52 to $16,187.52 - a premium over the code home of 2.6% and 4.3%, respectively. However, when the cost associated with the three strategies are financed through a 30-year home mortgage and offset by incentive structures and operating credits, the energy efficient homes are less expensive on an effective monthly cost basis. Further extrapolation of these monthly cost differences show that a minor difference in cost, when compounded over the 30-year life of the mortgage instrument, has a profound effect on the cumulative cash outlay of each building strategy. When total financing and operating costs are aggregated, the savings achieved through utilization of an energy efficient strategy can swell to more than $100,000 over a 30-year time horizon.

Introduction

The United States is a top contributor to the global energy mix and is directly responsible for one-fifth of the world's total primary energy consumption (EIA, 2016a). A more granular investigation into energy use reveals that 40% of the United States energy consumption is related to residential and commercial buildings (EIA, 2017a). An exercise in arithmetic, therefore, brings us to the conclusion that approximately 8% of world energy consumption is related to energy use in buildings located within the United States. As a result, it is imperative that the United States be aware of the nature of energy use in its buildings and whether it is actively combatting any inefficiencies in this sector - as it has such a profound effect on global energy consumption. Systematically addressing any portion of these embedded inefficiencies would have a significant economic and environmental effect on both the nation and the world.

In 2005, the United States spent $369 billion on its total bill for energy used in buildings (U.S. Department of Energy, 2008) and it is estimated that the average building wastes 30% of its total energy (EPA, 2010). Assuming a waste coefficient of 30% for the entirety of the United States' building stock, this places an annual cost of U.S. building energy waste at over $110 billion - more than the entire Gross Domestic Product of 130 nations around the globe (Statistics Times, 2017). American building and home owners are unknowingly being assessed fees for inefficient design practices in the form of higher utility bills to the tune of billions of dollars.

Furthermore, this particular lens does not even consider the vast array of externalized costs related to the environmental implications that a 30% waste of end-use energy consumption entails. Issues related to the exploration, production, distribution, and use of fossil fuels utilized in the national energy mix contain embedded externalities that lie outside of conventional market mechanisms but, nevertheless, can potentially have a profound effect on the total impact of energy use. Those particular externalities are outside of the scope of this study, but they do further compound the economic burden of embedded waste in American residential and commercial building infrastructure.

Fortunately, most energy efficiency issues plaguing the current American building stock are well-understood and have practical solutions that can be implemented today. Energy is wasted in a structure when its leaks allow for unintended airflow driven by forces such as wind and the stack effect - the movement of air due to density and buoyancy (Straube, 2012). To address such issues, designers must anticipate leaks and eliminate them from the final building design. Common issues such as thermal bridging, poor or insufficient insulation, and drafty windows can be eliminated by investing in the construction or renovation of the envelope of the home in order to prevent the possibility of leaks from ever developing. Supplementary to such an investment in the envelope, designers can also focus on issues such as the positioning of the home, placement of the windows, and materials that maximize solar gain. Institutions are already in place that specialize in designing buildings that maintain a low Energy Use Intensity (EUI) metric and assist in creating a pathway toward the creation of highly efficient buildings. The Passive House Institute of the United States (PHIUS) has developed a voluntary energy efficiency standard that takes a "maximize your gains, minimize your losses" approach to building design (PHIUS, 2017). PHIUS' five design standards focus on continuous insulation of the structure that address issues like thermal bridging, investing in an airtight envelope to prevent infiltration of outside air and loss of indoor air, installation of high-performance triple-glazed windows and doors, moisture-recovery ventilation and minimal heating and cooling systems, and the maximizing of solar gain in order to exploit the energy from the sun for heating purposes during the heating season and minimizing overheating during the cooling season. Designing a building to PHIUS standards is an exercise in reducing the load of a building that is then paired with a renewable energy source, such as photovoltaic panels, to approach net-zero and net-positive. The PHIUS standard is only one example of a multitude of solutions for building efficiency certification that is at the disposal of developers and their respective stakeholders.

So, if the solution to the United States $110 billion building energy waste issue lies in the adoption of energy efficient building design, why have green buildings not become the standard mode of design and construction in the United States? Since 2005, the green building industry has grown from a 2% market share to a 23% market share for new single-family residential construction (USGBC, 2016). While there appears to be some traction in the growth curve for green building, a 23% market share means that the vast majority of new American homes still contain obvious, energy-hemorrhaging design flaws. The building industry's secure grasp on the status-quo can be partially attributed to a perception of the economic burden associated with the creation of green buildings. Reports indicate that there is a widespread perception that the construction costs associated with green buildings are considerably higher than conventional buildings (Kats et al., 2013). Global Green Building Trends Reports that in a 2008 survey of over 700 construction professionals, 80% believed that higher first costs were an obstacle to green building (Kats et al., 2013). This perception permeates through the American zeitgeist, regardless of whether or not the premise is factually verifiable.

The research conducted for this paper aimed to test the hypothesis that green buildings, and net-zero buildings specifically, are more expensive to build and operate than conventional buildings. For the purposes of this study, three specific building categories have been investigated. The first is a home constructed through traditional means with energy optimization absent from the forefront of its design principles. The second category will be the "net-zero ready" home which is optimized for energy efficiency but does not incorporate on-site renewable energy generation. The final category is the net-zero home, which is optimized for energy efficiency from the initial design and incorporates the use of on-site renewables.

In the interest of precision, the geographic scope of this analysis is limited to the author's resident state of California, USA. Additionally, the analysis focuses on single-family residential structures and does not consider any buildings in the commercial space. The topic of green retrofits is of great interest, but is not explored in this paper as the focus is solely on new construction. These scoping limitations are due to the vast differences in incentive structures, solar potential, and myriad other considerations that vary with respect to geography and building type.

Though the environmental benefits of green buildings are understood and acknowledged by the author, the research focuses heavily on the economic factors inherent in the three building categories. A financial analysis was conducted that depicts the major costs for each building category, offset by any government incentives that are available for a particular category. This exercise culminates in a pro-forma statement detailing the total financial outlay for each type of building. This figure provides key insight into the financial nature of green and conventional building design strategies in the State of California. By utilizing the conclusions drawn from this paper, the state may pursue a going-forward strategy for building codes that take into account the true financial impact of the various options. Furthermore, as the data demonstrates that green building strategies are not prohibitively expensive - and may indeed improve the bottom line on residential construction projects - building contractors and associations may be influenced to rethink their business models. This amendment to the status quo could prove to fundamentally change the nature of residential construction in the United States.

This research builds on a 2015 report produced by Maclay Architects in collaboration with Efficiency Vermont, Energy Balance, JAMorrissey, and Huntington Homes. The Net Zero Energy Feasibility Study was aimed to test the financial feasibility of net zero energy buildings in the State of Vermont (Efficiency Vermont, 2015). The study analyzed the capital costs and energy use differences between code compliant and net-zero buildings (Efficiency Vermont, 2015). A portion of this analysis involves primary research in which the group approached industry consultants, electric companies, etc. to obtain quotes for the materials that would need to be obtained for their desired type of construction projects (Efficiency Vermont, 2015). This data was used for calculating operating costs in the first year, as well as operating, capital, and finance expenditures. The scope, scale, and geographical components of Efficiency Vermont's Net Zero Energy Feasibility study differs from the research conducted as part of the research project at hand. However, the central themes and hypotheses were similar enough in nature to warrant examination. As such, the Efficiency Vermont study was heavily referenced in this paper as a means of understanding component costs and strategies for developing a comprehensive budget for the aforementioned building categories.

Armed with a sound understanding of the nature of the United States construction industry, the national perception of green buildings, the cost components of various building strategies, the national and local level incentives for energy efficient buildings, and the work that has previously been conducted in this space, this research assisted in arriving at a set of conclusions regarding the true cost of single family residential structures in the State of California. This general strategy is supported by a set of methods and procedures that have been developed by the author to ensure an accurate, financially based analysis of the differences between the three specific building categories.

Methods

This capstone research was conducted by performing a quantitative analysis on costs and incentive structures of various building design strategies for single family residences in the State of California. The three building design strategies include a traditional code-complaint home, a "net-zero ready" home, and a net-zero home. Detailed explanations of each of these categories is discussed in subsequent sections of the documentation. The specific hypothesis being tested is as follows: *Higher initial costs are a financially material obstacle to green building.* In this instance, materiality will be defined by the traditional accounting definition which states that an item is material if it could influence the economic decisions of users (Schmidt, 2017). The author acknowledges that there are a multitude of ways to construct and design a single-family residence. This research examines a single instance of construction for each building category that is the most equitable utilization of building components and incentives available at the time. It is also acknowledged that regulatory requirements and policy modifications are likely to erode or improve incentive structures over time. In this way, this research relies on evidence from the current political climate as it exists in 2017.

The control case for this research will be the traditional code-compliant single family home. Estimations from the American Enterprise Institute (AEI) estimate that the average square footage of a home in the United States is 2,491 square feet (Perry, 2014). Given the roughly 2,500 square foot average, a set of design blueprints were obtained from an actual construction project completed in 2017 for a ranch-style home containing 2,537 square feet of heated space (Nickerson, 2017). These blueprints have been utilized to conduct various modeling functions throughout the study. Additionally, the literature estimates that the average construction price per square foot of a new home in 2017 is $150 (HomeAdvisor, Inc., 2017). Given this information, figures that require a square footage calculation will utilize an approximate square footage price of $150. For instances that require a base initial cost, these two figures have been extrapolated to arrive at a construction cost of $380,550 (2,537 square feet multiplied by $150 per square foot). It is acknowledged that specific price structures vary for each construction project completed in the State of California, but the design of this study is such that any variations in the total square footage or price per square footage would be transitive across all three building categories. The control case utilizes building components that meet or exceed building codes outlined in California's Title 24, Part 6 - 2016 Building Energy Efficiency Standards for Residential and non-Residential Buildings (California Energy Commission, 2015). Given that the study aimed to model an average sized home, electricity requirements for the control case are based on EIA United States average residential energy use of 901 kilowatt hours per month (EIA, 2016b). Electricity rates were calculated at 0.23073 dollars per kilowatt-hour by utilizing Pacific Gas & Electric's posted electric rates for residential homes' March 2017 rates (PG&E, 2017b) Natural gas requirements for the control case were determined through utilization of Pacific Gas & Electric's Residential Forecast 2017 table, which can be referenced in the appendices, and predicts an average monthly therm use of 35 therms per home and an average rate of $1.58 per therm (PG&E, 2017a). The code-compliant building, and thus the aforementioned cost structures, serve as the foundation upon which the other categories will build. Net-zero ready and net-zero homes follow a *Ceteris Paribus* methodology in which any cost components that do not change between building categories are excluded from the analysis. For example, cost components such as land acquisition are not included as it is assumed that these types of components are held constant, regardless of design methodology. Any component price variance that adds additional cost to the base case is depicted as a premium while any incentive structure that decreases the cost of the base case is depicted as a discount. This strategy eliminates elements that do not affect the conclusions of this study and avoids unnecessary noise in the analysis. Furthermore, the strategy ensures that any deviation of constant cost components from the assumed average will also not affect the conclusions of this study.

The second building category investigated is the net-zero ready single family residential home. To define net-zero ready, this study utilizes an efficiency strategy that achieves a 67% energy savings above code. This 67% figure was calculated in the Energy Vermont Feasibility Study through utilizing a third party company, Energy Balance, and Energy10 software to conduct a building energy simulation model (Energy Vermont, 2015). The 67% savings figure was used as a proxy in lieu of having the resources to conduct an energy simulation model on the home detailed in the AGUIRRE blueprints (Nickerson, 2017). The energy saving components for the net-zero ready home closely resemble those used in the Energy Vermont study and while the actual energy savings figure for all homes vary, it is assumed that the values would be consistent with the findings from the aforementioned energy simulation model (Energy Vermont, 2015). In the interest of *Ceteris Paribus,* all cost components are held constant outside of those components that contribute to meeting the 67% efficiency threshold. One caveat is the concession of an improved ventilation system to ensure safe air quality for residents given the investment in an airtight envelope inherent in this building strategy. This component is indirectly related to efficiency and will be considered as a premium to the base case. Tangible energy-efficient components considered include triple-pane windows, a vapor and moisture barrier, improved attic, wall, and raise-floor insulation, a heat recovery ventilation unit, domestic hot water heating via an air-source heat pump, and a 5-zone air-source heat pump for heating and cooling requirements. Components were considered at their fair market prices through research into the relevant literature and available marketplaces. The most economically viable energy efficiency contribution components were aggregated with the control cost component calculation to derive a total cost for the net-zero ready home.

The final building category is made up of the net-zero single family residential home. *Ceteris Paribus* is invoked once again to derive the initial base case cost for this strategy from the conventional code-compliant option. All tangible and intangible cost components from the net-zero ready home have been duplicated for the net-zero category. However, an additional cost component was added to the analysis that represents the financial outlay for an appropriately sized solar photovoltaic system in the region. This solar voltaic system meets the remaining 33% of energy draw of the code-compliant home that the net-zero ready building could not eliminate. Given the various climates zones in California, photovoltaic potential was estimated by utilizing the Energy Information Administration's average capacity factor of 28.1 for the State of California (Andrews, 2016). The 33% remaining energy draw was calculated to be approximately 300 kwh/month or 3,568 kwh per year by extrapolating the aforementioned 901 kwh/month total from the EIA (EIA, 2016b). Given this reduced energy draw, a modestly sized 2 kilowatt (kw) system was elected that more than meets the 3,568 kwh/yr electricity requirement. This figure was derived through a simple solar photovoltaic sizing calculation that multiplied the 28.1 California capacity factor, by 8,760 hours in a year, by 2kw which results in an annual production of 4,923 kwhrs/yr. A literature review was conducted to examine fair market rates and economical acquisition and installation options for this system. This cost was determined to follow Energysage's average January 2017 solar cost per watt of $3.26 figure (Matasci, 2016).

After deriving the specific cost structure for each building category, Federal and State level incentives and other relevant credits were credited back to the overall cost outlay for each project, where applicable. The goal of this analysis was to produce the most cost effective incentive structure for each building category in the State of California. Deducting incentives from each cost structure is designed to serve as a platform for comparison between the effective cash outlay that a homeowner would encounter when choosing a respective building category option. A full review of Federal incentives was undertaken and figures include Federal Income Tax Credits for Energy Efficiency which grant a discount factor of 30% of cost with no upper limit for solar photovoltaics (Energy Star, 2017a). For state and local level incentives, literature research was performed, leaning heavily on North Carolina Clean Energy Technology Center's Database of State Incentives for Renewables & Efficiency (DSIRE) tool (North Carolina Clean Energy Technology Center, 2017). This tool is funded by the U.S. Department of Energy and is the most comprehensive source for policies and incentives for renewables and energy efficiency (North Carolina Clean Energy Technology Center, 2017). The DSIRE tool currently lists 264 separate incentives for the State of California and each was assessed for its relevance to this particular research question (North Carolina Clean Energy Technology Center, 2017). As the study wished to assess the effective cost of the three building categories across the entire State of California, incentive structures that include one specific municipality were excluded from the final cost analysis (North Carolina Clean Energy Technology Center, 2017). As a result, a more granular study into specific municipalities would likely result in an incentive structure that offsets a greater amount of the cost of the net-zero ready and net-zero options. Component incentives utilized in this study were calculated in accordance with California's "Energy Upgrade California" program, which resulted from the California Public Utilities Commission's Decision 2 on Phase 2 Issues: Statewide Marketing, Education, and Outreach Plans for 2014 and 2015 (California Public Utilities Commission, 2013). As part of this decision, California's incumbent investor owned utility companies, including Southern California Edison, Sacramento Municipal Utility District, Pacific Gas & Electric, and SoCalGas, were directed by the California Public Utilities Commission to develop a strategy and budget for transitioning towards the use of a statewide umbrella brand, "Energy Upgrade California," for encouraging demand-side energy management by consumers (California Public Utilities Commission, 2013). The Energy Upgrade California program covers the state in its entirety and offers incentives of up to $8,000 for various energy efficiency upgrades (SMUD, 2017).

The aforementioned analysis of cost components, incentive structures, and credits was comparatively assessed for each option by creating a Google Sheets based pro-forma financial statement. This statement has three distinct verticals that depict each building category. In each vertical, the model sums the control case cost of construction and the added cost for each individual energy efficient cost component - that is, the variance between the cost of the control case component and the energy efficient component. For the net-zero option, the cost of the solar voltaic system is also added to the total upfront construction cost. Day one incentives, including the elimination of the traditional furnace and 4-ton HVAC system, the credits from the Energy Upgrade California Program, Energy Star rebates, and Federal tax credits are deducted from the total cost of the net-zero ready and net-zero verticals. This process led to a derivation of a 'Total

Effective Cost' for each building category. The Total Effective Cost for each vertical was fed into a mortgage calculator Excel spreadsheet provided by Guild Mortgage (Magnotta, 2012). The Total Effective Cost was financed by assuming a traditional 30-year fixed-rate mortgage with 20% cash down payment. Annual property taxes were calculated at 1.25% from average property tax rates reported in SF Gate by Mary Gallagher, owner of an urban planning and consulting business and planning director for the City of San Mateo, CA (Gallagher, 2017). Monthly homeowner's insurance fees were calculated at the default value of .004 inherent in Guild Mortgage's Mortgage Calculator multiplied by the Total Effective Cost (Magnotta, 2012). The interest rate was calculated at 3.84% as a result of the weekly reported rate on Bankrate.com for 30-year fixed California mortgages for the week of July 17, 2017 (Bankrate, 2017). In the interest of comprehensiveness, three additional escalated interest rate scenarios were calculated at 3.965%, 4.09%, and 4.215% to account for the inherent fluidity of mortgage interest rates. The figures for the control case, net-zero ready, and net-zero buildings were loaded into the mortgage calculator to derive a total monthly payment for each building category that considers principal and interest, estimated taxes, and estimated insurance. The total monthly payment was placed into the pro-forma Google Sheets document and was then reduced by the operating cost savings, calculated at 67% energy reduction, for the net-zero ready and net-zero buildings. An additional 5% insurance credit was deducted from the monthly cost for these two building categories due to a reported 5% green home discount from Travelers Insurance (Travelers Indemnity Company, 2017). For the net-zero home, an additional 33% energy credit was added to account for the remaining energy draw that would be eliminated by the 2kW solar voltaic system due to

California's status as a net-metering state (California Public Utilities Commission, 2017). These figures were finally summed for each vertical to arrive at a 'Monthly Financed Cost' for each building option. The Monthly Financed Cost was used as a final comparison metric to determine the cost-effectiveness of each option. This metric was utilized as the primary means of addressing the original hypothesis.

Results

The results indicate that the additional capital expenditures for energy efficient enhancements related to the net-zero ready and net-zero building categories range from $9,937.52 to $16,187.52 - a premium over the code home of 2.6% and 4.3%, respectively. The lower end of that range considers the net-zero ready strategy that does not deploy a solar photovoltaic system, while the high end of the range includes the 2kW solar photovoltaic system. The specific results are summarized in Figure 1 and discussed in detail below.

Net-Zero Capital Expenditures				
Building Component	**Code Option**	**Efficient Option**	**Unit**	**Added Cost**
Windows	JELD-WEN 35.5 in. x 35.5 in. V-1500 Series Left-Hand Sliding Vinyl Window - White. U-Value = .33, SHGC = .33	ReliaBilt 3900 Vinyl Triple Pane Single Strength Replacement Double Hung Window. U Value = .21, SHGC = .18	14 Windows	$3,696.56

Air/Vapor Barrier	10ft. x 12 ft. x .006 in. Roll of 6 mil Moisture Barricade Polyethylene Underlay Film over footprint of house for the crawl space area.	CertainTeed MemBrain 100 in. x 50 ft. Air Barrier with Smart Vapor Retarder. (Each roll is 416.5 square feet. 5888 square feet / 416.5 x $59.72. Adding $1,500 for additional air sealing, consistent with Vermont Study.	5888 Sq. ft	$1,963.46
Insulation - Attic	R30, just one roll per instead of two. R-30 Unfaced Insulation Continuous Roll 15 in. x 25 ft.Need 109 rolls	R-60 via two R-30 Unfaced Insulation Continuous Roll 15 in. x 25 ft. 31.25 per roll, need 218 rolls.	3392 Sq. ft	$2,021.95
Insulation - Walls	R-19 Kraft Faced Insulation Continuous Roll 15 in. x 39.2 ft. 48.96 per roll, bulk price of $20.15 per roll. Need 51 rolls.	R-40 EcoTouch PINK FIBERGLAS Insulation - 24-inch x 48-inch x 11-inch; 48 sq. Feet.	2496 Sq. ft	$2,574.91
Heat Recovery Ventilation	N/A	VENTS-US 162 CFM Whole-House Heat Recovery Ventilator Unit - 5 in. Round Duct	1 Unit	$936.74
Domestic Hot Water	Performance Plus 50 Gal. Tall 9-Year 38,000 BTU ULN Natural Gas Water Heater. Since california, needs to be Ultra Low Nox.	Platinum 50 Gal. 10-Year Hybrid High Efficiency Electric Tank Water Heater	1 Unit	$500.00
HVAC	Winchester 100,000 BTU 95.5% Multi-Positional Gas Furnace & 4-ton HVAC Unit 14 SEER	LG Wall Mounted 5-Zone System - 48,000 BTU Outdoor - 7k + 7k + 7k + 7k + 15k Indoor - 20.1	1 System	-$1,756.10

		SEER		
Solar Photovoltaics	N/A	2kW system @ $3.26 per Watt. California Capacity factor of 28.1, total production of 4,923 kWhrs/yr.	1 System	$6,250.00

Figure 1: Additional Capital Expenditures for Net-Zero Ready and Net-Zero Options

Additional fenestration expenditures of $3,696.56 was derived by assuming that all 14 windows from the AGUIRRE blueprints were roughly 36x36 inches in size and comparing Jeld-Wen V-1500 Series dual-pane windows at $84 each (Home Depot, 2017a) against Reliabilt 3900 triple-pane windows at $348.04 each (Lowe's, 2017). Additional expenditures of $1,963.46 related to the vapor barrier were calculated by comparing the $0.15 square foot cost of a Roberts 6 millimeter moisture barricade polyethylene underlay film over the 2,539 footprint of house (minus garage) for the crawl space area (Home Depot, 2017b) to a full house coverage of 5,888 square feet of CertainTeed MemBrain 100 in. x 50 ft. air barrier with smart vapor retarder at a cost of $59.72 per 416.5 square foot roll (Home Depot, 2017c). In addition, a $1,500 air sealing component was added to cost premiums to ensure that air sealing requirements were on par with the project detailed in the Efficiency Vermont study (Efficiency Vermont, 2015). Attic insulation was considered for the 3,392 square foot of attic space with R30 insulation for code and R60 for net-zero ready and net-zero options. The superior R60 options utilized Owens Corning un-faced insulation at a bulk purchase price of $18.55 per roll for an added cost of $2,021.95 (Home

Depot, 2017d). Wall insulation was calculated for 2,496 square feet of wall space at R19 Owens Corning Kraft Faced Insulation at a bulk price of $20.15 per roll for the code home (Home Depot, 2017e) and R-40 Owens Corning EcoTouch Insulation at $67.27 per 48 square feet for the energy efficient homes for a total added cost of $2,574.91 (Home Depot, 2017f). The heat recovery ventilation unit is a VENTS-US HRV 120s Unit 62 CFM Whole-House heat recovery ventilator that comes in at a cost of $936.74 and does not exist in the code building category (Home Depot, 2017g). Domestic hot water for the code home comes from an ultra-low nox Rheem Performance Plus 50 gallon tall 9-Year 38,000 BTU ULN natural gas water heater at a cost of $699 (Home Depot, 2017h). Domestic hot water for the energy efficient building categories comes from a $1,199 Rheem Performance Platinum hybrid heat pump water heater that boasts a 3.5 energy factor (Home Depot, 2017i). The HVAC system for the code home consists of a Winchester 100,000 BTU 95.5% multi-positional gas furnace at a cost of $1,640.10 (Home Depot, 2017j) and a 4 ton, 14 SEER air conditioning unit quoted at $4,600 for a 2,500 square foot home (Modernize, 2017). HVAC for the net-zero ready and net-zero home is handled via a 48,000 BTU, 20.1 SEER, LG wall mounted 5-Zone ductless air-source heat pump system at a cost of $4,484 (Power Equipment Direct, 2017). The sizing for this unit was calculated for 2,537 square feet of heated space through utilization of Sylvane's ASHP sizing estimate figures of 24,000 BTU per 1,400 to 1,500 square feet (Sylvane, 2017). The code HVAC components sum to a total of $6,240.10 which offsets the entire air-source heat pump system cost of $4,484 and adds an additional capital credit of $1,756.10. As previously mentioned, the $6,250 cost of the photovoltaic system was determined by utilizing Energysage's average January 2017 solar cost per watt of $3.26 (Matasci, 2016).

For day one capital incentives, a total of $5,800 was garnered for the net-zero ready home and a total of $7,556 was garnered for the net-zero home. For the net-zero home, a $1,756 credit was obtained from the Federal Income Tax Credits for Energy Efficiency program at a rate of 30% of the $6,520 spent on the 2kW solar photovoltaic system (Energy Star, 2017a). In addition, the Rheem Performance Platinum hybrid heat pump water heater was eligible for a $300 mail-in rebate from Energy Star was available for units purchased between January 1, 2017 and December 31, 2017 (Home Depot, 2017i). For California state incentives, the Energy Upgrade California program was deemed to be the most cost efficient and comprehensive method for redeeming state-level rebates. Each of the incumbent investor owned utility companies has its own specific program incentives and the maximum achievable incentives for these programs range from $5,500 (PG&E, 2017c) to $8,000 (SMUD, 2017). In addition, these incentives are only available through a version of each utility company's Home Performance Program and an individual must work with an approved contractor to calculate specific incentives for a given home (SMUD, 2017). The Sacramento Municipal Utility District was found to be the only company that publishes a breakdown of approximate rebates at a component level of granularity (SMUD, 2017). As a result, SMUD information was utilized to calculate the approximate savings that should be expected for the energy efficient measures placed in the net-zero ready and net-zero homes. The manual calculations are referenced in Figure 2.

SMUD Incentives		
Component	**Incentive**	**Details**
Windows	$375.00	$75 for every 25 sq ft of upgraded window area, $1000 max*. This rebate only available if windows were done as part of a Home Performance Program project, work completed by a listed Home Performance contractor.U-factor ≤ 0.30, SHGC ≤ 0.25
Vapor Barrier	$500.00	≥ R-19, vapor barrier (6 MIL plastic). $500*
Attic Insulation	$2,000.00	$15 for every 100 sq. ft. of attic insulation, $1,000 max*. ≥ R-38 (knee walls ≥ R-19). Re-use of existing insulation allowed if uncontaminated and free of debris.
Wall Insulation	$1,000.00	$50 for every 100 sq ft of insulation, $1000 max*. ≥ R-13, all exterior walls of living space.
HVAC	$1,000.00	Mini-split heat pump ≥ 15 SEER, ≥ 8.5 HSPF With DC inverter technology Enter # of indoor heads installed. $250 per indoor head, $1000 max
Domestic Hot Water	$1,000.00	Heat Pump DHW, EF ≥ 2.0; first hour rating ≥ 50 gallons/hr; insulate first 5 feet of hot and cold water pipes from the storage tank. $1,000
Bonus of 5+	$300.00	
	$6,175.00	**Total**

Figure 2: SMUD Component Rebate Incentives for Net-Zero Ready and Net-Zero Options (SMUD, 2017)

The total calculated rebate incentive of $6,175 in Figure 2 provided confidence that the energy efficient building categories qualify for home performance plans in California. As the study aimed to investigate a home to be constructed in any area of California, the Energy Upgrade California incentives that contribute to the Total Effective Cost of the net-zero ready and net-zero homes were calculated at $5,500 - the lowest of the investor owned utilities incentive structures (PG&E, 2017c).

After considering the full scope of capital expenditures and day one incentive credits, the data was input into the Pro-Forma Financial Statement detailed in Figure 3. The Total Effective Cost of the code home is calculated at $380,550, the Total Effective Cost of the net-zero ready home is $384,687.52, and the Total Effective Cost of the net-zero home is $389,251.52. After incentives and rebates, the net-zero ready home can be constructed at an effective premium of $4,137.52 and the net-zero home can be constructed at an effective premium of $8,701.52, when compared to code. It is important to note that these prices were garnered from online retailers that specialize in replacement components. Due to the lack of transparency in the building industry, there is a limited population of building components that have pricing available to consumers.

Pro-Forma Financial Statement							
Conventional			**Net-Zero Ready**			**Net-Zero**	
Category	**$**		**Category**	**$**		**Category**	**$**
Base Cost	$380,550.00		Base Cost	$380,550.00		Base Cost	$380,550.00

		Windows	$3,696.56	Windows	$3,696.56
		Vapor Barrier	$1,963.46	Vapor Barrier	$1,963.46
		Insulation	$4,596.86	Insulation	$4,596.86
		HRV	$936.74	HRV	$936.74
		DHW - ASHP/GSHP	$500.00	DHW - ASHP	$500.00
		HVAC - ASHP	$4,484.00	HVAC - ASHP	$4,484.00
		HVAC Credit	-$6,240.10	HVAC Credit	-$6,240.10
		Energy Upgrade California	-$5,500.00	Energy Upgrade California	-$5,500.00
		ASHP Water Heater	-$300.00	ASHP Water Heater	-$300.00
				Solar PV Cost	$6,520.00
				Solar PV Tax Credit	-$1,956.00
Total Effective Cost	**$380,550.00**	**Total Effective Cost**	**$384,687.52**	**Total Effective Cost**	**$389,251.52**

Figure 3: Pro-Forma Financial Statement (Total Effective Cost by Category)

After arriving at the Total Effective Cost for each building category, these totals were populated in the Guild Mortgage Mortgage Calculator and assumed that the increased cost for the energy efficient components would be financed as a traditional 30-year home loan (Magnotta, 2012). In the event that an individual was only qualified at the base cost of $380,550, it is assumed that an FHA Energy Efficient Mortgage was utilized which allows the mortgage loan amount to be increased by the cost of energy improvements and eliminates loan limits for additional energy efficient measures (Energy Star, 2017b). The total monthly financed cost for the conventional home is calculated at $1,948.76, the total monthly cost for the net-zero ready home is $1,972.29, and the total monthly cost for the net-zero home is $1,995.66 (Magnotta, 2012). A full explanation of the various building categories' loan calculations are available in the appendices. As seen in the calculated day one numbers, both the net-zero ready and net-zero options are more expensive than the conventional home.

The component upgrades, however, are not only restricted to non-recurring construction credits. These components were installed for the purpose of energy conservation and, thus, an operating credit was applied to the net-zero ready and net-zero building categories to account for these conservation efforts. The operating credit of 67% of the cost of current energy use was applied to each of the categories at $176.34 per month. For the net-zero option, an additional $86.85 monthly credit was applied to account for the remaining 33% of energy spend that will be avoided on an annual basis through the use of the 2kW solar photovoltaic system. Finally, the monthly 5% homeowner's insurance credit was applied at $6.42 per month for the net-zero ready home and $6.50 per month for the net-zero home. Once these credits are subtracted from the monthly financed cost, the monthly payment for the conventional category remains at $1,948.76 but falls to $1,789.53 and $1,725.97 for the net-zero ready and net-zero options, respectively. This revised figure indicates that the effective monthly cost for the net-zero ready and net-zero homes is actually *lower* than the conventional home beginning in the first month of occupancy.

Effective Monthly Cost							
Conventional			**Net-Zero**			**Net-Zero**	

			Ready				
Financing			Financing			Financing	
Code Mortgage	$1,948.76		NZR Mortgage	$1,972.29		Net-Zero Mortgage	$1,995.66
			Operating Credit	-$176.34		Operating Credit	-$176.34
			Insurance Credit	-$6.42		Insurance Credit	-$6.50
						Solar PV Operating Credit	-$86.85
Monthly Cost	**$1,948.76**		**Monthly Cost**	**$1,789.53**		**Monthly Cost**	**$1,725.97**

Figure 4: Effective Monthly Cost by Building Category

Further extrapolation of these monthly cost differences show that a minor difference in cost, when compounded over the 30 year life of a mortgage instrument, has a profound effect on the cumulative cash outlay of each building strategy. When calculating this effect, the operating and solar credit were escalated by 3% each year, estimated by the year-over-year change in electricity cost for California detailed in the residential section of the Department of Energy's Table 5.6 Average Price of Electricity to Ultimate Customers by End-Use Sector and extrapolated for the life of the 30 year loan (U.S. Department of Energy, 2017). The insurance credit was escalated by 4.92% per year, calculated as an average of the year-over-year change between the years 2004 and 2014 (Home Insurance King, 2017). The additional yearly operating and insurance credits range from $2,193.07 to $3,236.25 in year one to $5,296.74 to $7,756.67 in year 30. As illustrated in Figure 5, the total cash outlay over the 30-year time horizon is $701,553.60 for the code home, $604,304.74 for the net-zero ready home, and $563,070.81 for the net-zero home. These embedded costs create a 30-year cost differential savings of $97,248.86 for the net-zero ready option and $138,482.79.

Figure 5: Cumulative Cost by Building Category

The research conducted for this paper aimed to test the hypothesis that green buildings, and net-zero buildings specifically, are more expensive to build and operate than conventional buildings. The results indicate that the initial capital cost for the acquisition and construction of

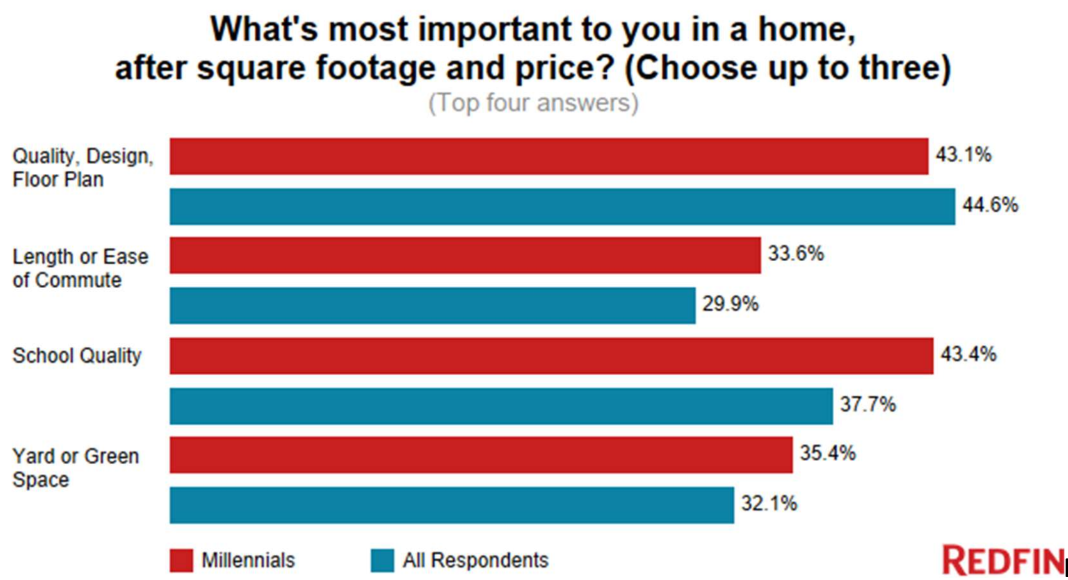
the net-zero ready and net-zero options, when considered in their own silos, are indeed more expensive than the conventionally-built home. This result holds true even when considering Federal incentives, Energy Upgrade California, and Energy Star incentives. The results also strongly indicate, however, that the operating costs and insurance discounts associated with the net-zero ready and net-zero strategies more than offset the increased capital cost when financed as part of a traditional 30-year residential mortgage. The results indicate that this statement holds true both in month one and over the entire life of the mortgage. When cumulative costs are aggregated, the total savings achieved through utilization of an energy efficient strategy can swell to more than $100,000 a 30-year time horizon.

Discussion

This study is not alone in its findings regarding the effective cost of energy efficient residential buildings. The Efficiency Vermont study that has been heavily referenced in this work also concluded that residential net-zero ready and net-zero homes had a lower first year operating cost and were significantly less expensive with respect to long-term capital and finance expenditures (Efficiency Vermont, 2015). Furthermore, and primarily related to propane use in boilers and furnaces, the Efficiency Vermont study was able to arrive at this same conclusion without layering in any Federal or State incentives and rebates (Efficiency Vermont, 2015). Other literature indicates that a green building can be built at a premium of roughly $3-$9 per square foot (Kats et al., 2013). For the home considered in this study, that would range from $7,611 to $22,833 which is in line with the research findings. Additional information from the United States Green Building Council shows that the average upfront costs of a green building are 2.4%, and those costs are quickly recouped through savings over the lifespan of the home (USGBC, 2016). Furthermore, the United States Department of Energy reports that, discovered through its Building America R&D program, it is possible to design and construct new houses that are 30 to 40% lower in energy use intensity than a code built house at little to no additional cost (U.S. Department of Energy, 2006). The trend that emerges from both the results of this study and a robust literature review is that energy efficient buildings are less expensive to own and operate than a code-compliant structure. This conclusion, while not intuitive, is supported by the data and holds true when considering both immediate and long-term time horizons.

Despite the reality indicated by the aforementioned data, 81% of consumers believe that environmentally friendly products are more expensive than traditional non-green products (PR Newswire, 2017) and 80% of professionals intimately familiar with the construction industry believe that higher first costs are an obstacle to green building (Kats et al., 2013). If those perceptions were the result of data-informed decisions, it would be clear that the solution to America's $110 billion annual building waste issue is to invest in energy efficient buildings while simultaneously reducing the overall operating cost and debt outlay for each individual housing unit. However, as has been demonstrated in the debate regarding climate change and other sustainability-centric issues, simply providing the data to drive change is not always enough to affect public opinion (Popovich, Schwartz, & Schlossberg, 2017). The question of how to drive systematic change in an industry is an exercise in psychology and the human condition. This question becomes increasingly difficult to answer for the construction industry, in particular, as a result of an industry culture that struggles to adopt and integrate new technology into its processes (KPMG, 2016).

In a recent survey of 1,800 homebuyers, participants indicated that the biggest concern amongst home purchasers is affordability (Starace, 2016). Furthermore, after square footage and price, participants indicated that the most important factor of choosing a home was quality, design, and floor plan, length or ease of commute, school quality, and yard or green space (Starace, 2016). As demonstrated in Figure 6, concerns related to anything even tangentially connected to energy efficiency and sustainability did not register on the scale of responses.



Figure

Figure 6: Effective Monthly Cost by Building Category (Source: Starace, 2016).

Given that a home purchase is likely the single largest purchase an individual will ever make (Prudential, 2017), this tendency towards heavily weighting monetary considerations is not surprising. The reality is that no amount of climate change awareness campaigns or sustainability education will affect the purchasing decisions of consumers if the components associated with those programs materialize as an exorbitant premium to the largest purchase of their life. Even the most sustainably inclined homebuyer must seriously consider the financial implications of the entire suite of aforementioned factors that go into the selection of home. Indeed, this is precisely the reason for the format of this particular study. Once a sustainability professional is able to make the case for green buildings on financial merit alone, the environmental and social aspects of the triple bottom line become ancillary value-add principles that serve to enhance the justification for ushering in greener practices.

Of course, in order for consumers to make smart purchasing decisions, it is imperative that the offerings available to them are transparent. As discovered through the research undertaken to support this study, the construction, home purchase, and residential energy distribution industries have a severe lack of transparency that permeates through the entire process of planning, purchasing, and operating a home. During the course of the study, reliable marketplaces for pricing energy efficient components were exceedingly difficult to uncover. Inquiries into the cost of items such as windows, insulation, and HVAC systems were generally met with sales calls and further inquiries into contracting for a project, as opposed to clear pricing options and their relevant costs and benefits. Even programs such as Energy Upgrade California, that were built for the purpose of influencing energy efficiency buildings, require that individuals work with an approved 'Home Performance Contractor' to conduct a comprehensive review of a home's energy efficiency (SMUD, 2017). Differences between a basic and advanced home upgrade program are vague - with the difference from one investor owned utility simply stating that the "Advanced Home Upgrade Package goes beyond the basics of improving your home's exterior shell and typically involves more complex upgrades (SCE, 2017)." This particular relationship to consumers may be compared to that of the auto-repair industry, where the services have no fixed fees, the issues are confusing to the average person, and the customer must rely on the honesty and trustworthiness of the business - as it currently holds dominion over one of the most important assets in that individual's life. This lack of transparency benefits the builders and incentivizes them to make decisions that enhance their profit margins instead of maximizing the long-term financial interests of their customers.

Furthermore, costs related to energy usage suffers from a similar lack of transparency. Energy for residential end-use is generally billed on a per-kilowatt-hour and therm basis, but these abstract numbers have little meaning to the average consumer. A simple inquiry into the amount of hot water that can be produced through 1 therm of natural gas use or how many minutes of television watch-time one can achieve through utilization of one kilowatt-hour of electricity would be a useful exercise, but becomes a complicated investigation into time-variant pricing and energy demand curves (Spiller, 2015). The effect of this black-box of energy distribution is profound, as it has been estimated that in the summer of 2014 in California, a diminutive 2.5% reduction in energy usage at *peak* times would have saved the state $700 million dollars (Wright, 2017). The complicated nature of these industries is compounding the inability for consumers to make smart choices that affects their economic interests and the triple-bottom line of the entire country.

Recommendations

In order to address the current state of waste in the United States' building stock, installing a culture of transparency in the construction, home purchase, and residential energy distribution industries is recommended. The data from this and other studies does not support the hypothesis that increased expense is a financially material obstacle to green building. In fact, while there is an additional capital expenditure for energy efficient components, when financed as part of a traditional 30-year mortgage, the operating savings cost outweigh this added cost during the first month of occupancy. Furthermore, it has been established that affordability and cost related concerns are the most important factor for American consumers when selecting a home (Starace, 2016). Therefore, the missing link exists in connecting budget conscious consumers with energy efficient home building techniques that provide lower monthly payments (after considering total home operating costs). Various measures geared towards installing transparency into this space would serve to amend this broken link and resolve the energy hemorrhaging nature of traditional construction in the United States.

As indicated in a report from the Residential Energy Services Network (RESNET), the lack of information available to consumers regarding the energy use and performance of homes is an issue for American homebuyers, as well as the U.S. economy and national energy security (RESNET, 2013). An equally concerning issue relates to mortgage underwriting practices that ignore energy and cost saving features that exist in homes (RESNET, 2013). In line with the recommendations of the RESNET proposal, the author recommends building monthly energy savings into the value and affordability calculations that exist when considering an energy efficient home (RESNET, 2013). Energy efficiency measures have a profound effect of the cost and, therefore, the affordability of a given home. There is, therefore, no rational explanation for excluding efficiency measures from the formulaic calculation that indicates whether or not an individual is able to own and operate a property. The RESNET proposal also calls for mandatory

Home Energy Rating System (HERS) Index Scores for all homes - both new construction and those that already exist within the built space (RESNET, 2013). This requirement would provide a metric to compare homes on an expected energy efficiency basis. This type of transparency would incentivize those with less desirable scores to improve their efficiency measures and would encourage builders to produce homes with the highest rating that is economically feasible for the project.

Supplemental to the previous recommendation, and also in the interest of improving the energy efficiency of the American building stock, is to issue a minimum required average HERS rating for all structures produced by a builder. This program would work similar to the Corporate Average Fuel Economy Standards in which the entire fleet of vehicles for a car manufacturer in 2017 must meet a minimum fuel efficiency metric of 40.3-41.0 miles per gallon in 2017 (U.S. Department of Transportation, 2014). Each model may be above or below that metric, as long as the entire fleet averages out to the minimum requirement prescribed by the program (U.S. Department of Transportation, 2014). For the building industry, a similar program would allow for each individual home to be above or below a given HERS Index Score, but the entire "fleet" of homes built by that specific builder must meet the minimum program requirements. Over time, as technology improves and prices for energy efficient components fall, it is assumed that the minimum HERS Index Score would increase to match market conditions. This strategy is more regulatory in nature but influences the shift to a more transparent paradigm in the built space. Given that the building sector's 40% contribution to United States energy mix is larger than that of the transportation sector, it only makes sense to have similar regulation that throttles deficiencies in efficiency (EIA, 2017b).

The final recommendation involves the self-education and research capabilities of the average consumer when pricing a potential home purchase or construction project. The inability to easily research component costs without introducing a third party consultant has the potential to hinder the introduction of green building projects. This relationship to the consumer should only exist for labor based services whose fulfillment requires the knowledge of an expert in the field. Simply researching the variance in pricing between a double-glazed and triple-glazed window does not warrant the inclusion of a third party profiteer, disguised as an advisor. Injecting consultants and black-box pricing into the building process eliminates the customer's ability to compare his/her best options and runs the risk of price manipulation and cartel-like behavior from suppliers. With this in mind, a nationally-funded online platform to be utilized in the price comparison of building components would serve as a necessary step forward in transparency. This service may operate similar to TrueCar in the transportation industry, in which comprehensive pricing information is analyzed and made available to consumers that establishes a baseline of trust and sets parameters for a fair deal (TrueCar, 2017). In the building sector implementation of such a platform, all completed building projects would submit a component price form as part of the requirements for obtaining the certificate of occupancy - a government issued certificate that ensures a house is up to code and fit for habitation (Di Jensen, n.d.). The component price form would detail the price charged to consumers for the main components of the build and that data would be uploaded into a State or National database that could be queried by consumers. This recommendation would encourage builders to charge fair market value or suffer the appropriate market consequences of price gouging.

Due to the nature of different climate zones and varying market concerns in the myriad regions throughout the country, the above recommendations should only be implemented after additional research is conducted into the financial feasibility of green buildings for all geographic areas. While the literature indicates that a vast array of climate zones realize affordability benefits when including efficient components, it is possible that certain extreme climates may not prove to be financially feasible. The goal of these recommendations is to address a lack of transparency and leaky infrastructure through affordable means, not penalize builders and homebuyers with additional financial burden. It is therefore important that this decision, and any other action related to major sectors of the economy, are carefully considered through the utilization of a thorough cost-benefit analysis and the use of data-informed and data-driven decision making. It is imperative that any modifications to current policies aim for bipartisan buy-in, as the array of effects related to improvements in energy efficiency in buildings can benefit parties from both sides of the aisle. However, once this baseline of due diligence has been established, the question does not become "How can we afford green buildings" but rather, "How can we afford to do anything else?"

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Appendix A: Residential Forecast 2017 (Natural Gas)

Pacific Gas and Electric Company

Residential Average Gas Rate 1/ ($/therm)
and
Residential Average Gas Bill 1/ (per month)

May 2017 Forecast

Average Rate 2/ ($/therm)	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15	Average 2015
Procurement 3/	$0.50	$0.48	$0.40	$0.35	$0.30	$0.40	$0.32	$0.40	$0.33	$0.33	$0.38	$0.39	$0.38
Transportation & PPP 4/	0.98	0.98	0.98	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.00	1.00	1.01
Total 5/	**$1.49**	**$1.46**	**$1.38**	**$1.37**	**$1.33**	**$1.43**	**$1.35**	**$1.43**	**$1.35**	**$1.35**	**$1.38**	**$1.39**	**$1.39**
Actual Avg Use (therm) 6/	**62**	**42**	**29**	**25**	**21**	**16**	**14**	**14**	**15**	**17**	**45**	**69**	**31**
Average Bill Per Month 2/													
Procurement 3/	$31.25	$20.25	$11.42	$8.85	$6.34	$6.40	$4.53	$5.64	$4.89	$5.54	$17.28	$27.19	$12.47
Transportation & PPP 4/	61.05	41.72	28.47	25.99	21.53	16.40	14.35	14.35	15.38	17.43	44.89	68.83	30.87
Total 5/	**$92.30**	**$61.97**	**$39.90**	**$34.84**	**$27.87**	**$22.80**	**$18.88**	**$19.99**	**$20.27**	**$22.97**	**$62.17**	**$96.02**	**$43.33**

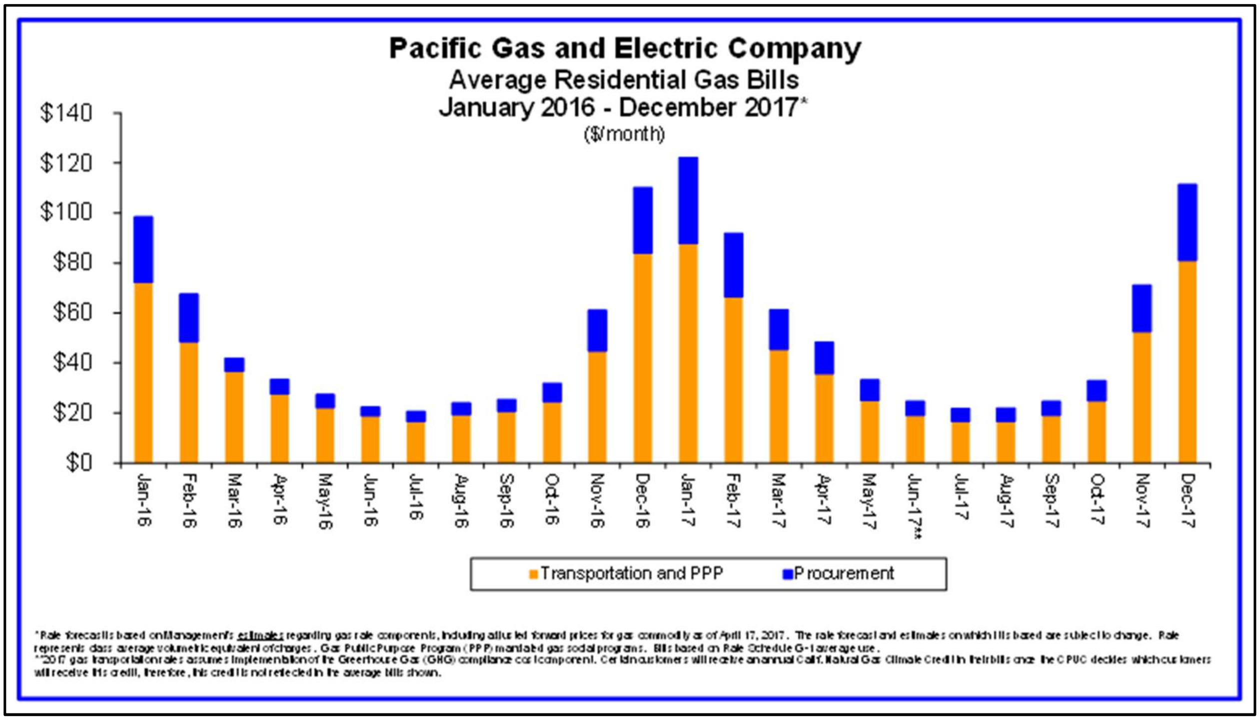
Average Rate 2/ ($/therm)	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Average 2016
Procurement 3/	$0.39	$0.42	$0.15	$0.23	$0.27	$0.21	$0.27	$0.31	$0.30	$0.39	$0.46	$0.39	$0.32
Transportation & PPP 4/	1.08	1.08	1.08	1.10	1.10	1.10	1.10	1.29	1.29	1.29	1.26	1.26	1.17
Total 5/	**$1.47**	**$1.50**	**$1.23**	**$1.34**	**$1.37**	**$1.31**	**$1.37**	**$1.60**	**$1.59**	**$1.68**	**$1.72**	**$1.66**	**$1.49**
Actual Avg Use (therm) 6/	**67**	**45**	**34**	**25**	**20**	**17**	**15**	**15**	**16**	**19**	**35**	**67**	**32**
Average Bill Per Month 2/													
Procurement 3/	$26.20	$19.04	$5.20	$5.85	$5.30	$3.54	$4.05	$4.64	$4.72	$7.32	$16.28	$26.23	$10.70
Transportation & PPP 4/	72.26	48.53	36.67	27.59	22.07	18.76	16.55	19.35	20.64	24.52	44.72	83.91	36.30
Total 5/	**$98.45**	**$67.57**	**$41.87**	**$33.44**	**$27.37**	**$22.29**	**$20.60**	**$23.99**	**$25.36**	**$31.83**	**$61.00**	**$110.14**	**$46.99**

Average Rate 2/ ($/therm)	Jan-17	Feb-17	Mar-17	Apr-17	May-17 7/	Forecast > Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17 8/	Dec-17 8/	Average 2017
Procurement 3/	$0.45	$0.44	$0.40	$0.42	$0.40	$0.36	$0.37	$0.38	$0.35	$0.38	$0.43	$0.45	$0.40
Transportation & PPP 4/	1.16	1.16	1.16	1.19	1.19	1.18	1.18	1.18	1.18	1.18	1.19	1.19	1.18
Total 5/	**$1.61**	**$1.60**	**$1.56**	**$1.61**	**$1.58**	**$1.54**	**$1.55**	**$1.57**	**$1.54**	**$1.57**	**$1.62**	**$1.64**	**$1.58**
Actual/Forecast Avg Use (therm) 6/	**76**	**57**	**39**	**30**	**21**	**16**	**14**	**14**	**16**	**21**	**44**	**68**	**35**
Average Bill Per Month 2/													
Procurement 3/	$34.34	$25.43	$15.77	$12.66	$8.36	$5.71	$5.14	$5.38	$5.65	$8.00	$18.74	$30.40	$14.63
Transportation & PPP 4/	87.84	66.50	45.46	35.57	24.90	18.95	16.58	16.58	18.95	24.87	52.43	81.03	40.80
Total 5/	**$122.19**	**$91.93**	**$61.24**	**$48.23**	**$33.26**	**$24.66**	**$21.72**	**$21.95**	**$24.59**	**$32.87**	**$71.17**	**$111.43**	**$55.44**

1/ Average Rate and Bill based on Non-Care Class Average, including PPP surcharges. Individual customers bills will vary depending on actual use.
2/ CARE Customers receive a 20% Discount (80% of average rate or average bill).
3/ Procurement rate includes cost of gas commodity and transportation to the Citygate (PG&E's local transmission system).
4/ Public Purpose Programs (State mandated gas social programs).
5/ Totals may not sum exactly due to rounding.
6/ Actual and forecast usage is based on Rate Schedule G-1. Availability of actual usage data is lagged 2 months. Forecast usage is based on normal weather.
7/ The procurement rate and bill includes a charge of $0.03060 per therm to reflect account balance amortizations in accordance with Advice Letter 3157-G.
8/ 2017 gas transportation rates assumes implementation of the Greenhouse Gas (GHG) compliance cost component. Certain gas customers will receive an annual Calif. Natural Gas Climate Credit in their bills once the CPUC decides which customers will receive this credit, therefore, this credit is not reflected in the class average rates or bills shown.

Seasons: Winter = Nov-Mar **Summer** = April-Oct
Rate forecast is based on Management's estimates regarding gas rate components, including adjusted forward prices for gas commodity as of April 17, 2017.
The rate forecast and estimates on which it is based are subject to change. Rate represents class average volumetric equivalent of charges.

Appendix B: Monthly Average Bill Graph 2017 (Natural Gas)



Appendix C: Residential Electric Rates - March 2017

Rate Schedule	Rate Design	Delivery Minimum Bill Amount (per meter per day)	Discount (per dwelling unit per day)	Minimum Average Rate Limiter (per kWh per month)	Energy Charge 1/ ($/kWh)			California Climate Credit 2/	"Average" Total Rate 3/ (per kWh)
			ES, ET, ESL & ETL Only	ES, ET, ESL & ETL Only	Baseline Usage 4/	101% - 400% of Baseline	High Usage Over 400% of Baseline		
Residential Schedules: E-1, EM, ES, ESR, ET	Tiered Energy Charges	$0.32854	ES = $0.05793 ET = $0.19908	ES and ET $0.04892	$0.19979	$0.27612	$0.40139	($17.40)	$0.23073
Residential CARE Schedules: EL-1, EML, ESL, ESRL, ETL	CARE Tiered Energy Charges	$0.16427	ESL = $0.05793 ETL = $0.19908	ESL and ETL $0.04892	$0.12643	$0.17261	$0.23970	($17.40)	$0.13661

1/ Customers receiving a medical baseline allowance shall pay for all usage in excess of 130% of baseline at rates applicable to usage from 131 percent through 200 percent of baseline.
2/ Bill credit per household, per semi-annual payment occurring in the April and October bill cycles.
3/ Average rates based on estimated forecast. Average rates provided only for general reference, and individual customer's average rate will depend on it's applicable kWh, and TOU data.
4/ For Baseline Territory and Quantity information, please view separate online worksheet or rate schedule in online Tariff Book.
Note: **Summer** Season: May-October **Winter** Season: November-April
This table provided for comparative purposes only. See current tariffs for full information regarding rates, application, eligibility and additional options.

Appendix D: Guild Mortgage - Mortgage Calculator (Code Home)

Inputs				
Purchase price	$ 380,550			
Down payment	$ 76,110			
Annual Taxes	$ 4,757			
Annual Insurance	$ 1,522			
HOA Monthly	$ -			
Mortgage Insurance Factor	0.000%			
Earnest Money	$ -			
	Option 1	**Option 2**	**Option 3**	**Option 4**
Payment **Rate**	3.840%	3.965%	4.090%	4.215%
Principal and interest	$ 1,426	$ 1,447	$ 1,469	$ 1,491
Estimated Taxes	$ 396	$ 396	$ 396	$ 396
Estimated Insurance	$ 127	$ 127	$ 127	$ 127
Mortgage insurance	$ -	$ -	$ -	$ -
HOA	$ -	$ -	$ -	$ -
Total payment	$ 1,948.76	$ 1,970.56	$ 1,992.54	$ 2,014.69
	Option 1	**Option 2**	**Option 3**	**Option 4**
Cash to close **Rate**	3.840%	3.965%	4.090%	4.215%
Down Payment	$ 76,110	$ 76,110	$ 76,110	$ 76,110
Prepaid insurance and taxes	$ 3,406	$ 3,406	$ 3,406	$ 3,406
Prepaid interest	$ -	$ -	$ -	$ -
Title, Appraisal, Underwriting, Government, ect	$ 2,100	$ 2,100	$ 2,100	$ 2,100
Points	$ 7,915	$ 6,089	$ 4,567	$ 3,044
Earnest Money	$ -	$ -	$ -	$ -
Lender Credit	$ -	$ -	$ -	$ -
Seller Concessions	$ -	$ -	$ -	$ -
Total cash to close	$ 89,531	$ 87,705	$ 86,183	$ 84,660

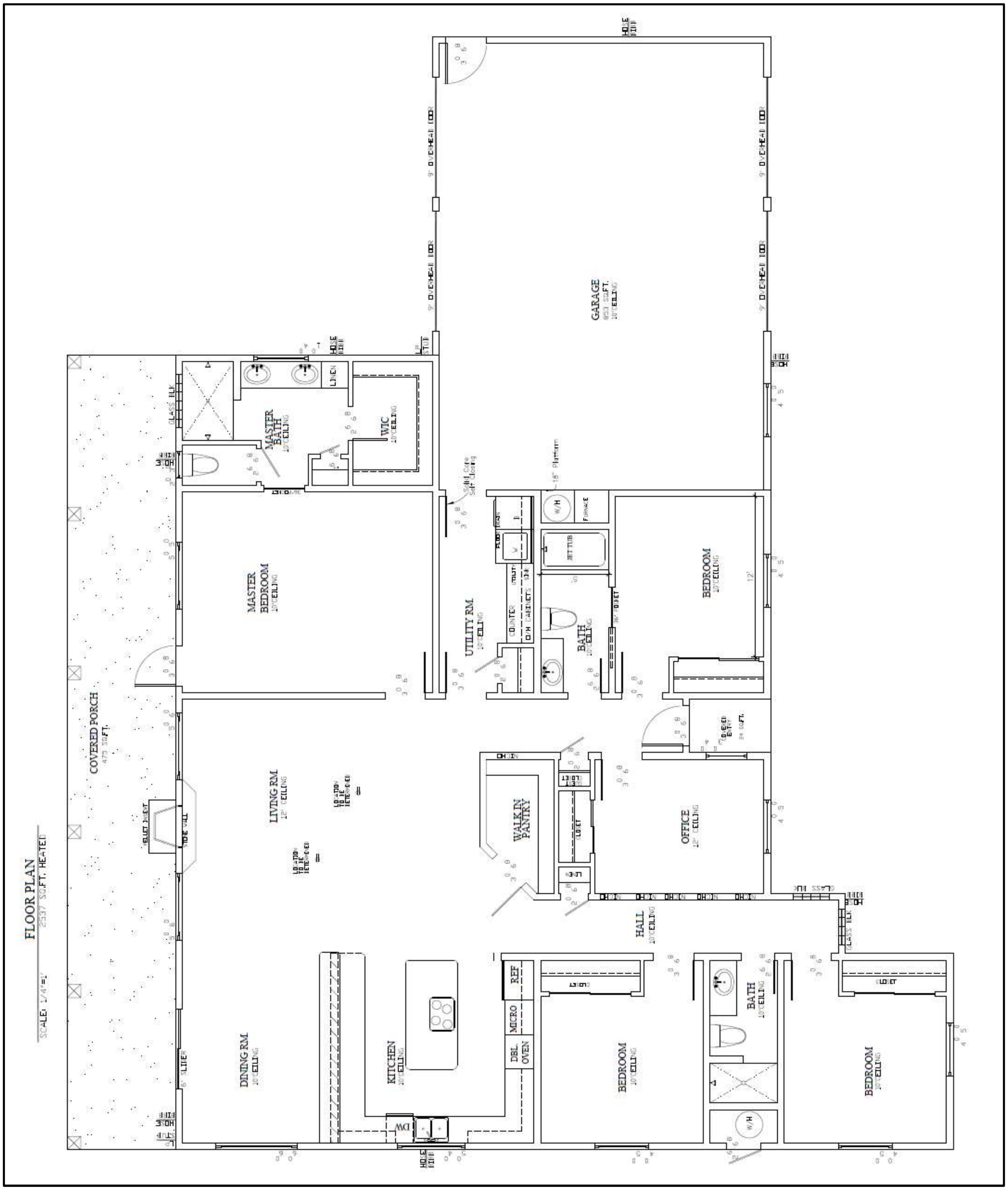
Appendix E: Guild Mortgage - Mortgage Calculator (Net-Zero Ready Home)

Inputs					
Purchase price		$ 385,146			
Down payment		$ 77,029			
Annual Taxes		$ 4,814			
Annual Insurance		$ 1,541			
HOA Monthly		$ -			
Mortgage Insurance Factor		0.000%			
Earnest Money		$ -			
		Option 1	**Option 2**	**Option 3**	**Option 4**
Payment	**Rate**	3.840%	3.965%	4.090%	4.215%
Principal and interest		$ 1,443	$ 1,465	$ 1,487	$ 1,509
Estimated Taxes		$ 401	$ 401	$ 401	$ 401
Estimated Insurance		$ 128	$ 128	$ 128	$ 128
Mortgage insurance		$ -	$ -	$ -	$ -
HOA		$ -	$ -	$ -	$ -
	Total payment	$ 1,972.29	$ 1,994.36	$ 2,016.60	$ 2,039.02
		Option 1	**Option 2**	**Option 3**	**Option 4**
Cash to close	**Rate**	3.840%	3.965%	4.090%	4.215%
Down Payment		$ 77,029	$ 77,029	$ 77,029	$ 77,029
Prepaid insurance and taxes		$ 3,447	$ 3,447	$ 3,447	$ 3,447
Prepaid interest		$ -	$ -	$ -	$ -
Title, Appraisal, Underwriting, Government, ect		$ 2,100	$ 2,100	$ 2,100	$ 2,100
Points		$ 8,011	$ 6,162	$ 4,622	$ 3,081
Earnest Money		$ -	$ -	$ -	$ -
Lender Credit		$ -	$ -	$ -	$ -
Seller Concessions		$ -	$ -	$ -	$ -
	Total cash to close	$ 90,587	$ 88,738	$ 87,198	$ 85,657

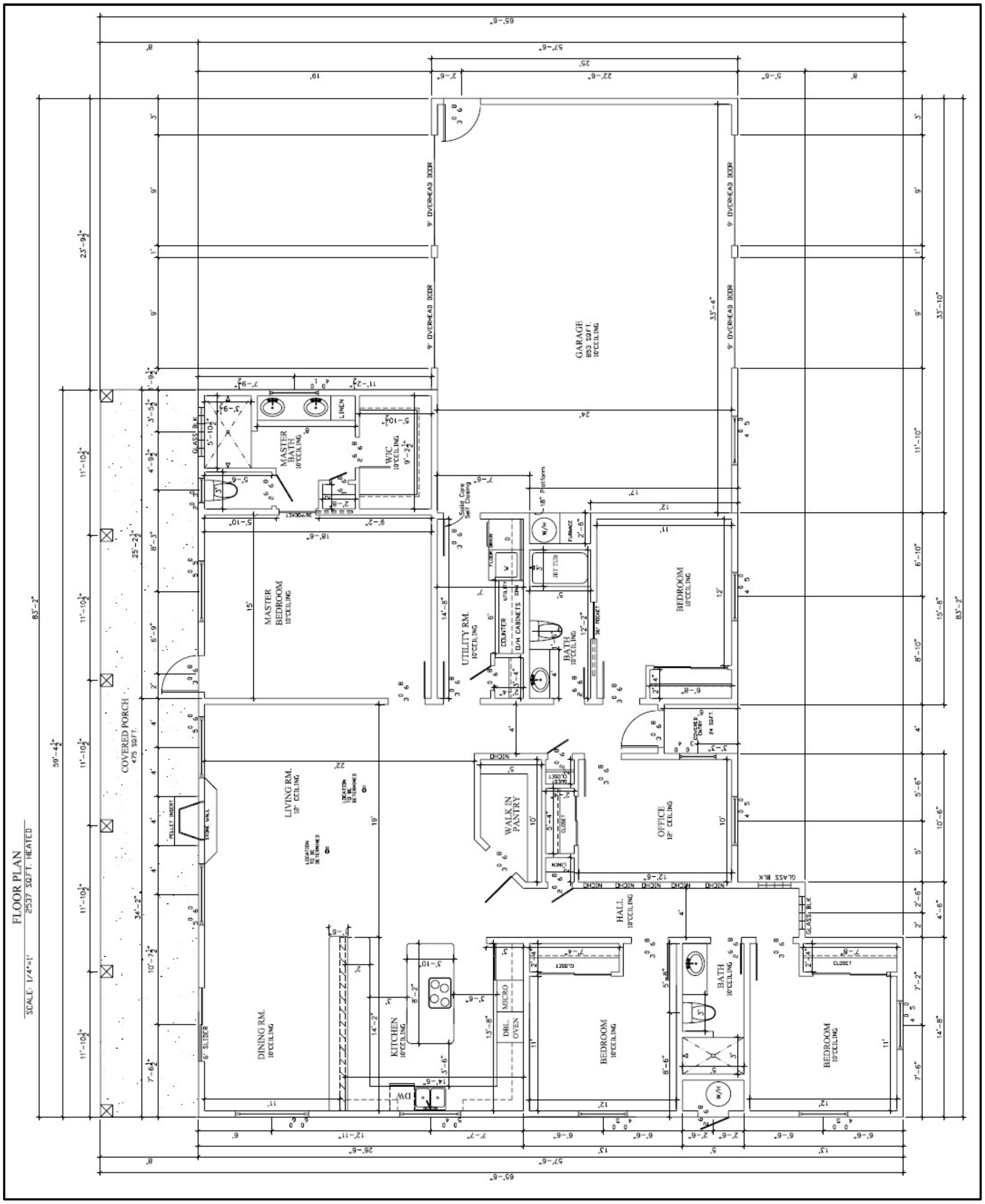
Appendix F: Guild Mortgage - Mortgage Calculator (Net-Zero Home)

Inputs				
Purchase price	$ 389,710			
Down payment	$ 77,942			
Annual Taxes	$ 4,871			
Annual Insurance	$ 1,559			
HOA Monthly	$ -			
Mortgage Insurance Factor	0.000%			
Earnest Money	$ -			
	Option 1	**Option 2**	**Option 3**	**Option 4**
Payment **Rate**	3.840%	3.965%	4.090%	4.215%
Principal and interest	$ 1,460	$ 1,482	$ 1,505	$ 1,527
Estimated Taxes	$ 406	$ 406	$ 406	$ 406
Estimated Insurance	$ 130	$ 130	$ 130	$ 130
Mortgage insurance	$ -	$ -	$ -	$ -
HOA	$ -	$ -	$ -	$ -
Total payment	$ 1,995.66	$ 2,017.99	$ 2,040.50	$ 2,063.18
	Option 1	**Option 2**	**Option 3**	**Option 4**
Cash to close **Rate**	3.840%	3.965%	4.090%	4.215%
Down Payment	$ 77,942	$ 77,942	$ 77,942	$ 77,942
Prepaid insurance and taxes	$ 3,488	$ 3,488	$ 3,488	$ 3,488
Prepaid interest	$ -	$ -	$ -	$ -
Title, Appraisal, Underwriting, Government, ect	$ 2,100	$ 2,100	$ 2,100	$ 2,100
Points	$ 8,106	$ 6,235	$ 4,677	$ 3,118
Earnest Money	$ -	$ -	$ -	$ -
Lender Credit	$ -	$ -	$ -	$ -
Seller Concessions	$ -	$ -	$ -	$ -
Total cash to close	$ 91,636	$ 89,765	$ 88,206	$ 86,647

Appendix G: AGUIRRE Blueprints



Appendix H: AGUIRRE Measurements


FLOOR PLAN
2537 SQ.FT. HEATED
SCALE: 1/4"=1'
GARAGE
MASTER BEDROOM
MASTER BATH
W/C
UTILITY RM.
BATH
BEDROOM
COVERED PORCH
LIVING RM.
WALK IN PANTRY
OFFICE
HALL
KITCHEN
DINING RM.
BEDROOM
BATH
BEDROOM

Appendix I - AGUIRRE Elevations