CAPITALIZATION OF ENERGY EFFICIENT FEATURES INTO HOME VALUES IN THE AUSTIN, TEXAS REAL ESTATE MARKET

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Submitted to the Department of Urban Studies and Planning in Partial Fulfillment for the Requirements for the Degree of

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at the

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ABSTRACT

Volatile and rising energy prices have made consumers aware of their opportunity costs for energy. Information on the cost-savings of energy efficient features in homes has not been well researched to date and is an option for consumers in the marketplace. The purpose of this thesis is to empirically investigate whether energy efficient features influence the sales price of Austin residential single-family homes. The data for this study comes from the Austin Board of Realtors multiple listing service database. The results should be applicable to other US cities with similar climate.

This study examines over 800 single family residences in the Austin, Texas real estate market from 1998-2004. The dataset contains green and non-green rated homes as well as twelve energy features for homes. Log-Linear regression was used to explain the variation of sales price, while factor analysis was used to reduce the number of correlated energy variables into groups of factors. The results of the regression concluded that homes in the Austin metro area with efficient heating ventilation & air conditioning systems and controls sell for 4% more than homes without these features. Pricing of other related energy features commanded a price discount on the home.

In conclusion, more efficient heating & ventilation features of new homes in Austin, Texas exert a positive influence on home prices. At least for this market, consumers appear to recognize and pay for this form of expected future energy savings.

Key Words: Energy efficiency, energy policy, green homes, green rating, sustainability

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Thesis Reader: Sam Bass Warner, Professor of Urban History

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INTRODUCTION

The conversation about energy efficient homes and the consumption of utilities has been a topic that has phased in and out of US agenda in the government and private sectors for about 40 years with the advent of the US importing more energy than it produced in the early 1960s (Energy Information Agency, 2005). The conversation on energy intensified with the 1973 oil crisis and again recently with sharply rising energy prices. Since the early 1990s an increasing concern about the environment has surfaced. The arrival of "Energy Star" (est. 1992) products and homes further stimulated government and public discussion. Numerous buzz words, such as "Green Homes," "Environmentally Conscious," or "Energy Efficient," have headlined newspapers, magazines articles, and other published literature. These buzz words and conversations continue to be vague because there are many unknowns (See Table 1).

The market for energy efficient homes and features has grown but it has affected new homes more than the existing housing stock. The task of this study is to see if consumers recognize and price certain energy features of new homes as analyzed by a log-linear regression model. I will also make the connections between the real estate market, energy usage, public policy, and home improvement sectors to determine how they value energy efficiency features. To date there have been few studies that look at issues having these elements.

Purpose of Thesis Research

The purpose of this research is to quantify the relationship between energy efficiency features and market value of a residential home in Austin, Texas. The following four issues are what I conclude compromise the subject.

1. Volatility in energy prices
2. Lack of information and education on:
    a. Valuation and understanding of energy features in home pricing
    b. Risk, cost, and benefits of energy features in real estate
    c. Best practices in investment underwriting and construction
3. Growing market for energy efficient features in homes
4. Need for information for decision making and legislation

The significance of this study will lead to a better understanding of how a real estate market prices homes with energy efficient features versus homes that do not contain those features in one market. The hypothesis that energy efficient features save money I would expect to be capitalized in the price of the home. Underwriting for financial incentives of energy efficient homes can be adapted to the investments homeowners put into their homes. On a bigger scale one can see if energy efficient features are valuable and effective for homes so that they might reduce strain on natural ecosystems to produce resources.

Historical Background

The era of 1850-1950 saw systematic changes in the environment due to industrialization and urbanization across the US. Furthermore, from 1950 to the present (2007) transformations of natural environments progressed rapidly under pressures of rapidly rising energy consumption (See Figure 2).

In the early settlements (pre-1850), clearing and stripping of land was primarily done for agriculture and timber harvesting. In addition, early manufacturing used water power for energy which was perceived as more of a local or regional issue with complaints from locals about noise or smell. The industrial years brought three major pressures to the environment: steady rising levels of population, consumption, and industrial production (Hays 10). The growing population continued to expand into new territories to farm or produce industrial products, and it abandoned an area once resources were exhausted. Consumption went from inelastic goods to "convenience goods" which required more energy and factories to produce. This shift in consumption could arguably be the root cause of the environmental pressures, especially energy, the US faces in 2007.

From 1938-1956 the US population rose dramatically and consumer spending grew with higher incomes after World War II (Hays 16). Young people in the population needed new housing and could afford more commodities such as cars and appliances. To respond to these needs housing, transportation, and energy were all added to. Increased construction of residences, commercial buildings, factories, and shopping malls were a US phenomenon of post World War II. Cities lost growth to the residential areas that grew up around them and drew the commercial centers towards these suburbs. Transportation networks for automobiles, airplanes, and trucks sprang up over the nation in and between cities to carry goods and humans. According to Sammuel Hays this development was and is essentially an energy issue. His stance was the following:

> Almost every development issue was, in one way or another, an energy issue, since development required energy, gave rise to new modes of transportation that required energy, produced pollution that required energy to mitigate, and generated consumption that required energy both to produce what was consumed and to facilitate consumption itself. –Hays 12

Therefore, energy efficient residential development will become a pressing issue due to the underlying distribution of energy consumption in the US.

LITERATURE REVIEW

The subsequent sections will be on energy usage and policy, real estate modeling, and the home improvement sectors. I first begin with the US Energy Information Agency's (EIA) "Annual Energy Review 2005" which offers a glimpse at why one should be concerned about energy consumption and specifically in the residential sector. I use time series graphs of different energy sources and rates in the US to summarize 50+ years of data. I then move to historical events that transformed energy policy in the residential sector in the US. Finally, I conclude what effect these historical events and policy decisions have had on residential real estate in terms of energy efficiency.

Energy Policy

The EIA's 2005 Annual Energy Review has reliable data and statistics on energy consumption in the US over time. For example, the EIA states the US was "self-sufficient in energy [pre-1949]—producing and consuming 32 quadrillion British thermal units (BTU), [and] importing less than 1.5 quadrillion BTUs…By the early 1960s indigenous supplies were no longer sufficient to meet demand" (EIA 2005). This phenomenon is attributed to many factors, but the US's thirst for energy is apparent with an average 2.5%/yr growth in the residential sector since 1949. The residential sector consumes approximately 22% of all end-use energy relative to commercial, industrial, and transportation (Figure 3). Figure 3 demonstrates an extrapolated positive linear trend in the residential sector in the future. Such a trend is what energy efficiency is trying to mitigate. Notable statistics in EIA's report are: in 2001, 65% of US households had a ceiling fan, 55% had central air conditioning, and 83% had one refrigerator. (EIA 2005).

To support these claims I look at the trends and rates of energy consumption in the residential sector. Figure 3 shows us that residential, commercial, industrial, and transport sectors all positively increased in energy consumption from 1949-2005; with residential averaging 2.5% per year. Figure 4 illustrates the aggregate energy consumption by sector with residential ranking third in the four sectors. Figure 5 represents a phenomenon where energy loss became greater than the supply of energy sources starting circa 1976. Lastly, Figure 6 shows renewable energy to be a very low contributor for producing energy for the residential sector. One graph that is helpful in understanding regional consumption in the US can be seen in Figure 6.

Another concern over energy prices is the severance tax, a tax on extracting natural resources such as oil, coal, or gas, imposed by states (See Figure 4, Appendix A). In an article of the April 2006 *State Legislature* magazine stated a "handful of major energy-producing states are reporting a significant rise in 2005 severance tax collection related to recent up tick in energy prices" ("State Energy Revenues Gushing" 7). This means if it costs more for producers to make energy then energy will be that much less affordable. In broad terms, Figures 1-8 depict the US's finite amount of resources which it can draw from to consume energy. Those natural resources must be able to sustain themselves if US single family household residents' current standard is not to fall.

With an overview on energy consumption I move to what caused energy efficiency to become important. Most US energy concerns were brought forth during the 1970s with the two energy and oil crises. In 1973 the Arab Oil Embargo created by the Yom Kippur War in the Middle East was the first time that the US and other foreign countries realized the degree of their dependence on crude oil for the production of energy and industrialized needs. A second oil crisis occurred in the 1979 in the midst of the Iranian revolution that considerably affected the US again. When the new Iranian regime seized power, it also took custody of Iran's oil exports, and they exported at capricious and low volume levels that spread US and world panic because of inconsistency in price and supply expectations. We can see the risk profile of oil in the 1970s through its price spike seen in Figure 1. As a result of the 1973 oil crisis the Department of Energy was created in 1977 to oversee energy and nuclear policy (Jones 10).

On July 15, 1979 President Jimmy Carter publicly addressed the topic of energy in his "Crisis of Confidence" speech (Carter 1979). In Carter's address to the nation, three of his six points speak to the purpose of this study. Point three, addressed energy security and independence by developing alternative sources of fuel for the US. Point three conceived and shaped alternative sources of fuel, everything from solar power to ethanol gasoline, in order to decrease dependency on foreign oil. Point four asked "Congress to mandate, to require as a matter of law, that our nation's utility companies cut their massive use of oil by 50% within the next decade and switch to other fuels, especially coal, our most abundant energy source" (Carter 1979). Point six proposed an affordable conservation program for residential homes[1]. Point six is crucial in respects to the federal government taking a stand on energy efficiency in buildings and creating public education to encourage energy conservation. In his sixth point, Carter asked Americans to "set your thermostats to save fuel" (Carter 1979). All three of these points Carter addressed were implemented in the National Energy Conservation Policy Act of 1978, but only point four was enforced over the long term. As part of The National Energy Conservation Policy Act of 1978 utilities were required to make available energy conservation audits and other services to slow the demand of electricity. These audits would later be helpful in gathering data for studies like that of Metcalf and Hassett, to be discussed later.

Presently, many states have and are considering passing legislation and allocating money to "green" practices like energy efficiency. For example, in the State of Massachusetts governor Deval Patrick issued an executive order "setting higher standards on energy efficiency and mandating greater use of renewable energy throughout state government" (Patrick 2007). The executive order required state agencies to reduce overall energy consumption by 20 percent by 2012 from 2002 levels and 35% by 2020. To implement these goals state agencies would be required to:

1. Obtain 15 percent of their electricity from clean renewable sources by 2012, 30 percent by 2020
2. Use biofuels for 3 percent of heating oil next winter, 5 percent in 2008-09
3. Meet Massachusetts's LEED-Plus green building standards for all new construction and major renovations, and consider energy performance in leasing decisions
4. Reduce potable water use 10 percent over the next five years, 15 percent by 2020.

The executive order requires state facilities over 100,000 square feet to be retrofitted for energy efficiency by 2012 and requires the purchase of energy efficient products such as "programmable thermostats."

In San Diego, California, the city announced an initiative to achieve 50-megawatts of energy efficiency in the next ten years (Atkins & Turk 2006). Toni Atkins stated that the city's "Commitment to fulfill 10 percent of that goal by performing efficiency upgrades in city-owned facilities. In the past year, the city upgraded 84 structures and reduced electrical needs by more than 2.3 million kilowatt-hours a year" (Atkins & Turk 2006). The Rebuild a Greener San Diego program, started in 2003, evolved from its original mission to help

[1] Residential homes are defined to be detached single family households not including apartments, houseboats, or trailers

residents rebuild their home after the 2003 San Diego fires. The program progressed into the County of San Diego Green Building Incentive Program. It has become a successful program in which the city, county, and regional government offices, as well as the local electrical utility, support. The program offers three incentives for eligible homes that incorporate energy efficient standards in residential and commercial buildings. The program is proving worthwhile by offering the following incentives:

1. Reduced plan review turn around time by city officials (saves 7-10 days on project timeline)
2. A 7.5% reduction in plan review and building permit fees
3. No fees for the building permit and plan review for residential photovoltaic systems

By cutting entitlement times and permit fees for builders, developers, and residential owners this program has become extremely attractive. The first qualifications of the program were that your home was affected by the fire. It offered the three incentives to build with energy efficiency as part of San Diego's Energy Conservation and Management's mission created in 2001 The application requires that one or more of the energy efficiency standards be applied to receive the incentives. With many attractive incentives the program has become competitive for funding and many people put in more energy features than is required.

The states of Hawaii and New Hampshire have created a Pay-as-You-Save pilot project that allows building owners and tenants to purchase and install energy efficient features with no-upfront payment or debt commitment (Cilo 2005). The costs of the energy efficient products are added to the utility bill while one occupies the unit. This program is being studied to see if it is effective and if it should replicated elsewhere.

A recent study by Neal Elliot et al "Potential for Energy Efficiency, Demand Response, and Onsite Renewable Energy to Meet Texas's growing Electricity Needs" (2007) stated that Texas's energy challenges could be met through energy efficiency. The study found that "the most pressing short-term policy issue in Texas is rapid growth in peak [electric] demand" (Elliot et al 2007). The Electric Reliability Council of Texas (ERCOT) reported that peak demand on the electric system increased 2.5%/yr between 1990 and 2006 and forecasts for peak-demand would increase 2.3%/yr from 2007-2012 (Elliot et al 2007). ECROT has raised issues that Texas may have insufficient capacity to meet peak demand if the current trend continues to 2009. The study recommends nine policies that would mitigate peak demand energy through energy efficiency in Texas. Those policies are:

1. Expanded Utility-Sector Energy Efficiency Improvement Program
2. New State-Level Appliance and Equipment Standards
3. More Stringent Building Energy Codes
4. Advanced Energy-Efficient Building Program
5. Energy-Efficient State and Municipal Buildings Program
6. Short-Term Public Education and Rate Incentives
7. Increased Demand Response Programs
8. Combined Heat and Power (CHP) Capacity Target
9. Onsite Renewable Energy Incentives

These policies are very similar to what other states like Massachusetts and California have done to address energy issues and save money. Texas has programs like that of the Austin Green Building Program in place, and these polices try to get energy efficiency standardization across the state while stabilizing electricity supply. The policies are steering Texas to sustainable practices on energy while potentially saving money at the state and individual level.

In Judith Crosson's article "Gung Ho for Green" argues that consistency and predictability of government rules and regulations are what business people desire to convert to green homes and add energy efficient features. For example, she states "Developers need to know the true costs of a new technology. Bankers deciding on a loan application need to know if a tax credit will be around for the term of the loan. Manufacturers who plan to increase capacity for a cutting-edge technology want to know how long a tax credit will run" (16). Polices come in and fade out with changing administrations and that leave industry to take on the full risks of going green or incorporating energy efficient features. The uncertainty of the government leads businesses as well as the real estate market, which is risk-averse, to take the full risk when the cash flows from the government are cut off because those funds need to be allocated somewhere else. Ellen Anderson, a senator of the state of Minnesota, says that this is one the reasons "Fossil fuels and nuclear [energy] have been the winners for decades" (Crosson 16). Stable policies over the life of real estate investments, which are typically long term, are what are desired.

In February of 2007, Austin's mayor Will Lynn approved the Austin Climate Protection Plan. The plan included progressive legislation that strives to curb global warming. Within the plan, energy efficiency in Austin homes is addressed. The plan calls for 700 megawatts of electricity savings through energy efficiency by 2012. The City of Austin will do this through energy efficient building codes for new construction. Moreover, the plan takes existing homes and buildings into account and will require them to "meet basic energy efficiency requirements upon resale." Mayor Lynn mentions insulation, weather stripping, and solar screens as "low-cost high-return investments…that outweigh the costs of the improvements." This is a progressive stance, but its impact on energy efficiency would be large since most of the housing stock is existing.

Energy Usage

Steven Nadel suggests that standards for household appliance, lighting, and equipment are part of the solution. He also states that Carter Administration's mandatory state standards which ultimately ended up in the National Energy Conservation and Policy Act of 1978 paved the way for the US Department of Energy to develop minimum standards on appliances (Nadel 2002). These standards were reversed in federal court in 1985 under the Regan administration's favoring open market policies, but were resurrected under the National Appliance Energy Conservation Act of 1987 which was signed by President Reagan. Nadel concludes that equipment efficiency standards are an effective energy-savings policy (Nadel 2002). With other countries in the lead on efficiency standards, e.g. European Union, the US can look at examples of what increasing the standards for appliances mean.

To assess progress in energy efficiency behavior a study conducted in Sweden examined how the information that was available in the 1980s differed from that in 2005. The 2005 study looked specifically at residential energy behavior and the policy instruments of a city. The examination of 600 Swedish households showed that in order to promote energy efficiency at the individual level, economic measures such as taxes and pricing need to be used (Linden 2005). The study concluded that when consumers are confronted with energy efficient (and inefficient) behaviors that consumers request information, and pay special attention to user friendly technology & economic programs for lowering their energy use. In essence from a policy perspective, the decision maker requires information that is noteworthy in order to voluntarily consider a change while receiving some form of individual economic benefit to supplement the information.

While the economic benefit acts as an incentive to consider switching to energy efficient behavior, the actual physical improvement has the effect of changing individual habits because it acts as a repeating reminder (Linden 2001). Information is one of the key reasons the Department of Energy and the Energy Star Program were created. Residential mortgage lenders did not know how to price energy efficiency in the 1980s, and home improvement manufacturers thought there was no way of measuring energy efficiency. For example, in 1985 a study commissioned by Owens-Corning Fiberglass Corporation studied 150 mortgage lenders nationwide and found that "one in ten lenders offered preferential loan treatment to buyers of energy efficient homes" (Savings Institution 122). Yet, Robert Patnaude of Ownes-Corning suggested that this difference in lender's attitudes on energy efficiency and practice is due to no "accurate method for measuring energy efficiency" (US League of Savings Institutions 122). The study, which may be still true today, showed that "43% of lenders surveyed used visual appraisals as their method of determining energy efficiency." We now have data to support or fail to support energy efficient claims in the residential market with energy audits.

Home Improvement Business

Energy efficiency in the real estate sector to date has not been well researched. Bradshaw's "Buying Green" (2005) and Metcalf & Hassett's "Measuring the Energy Savings from Home Improvement Investments: Evidence from Monthly Billing Data" (1999) are the few studies to date that address how real estate, energy usage, and the home building sectors interact on a single home. Golove and Eto (1996) recommended "continued inquiry" on market barriers to energy efficiency in their report funded by the Assistant Secretary of Energy Efficiency and Renewable Energy- US Department of Energy.

In real estate, advocates of energy efficient features think that the real estate market undervalues energy efficient features in homes. Kempton and Montgomery (1982) looked at how consumers calculate energy savings from energy efficient investments, and they concluded that predominant ex-ante 1982 methods systematically underestimated energy savings. This they attributed to lack of information. This has most likely changed since 1992 when the federal government created the ENERGY STAR program.

There is now more information about energy efficient features for homes from sources like Energy Star and the US Department of Energy, but that information has not been analyzed usefully for pricing homes. In William Prindle's "Quantifying the Effects of

Market Failures in the End-Use of Energy" (2007) study he argues that price information for energy efficient investments are not adequate and that market barriers, such as the "principle-agent" barrier, obstruct energy efficient investments. Prindle looks at five countries and studied average energy use, devices affected by barrier, and energy use affected by barrier. The principle-agent barrier was defined as a situation in which one party, the agent (i.e. residential developer), makes decisions affecting end-use energy efficiency in a given market, and a different party, the principal (i.e. facility manager or home owner), bears the consequence of those decisions. For example, decisions for new residential homes are made by the developer; his decisions ultimately affect the energy use and expenditures of homebuyers (Prindle, iii). Prindle's study found that in the USA the principal-agent problem affected energy end-use 25.2% of the time in residential refrigeration, 77% in residential water heating, 47.5% in residential space heating, and 2.3% of the time in residential lighting. Prindle concluded that "Market failures are significant and widespread…in many kinds of economies" (Prindle vii). These numbers imply that the consumer ends up stuck with a system in their home that is more costly than energy efficient systems would be.

If information is available about cost savings, shouldn't developers be encouraged to use energy efficient features? The answer may be in the following quote in a *New York Times* article about Toll Brothers:

> The company [Toll Brothers] had already learned that buyers will choose visible flourishes over pragmatism every time. During the energy crisis of the late 1970's, for instance, one option was a higher grade of insulation. 'No one bought it,' Barzilay, Toll's president, says. "Everyone spent their extra money on moldings."- Gertner, Oct 2005

Maybe energy efficiency is not important to consumers, even though they will pay costs incurred in higher energy bills later for extended periods of time. The Toll Brothers' statement is in defense of the agency problem, and the company is simply responding to market demand. Another issue maybe that some energy features are used in the home so infrequently that developers or consumers will not bother with these installations since homebuyers will rarely them. Also, the maintenance costs and effort associated with energy features maybe too great for consumers or developers. Inspections of homes by the city or consumer may deem energy features out-of-date or not-to-code after new technologies are on the market. If consumers, won't buy the features then developers have no incentive to put those upfront costs into the house.

Gilbert Metcalf and Kevin Hassett (1999) may have one of the few rigorous studies that look at energy savings from the perspective of home improvement. They used the Department of Energy's Residential Energy Conservation Survey (RECS) survey which was unique because it combined the Household Survey and the Energy Supplier Survey data. The Household Survey contains structural, neighborhood, and location information. The Energy Supplier Survey has billing statements of the actual energy usage for each of the households in the Household Survey. These two datasets connect energy efficiency to households while at the same time "eliminating noise" and narrowing down assumptions made about the household (Metcalf & Hassett 1999).Their study on energy efficiency home improvement looks at the following energy features from the RECS:

1. attic insulation
2. thermostat setting
3. central or room air conditioning
4. area heated (ft^2)
5. furnace age
6. number of windows

Metcalf and Hassett find that "mean income, education levels, and age of the main householder all show no statistically significant difference between investors and non-investors [of energy improvements]" (Metcalf and Hassett 1999). Although, the authors expected such an outcome since these variables are independent of return on investment. The results do suggest that these variables shouldn't affect the decision to add energy efficient features. The main conclusion that Metcalf and Hassett drew from their empirical study was that rates of return for energy investments are substantially lower than former engineers' or manufacturer's estimates. This means that consumers are most likely pricing energy savings for home improvements correctly and that a change to energy efficient features may not be worth it to homeowners in this study. The "energy paradox, the perception that consumers apply unreasonably high hurdle rates to energy-savings investments", was confirmed not to be true (Metcalf and Hassett 1999). For example, the average rate of return on attic insulation was 11% which was statistically significant; however, the median (a more robust figure) was 9.7%. Metcalf and Hassett report that these two figures "put an upper bound on the implied discount rate for the energy investments …and are consistent with plausible discount rates suggested by a CAPM [Capital Asset Pricing Model] analysis" (Metcalf and Hassett 1999). These may sound like decent returns on investment but the consumer may attribute more risk, time, and effort to the rates above what they maybe financially saving on energy features. Consumers may need, say a 20%, present value savings in order to take on the investment. They would have to consider the cost of the investment versus the change in energy consumption. One drawback on Metcalf and Hassett's data is that houses tend to be a bit older, 50% built before 1950, for their 1984, 1987, and 1990 surveys. On the up-side, their auxiliary test for attic insulation is a two-stage (log linear) least squares regression. The overarching story in the Metcalf and Hassett study is that consumers do not bear the societal costs on the environment for using more energy.

Claims of Green Housing

A "green home" in this thesis will be taken to mean a home that has been rated as green by the single-family residential rating program run by the Austin Green Building Program (GBP). A conventional home is one that has not been rated by GPB. The author recognizes the incomplete nature of the assumptions underlying this delineation of green and conventional. It is likely that some homes that have not been rated have adopted green principles in some measure, and vice versa. In effect, this definition has "noise," yet acts as a baseline (Bradshaw 2005).

The marketing efforts of advocates of green housing have good intentions but are potentially misleading. Across many studies on green development[2] the following claims that green buildings are better private investments are apparent as seen in the below:

- Green homes cost the same or slightly more to build
- Green homes cost less to operate
- Green homes sell/rent higher than conventional homes

(Bradshaw 2005, Rocky Mountain Institute 1998, Urban Environmental Institute 2002, Yates 2001)

[2] Green development is defined as real estate development with explicit ecological and/or environmental goals. In effect, green development attempts to care for the environment (cultural and natural) in which buildings are placed (Bradshaw 2005).

However, most green building studies look and describe highly successful developments of the "Could be" with no respect to the working real estate market of "What's expected." This means that advocates mislead in extrapolating a few successful cases of energy efficiency or green homes to be a general model for how housing should be constructed in order to maximize public benefit to society. Advocates of green development tend not to address the expectations and variables that the established real estate market examine. Advocates are absent in the financial evaluation of green building. Three premises of the real estate market that are often overlooked by advocates are:

1. Real estate markets are stratified by location (space) and product type (asset)
2. Real estate investments are based on expectations about a future state of the market based on average performance above the risk-free rate of return
3. Real estate development is intricately linked to the capital market

Fundamentally, real estate development is a risk-return industry which has established variables which are used in decision making. The private sector seeks value because it is required to keep the company maintained, allows for funding of new ventures (such as green building and energy efficiency), and it must satisfy its shareholders. Conversely, green building advocates tend to be concerned with other objectives such as open space, meeting public needs, and societal benefit. These variables do not speak to the language of the real estate market and may not directly affect private returns, but are important in a different realm. If the three premises above are true, the conclusion of the hypothesis of this study could be generalized to other real estate markets with similar characteristics.

Both parties' objectives have public and private value if the financial estimation can be verified. A sub-purpose of this study is to use variables that the real estate sector uses, such as monetary savings, to make a rigorous statement about green housing. The author suggests that the current instruments/variables used to make statements about green housing from the advocate's point of view have been insufficient in measuring the issue to apply to the working real estate market. Conversely, traditional real estate methodology has not had the tools to evaluate green housing

Marketing of Green Homes & Energy Efficient Features

The marketing efforts of energy efficiency and green housing are primarily concerned about promotion of green housing and energy efficient features. The promotion is backed by case studies of highly successful projects that had energy efficient features or were green rated. There have been strides taken by diverse industries to market green building and energy efficiency. Most marketing focuses on global trends such as the theory of global warming, release of carbon into the atmosphere, or climate change; however, many times these issues fail to relate down to the scale of a house and its consumption of resources and energy. A large amount of press and marketing of green buildings and energy efficiency has been surfacing lately in local, national, and world news.

In the Judith Crosson's article "Gung Ho for Green" in *State Legislatures* magazine, Minnesota Senator Ellen Anderson, states "I think high energy costs have really hit home. People have a general understanding that the reason we have these high energy costs is that we are at the whim of unstable regimes, hurricanes and other factors, some out of our control. It makes people believe very strongly in the idea of energy independence" (2006). A statement like this blankets what energy efficiency and green homes are trying to achieve, saving money while being environmentally conscious. Anderson's statement does not address the variables the real estate market measures. *Vanity Fair*, a culture and fashion magazine, had a special "green issue" that talked about how "green is the new black" with support from activists, such as Al Gore and George Clooney, who are well known to the American public. In *Realtor Magazine*, a 2003 article titled "Selling Green" Pattie Glenn, a RE/MAX broker in Gainesville, FL, uses the following models to understand what green features appeal to different consumers:

- *Thinkers* want things quantified. A home's energy efficiency rating is a big selling point with these buyers.
- *Drivers* want to be recognized as the best. They want others to know what a great home they have, so they are a good source of customer referrals.
- *Amiables* relate to the comfort, health, and safety benefits of a green home.
- *Expressives* will want to use their added purchasing power to buy frills such as nicer kitchen cabinets. (Stahl 2003)

Glenn like many others must translate technical data to various consumers with different tastes. Price is the best and most standard way to translate all technical aspects that reflect all available and relevant information in a particular market (efficient market model[3]).More recently and financially speaking, Hines, a large international real estate firm, announced on September 27, 2006 that it created the first US "green" fund ($120 million of

[3] Established by Eugene Fama in his article *Efficient Capital Markets* in the Journal of Finance, 1970.

contractual equity) with CalPERS, the US's largest pension fund, which would target solely sustainable development. This move sets a precedent for the real estate development industry as whole, but does not assess the risk associated with making this financial commitment for other developers to follow.

Green marketing offers publicity (good or bad) which exposes and informs persons about these issues, yet it can be heavily biased. Two common fallacies of green marketing are that cost equals value[4] and that the private sector's stance is unknown. From a value engineering perspective a green home's value can be increased by increasing its "function" (See equation in footnote) or reducing cost, and quality should not be reduced at the consequence of value. Secondly, the author believes that the private sector's stance is quite clear; if there is de facto value to be pursued for shareholder/stakeholders the private sector will undertake the investment with manageable risk.

Green building could be similar to a story of the "Plastic House" built at MIT and exhibited at Disneyland on June 1957. The plastic house was conceptualized and designed by the Massachusetts Institute of Technology's Marvin Goody. The plastic house was an experimental design which showed how living 30 years from 1957 (i.e. 1987) might look and be like. Plastic was still relatively new then and "excited the public imagination" (Kissell 2005). The "house of the future" was located in Disney's Tomorrowland and lasted until 1967 with 20 million visitors having visited the plastic house. Robert Whittier, the plastic house's project manager, remembers "everyone loved it, and everybody wanted one," and his desk would be flooded with mail from the plastic houses' admirers. Even with the overwhelmingly number of responses, he said it "wasn't enough to create a viable market…this was a pretty radical proposal for a very conservative housing market." The plastic house brings many questions to mind that green housing does. One is, who and why would anyone live in a green home or a plastic home? Another important factor is that Whittier mentions the market as the driving force which would carry the project on, which green building is trying to achieve. The *why* for green housing is that it potentially saves money, but the *who* is a much harder question to answer.

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[4] $Value = \frac{(Performance + Capability)}{Cost} = \frac{Function}{Cost}$ where value is measured from the customer's perspective
http://www.npd-solutions.com/va.html Accessed December 12, 2006.

The intersections of energy, the environment, and housing are possibly approaching a tipping point[5] within the US and beyond. The marketing of these issues with affluent and "glamorous" activists send a message to the general population that it is an issue to be concerned about and that green housing may become main stream. However, the evidence to support the claims that energy efficient features or green homes save significant money is somewhat of a wash and could be a concept that fascinates the market like that of the plastic home. For this reason and until further research is conducted, one must ask if green housing is a fashion?

Real Estate Economics for Green Homes

Green homes have become a real consumer option in the real estate market because of the possibility that they are better and higher use than conventionally built houses. Moreover, depending on how the US economy changes with respect to short/long term interest rates, tax code, construction costs, and zoning regulation the supply and demand of green homes may be in the price range to more consumers (DiPasquale-Wheaton 1996). Following consumer theory's income effect, the relative elasticity of commuting costs and land demand will be factors in paying a premium for a green home. The substitution effect of a conventional home for a green home is one the biggest barriers for the green home market. The assumption is that a person's tendency is to substitute a green home that is comparatively more expensive than a conventional home not because of quality but because of cost with the expectation of future savings. One of the qualities that a green home offers that will be forgone is energy costs. Consumers would not know this otherwise or would know it, but forgo it due to the cost burden at that particular time. One of the difficulties of energy efficiency is how to show it as mentioned previously. Presently, in 2007, energy efficiency indicators are limited by the availability and cost of data. Collection, organizing, and analyzing energy efficiency data, in addition to the equipment recording data, is expensive.

An efficient market model[6] would expect that at any given time, prices fully reflect all available and relevant information in a particular market (e.g. real estate); thus, no investor

[5] A term coined by Morton Grodzins that refers to the dramatic point when something unique becomes common.
Source: www.urbandictionary.com Accessed November 3, 2006.

[6] Established by Eugene Fama in his article *Efficient Capital Markets* in the Journal of Finance, 1970.

has an advantage in predicting a return on an asset. The three forms of efficiency commonly accepted are:

1. **Strong Form Efficiency**- No investor can earn excess returns [in the long term] using any information, whether publicly available or not (Copeland et al,355).
2. **Semi-Strong Form Efficiency**-No investor can earn excess returns from trading rules based on any publicly available information [potential future events] (Copeland et al 355).
3. **Weak Form Efficiency**-No investor can earn excess returns by developing trading rules based on historical prices, returns, or trading history of an asset (Copeland et al 355).

Gutermann and Smith in their study of weak form efficiency in the residential real estate markets across different geographic locations test results showed market inefficiency. However, since their study did not include transaction costs and the maximum expected appreciation was less than two percent they attributed this profit would be captured by transaction costs. Hence, they concluded that real estate markets were weak form efficient once transactions cost are included. One vulnerability the study cites is that the study was "focused on differences across multiple markets for similar properties," which could diversify out risks and leaves the question of trading strategies of different property types in different locations within a metro market (42). They also state "There may also be more complex trading strategies which could yield positive abnormal returns" (42). This study alludes to the fact that inefficiency may be occurring, but is unknown due to variables outside the model.

On the contrary, Keogh and D'Arcy argue that it is inappropriate to "assess efficiency with respect to idealized concepts based on either Pareto optimality or full information" for the property market (2411). They believe most studies fail to make a connection between informational efficiency and the issues of operational and allocative efficiency. This stems from their assumption that Fama's model is extensively used in real estate markets when it was intended for financial securities markets. Keogh and D'Arcy argue that standard textbook (Fraser, 1993; Harvey, 1996) and research papers on the subject (Jaffe & Sirmans, 1984; Gau, 1987; Gutermann & Smith, 1987; Evans, 1995) suggest the property market is "subject to imperfections, implying allocative inefficiency" (2402). This discernment emanates from their belief of legal and physical characteristics of property, which is exemplified in Gutermann & Smith. This begs the question if there is an arbitrage opportunity. For example, if the transaction cost of a real estate agent's fee and commission can be reduced or eliminated suggests one can systematically beat the market as long as this common practice is in place, consequently the presence of an inefficient market. But finance theory states a project will be undertaken until the rate of return on even the most least profitable project is just over opportunity cost of capital. This criterion yields an allocationally efficient market for the reason that prices are determined in a way that equates the marginal rates of return, adjusted for risk, for all producers and savers (Copeland 353).

Nature

Aside, from the range of prices buyers are willing to pay there are separate unaccounted reasons why a buyer would want a green home that are qualitative in character. Two of these aspects that the author feels are important are a biological connection to nature and layout of place.

Across many cultures, nature is one of the few aspects that humans can relate to as a lowest common denominator. An easy conversation starter between humans has always been to talk about the weather. For example, the following common sayings use similes and metaphors to compare nature to something else which can easily be understood by others; "It's colder/hotter than a …," or "It's raining cats and dogs out there," or "It's as cold as ice." Acclaimed biologist Edward O. Wilson's Biophilia hypothesis suggests humans have a deep preference to natural environments which stem from humans long evolutionary biological process. The hypothesis asks why normal people tend to go to parks, be with or look at animals, or have plants around the home. Wilson believes that human's love for life [nature] sustains life. This biological connection is important because humans can distinctly determine the difference between a natural and artificial product (Salingar 1). This innate attribute could behaviorally affect the outcome of purchasing or paying a premium for a green home. In <u>The Blank Slate: The Modern Denial of Human Nature</u> Steven Pinker, expert on cognitive neuroscience, believes that "Human tastes are reversible cultural preferences [that] ha[ve] led social planners to write off people's enjoyment of ornament, natural light, and human scale and force millions of people to live in drab cement boxes" (x-xi). Pinker goes on to show real life examples of cities that were "failures" in not recognizing inborn desires such as nature exemplified in modernists cities like Chandigrah and Brasilia that incorporated "scientific principles" over common sense. The author of this paper believes, through observation, that through these two theories people are concerned about the aesthetics of a green home because it may not feel natural to people. A thought that something is drastically different from what used to be there, e.g. a greenfield that is now a brownfield with a house on it, brings thoughts that are uncomfortable which may deter a purchase or premium paid for a green home. The human touch of a home versus a house perceived as a machine through its controls, layout, and design could deter purchases or lower value of a green home that may be energy efficient. On the other hand, McHarg, Alexander, and Barry Barton believe that greening of a home is a movement away from highly technical forms of building and ventilation, and a rebirth to more localized colloquial methods. Buildings as gardens rather buildings as a machine are the themes which McHarg and Alexander get at. These two biological theories by Wilson and Pinker are examples of aspects that could affect the purchase or price premium of a green home not encompassed by the model assessing savings later in the paper.

Relating this human-nature phenomenon to urban planning for green homes, Kevin Lynch's studies looked exclusively at how easy it was for humans to understand the layout of a place. Of the elements Lynch defined (paths, edges, districts, nodes, and landmarks) many natural features such as rivers (an edge), mountains (landmark), or trees (path) define cities and make them attractive to people. Lynch's studies of determining place found that interviewees when asked to navigate tended to veer off their destination to go through a vivid part of the city, and most people mentioning water and vegetation with pleasure in their response. It could be possible that a conglomeration of green homes could be attractive to consumers which would be easily identifiable as a landmark, district, or node within a metropolitan area. The new urbanism movement suggests that this element could be true for the single family residential market citing examples like Celebration, Florida and Legacy Town Center in Plano, Texas. Critics of new urbanism tend to allude that aesthetics are sensationalized over practicality, which would support the inclination that persons care about nature through aesthetics.

The biological connection and layout of place could be other variables not measured in the model which could explain the variation of price premiums willing to be paid upfront rather than later if the hypothesis was found to be null.

Hypothesis

In order for one to make a claim with confidence about energy features in residential homes one must have a hypothesis to empirically test. The following hypothesis will be tested:

H_1: Energy features in Austin residential homes provide future cost savings that are capitalized into house price.

The regression models will suggest if energy features influence house prices negatively or positively. Once we know the outcome of the hypothesis we can speculate on the notion that the market perceives energy features to save money and/or add value to a home. If there is a price premium for energy features we can assume there is future cost savings or that consumers price energy features. If energy features are not significant the following three reasons are the most likely candidates. One is that the model is not a good predictor of price. Second, the price effects of energy features are too small. Or thirdly, homebuyers do not capitalize energy features when buying a home.

DATA SETS

The data for this study used were collected by William Bradshaw, in his 2005 dual degree thesis, from four primary sources in Austin. Those sources come from the Austin Board of Realtors[7] (ABoR), Austin Green Building Program[8] (GBP), Williamson County Appraisal District (WCAD), and the Travis County Appraisal District Data[9] (TCAD). Structure, neighborhood, and transaction information along with energy efficient features were contained in the ABoR dataset. The GBP supplied green rating information while the WCAD and TCAD dataset provided lot size and square footage information.

From the start, there were inconsistencies with the recording of certain fields in the ABoR dataset. For example, some homes would have a large amount of beds, but would be less than 400 square feet. The ABoR dataset had a large amount of homes priced below $55,000 which seemed highly unlikely in today's market. These inconsistencies would make interpretation and reliability an issue. Hence, the ABoR dataset was put through a series of logic rules (See Table 2). Once the ABoR dataset was downsized, the issue of how to interpret a zero versus a blank cell in the energy variable columns was questioned. This could be interpreted in two ways. A blank was truly a zero and had no energy features in the home or that there was an energy feature in the home, but it was not recorded in the file. In order to ensure interpretable and reliable results a series of robustness checks in the regression model were preformed.

Austin Board of Realtors Data

The ABoR data contained mainly structural attributes, with the exception of square footage, lot size, and school test scores. Specifically, this dataset had the energy features of homes recorded (See Table 3). Records for 15-20% of all new homes made in the Austin area are included in the ABoR data set; 16,973 home sales transactions marked as new, under construction, or to be built are in the dataset from 1997-2004. Spatially, the ABoR data is has the biggest range stretching out radially 50 miles from the central business district in downtown. There was no information of home sales about the other 80-85% of Austin homes sold.

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7 Source: Data purchased by Will Bradshaw under special agreement with ABoR
8 Source: Data provided by special agreement with GBP
9 Source: Data purchased by Will Bradshaw from TaxNetUSA

Austin Green Building Program Data

The GBP is run by Austin Energy, a municipally owned electric company. The residential rating system records information on 136 variables of sustainable building in five categories- water, energy, materials, health and safety, and community. In order to be eligible for a green rating 13 initial requirements must be fulfilled such as the use of low volatile organic compound paints in the interior (Green Builder Residential Program Version 6.1). The other 123 green features are assigned a point value from one to six points depending on the feature. Each feature has a particular number of points associated with it i.e. double pane windows are worth two points and tile or metal roofing are worth three points. The points for each feature are awarded entirely or not at all; there are no partial points allowed. These points are totaled by category and then summed for a grand total to reveal the green rating. The green rating for a home is assigned one to five stars based on its grand total as seen in Table 4. There are a total of 281 possible points yet the maximum score is 266 due to some features being mutually exclusive. One caution of this dataset is that builders/developers self-report the results, although specific tests (referred to as commissioning) are carried out by independent technicians to earn four and five star ratings (Bradshaw 2005). This self-reporting could bias the results, but can also be offset since a builder/developer would not want to soil their reputation and brand name if they want to continue doing business in the area.

Travis County Appraisal District Data

The TCAD data provides square feet and lot size information which were absent in the ABoR data. These variables are taken from property tax records that are administered at the county level. Approximately, 80% of Austin is located in Travis County. Will Bradshaw requested property tax information on homes built between1997-2004, and 38,928 records were provided.

Williamson County Appraisal District Data

Williamson County is situated on the north side of the city and contains ~20% of Austin. WCAD data provided the additional square footage and lot size information in property taxes for ABoR and GBP data. Bradshaw requested tax information for homes built between 1997 and 2004, and received 32,563 records.

Data Matching

The method used to join energy features from the ABoR dataset onto Bradshaw's dataset was through a spatial join using Geographical Information Systems (GIS). The spatial join used x and y coordinates to join the ABoR and Bradshaw datasets. The spatial join required that the addresses be geo-coded. The City of Austin street location file was used for adding an x and y coordinate (geo-coding) based on address in the ABoR data. With both datasets having an x and y coordinate, they were concatenated into a unique identifier. GIS used this unique identifier to join the ABoR and Bradshaw datasets together and yielded 3,553 matches. From the 3,553 observations, there were 824 observations with lot size information. The final data set of 824 observations was used for the study and hereinafter will be referred to as the energy dataset. Figure 8 illustrates the matching process.

Summary Statistics & Correlation Matrix

Table 5 lists and defines the variables in the energy dataset that were acknowledged as potential variables to be incorporated in the hedonic model. The expected sign were included as an ex ante predictor of a positive or negative beta in the hedonic model. The variables in Table 5 were selected based on the following premises. First, hedonic research and literature has put emphasis on similar variables for determining the price of a home (Malpezzi 2002, Thibodeau 1998, and Miller 2002). Second, I wanted strong predictors of home value based in the Austin real estate market for this particular energy dataset. Third, I did not want high correlation between the independent variables.

Table 6 shows us that over half the homes have views and sit on ~0.4 of an acre. Structurally, the homes in the sample on average have 2,800 square feet, are fairly new, and average two energy features. From a neighborhood perspective there is high ownership (82%) compared to the US Census Austin profile which specifies a 44.8% owner occupied rate (See Figure 9). The average distance from the city center was 10 miles and the average price a home was $357,000 which begins to imply that the sample is mainly suburban. For confirmation, we look at the spatial distribution of the sample in Figure 10.

The majority of the spatial distribution in the sample is concentrated to the west of Interstate 35 and outside the city limits, which would be expected for new development. Clustering happens between highway 620 and Lake Travis, to the southwest of the intersection of highway 1 and 360, and in the north along Interstate 35. Since many of the homes fall to the west of Interstate 35, the interstate acts as a Northeast-Southwest axis and physical boundary. Figure 11 shows that most of the homes in the sample fall outside established Austin neighborhoods boundaries. We would expect this phenomenon for newly constructed homes since they are likely to be built on previously undeveloped land. This concentration of homes in future planning areas and non-neighborhood planning areas shows us where new homes are likely to be situated. This concentration clustering is brought up in Bradshaw's 2005 study and dataset which introduces self- selection[11]. The Lake Travis area could be captured in the views variable, while the other polygons in Figure 11could be captured through school test scores and percent owner occupied.

Table 7 shows the correlation between variables in Table 5. The correlation table was consistent with expectations on sales price; sales price was highly correlated with *Square_FT* (64.3%) and *LotSize_SF* (46.7%). For lot characteristics, *LotSize_SF* was not highly correlated with *FloodCode,* but was with *ViewCode* (22.9%). We would expect high correlation with *ViewCode* and *LotSize_SF* because people are likely to pay more for views on the land that they buy. Structurally, *Square_FT* was highly correlated with *Beds* (49.6%), *dPool* (27.9%), *FirePlaces* (39.3%), *GarageCap* (47.5%), *NumLiving*R (54.6%), *Stories* (31.2%), and *TotBath* (58.8%). Neighborhood characteristics, *PerBlack*, *PerHispan*, *PerOwnOcc*, and *PerPassAll* were all highly correlated with each other. I was also concerned with the high correlation of the neighborhood characteristics and energy variables because many of the correlations were significant. This meant that there was little difference between variables and represented redundancy. After running preliminary regression models on the energy dataset it was apparent that these aforementioned variables competed for predictive power and significance in the hedonic model.

[11] This concentration issue introduces some difficulty with self-selection. Location efficiency (i.e. being close to existing services, already established infrastructure, and already developed areas) is an important part of the green building ethic. While many of the homes rated as green by the Austin program are well outside of downtown and most are part of "greenfield" developments (developments built on previously undeveloped land), they do not stretch as far into the outlying areas around the city as homes which are not rated. This may have something to do with where the green building program has chosen to rate homes, but it also may have something to do with where marketing a green building is useful for homebuilders. If someone is going to sell a home in a new ex-urban community twenty-five miles outside of downtown, it is likely that the target buyer is less concerned about environmental issues as someone looking to buy a home in downtown or even a new, inner-ring suburb. This self-selection problem crops up in several other ways throughout this study (Bradshaw 2005).

Dropped Variables

To minimize bias in the sample, certain variables were condensed or removed. Due to high inter-correlation and competition in the neighborhood characteristics *PerBlack*, *PerHispan*, and *PerOwnOcc* were dropped because *PerPassAll* was a relatively better predictor of price. The structural variables *Beds* and *NumlivingR* were eliminated because *Square_FT* and *LotSize_SF* were better predictors of price. *dPool* was dropped while fireplaces and garages were recoded into dummy variables to better represent the underlying data. *Stories* was taken out because it was not significant in the preliminary regression models and had low variation. *YearBuilt* was collinear with the year of sale and therefore not used. The energy variables *dSolarHeat* and *dSolarWtrHtr* were disregarded because there were no observations in the sample and were not included in Table 6 or Table 7. *EnergySum* was highly correlated with other energy variables, as it is an indicator summing up the presence of these features, and was not included in the final regression.

Recoding

Fireplaces, *GarageCap*, and *TotBath* were variables that were deemed to be significant in preliminary regression models, but needed to be condensed in order to be representative of the underlying distribution or to remove outliers. In order to capture most of the variation in the variable the frequency at which they occurred were looked at (See Table 8, Table 9, & Table 10). For *Fireplaces*, 87% of the sample had at least one fireplace, so the dummy variable (*dFireplace1G*) for one or more fireplaces was created as it would significantly represent homes with a fireplace. The dummy variable *GarageCap3* was created in order to make comparisons to homes with two, one, or zero garages. Ideally, we would have liked to have made a comparison to homes without a garage to those that did, but homes without a garage was a small minority of 3.8% of the sample. The dispersion of *TotBath* was large and displayed bimodal characteristics. There were a large amount of homes with half to two-and-half bathrooms and three or more; therefore, *dTotBath2p5* and *dTotBath3G* were produced to represent homes with less than two-and-half baths and those with more than three baths respectively.

Principal Component Factor Analysis

Before reaching the final dataset, principal component analysis was employed on the energy variables. The purpose of principal component factor analysis was used to remove redundant (highly correlated) energy variables from the dataset, and replace them with a smaller number of uncorrelated variables that will explain a large portion of the variation found amongst these variables.

The principal components method of extraction begins by finding a linear combination of variables (a component) that accounts for as much variation in the original variables as possible. It then finds another component that accounts for as much of the remaining variation as possible and is uncorrelated with the previous component, continuing in this way until there are as many components as original variables. Usually, a few components will account for most of the variation, and these components can be used to replace the original variables (Statistical Package for Social Sciences v 12.2).

Table 11 shows us the extracted components with eigen values over the value of one. The principal component method for the energy variables was able to reduce the number of energy variables examined from ten to five while explaining 74% of the variation. For interpretation purposes the components were rotated using a VARIMAX procedure with Kaiser Normalization while ensuring zero correlation (See Table 11 and Table 7). Table 7 shows zeros for all correlations between the factors.

Table 12 illustrates which energy variables load most heavily on the five components, and is where Table 13 is derived from for grouping of the variables. For factor one *dZoneAirHeat* loaded most heavily (0.829), factor two on *dSolarScreen* (0.794), factor three on *dStormWin* (0.838), factor four on *dStormDoor* (0.928), and factor five on *dWhlHouseFan* (0.97). These components were then labeled by the dominant characteristic (See Table 13) that at least had a 70% loading of the variance. One caution in Table 13 is that within each grouping one factor may be more important than the others.

METHODOLOGY

I begin with how real estate theorists and professionals would likely price and value energy features in the residential marketplace. Hedonic models are an econometric view of pricing the features that comprise an entire finished product. Hedonic modeling has been the one of the primary pricing methods of appraisal for over 40 years, and continues to advance and become a standard way of valuating homes (Dubin 1998).

Kelvin Lancaster is regarded as the developer of the hedonic model and its application to real estate price estimation. "A New Approach to Consumer Theory" (1966) suggests that the pre-1966 methods of valuation must "Break away from the traditional approach that goods are the direct objects of utility and, instead, supposing that it is the properties or characteristics of goods from which utility is derived" (Lancaster 1966). That is to say Lancaster's econometric foundations yielded a way to model what a house is and how it can be priced quantitatively. The advantages of using a hedonic model for residential homes are three-fold. First, one can assume that a house is composed by the sum of its features. Secondly, hedonic models correct for changes in quality over time. Lastly, they can be used to assess the value of a home without specific market transaction data. Lancaster's model not only works for housing, but other commodities such as cars (A.T. Court1939 & Griliches 1961).

More recent and refined derivations of the hedonic model for estimating pricing of homes more accurately have come from Stephen Malpezzi's "Hedonic Pricing Models: A Selective and Applied Review" (2002) and others such as James Follain and Emmanuel Jimenez's "Estimating the Demand for Housing Characteristics: A Survey and Critique" (1985), and Stephen Sheppard's "Hedonic Analysis of Housing Markets" (1999). The theoretical foundations of these works stem from the work of Kain and Quigley 1970, who concluded that residential services, e.g. schools, sewer, etc, have an impact on the price a consumer is willing to pay for a home. The culmination of hedonic research has provided Equation 1 (on page 34).

While this refined hedonic model is more accurate and tailored to the residential sector than Lancaster's original model it still has a few drawbacks. There are three drawbacks that researchers and Malpezzi often confront are:

1. Heterogeneity of houses and consumer preference
2. Identification of whether problem is from the supply or the demand side
3. Housing market is cyclical (disequilibrium), yet model assumes equilibrium (Malpezzi 2002)

The heterogeneity problem of homes and the features they contain can make them very different from one another; this variety makes it difficult to price them as a single commodity. Furthermore, consumers themselves possess very different preferences so they purchase differing bundles of attributes. Malpezzi suggests that this issue produces non-linear measures, but can be corrected with "Second Stage" hedonic modeling; where non-linear mathematical functions such as the *log* function are used.

The identification problem has been a classical dilemma in economics. Distinguishing whether supply or demand are the causal factors can be ambiguous because lack of reliable instruments of analysis (Malpezzi 2002). The identification problem is attributed to unobservable characteristics or endogenous variables not captured in the model. Within the scope of hedonic modeling, Diamond and Smith (1985) look at demand for individual characteristics of homes and locations. Diamond and Smith conclude that estimating the price elasticity of supply (i.e. sensitivity of quantity based on price) does not assist in estimation of household demand characteristics. They put forward that price elasticity of supply is a non-linear trait in hedonic modeling, and could be addressed through non-linear transformations of endogenous variable(s) in the demand function. Bloomquist and Worley (1982) look at the demand side of amenities in housing and use non-linear transformations in their studies. They concluded that a *Two stage* or "Second Step" method with their 0.1 power transformation is superior to linear hedonics using a Box-Cox method, but bias varies from attribute to attribute in their model. To give an example of magnitude: the number of rooms variable in the power transformation function overestimated by three percent while the traditional linear hedonic overestimated by 14-56%. However, they also conclude that the 0.1 power transformation "is not significantly different from the log form of the hedonic" (Bloomquist & Worley, 1985). Sheppard (1999) concludes that, in addition to model specification and measurement error, that "nonlinearity in household budgets implies endogenous determination of attribute price" (Sheppard, 23, 1999). This means that non-linear factors arise within the model, usually in the error term, that could not explain the variation in a house attribute price. Ivar Ekland et al in their paper "Identifying Hedonic

Models" (2007) have showed that the hedonic models are "Generically non-linear. It's the linearization of a fundamentally non-linear model that produces the form of the identification problem that dominates[s] discussion in the applied literature." These studies grapple with a difficult question and the identification problem continues to make conclusions somewhat ambiguous. For now the approximations caused by the identification problem will have to be accepted and acknowledged until further methodologies are developed.

The equilibrium and disequilibrium problem is an issue also since hedonic modeling assumes equilibrium, when in reality the market is in a constant state of change of price fluctuations. Malpezzi suggests to "estimate hedonic price functions using only observation in or near equilibrium" (Malpezzi 2002). Abraham and Hendershott tried to look at this phenomenon but could not conclude any concrete evidence, since their results varied across the US (Abraham & Hendershott 1994). The static nature of the model will yield a snapshot in time rather than a dynamically changing model over time.

Hedonic Model

This statistical model was chosen because of the heterogeneous nature of real estate in the sample. Specifically each home has a diverse range of components and features which is difficult to estimate the demand for. Hedonic models estimate prices for individual characteristics bundled together to form a good; they assume there is an autonomous market for each individual characteristic e.g. double pane windows. Equation 1 shows a general model of a hedonic equation.

Equation 1: Standard Hedonic Attributes

V=f (S, N, L, C, T) where

V= value of house
S= structural characteristics
N= neighborhood characteristics
L= location within the market
C= contract conditions
T= time the value, V, is observed (Malpezzi 2002)

The statistical method underlying the model is ordinary least squares regression analysis. The regression analysis can tell us maximum likelihoods of occurrence and correlations of home features to price in a multivariate setting. Hedonic modeling is used extensively in the real estate literature and will be employed in this study. We used log-linear regression in the hedonic model because it took into consideration the economic law of diminishing marginal utility and was a good estimator of house prices. Since we use a log-linear regression we can interpret the beta coefficients as a percent change in the home's value given a change in the independent variable.

Hypothesis Testing

I first develop a baseline model of transaction, housing, and neighborhood attributes that explain house prices in this sample. From there I add the energy variables to see if there is any explanatory power and to see if the individual coefficients on the energy variables are significantly different from zero.

Specifying the Regression Models

In order to reduce the effects of co-linearity and competition of significance between variables in the model I started with a baseline model. The baseline model (See Table 14)

was created for the variables that are well known in literature and practice to explain a large portion of the variation in home price. Choosing variables for the baseline was also supported through the relationships shown in the correlation tables. *LotSize_SF* and *Square_FT* were strong predictors of house price, *DistFrCtyCtr_Miles* controlled for clustering of homes and neighborhood attributes, the square of *LotSize_SF* and *Square_FT* were used to detect non-linear relationships, and *dClosedYear* controlled for markets fluctuations.

The baseline model was created as a basis from which comparison would be drawn upon for keeping an additional variable added to the model from list of variables in Table 5. For the baseline, a variable from each attribute in Equation 1 was used, except a neighborhood characteristic. By using this baseline model it would be easier to see changes in standard errors, R^2, and significance by adding additional variables. The motivation for small standard errors was to minimize non-random variation. A higher R^2 would yield more predictive power for the overall model. Significance of each variable would offer confidence in reporting a particular variable affect on house price.

From the baseline model, an additional variable would be added and kept in the hedonic model if the addition of the variable lowered the standard errors of the baseline model, increased the R^2, and/or if the variable was significant or could explain a trend. This was iterated with all the variables in Table 5 to generate Table 15. To see how the energy factors would affect the standard errors, R^2, and to see if they were significant Table 16 is shown separately to compare to Table 15. In addition to the energy factors, I wanted to know if a green rating had anything to say about price and if it was positively or negatively associated with home value; thus Table 17 was created.

Results

The results of Table 16 are interpreted as follows:

- These 23 variables explain 81.6% of the variation in Austin home prices.
- The significance value of the F statistic in the ANOVA table means that the variation in price explained by the model is most likely not due to chance.
- All the variables except *Square_FT*, *REGR factor score 3*(energy retrofits), and *REGR factor score 5*(energy accessories) were all statistically significant at the 95% confidence level as indicated by the t-statistic (>|1.96|). By being significant we know these variables contribute to the model.
- All 23 variables have a less than 9% chance of its coefficient being equal to zero as indicated by the standard errors.
- Distance from the State Capitol building in Austin decreases the value of the home at a rate of 3.1% per mile.
- Each additional square foot of livable space increases the value of the home by 0.004% and each additional square foot of land increases the value of the home by 0.0006%.
- Having two-and-half bathrooms adds 13.4% to the price of a homes relative to zero to two bathrooms. Three or more bathrooms adds 39.3% to price relative to a home with three bathrooms.
- *REGR factor score* I (HVAC systems and controls) was significant in explaining house price and each additional HVAC energy feature of *REGR factor score I* would add 3.98% to the value of the home.
- *REGR factor score II* (Solar Screens) was significant in explaining house price and each additional solar screen decreases the value of a home by 5.2%.
- *REGR factor score IV* (Storm Doors) was significant in explaining house price and each additional storm door decreases the value of the home by 2.9%.
- *REGR factor score III and V* (Energy retrofits and attributes) were not significant in predicting price and did not contribute to the model.

If we were to solve for price in Table 16's regression model we would have the following equation:

Price= Exp[(constant) -0.03*DistFrCtyCtr_Miles+… -0.006*REGR factor score 5)
(Equation 2)

The addition of the *dGreen* variable in Table 17 was insignificant, did not contribute to the model, and had a price premium of 5.6%. Bradshaw's study had a similar finding. When he did not control for distance he found a 3.6% price premium for green rated homes. When Bradshaw controlled for distance that premium dropped to a 0.73% price premium.

In both Bradshaw's regressions, *gGreen* was insignificant in contributing to the model in predicting price.

Robustness

Given we had reliability and interpretation issues in the data at early stages of the study I wanted to perform robustness checks on the tests we ran. First, I made sure that the number of energy feature observations was comparable to the original ABoR 65,000 observation dataset. Both the original ABoR dataset and the energy dataset had ~30% of homes without energy features; thus they were comparable. Next, I ran descriptive statistics on the energy dataset for homes with no energy features and those with at least one energy feature (See Table 18 and Table 19). Table 18 and Table 19 showed us that the means were comparable to the energy dataset sample with possible discrepancies in lot size and sales price.

Next I ran the regression with homes that had at least one energy feature (See Table 21). I found that factors I, II, and IV were still significant but now factor II (Solar screens) becomes significant. The component factors with homes that had at least one energy factor explained 68% of the variance which is comparable to the 74% I got earlier (See Table 22). The components loaded on the same energy variables with the exception of factor IV (exterior attributes) (See Table 23). Factor IV (exterior attributes) now loaded on ceiling fans whereas before it had loaded on storm doors. Factor II's (solar screens) highest two loading factors switched, before it was most heavily loaded on solar screens and now it was on double pane windows; the loading scores were very close now whereas before the difference was larger.

In Table 21 we see that factor one is still significant, positive, and nearly three times larger in magnitude from the final regression model (Table 16) with a 9.5% price premium compared to a 3.9. Factor two is still negative, significant, and drops in magnitude a little less than a percent. Factor three now becomes significant, still negative, and increase by a little over one percent in magnitude. Factor four now becomes insignificant, becomes positive, and drops almost 2.5% in magnitude. These results suggest that energy factors one through three are robust and reliable to make conclusions on. Factor four (Storm doors) changes sign and factor five was never significant therefore these features are not very robust.

Discussion

The role of the energy variables relative to *dGreen* is that the energy variables bring a level of detail in understanding on how sales price is affected through energy features. The green rating encompasses energy features (See Figure 12), and I focus on the energy features because it is the most substantive in terms of homebuyers noticing the value in investing in these products. However, the energy features come from the ABoR and do not measure all of the GBP features in Figure 12. We can see this most visibly in Table 7 where *dGreen* is negatively correlated with all the energy variables except *dWhlHouseFan* This leads me to believe that the GBP green rating looks at different aspects than the ABoR. When comparing Table 3 to Table 20 one can see that the overlapping features are heating ventilation & cooling and solar aspects. The two organizations differ by "green" design, lighting, and appliances. Being green does not always measure energy; it is only one aspect in the Austin GBP. We would expect that the overlapping features would explain some variation in price while the other features would explain very little in price. This expectation was for the most part true as seen in Table 17.

The interpretation of the green rating or energy factor is intended for home-to-home or factor-to-factor comparison. The rating or factor says nothing about how the energy features are actually used. For example, a family who leaves the ceiling fan(s) on all day and night versus a family who only uses the fan when they are home. The effect on price will depend on how these features are used and maintained. Assumptions on average use and time are assumed to make fair comparisons. The green rating is supposed to play a role that has a direct proportional relationship to environmental health; the higher the green rating the lower the home's harm to the environment and humans. From the model in Table 17, we can say that having a green rating has a positive relationship with sales price, but is not significant in contributing to the model which does not tell us much. If the green rating was significant we could speculate that the market perceives the rating to be helping the environment while adding value to the home.

Variable Interpretation

For the green rating, I decided to go with a binary variable because there was not enough variation in the amount of stars a home received for a green rating (See Table 24). The energy variables had high correlation with each other so principal component analysis was performed. Table 16 shows us that this sample follows a mono-centric city model with a decrease in price the further a home is situated from downtown. Lot size and square feet are strong predictors of price. Large homes showed that garages, fireplaces, and bathrooms were very important with its positive sign in *Square_FtSqrd*. Market fluctuations can be seen in the *ClosedYear* variable; where, relative to 1997, the ABoR had a large amount of sales between 1998 and 2001. The year 2001 had the largest amount of home sales. Structurally, having one or more fireplaces, a three-car garage, two and a half or three bathrooms was very useful in selling a home in Austin. Strong school test scores were a significant consideration for home buyers. A home fully or partially in a designated flood code negatively affected a homes sales prices. A broadly defined view helped considerably in sales price. Component factor I or HVAC attributes have a fairly high correlation with sales price at 23.1%. A consumer could fathomably keep approximately 4% on the value of his home by not investing in HVAC features but would pay that money in the future on operating expenses. Contrarily, a homeowner could pay 4% upfront at the point-of-sale and not hassle with installation and receive the benefit of lower operating expenses in the future.

The hedonic models suggest that certain energy features are actively priced. Specifically, features of homes represented here by HVAC systems and controls, solar screens, and storm doors seem to be actively priced and incorporated in the value of a home as suggested by their significance. HVAC energy features had a positive relationship with price, while solar screens and storm doors were negatively associated with price.

When I talked with real estate agents from Austin she said that most new home buyers (typically the younger population and the largest group) do not ask or are not concerned with energy features since it will cost more. New or first time homebuyers are concerned about the basic structural aspects of a home, such as bathrooms and bedrooms. The retirement homebuyers, a much smaller population relative to new homebuyers in Austin, do ask about energy features, but are marginally concerned with those aspects. From her perspective, the average builder does not include energy features in homes or market them heavily.

Another Austin real estate agent said homebuyers when confronted with energy features will look for double pane or low- emittance windows, minimum air conditioning, and insulation requirements if they are affordable features. He also stated that wear and tear of solar screens happens sooner than expected and fraying of the screen becomes a problem and are no longer functional. He suggests window film as a substitute for buyers looking into a home with solar screens. He also stated that most solar screens are "plain ugly" and only the most expensive ones are transparent. This attractiveness feature may play a role in how homebuyers emotionally attach themselves to a home. Lastly, the real estate agent said that the hot climate in Austin deters homebuyers from using storm doors.

From the results in Table 16 we can estimate that a homebuyer that invests in HVAC energy features would expect to save 3.97% from the value of their home. For the average home in this sample that's a little over $14,000 in savings from having HVAC energy features. In relation to the Metcalf and Hassett study they computed a median internal rate of return for energy cost savings to the cost of attic insulation to be 9.7%.

CONCLUSION

From the regression results we see that HVAC systems and controls, solar screens, and storm doors are all significant in explaining variation in home prices for this sample of new homes in Austin, Texas. Since the variable indicating the presence of an energy efficient HVAC system and control system is positive and statistically different from zero, it suggests that the expected cost savings of this energy feature is capitalized in the price of a home. However, we see that while HVAC systems and controls are positively associated with price solar screens and storm doors are negatively associated with price. This leads me to believe that the market is valuing energy features differently given the information they have.

As more research is conducted on the energy efficiency of homes, we expect that consumers will make more informed decisions about incorporating these features in the future. However, energy efficient products will have to be competitive in price to conventional products in order to have scales of economy. The home improvement and construction sectors will also need training on how to install and service new energy efficient products if they differ from conventional products. Energy efficient products particular to orientation towards the sun or other design specifications will take time to become common practice as the information is absorbed and learning curves become smaller.

The environmental dilemma is not necessarily resolved with more information, however, and thus changes in production of homes with energy features will most likely happen through government and legal channels. Political pressures rather than market forces will be the motivation for some changes. Building codes, requirements, and compliance will be the targeted aspects that will affect the homebuilding industry, and within those codes product minimums and efficiency standards would be mandated. The Austin Climate Protection Plan is well intentioned for energy efficiency in the home sector, but may not be the most optimal method in achieving energy efficiency in homes because of increased cost to taxpayers, oversight of new regulations, and potential to deter home buyers from investing in the Austin area. The greatest impact the Austin Climate Protection Plan could have is making policy when homeowners consider reinvesting in home features because in time a new water heater will always be needed, and what better way to invest than in an environmentally conscious way. The use of energy audits may facilitate the decision to reinvest or not, as well as make it easier for the homeowner to get contractors if they decide to reinvest in energy features.

Many people do not expect that energy prices will not go back down to 1980 prices. The costs borne by homebuyers when energy prices are high should continue to provide incentives to lower those costs through increased energy efficiency in the home. Education on energy efficiency rather than political force may be the best policy encourage chioices to include energy efficient features in homes. Education coupled with market forces will last longer than a single administration's policies.

Future Areas of Research

Further research on how homebuyers access available information about energy efficiency is necessary to better understand the energy paradox. Data on why home builders do not market energy efficiency is needed as well, especially if new homebuyers feel that those attributes are desirable. A variable that captures the climate of Austin is missing from this study and could help to explain the impact of certain features since some "green" features are design and orientation specific. Other research could investigate affordability challenges that new rules and regulations about energy efficient features will impose on certain types of households. One aspect to look at could be the effect, before and after, the Austin Climate Protction Plan to see if the energy efficiency market grows and if the prices of homes increases. Finally, information and research on the construction phase of homebuilding would greatly help in understanding the actual costs of building more energy efficient homes.

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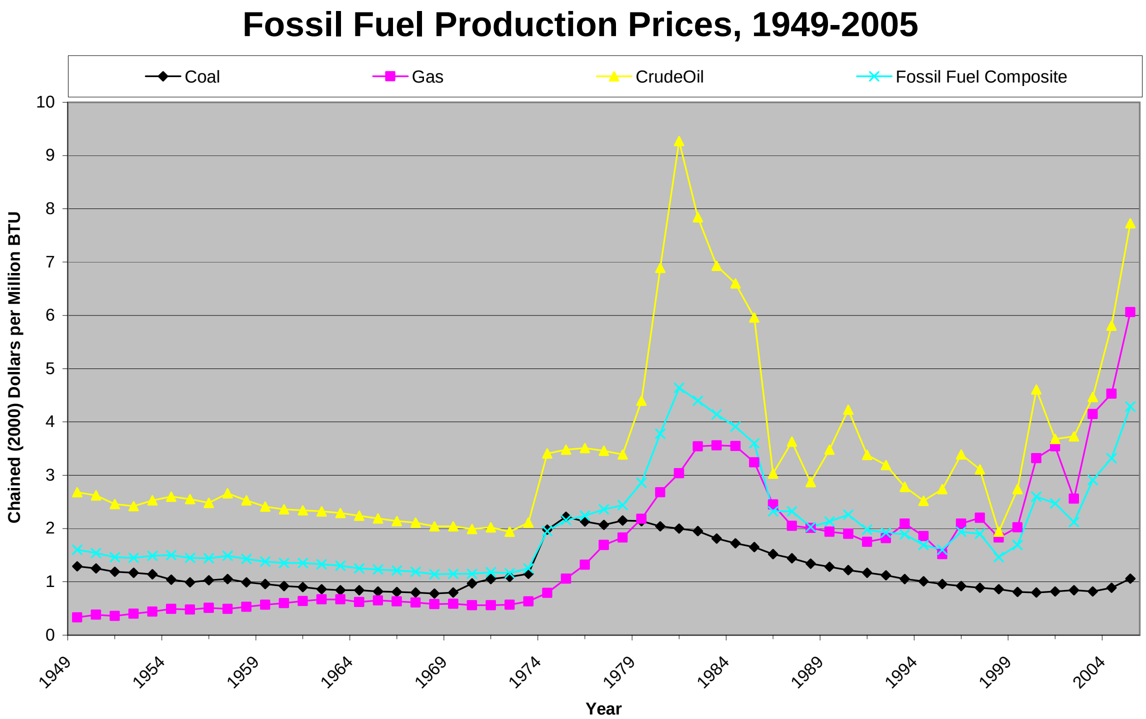
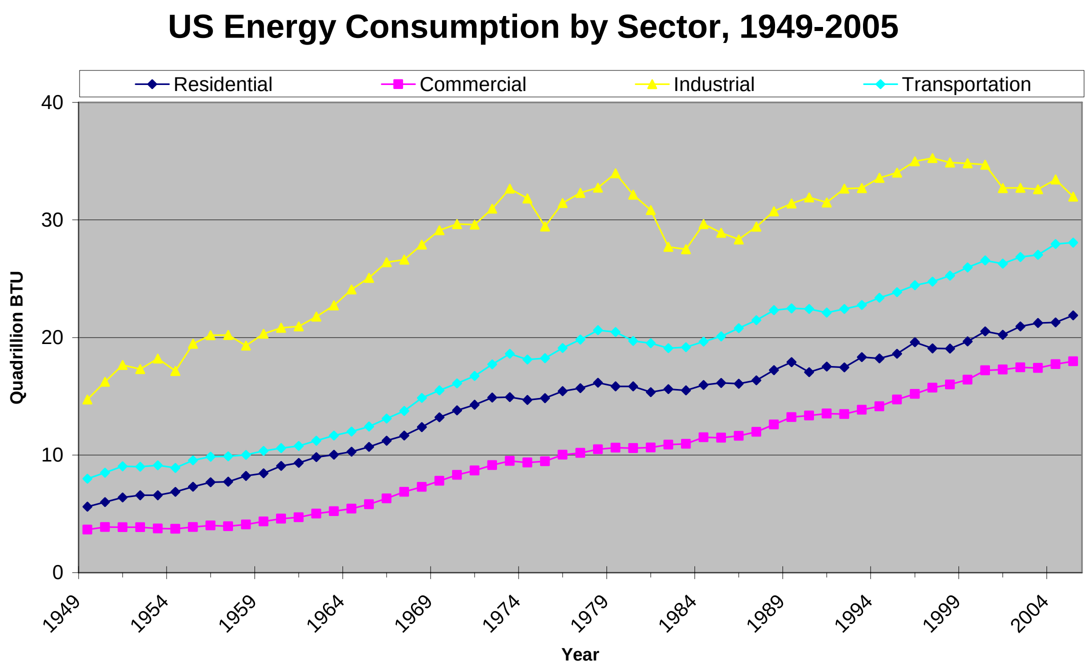
APPENDIX A- FIGURES



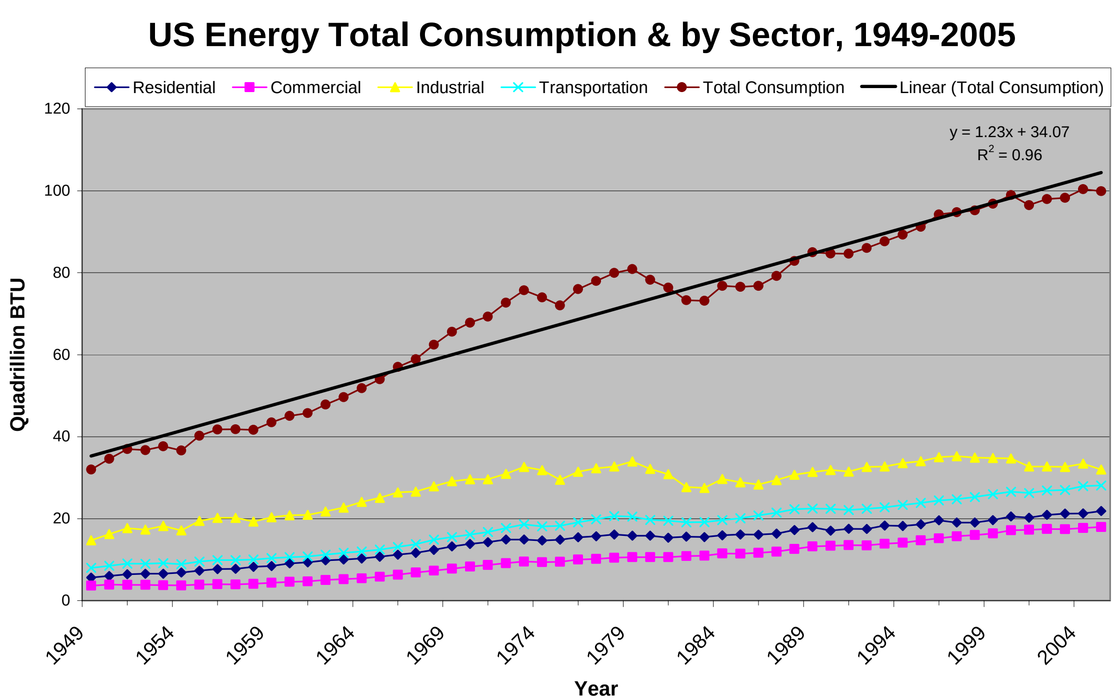
Source: US Energy Information Agency- Annual Energy Review 2005
Created by Antonio Amado March 26, 2007

Figure 1: Fossil Fuel Production Prices. The average percent difference of Coal was +0.14%/yr, Gas was +6.65%/yr, Crude Oil was +3.98%/yr, and the Fossil Fuel Composite was 2.86%/yr from 1949-2005.Take note of the spike in the 1970s with the oil crisis.



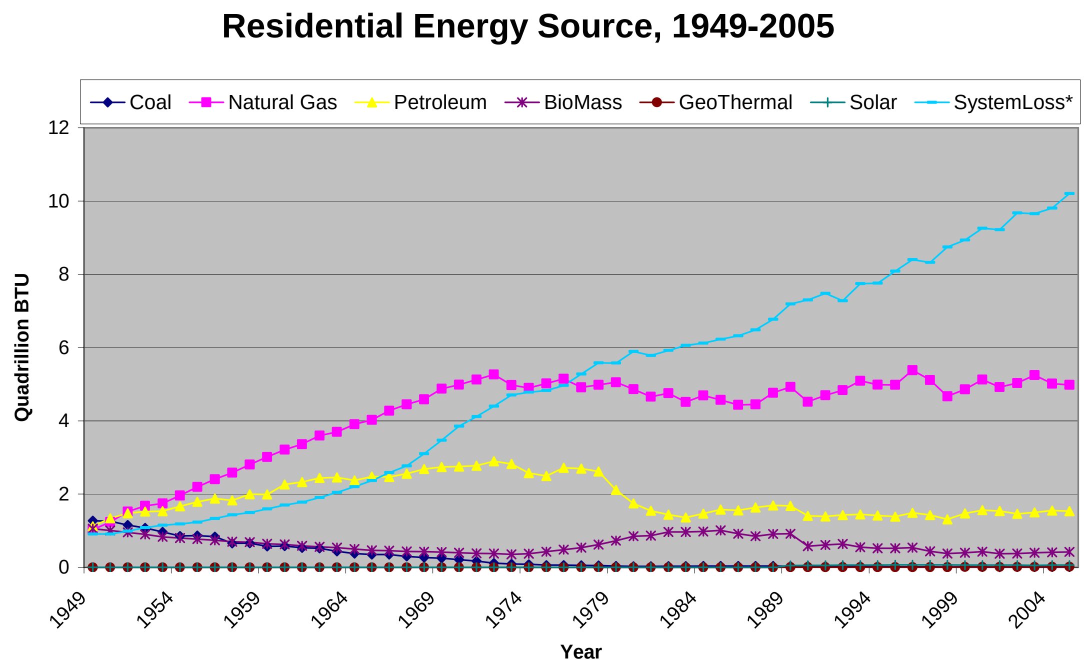
Source: US Energy Information Agency-Annual energy Review 2005
Created by Antonio Amado March 26,2007

Figure 2: The average % change in Residential was +2.5%/yr, Commercial was +2.92%/yr, Industrial was +1.49%/yr, and transportation was +2.30%/yr for the time period of 1949-2005.



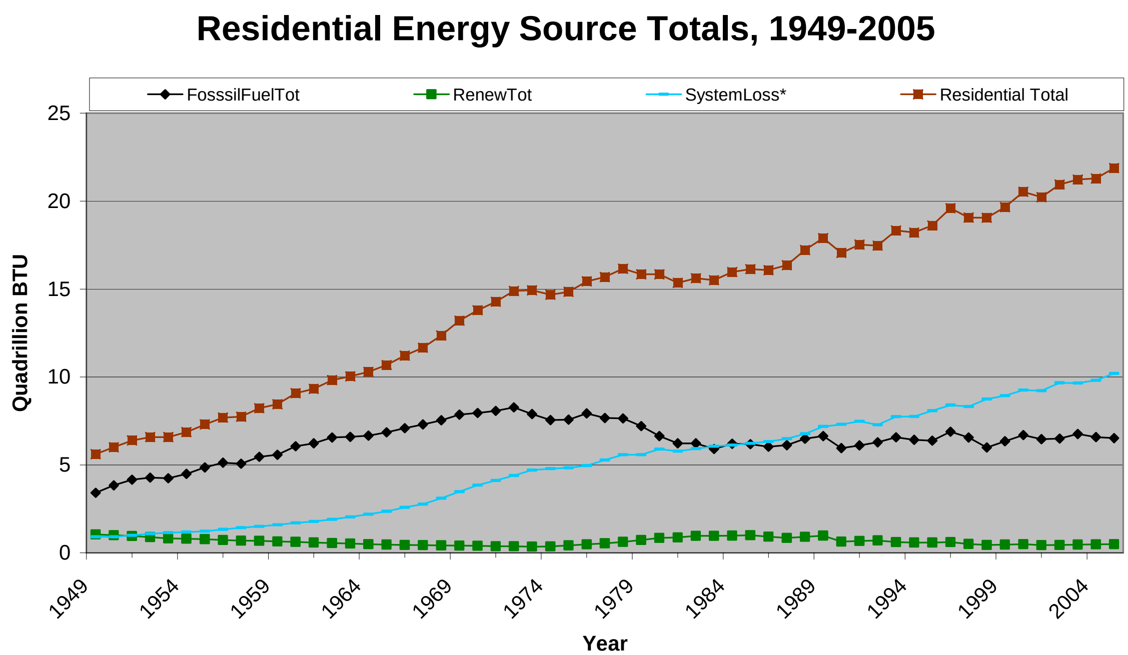
Source: US Energy Information Agency-Annual energy Review 2005
Created by Antonio Amado March 26,2007

Figure 3: The average % difference in Total Consumption was +2.10%/yr from 1949-2005.



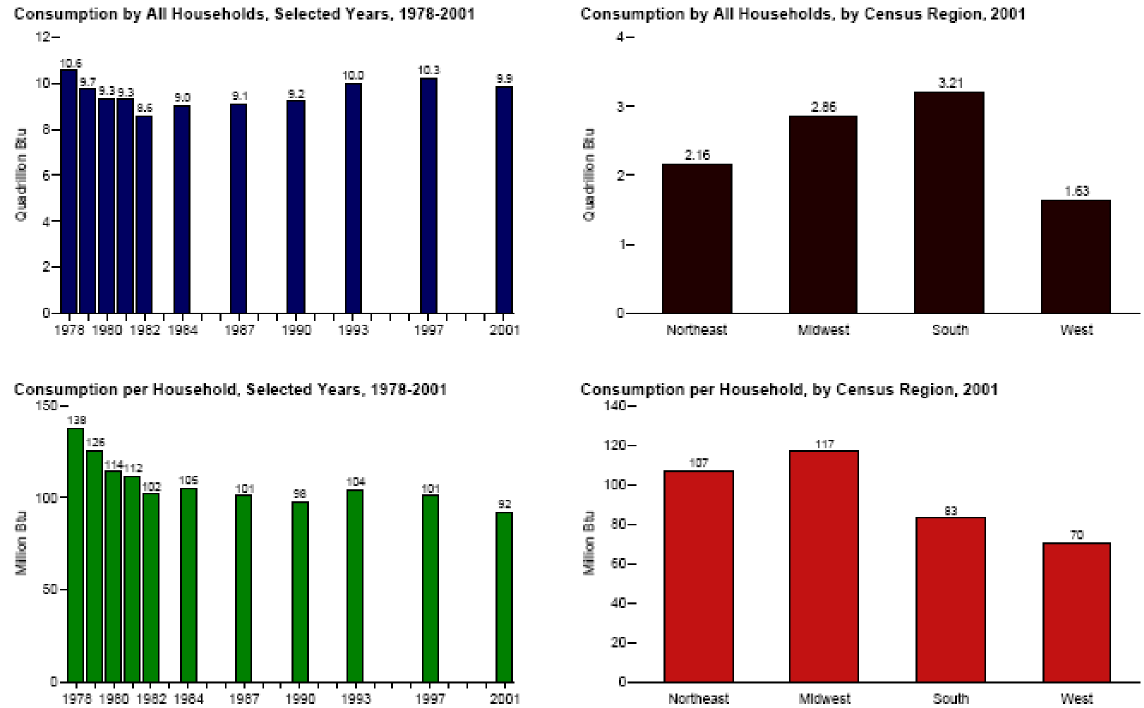
Source: US Energy Information Agency-Annual Energy Review 2005
Created by Antonio Amado March 26,2007
*Total losses are calculated as the primary energy consumed by the electric power sector minus the energy content of electricity retail sales. Total losses are allocated to the end-use sectors in proportion to each sector's share of total electricity retail sales. See Note, "Electrical System Energy Losses," in EIA Annual Energy Review 2005

Figure 4: The average percent difference for Coal was -7.26%/yr, Natural Gas was +3.03%/yr, Petroleum was 0.83%/yr, BioMass was -1.18%/yr, GeoThermal was +7.72%/yr (recording started in 1989, average was taken from this year forward), and Solar was +0.74%/yr (recording started in 1989, average was taken from this year forward) for the years 1949-2005.



Source: US Energy Information Agency-Annual Energy Review 2005
Created by Antonio Amado March 26,2007
*Total losses are calculated as the primary energy consumed by the electric power sector minus the energy content of electricity retail sales. Total losses are allocated to the end-use sectors in proportion to each sector's share of total electricity retail sales. See Note, "Electrical System Energy Losses," in EIA Annual Energy Review 2005

Figure 5: The average percent difference for Fossil Fuel Total was +1.27%/yr, Renewable Total was -0.93%/yr, System Loss was +4.46%/yr, and the Residential Total was +2.50%/yr.



Notes: • Data include natural gas, electricity, distillate fuel oil, kerosene, and liquefied petroleum gases; data do not include wood. • For years not shown, there are no data available. Data for 1978 through 1984 are for April of the year shown through March of the following year; data for 1987, 1990, 1993, 1997, and 2001 are for the calendar year. • Because vertical scales differ, graphs should not be compared. • See Appendix C for Census regions.

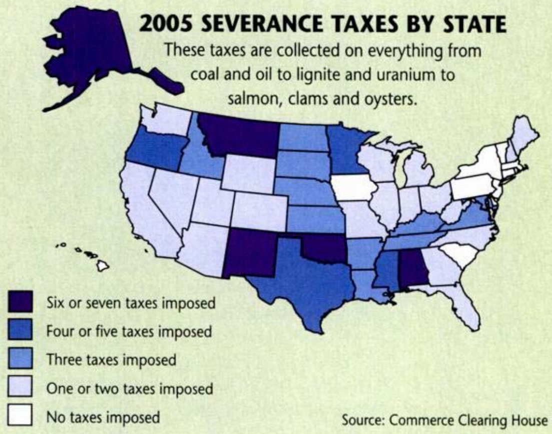
Source: Table 2.4.

Figure 6: Household consumption by region

Source: US Energy Information Agency Annual Energy Review 2005

2005 SEVERANCE TAXES BY STATE

These taxes are collected on everything from coal and oil to lignite and uranium to salmon, clams and oysters.



Source: Commerce Clearing House State Taxes, 2006.

A BIG RISE

In the first three quarters of 2005, severance taxes were well above 2004 levels.

2005 TAX COLLECTIONS AS A PERCENT OF TOTAL 2004 SEVERANCE TAX

Alaska	125.4%
Wyoming	104.9
New Mexico	90.8
North Dakota	129.2
Oklahoma	95.3
Texas	97.2
Louisiana	97.7
West Virginia	107.2
Montana	62.1
Kentucky	99.2
Kansas	93.6
Alabama	94.6
Colorado	106.2
Utah	135.0
United States	101.5%

Source: U.S. Census Bureau, Estimated State Tax Collections, 2005, Quarter 1 (January-March), Quarter 2 (April-June) and Quarter 3 (July-September). www.census.gov

2004 COLLECTIONS

State	Severance Tax Revenue in Millions of Dollars	As a Percent of Total State Tax Collections
Alaska	$646.9	50.2%
Wyoming	683.2	45.4
New Mexico	587.6	14.7
North Dakota	175.6	14.3
Oklahoma	655.1	10.2
Texas	1,896.8	6.2
Louisiana	476.6	5.9
West Virginia	204.1	5.4
Montana	83.5	5.1
Kentucky	187.1	2.2
Kansas	98.1	1.9
Alabama	113.6	1.6
Colorado	115.9	1.6
Utah	47.8	1.1
United States	$593,488.9	1.1%

Source: U.S. Census Bureau, State Tax Collections 2005. www.census.gov

APRIL 2006 STATE LEGISLATURES 7

Figure 7: 2005 Severance Taxes by State, Source: State Legislatures

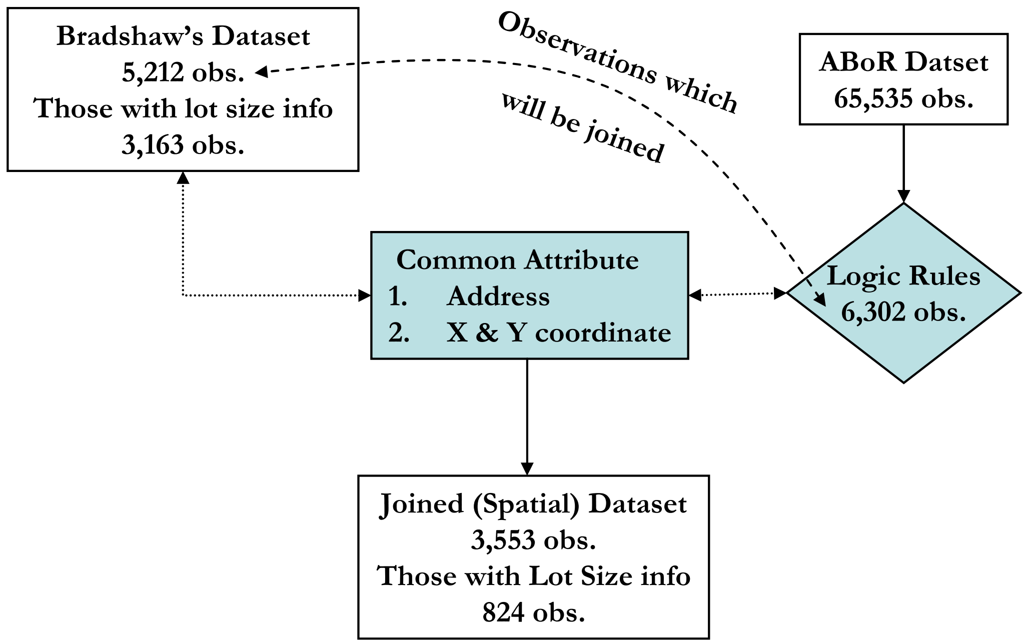


Figure 8: Data Matching Process

Table DP-1. Profile of General Demographic Characteristics: 2000

Geographic area: Austin city, Texas

[For information on confidentiality protection, nonsampling error, and definitions, see text]

Subject	Number	Percent
Total population	**656,562**	**100.0**
SEX AND AGE		
Male	337,569	51.4
Female	318,993	48.6
Under 5 years	46,715	7.1
5 to 9 years	41,227	6.3
10 to 14 years	37,108	5.7
15 to 19 years	48,809	7.4
20 to 24 years	82,945	12.6
25 to 34 years	138,643	21.1
35 to 44 years	104,874	16.0
45 to 54 years	75,844	11.6
55 to 59 years	21,440	3.3
60 to 64 years	15,052	2.3
65 to 74 years	23,008	3.5
75 to 84 years	15,074	2.3
85 years and over	5,823	0.9
Median age (years)	29.6	(X)
18 years and over	509,014	77.5
Male	261,583	39.8
Female	247,431	37.7
21 years and over	465,697	70.9
62 years and over	52,510	8.0
65 years and over	43,905	6.7
Male	17,396	2.6
Female	26,509	4.0
RACE		
One race	636,912	97.0
White	429,100	65.4
Black or African American	65,956	10.0
American Indian and Alaska Native	3,889	0.6
Asian	30,960	4.7
Asian Indian	7,749	1.2
Chinese	8,093	1.2
Filipino	1,582	0.2
Japanese	1,164	0.2
Korean	3,441	0.5
Vietnamese	5,942	0.9
Other Asian [1]	2,989	0.5
Native Hawaiian and Other Pacific Islander	469	0.1
Native Hawaiian	182	-
Guamanian or Chamorro	95	-
Samoan	69	-
Other Pacific Islander [2]	123	-
Some other race	106,538	16.2
Two or more races	19,650	3.0
Race alone or in combination with one or more other races: [3]		
White	445,388	67.8
Black or African American	69,943	10.7
American Indian and Alaska Native	7,453	1.1
Asian	35,152	5.4
Native Hawaiian and Other Pacific Islander	1,061	0.2
Some other race	118,333	18.0

Subject	Number	Percent
HISPANIC OR LATINO AND RACE		
Total population	**656,562**	**100.0**
Hispanic or Latino (of any race)	200,579	30.5
Mexican	153,868	23.4
Puerto Rican	2,529	0.4
Cuban	1,425	0.2
Other Hispanic or Latino	42,757	6.5
Not Hispanic or Latino	455,983	69.5
White alone	347,554	52.9
RELATIONSHIP		
Total population	**656,562**	**100.0**
In households	636,432	96.9
Householder	265,649	40.5
Spouse	101,098	15.4
Child	159,393	24.3
Own child under 18 years	129,143	19.7
Other relatives	42,674	6.5
Under 18 years	14,352	2.2
Nonrelatives	67,618	10.3
Unmarried partner	16,886	2.6
In group quarters	20,130	3.1
Institutionalized population	6,799	1.0
Noninstitutionalized population	13,331	2.0
HOUSEHOLD BY TYPE		
Total households	**265,649**	**100.0**
Family households (families)	141,589	53.3
With own children under 18 years	71,280	26.8
Married-couple family	101,098	38.1
With own children under 18 years	49,148	18.5
Female householder, no husband present	28,563	10.8
With own children under 18 years	17,387	6.5
Nonfamily households	124,060	46.7
Householder living alone	87,026	32.8
Householder 65 years and over	12,124	4.6
Households with individuals under 18 years	78,817	29.7
Households with individuals 65 years and over	31,097	11.7
Average household size	2.40	(X)
Average family size	3.14	(X)
HOUSING OCCUPANCY		
Total housing units	**276,842**	**100.0**
Occupied housing units	265,649	96.0
Vacant housing units	11,193	4.0
For seasonal, recreational, or occasional use	1,437	0.5
Homeowner vacancy rate (percent)	1.0	(X)
Rental vacancy rate (percent)	3.5	(X)
HOUSING TENURE		
Occupied housing units	**265,649**	**100.0**
Owner-occupied housing units	119,102	44.8
Renter-occupied housing units	146,547	55.2
Average household size of owner-occupied units	2.65	(X)
Average household size of renter-occupied units	2.19	(X)

\- Represents zero or rounds to zero. (X) Not applicable.

[1] Other Asian alone, or two or more Asian categories.

[2] Other Pacific Islander alone, or two or more Native Hawaiian and Other Pacific Islander categories.

[3] In combination with one or more of the other races listed. The six numbers may add to more than the total population and the six percentages may add to more than 100 percent because individuals may report more than one race.

Source: U.S. Census Bureau, Census 2000.

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Figure 9: US Census 2000 General Demographics for Austin

Table DP-2. Profile of Selected Social Characteristics: 2000
Geographic area: Austin city, Texas

[Data based on a sample. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see text]

Subject	Number	Percent
SCHOOL ENROLLMENT		
Population 3 years and over enrolled in school	**192,181**	**100.0**
Nursery school, preschool	11,139	5.8
Kindergarten	9,260	4.8
Elementary school (grades 1-8)	63,043	32.8
High school (grades 9-12)	28,096	14.6
College or graduate school	80,623	42.0
EDUCATIONAL ATTAINMENT		
Population 25 years and over	**401,137**	**100.0**
Less than 9th grade	33,200	8.3
9th to 12th grade, no diploma	33,311	8.3
High school graduate (includes equivalency)	68,316	17.0
Some college, no degree	84,486	21.1
Associate degree	19,887	5.0
Bachelor's degree	103,111	25.7
Graduate or professional degree	58,826	14.7
Percent high school graduate or higher	83.4	(X)
Percent bachelor's degree or higher	40.4	(X)
MARITAL STATUS		
Population 15 years and over	**530,599**	**100.0**
Never married	208,821	39.4
Now married, except separated	232,962	43.9
Separated	10,769	2.0
Widowed	19,531	3.7
Female	16,152	3.0
Divorced	58,516	11.0
Female	33,746	6.4
GRANDPARENTS AS CAREGIVERS		
Grandparent living in household with one or more own grandchildren under 18 years	**11,697**	**100.0**
Grandparent responsible for grandchildren	5,105	43.6
VETERAN STATUS		
Civilian population 18 years and over	**508,303**	**100.0**
Civilian veterans	46,762	9.2
DISABILITY STATUS OF THE CIVILIAN NONINSTITUTIONALIZED POPULATION		
Population 5 to 20 years	**142,526**	**100.0**
With a disability	11,763	8.3
Population 21 to 64 years	**418,130**	**100.0**
With a disability	63,935	15.3
Percent employed	66.5	(X)
No disability	354,195	84.7
Percent employed	80.1	(X)
Population 65 years and over	**41,741**	**100.0**
With a disability	17,840	42.7
RESIDENCE IN 1995		
Population 5 years and over	**609,773**	**100.0**
Same house in 1995	219,521	36.0
Different house in the U.S. in 1995	349,522	57.3
Same county	180,509	29.6
Different county	169,013	27.7
Same state	107,425	17.6
Different state	61,588	10.1
Elsewhere in 1995	40,730	6.7

Subject	Number	Percent
NATIVITY AND PLACE OF BIRTH		
Total population	**656,302**	**100.0**
Native	547,296	83.4
Born in United States	537,336	81.9
State of residence	360,604	54.9
Different state	176,732	26.9
Born outside United States	9,960	1.5
Foreign born	109,006	16.6
Entered 1990 to March 2000	66,018	10.1
Naturalized citizen	26,747	4.1
Not a citizen	82,259	12.5
REGION OF BIRTH OF FOREIGN BORN		
Total (excluding born at sea)	**109,006**	**100.0**
Europe	7,474	6.9
Asia	25,036	23.0
Africa	2,263	2.1
Oceania	298	0.3
Latin America	72,097	66.1
Northern America	1,838	1.7
LANGUAGE SPOKEN AT HOME		
Population 5 years and over	**609,773**	**100.0**
English only	419,884	68.9
Language other than English	189,889	31.1
Speak English less than "very well"	84,821	13.9
Spanish	149,123	24.5
Speak English less than "very well"	71,099	11.7
Other Indo-European languages	16,534	2.7
Speak English less than "very well"	3,749	0.6
Asian and Pacific Island languages	20,955	3.4
Speak English less than "very well"	9,027	1.5
ANCESTRY (single or multiple)		
Total population	**656,302**	**100.0**
Total ancestries reported	*677,341*	*103.2*
Arab	3,177	0.5
Czech[1]	7,903	1.2
Danish	2,590	0.4
Dutch	6,591	1.0
English	57,443	8.8
French (except Basque)[1]	17,607	2.7
French Canadian[1]	3,422	0.5
German	84,350	12.9
Greek	1,437	0.2
Hungarian	1,741	0.3
Irish[1]	55,446	8.4
Italian	16,185	2.5
Lithuanian	791	0.1
Norwegian	5,544	0.8
Polish	9,466	1.4
Portuguese	872	0.1
Russian	4,168	0.6
Scotch-Irish	16,024	2.4
Scottish	15,382	2.3
Slovak	645	0.1
Subsaharan African	4,683	0.7
Swedish	7,553	1.2
Swiss	1,633	0.2
Ukrainian	854	0.1
United States or American	28,052	4.3
Welsh	4,261	0.6
West Indian (excluding Hispanic groups)	1,241	0.2
Other ancestries	318,280	48.5

-Represents zero or rounds to zero. (X) Not applicable.
[1]The data represent a combination of two ancestries shown separately in Summary File 3. Czech includes Czechoslovakian. French includes Alsatian. French Canadian includes Acadian/Cajun. Irish includes Celtic.

Source: U.S. Bureau of the Census, Census 2000.

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U.S. Census Bureau

Figure 9: US Census 2000 General Demographics for Austin

Table DP-3. Profile of Selected Economic Characteristics: 2000
Geographic area: Austin city, Texas
[Data based on a sample. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see text]

Subject	Number	Percent
EMPLOYMENT STATUS		
Population 16 years and over	**523,758**	**100.0**
In labor force	376,704	71.9
Civilian labor force	376,212	71.8
Employed	359,804	68.7
Unemployed	16,408	3.1
Percent of civilian labor force	4.4	(X)
Armed Forces	492	0.1
Not in labor force	147,054	28.1
Females 16 years and over	**255,902**	**100.0**
In labor force	167,030	65.3
Civilian labor force	166,931	65.2
Employed	159,108	62.2
Own children under 6 years	**52,038**	**100.0**
All parents in family in labor force	28,622	55.0
COMMUTING TO WORK		
Workers 16 years and over	**353,109**	**100.0**
Car, truck, or van - - drove alone	259,905	73.6
Car, truck, or van - - carpooled	49,131	13.9
Public transportation (including taxicab)	15,743	4.5
Walked	8,995	2.5
Other means	7,306	2.1
Worked at home	12,029	3.4
Mean travel time to work (minutes)[1]	22.4	(X)
Employed civilian population 16 years and over	**359,804**	**100.0**
OCCUPATION		
Management, professional, and related occupations	155,009	43.1
Service occupations	47,559	13.2
Sales and office occupations	93,479	26.0
Farming, fishing, and forestry occupations	536	0.1
Construction, extraction, and maintenance occupations	32,353	9.0
Production, transportation, and material moving occupations	30,868	8.6
INDUSTRY		
Agriculture, forestry, fishing and hunting, and mining	1,383	0.4
Construction	27,728	7.7
Manufacturing	45,169	12.6
Wholesale trade	8,071	2.2
Retail trade	39,209	10.9
Transportation and warehousing, and utilities	9,269	2.6
Information	16,147	4.5
Finance, insurance, real estate, and rental and leasing	24,108	6.7
Professional, scientific, management, administrative, and waste management services	49,651	13.8
Educational, health and social services	63,182	17.6
Arts, entertainment, recreation, accommodation and food services	32,084	8.9
Other services (except public administration)	17,050	4.7
Public administration	26,753	7.4
CLASS OF WORKER		
Private wage and salary workers	269,163	74.8
Government workers	66,772	18.6
Self-employed workers in own not incorporated business	23,098	6.4
Unpaid family workers	771	0.2

Subject	Number	Percent
INCOME IN 1999		
Households	**265,594**	**100.0**
Less than $10,000	24,799	9.3
$10,000 to $14,999	14,492	5.5
$15,000 to $24,999	32,628	12.3
$25,000 to $34,999	35,546	13.4
$35,000 to $49,999	43,524	16.4
$50,000 to $74,999	51,029	19.2
$75,000 to $99,999	27,568	10.4
$100,000 to $149,999	21,889	8.2
$150,000 to $199,999	6,742	2.5
$200,000 or more	7,377	2.8
Median household income (dollars)	42,689	(X)
With earnings	238,330	89.7
Mean earnings (dollars)[1]	55,754	(X)
With Social Security income	33,936	12.8
Mean Social Security income (dollars)[1]	10,996	(X)
With Supplemental Security Income	6,175	2.3
Mean Supplemental Security Income (dollars)[1]	5,974	(X)
With public assistance income	4,812	1.8
Mean public assistance income (dollars)[1]	2,138	(X)
With retirement income	26,807	10.1
Mean retirement income (dollars)[1]	22,062	(X)
Families	**143,286**	**100.0**
Less than $10,000	7,909	5.5
$10,000 to $14,999	5,891	4.1
$15,000 to $24,999	13,996	9.8
$25,000 to $34,999	15,724	11.0
$35,000 to $49,999	21,896	15.3
$50,000 to $74,999	30,984	21.6
$75,000 to $99,999	19,245	13.4
$100,000 to $149,999	16,419	11.5
$150,000 to $199,999	5,413	3.8
$200,000 or more	5,809	4.1
Median family income (dollars)	54,091	(X)
Per capita income (dollars)[1]	24,163	(X)
Median earnings (dollars):		
Male full-time, year-round workers	35,545	(X)
Female full-time, year-round workers	30,046	(X)

Subject	Number below poverty level	Percent below poverty level
POVERTY STATUS IN 1999		
Families	**12,993**	**9.1**
With related children under 18 years	10,265	13.0
With related children under 5 years	6,104	16.4
Families with female householder, no husband present	**6,250**	**22.5**
With related children under 18 years	5,341	27.4
With related children under 5 years	2,975	39.3
Individuals	**92,011**	**14.4**
18 years and over	67,277	13.6
65 years and over	3,641	8.7
Related children under 18 years	23,752	16.5
Related children 5 to 17 years	15,427	15.8
Unrelated individuals 15 years and over	44,517	23.7

-Represents zero or rounds to zero. (X) Not applicable.
[1]If the denominator of a mean value or per capita value is less than 30, then that value is calculated using a rounded aggregate in the numerator. See text.
Source: U.S. Bureau of the Census, Census 2000.

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U.S. Census Bureau

Figure 9: US Census 2000 General Demographics for Austin

Table DP-4. Profile of Selected Housing Characteristics: 2000

Geographic area: Austin city, Texas

[Data based on a sample. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see text]

Subject	Number	Percent
Total housing units	**276,611**	**100.0**
UNITS IN STRUCTURE		
1-unit, detached	128,737	46.5
1-unit, attached	13,084	4.7
2 units	14,777	5.3
3 or 4 units	12,908	4.7
5 to 9 units	17,989	6.5
10 to 19 units	26,530	9.6
20 or more units	57,187	20.7
Mobile home	4,961	1.8
Boat, RV, van, etc	438	0.2
YEAR STRUCTURE BUILT		
1999 to March 2000	8,273	3.0
1995 to 1998	30,581	11.1
1990 to 1994	20,219	7.3
1980 to 1989	72,998	26.4
1970 to 1979	66,219	23.9
1960 to 1969	33,265	12.0
1940 to 1959	34,571	12.5
1939 or earlier	10,485	3.8
ROOMS		
1 room	14,337	5.2
2 rooms	29,105	10.5
3 rooms	45,984	16.6
4 rooms	50,659	18.3
5 rooms	49,338	17.8
6 rooms	38,778	14.0
7 rooms	22,350	8.1
8 rooms	13,420	4.9
9 or more rooms	12,640	4.6
Median (rooms)	4.5	(X)
Occupied housing units	**265,409**	**100.0**
YEAR HOUSEHOLDER MOVED INTO UNIT		
1999 to March 2000	97,130	36.6
1995 to 1998	85,666	32.3
1990 to 1994	33,572	12.6
1980 to 1989	25,372	9.6
1970 to 1979	13,447	5.1
1969 or earlier	10,222	3.9
VEHICLES AVAILABLE		
None	20,806	7.8
1	112,752	42.5
2	100,459	37.9
3 or more	31,392	11.8
HOUSE HEATING FUEL		
Utility gas	137,576	51.8
Bottled, tank, or LP gas	3,716	1.4
Electricity	122,826	46.3
Fuel oil, kerosene, etc	156	0.1
Coal or coke	-	-
Wood	169	0.1
Solar energy	165	0.1
Other fuel	167	0.1
No fuel used	634	0.2
SELECTED CHARACTERISTICS		
Lacking complete plumbing facilities	1,296	0.5
Lacking complete kitchen facilities	2,006	0.8
No telephone service	5,723	2.2

Subject	Number	Percent
OCCUPANTS PER ROOM		
Occupied housing units	**265,409**	**100.0**
1.00 or less	241,881	91.1
1.01 to 1.50	10,664	4.0
1.51 or more	12,864	4.8
Specified owner-occupied units	**104,794**	**100.0**
VALUE		
Less than $50,000	4,130	3.9
$50,000 to $99,999	33,071	31.6
$100,000 to $149,999	27,192	25.9
$150,000 to $199,999	15,664	14.9
$200,000 to $299,999	14,762	14.1
$300,000 to $499,999	7,064	6.7
$500,000 to $999,999	2,284	2.2
$1,000,000 or more	627	0.6
Median (dollars)	124,700	(X)
MORTGAGE STATUS AND SELECTED MONTHLY OWNER COSTS		
With a mortgage	79,835	76.2
Less than $300	150	0.1
$300 to $499	1,776	1.7
$500 to $699	5,894	5.6
$700 to $999	19,761	18.9
$1,000 to $1,499	28,558	27.3
$1,500 to $1,999	12,569	12.0
$2,000 or more	11,127	10.6
Median (dollars)	1,181	(X)
Not mortgaged	24,959	23.8
Median (dollars)	381	(X)
SELECTED MONTHLY OWNER COSTS AS A PERCENTAGE OF HOUSEHOLD INCOME IN 1999		
Less than 15.0 percent	35,948	34.3
15.0 to 19.9 percent	19,736	18.8
20.0 to 24.9 percent	16,227	15.5
25.0 to 29.9 percent	10,523	10.0
30.0 to 34.9 percent	6,210	5.9
35.0 percent or more	15,558	14.8
Not computed	592	0.6
Specified renter-occupied units	**146,131**	**100.0**
GROSS RENT		
Less than $200	2,915	2.0
$200 to $299	1,768	1.2
$300 to $499	13,199	9.0
$500 to $749	59,909	41.0
$750 to $999	42,220	28.9
$1,000 to $1,499	19,439	13.3
$1,500 or more	4,093	2.8
No cash rent	2,588	1.8
Median (dollars)	724	(X)
GROSS RENT AS A PERCENTAGE OF HOUSEHOLD INCOME IN 1999		
Less than 15.0 percent	21,044	14.4
15.0 to 19.9 percent	20,763	14.2
20.0 to 24.9 percent	20,567	14.1
25.0 to 29.9 percent	16,344	11.2
30.0 to 34.9 percent	11,942	8.2
35.0 percent or more	48,952	33.5
Not computed	6,519	4.5

-Represents zero or rounds to zero. (X) Not applicable.

Source: U.S. Bureau of the Census, Census 2000.

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U.S. Census Bureau

Figure 9: US Census 2000 General Demographics for Austin

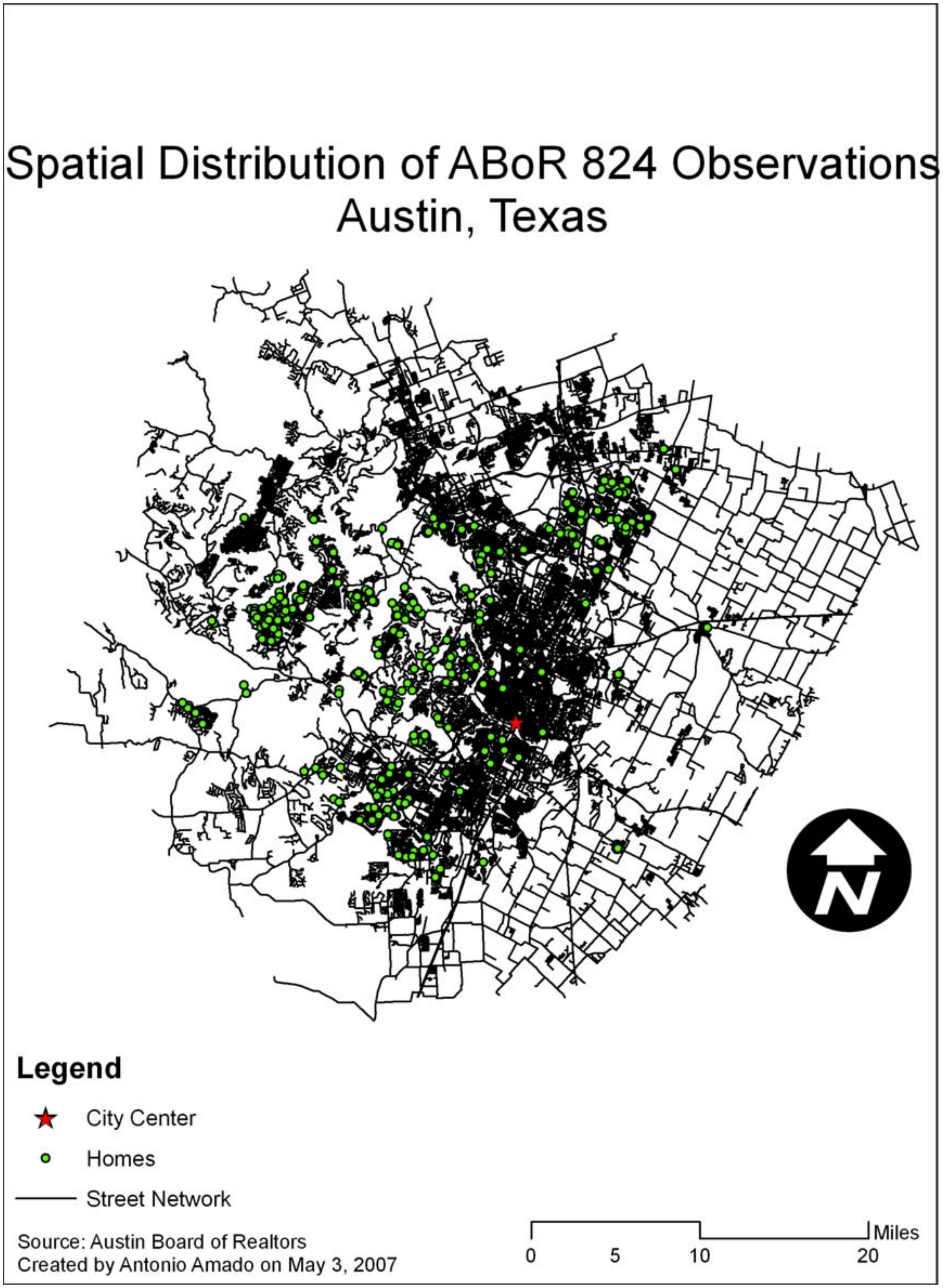

Figure 10: Sample Spatial Distribution

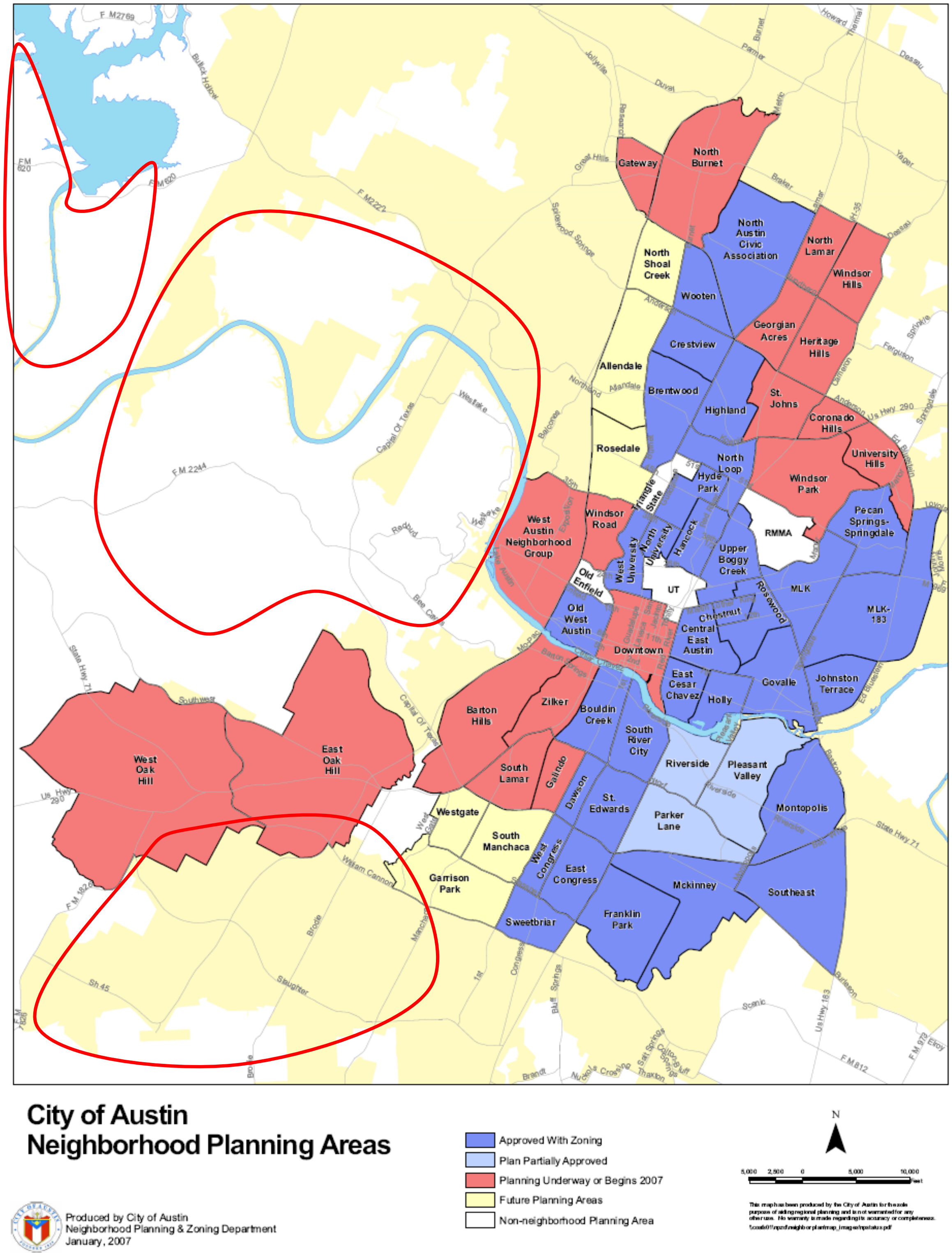

Figure 11: Submarkets for Green Homes

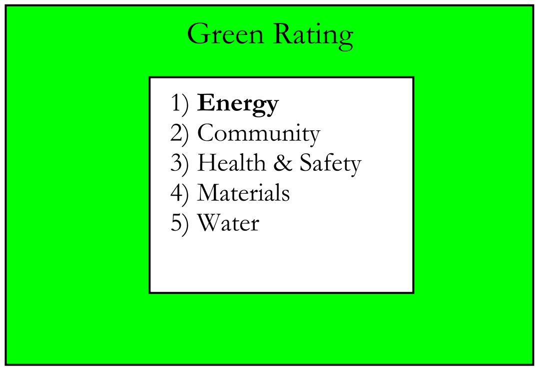

Figure 12: Green Rating Sections

APPENDIX B- TABLES

Table 1: Advocates versus detractors on development costs for energy efficient features.

	ADVOCATE	DETRACTOR
Construction Cost	**(Somewhat known)** ~0-5% Premium	**(Unknown)** ~10-15% Premium
Operating Cost	**(Somewhat known)** Significant Savings (There are case studies of individual buildings but not an entire market)	**(Unknown)** No significant savings
Sales Price	**(Somewhat known)** ~2-3% premium	**(Unknown)** No value added

Table 2: Logic Rules for ABoR Matching Process

Rule	***Deletes***	***Total***
ABoR data set	0	65,535
SalesPrice>$55K	20,000	40,751
0<BathsFull>=7	15	40,736
BathsHalf<=6	229	40,507
Beds>BedsMain	24,211	16,296
Beds>BedsUpper	6,293	9,373
ListPrice>=$30K	0	9,373
SalesPrice>=$30K	0	9,373
SqFtTotal>=400	3,063	6,310
SqFtTotal<=25K	7	6,303
Beds<=13	0	6,303
NumLivngRm<=6	1	6,302

Table 3: ABoR Energy Variables

Ceiling Fan(s) Double Pane Windows Energy Audit Heat Pump Programmable Thermostat Solar Heat Solar Screen Solar Water Heater Storm Door(s) Storm Windows Whole House Fan Zone Air/Heat

Table 4: Green Rating Criteria

Rating	Total Points
*	40-59
**	60-89
***	90-129
****	130-179
*****	180-266

Table 5: Full Variable List

Variable	Definition	Expected Sign
Lot Characteristics		
FloodCode	In a floodplain. Includes homes partially in a floodplain (0=Not in floodplain 1= In a floodplain)	-
LotSize_SF	Lot size in square feet; Source: Property tax records	+
LotSize_SFSqrd	LotSize_SF^2, The square of LotSize_SF	-
ViewCode	Has a view (0= No view, 1=Home has view)	+
Structural Characteristics		
Beds	Number of bedrooms	+
dPool	Has a pool (1=yes, 0= no)	+
dGreen	Dummy for a green rating (1=yes, 0=no)	+
dCeilingFan	Dummy for ceiling fans(s) (1=yes, 0= no)	+
dDblePaneWin	Dummy for double pane windows (1=yes, 0= no)	+
dEnergyAudit	Dummy for an energy audit (1=yes, 0= no)	+
dHeatPump	Dummy for a heat pump (1=yes, 0= no)	+
dProgrThermo	Dummy for a programmable thermostat (1=yes, 0= no)	+
dSolarHeat	Dummy for solar heat (1=yes, 0= no)	+
dSolarScreen	Dummy for solar screens (1=yes, 0= no)	+
dSolarWtrHtr	Dummy for a solar water heater (1=yes, 0= no)	+
dStormDoor	Dummy for storm door(s) (1=yes, 0= no)	+
dStormWin	Dummy for storm windows (1=yes, 0= no)	+
dWhlHouseFan	Dummy for a whole house fan (1=yes, 0= no)	+
dZoneAirHeat	Dummy for zone air/heat (1=yes, 0= no)	+
EnergySum	Number of energy features a home has	+
Fireplaces	Number of fireplaces	+
dFireplace1G	Dummy for one or more fireplaces in house	+
GarageCap	Number of garage parking spaces	+
GarageCap3	Dummy for three garages (1=yes, 0=no)	+
NumLivingR	Number of living rooms	+
REGR factor score 1	Linear transformation, energy variable component score 1	+
REGR factor score 2	Linear transformation, energy variable component score 2	+
REGR factor score 3	Linear transformation, energy variable component score 3	+
REGR factor score 4	Linear transformation, energy variable component score 4	+
REGR factor score 5	Linear transformation, energy variable component score 5	+
Square_FT	Livable square fottage of home; Source: Property tax records	+
Square_FTSqrd	Square_FT^2, the square of Square_FT	-
Stories	Number of stories (1=1-story, 2=more than 1-story)	+/-
TotBath	Number of bathrooms (TotBath=fullbaths=0.5*halfbaths)	+
dTotBath2p5	Dummy for two and a half TotBath (1=yes, 0=no)	+
dTotBath3G	Dummy for three or more TotBath (1=yes, 0=no)	+
YearBuilt	Year in which home was constructed	+/-
Neighborhood Characteristics		
PerBlack	Percentage of black residents in census tract	-
PerHispan	Percentage of hispanic residents in census tract	-
PerOwnOcc	Percentage of owner-occupied housing in the census tract	+
PerPassAll	Percentage of 10th graders in the school district that passed all sections of state standardized tests in 2000	+
Locational Characteristic		
DistFrCtyCtr_Miles	Radial distance in miles from the home to the State Capitol (an approximation of the distance to downtown)	-
Transactional Characteristics		
ClosedYear	Year in which home was sold for the first time, (1998 omitted)	+
LnSalesPrice	Ln(SalesPrice), the natural log of SalesPrice	Dependent Var

Var=variable

Table 6: Summary Statistics for Variables

	Min	Max	Mean	Std. Deviation
Beds	1	6	3.767	.762
ClosedYear	1998	2004	2001	1.463
dCeilingFan	0	1	.612	.488
dDblePaneWin	0	1	.533	.499
dEnergyAudit	0	1	.076	.266
dFireplace1G	0	1	.873	.334
dGreen	0	1	.124	.330
dHeatPump	0	1	.059	.237
DistFrCityCtr_Miles	1	25	10.980	3.684
dPool	0	1	.032	.175
dProgThermo	0	1	.256	.437
dSolarScreen	0	1	.286	.452
dStormDoor	0	1	.011	.104
dStormWin	0	1	.022	.146
dWhlHouseFan	0	1	.004	.060
dZoneAirHeat	0	1	.288	.453
EnergySum	0	6	2.147	1.813
FirePlaces	0	5	.964	.537
FloodCode	0	1	.057	.232
GarageCap	0	5	2.194	.673
GarageCap3	0	1	.246	.431
LotSize_SF	3,023	665,335	16,804.079	31,180.980
LotSize_SFSqrd	9,138,529	442,670,662,225	1,253,450,676.826	15,861,915,805.196
NumLivingR	1	7	2.158	1.000
PerBlack	0	68	6.527	10.385
PerHispan	3	87	14.632	11.022
PerOwnOcc	27	97	81.999	14.870
PerPassAll	60	94	86.609	7.504
SalesPrice	72,000	3,700,000	356,973.766	331,496.084
Square_FT	929	9,410	2,759.066	1,202.168
Square_FtSqrd	863,041	88,548,100	9,055,896.650	9,196,880.054
Stories	1	2	1.694	.461
TotBath	.5	7.5	2.917	.903
ViewCode	0	1	.519	.500
YearBuilt	1998	2004	2000	1.508

Table 7: Pearson Correlations for Variables
Line 32=Factor Score 1, Line 33=Factor Score 2, Line 34=Factor Score 3, Line 35=Factor Score 4, Line 36=Factor Score 5

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
1 Beds	1																																			
2 ClosedYear	.024	1																																		
3 dCeilingFan	.031	.162	1																																	
4 dDblePaneWin	.020	.069	.716	1																																
5 dEnergyAudit	-.170	-.055	.220	.269	1																															
6 dGreen	.018	.028	-.071	-.032	-.053	1																														
7 dHeatPump	.063	-.041	.158	.009	-.072	-.063	1																													
8 DistFrCityCtr_Miles	.037	.083	-.064	-.124	-.261	-.024	.235	1																												
9 dPool	.156	.004	.016	-.012	-.026	-.047	.101	.101	1																											
10 dProgThermo	.205	-.001	.422	.427	.135	-.052	.029	-.151	.005	1																										
11 dSolarScreen	-.145	-.121	.296	.351	.222	-.002	-.091	-.074	-.068	.090	1																									
12 dStormDoor	-.075	.130	.084	-.065	-.030	-.004	.023	-.055	-.019	-.035	-.067	1																								
13 dStormWin	-.096	.197	.119	.073	.363	-.056	.103	-.261	-.027	.160	-.095	-.02	1																							
14 dWhlHouseFan	.019	.075	.048	.016	-.017	.038	-.015	.017	-.011	.011	-.038	-.01	-.009	1																						
15 dZoneAirHeat	.251	.015	.429	.407	.080	-.068	.192	-.083	.085	.622	.007	-.07	.217	.006	1																					
16 EnergySum	.062	.049	.818	.804	.405	-.077	.206	-.158	.012	.684	.457	.017	.267	.040	.679	1																				
17 FirePlaces	.354	-.115	.090	.073	.020	-.016	.094	-.059	.388	.133	-.097	-.01	.010	.004	.203	.118	1																			
18 FloodCode	-.193	-.136	.110	.157	.579	-.045	-.040	-.156	-.014	-.072	.261	-.03	-.037	-.015	-.098	.171	.007	1																		
19 dGarageCap	.191	-.081	.052	.032	-.255	.016	.050	.247	.036	-.089	.125	.021	-.538	.012	-.058	-.054	.141	.049	1																	
20 LotSize_SF	.242	.042	.052	.062	-.069	-.017	.080	.140	.309	.075	-.104	-.03	-.052	.035	.143	.055	.394	-.053	.052	1																
21 NumLivingR	.548	-.050	.036	.014	-.114	-.015	.053	-.089	.180	.199	-.140	-.04	-.107	.031	.254	.070	.432	-.149	.210	.189	1															
22 PerPassAll	.299	-.081	-.190	-.172	-.506	.071	.039	.198	.058	.047	-.222	.023	-.286	-.005	.078	-.214	.110	-.438	.253	.088	.285	1														
23 PerOwnOcc	.104	-.029	-.112	-.118	-.212	-.041	.008	.254	-.018	.065	-.118	-.02	-.073	.003	.084	-.092	-.021	-.194	.097	.011	.061	.413	1													
24 PerBlack	-.287	-.035	.108	.106	.447	-.029	-.090	-.067	-.061	-.180	.346	-.02	-.044	-.019	-.232	.092	-.106	.573	-.032	-.093	-.282	-.610	-.339	1												
25 PerHispan	-.348	.034	.093	.091	.306	-.043	-.148	-.142	-.055	-.141	.270	.015	.062	.015	-.248	.054	-.170	.410	-.212	-.110	-.348	-.643	-.284	.684	1											
26 SalesPrice	.497	.053	.077	.025	-.107	.001	.151	-.053	.486	.163	-.193	-.05	-.031	.017	.272	.086	.649	-.134	.094	.467	.524	.217	.022	-.255	-.287	1										
27 Square_FT	.496	-.008	.046	.022	-.146	-.012	.106	.000	.279	.136	-.217	-.06	-.048	-.006	.252	.045	.393	-.198	.134	.244	.546	.341	.115	-.454	-.561	.643	1									
28 Stories	.375	.008	-.021	-.046	-.077	.018	.033	-.104	.060	.142	-.116	.044	.027	-.004	.206	.036	.181	-.166	.090	-.025	.495	.168	.005	-.250	-.292	.238	.312	1								
29 TotBath	.706	.049	.088	.055	-.125	.004	.106	-.020	.278	.253	-.126	-.06	-.064	.028	.338	.141	.542	-.154	.137	.370	.638	.276	.022	-.283	-.347	.739	.588	.445	1							
30 ViewCode	.341	.066	.036	.010	-.080	.000	.139	.116	.132	.186	-.078	.008	.061	.058	.311	.129	.238	-.182	.040	.229	.356	.188	.069	-.280	-.345	.397	.324	.310	.462	1						
31 YearBuilt	.010	.837	.124	.068	-.024	.040	-.041	.106	-.061	-.012	-.124	.118	.195	.072	-.025	.028	-.125	-.096	-.071	.000	-.065	-.068	-.016	-.020	.058	.003	-.035	-.005	.010	.057	1					
32 REGR factor score	.216	.059	.744	.704	.068	-.074	.320	-.049	.059	.778	.144	-.08	.153	.050	.829	.885	.181	-.068	.012	.136	.205	.022	.024	-.164	-.161	.231	.202	.122	.290	.228	.026	1				
33 REGR factor score	-.185	-.071	.357	.500	.369	.021	-.464	-.132	-.093	-.019	.794	-.05	-.268	-.041	-.203	.344	-.109	.390	.160	-.104	-.165	-.286	-.176	.454	.368	-.235	-.235	-.178	-.193	-.209	-.062	.000	1			
34 REGR factor score	-.177	.097	.088	.090	.792	-.056	-.044	-.319	-.038	.088	-.013	.001	.838	-.021	.087	.265	.001	.302	-.506	-.085	-.149	-.463	-.163	.227	.220	-.100	-.128	-.031	-.141	-.030	.117	.000	.000	1		
35 REGR factor score	-.110	.146	.280	.053	.010	-.021	.271	.017	-.002	-.128	.006	.928	-.010	.026	-.114	.122	-.012	.039	.066	-.021	-.078	-.052	-.075	.058	.067	-.053	-.073	-.011	-.084	-.020	.132	.000	.000	.000	1	
36 REGR factor score	.020	.104	.027	.017	-.007	.048	-.229	-.039	-.028	.034	-.112	.030	-.015	.970	-.020	-.011	-.002	-.027	-.014	.028	.035	.001	.008	-.031	.024	.004	-.007	.002	.020	.034	.101	.000	.000	.000	.000	1

Table 8: Fireplace Frequency Chart

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	105	12.7	12.7	12.7
	1	665	80.7	80.7	93.4
	2	39	4.7	4.7	98.2
	3	11	1.3	1.3	99.5
	4	2	.2	.2	99.8
	5	2	.2	.2	100.0
	Total	824	100.0	100.0	

Table 9: GarageCap Frequency Chart

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	31	3.8	3.8	3.8
	1	11	1.3	1.3	5.1
	2	565	68.6	68.6	73.7
	3	203	24.6	24.6	98.3
	4	12	1.5	1.5	99.8
	5	2	.2	.2	100.0
	Total	824	100.0	100.0	

Table 10: TotBath Frequency Chart

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.5	1	.1	.1	.1
	1.0	5	.6	.6	.7
	1.5	2	.2	.2	1.0
	2.0	178	21.6	21.6	22.6
	2.5	269	32.6	32.6	55.2
	3.0	101	12.3	12.3	67.5
	3.5	149	18.1	18.1	85.6
	4.0	61	7.4	7.4	93.0
	4.5	30	3.6	3.6	96.6
	5.0	4	.5	.5	97.1
	5.5	13	1.6	1.6	98.7
	6.0	4	.5	.5	99.2
	6.5	4	.5	.5	99.6
	7.0	2	.2	.2	99.9
	7.5	1	.1	.1	100.0
	Total	824	100.0	100.0	

Table 11: Principal Component Analysis

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.778	27.776	27.776	2.778	27.776	27.776	2.500	25.003	25.003
2	1.351	13.506	41.282	1.351	13.506	41.282	1.477	14.768	39.771
3	1.221	12.211	53.493	1.221	12.211	53.493	1.363	13.629	53.400
4	1.039	10.393	63.886	1.039	10.393	63.886	1.046	10.459	63.860
5	1.007	10.071	73.957	1.007	10.071	73.957	1.010	10.098	73.957
6	.916	9.155	83.112						
7	.578	5.777	88.889						
8	.511	5.109	93.998						
9	.348	3.484	97.482						
10	.252	2.518	100.000						

Extraction Method: Principal Component Analysis.

Table 12: Component Scores

Rotated Component Matrix[a]

	Component				
	1	2	3	4	5
dCeilingFan	.744	.357	.088	.280	.027
dDblePaneWin	.704	.500	.090	.053	.017
dEnergyAudit	.068	.369	.792	.010	-.007
dHeatPump	.320	-.464	-.044	.271	-.229
dProgThermo	.778	-.019	.088	-.128	.034
dSolarScreen	.144	.794	-.013	.006	-.112
dStormDoor	-.078	-.047	.001	.928	.030
dStormWin	.153	-.268	.838	-.010	-.015
dWhlHouseFan	.050	-.041	-.021	.026	.970
dZoneAirHeat	.829	-.203	.087	-.114	-.020

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 6 iterations.

Table 13: Component Analysis Loading Factors, Variable loadings > 0.70

Component Factor	Grouping	Definition	Score
I	HVAC systems and controls	dZoneAirHeat (zone air/heat)	.829
		dProgrammableTherm (programmable thermostat)	.778
		dDblePaneWin (double pane windows)	.704
		dCeilingFan (ceiling fan)	.744
II	Solar	dSolarScreen (solar screens)	.794
III	Energy retrofit, strategies	dStormWin(storm windows)	.838
		dEnergyAudit (energy audit)	.792
IV	Exterior attribute	dStormDoor(storm doors)	.928
V	Accessories	dWhlHouseFan (whole house fan)	.970

Table 14: Baseline Model

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.784[a]	.614	.609	.4069464198579

a. Predictors: (Constant), dClosed2004, LotSize_SFSqrd, Square_FT, DistFrCityCtr_Miles, dClosed2002, dClosed2003, dClosed1999, dClosed2001, LotSize_SF, Square_FtSqrd, dClosed2000

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	214.087	11	19.462	117.523	.000[a]
	Residual	134.472	812	.166		
	Total	348.558	823			

a. Predictors: (Constant), dClosed2004, LotSize_SFSqrd, Square_FT, DistFrCityCtr_Miles, dClosed2002, dClosed2003, dClosed1999, dClosed2001, LotSize_SF, Square_FtSqrd, dClosed2000

b. Dependent Variable: LnSalesPrice

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	11.121	.132		84.222	.000
	DistFrCityCtr_Miles	-.024393273	.0039348399	-.138	-6.199	.000
	LotSize_SF	1.174E-05	.0000009640	.562	12.174	.000
	LotSize_SFSqrd	-1.317E-11	.0000000000	-.321	-7.267	.000
	Square_FT	.0005202207	.0000405639	.961	12.825	.000
	Square_FtSqrd	-3.167E-08	.0000000054	-.448	-5.869	.000
	dClosed1999	.1598765238	.1119501062	.088	1.428	.154
	dClosed2000	.3226914003	.1090744677	.226	2.958	.003
	dClosed2001	.4638350571	.1095273446	.314	4.235	.000
	dClosed2002	.6184920049	.1137821586	.302	5.436	.000
	dClosed2003	.4621117931	.1159383607	.203	3.986	.000
	dClosed2004	.1336998378	.1191184521	.052	1.122	.262

a. Dependent Variable: LnSalesPrice

Table 15: Regression Model With out Energy Variables

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.898[a]	.807	.803	.2891223518720

a. Predictors: (Constant), ViewCode, dClosed2004, LotSize_SFSqrd, dTotBath2p5, dClosed2003, DistFrCityCtr_Miles, dClosed2002, FloodCode, dClosed1999, Square_FtSqrd, dFireplace1G, GarageCap3, PerPassAll, dClosed2001, dTotBath3G, LotSize_SF, dClosed2000, Square_FT

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	281.267	18	15.626	186.932	.000[a]
	Residual	67.291	805	.084		
	Total	348.558	823			

a. Predictors: (Constant), ViewCode, dClosed2004, LotSize_SFSqrd, dTotBath2p5, dClosed2003, DistFrCityCtr_Miles, dClosed2002, FloodCode, dClosed1999, Square_FtSqrd, dFireplace1G, GarageCap3, PerPassAll, dClosed2001, dTotBath3G, LotSize_SF, dClosed2000, Square_FT

b. Dependent Variable: LnSalesPrice

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	10.904	.162		67.120	.000
	DistFrCityCtr_Miles	-.029498616	.0028999292	-.167	-10.172	.000
	LotSize_SF	6.233E-06	.0000007288	.299	8.553	.000
	LotSize_SFSqrd	-5.830E-12	.0000000000	-.142	-4.380	.000
	Square_FT	6.397E-05	.0000346311	.118	1.847	.065
	Square_FtSqrd	1.346E-08	.0000000043	.190	3.134	.002
	dClosed1999	.2466389089	.0797734514	.136	3.092	.002
	dClosed2000	.3513266917	.0777085549	.246	4.521	.000
	dClosed2001	.4838399858	.0780284011	.328	6.201	.000
	dClosed2002	.4983504476	.0814263142	.244	6.120	.000
	dClosed2003	.4320537471	.0829460437	.190	5.209	.000
	dClosed2004	.3316369599	.0863281540	.129	3.842	.000
	dTotBath2p5	.1307745595	.0303973498	.094	4.302	.000
	dTotBath3G	.4167504658	.0364835659	.319	11.423	.000
	dFireplace1G	.3523336601	.0347044113	.181	10.152	.000
	GarageCap3	.1196819381	.0288630292	.079	4.147	.000
	PerPassAll	.0060537857	.0016689583	.070	3.627	.000
	FloodCode	-.403053822	.0505938537	-.144	-7.966	.000
	ViewCode	.2201346137	.0243283725	.169	9.048	.000

a. Dependent Variable: LnSalesPrice

Table 16: Final Hedonic Model

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.903[a]	.816	.811	.2832638722430

a. Predictors: (Constant), REGR factor score 5 for analysis 1, REGR factor score 4 for analysis 1, REGR factor score 3 for analysis 1, REGR factor score 2 for analysis 1, REGR factor score 1 for analysis 1, dClosed2001, LotSize_SFSqrd, dTotBath2p5, dClosed2004, dClosed2003, ViewCode, dClosed2002, Square_FtSqrd, DistFrCityCtr_Miles, dFireplace1G, dClosed1999, FloodCode, GarageCap3, PerPassAll, dTotBath3G, LotSize_SF, dClosed2000, Square_FT

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	284.368	23	12.364	154.088	.000[a]
	Residual	64.191	800	.080		
	Total	348.558	823			

a. Predictors: (Constant), REGR factor score 5 for analysis 1, REGR factor score 4 for analysis 1, REGR factor score 3 for analysis 1, REGR factor score 2 for analysis 1, REGR factor score 1 for analysis 1, dClosed2001, LotSize_SFSqrd, dTotBath2p5, dClosed2004, dClosed2003, ViewCode, dClosed2002, Square_FtSqrd, DistFrCityCtr_Miles, dFireplace1G, dClosed1999, FloodCode, GarageCap3, PerPassAll, dTotBath3G, LotSize_SF, dClosed2000, Square_FT

b. Dependent Variable: LnSalesPrice

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	11.020	.169		65.149	.000
	DistFrCityCtr_Miles	-.0309500281	.0029622654	-.175	-10.448	.000
	LotSize_SF	6.108E-06	.0000007157	.293	8.534	.000
	LotSize_SFSqrd	-5.806E-12	.0000000000	-.142	-4.444	.000
	Square_FT	4.127E-05	.0000343849	.076	1.200	.230
	Square_FtSqrd	1.560E-08	.0000000042	.220	3.671	.000
	dClosed1999	.2752026733	.0785955213	.152	3.502	.000
	dClosed2000	.3894610639	.0767227486	.272	5.076	.000
	dClosed2001	.5111802275	.0768393011	.346	6.653	.000
	dClosed2002	.5182444553	.0801242216	.253	6.468	.000
	dClosed2003	.4803261760	.0818941289	.211	5.865	.000
	dClosed2004	.3892518346	.0857512445	.152	4.539	.000
	dTotBath2p5	.1342189379	.0298551719	.097	4.496	.000
	dTotBath3G	.3934220306	.0360705950	.301	10.907	.000
	dFireplace1G	.3522469959	.0346015952	.181	10.180	.000
	GarageCap3	.1122303372	.0286028376	.074	3.924	.000
	PerPassAll	.0051692783	.0017671397	.060	2.925	.004
	FloodCode	-.3112174022	.0528726931	-.111	-5.886	.000
	ViewCode	.2111103744	.0241408497	.162	8.745	.000
	REGR factor score 1 for analysis 1	.0397971751	.0109095250	.061	3.648	.000
	REGR factor score 2 for analysis 1	-.0516646182	.0114558375	-.079	-4.510	.000
	REGR factor score 3 for analysis 1	-.0227611049	.0125279950	-.035	-1.817	.070
	REGR factor score 4 for analysis 1	-.0292688242	.0102369244	-.045	-2.859	.004
	REGR factor score 5 for analysis 1	-.0064500378	.0100598418	-.010	-.641	.522

a. Dependent Variable: LnSalesPrice

Table 17: Regression Model with dGreen Rating and Energy Factors

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.904[a]	.817	.811	.2828416697958

a. Predictors: (Constant), dGreen, ViewCode, REGR factor score 4 for analysis 1, REGR factor score 5 for analysis 1, REGR factor score 3 for analysis 1, LotSize_SFSqrd, dClosed2001, dTotBath2p5, REGR factor score 2 for analysis 1, dFireplace1G, dClosed2003, REGR factor score 1 for analysis 1, dClosed2002, Square_FtSqrd, DistFrCityCtr_Miles, dClosed1999, dClosed2004, FloodCode, GarageCap3, PerPassAll, dTotBath3G, LotSize_SF, dClosed2000, Square_FT

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	284.639	24	11.860	148.250	.000[a]
	Residual	63.920	799	.080		
	Total	348.558	823			

a. Predictors: (Constant), dGreen, ViewCode, REGR factor score 4 for analysis 1, REGR factor score 5 for analysis 1, REGR factor score 3 for analysis 1, LotSize_SFSqrd, dClosed2001, dTotBath2p5, REGR factor score 2 for analysis 1, dFireplace1G, dClosed2003, REGR factor score 1 for analysis 1, dClosed2002, Square_FtSqrd, DistFrCityCtr_Miles, dClosed1999, dClosed2004, FloodCode, GarageCap3, PerPassAll, dTotBath3G, LotSize_SF, dClosed2000, Square_FT

b. Dependent Variable: LnSalesPrice

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	11.029	.169		65.272	.000
	DistFrCityCtr_Miles	-.0306646026	.0029619096	-.174	-10.353	.000
	LotSize_SF	6.087E-06	.0000007147	.292	8.516	.000
	LotSize_SFSqrd	-5.764E-12	.0000000000	-.140	-4.418	.000
	Square_FT	4.016E-05	.0000343389	.074	1.169	.243
	Square_FtSqrd	1.585E-08	.0000000042	.224	3.733	.000
	dClosed1999	.2738815597	.0784816554	.152	3.490	.001
	dClosed2000	.3861275018	.0766297851	.270	5.039	.000
	dClosed2001	.5078334939	.0767463006	.344	6.617	.000
	dClosed2002	.5157348958	.0800164063	.252	6.445	.000
	dClosed2003	.4778096017	.0817834883	.210	5.842	.000
	dClosed2004	.3819129038	.0857161568	.149	4.456	.000
	dTotBath2p5	.1324409428	.0298263092	.095	4.440	.000
	dTotBath3G	.3902854060	.0360570973	.298	10.824	.000
	dFireplace1G	.3507590723	.0345594713	.180	10.149	.000
	GarageCap3	.1131290459	.0285643759	.075	3.960	.000
	PerPassAll	.0050259236	.0017662227	.058	2.846	.005
	FloodCode	-.3096163533	.0528010474	-.110	-5.864	.000
	ViewCode	.2112772532	.0241050384	.162	8.765	.000
	REGR factor score 1 for analysis 1	.0414603236	.0109306508	.064	3.793	.000
	REGR factor score 2 for analysis 1	-.0525655933	.0114492244	-.081	-4.591	.000
	REGR factor score 3 for analysis 1	-.0218835832	.0125183977	-.034	-1.748	.081
	REGR factor score 4 for analysis 1	-.0289271069	.0102233510	-.044	-2.830	.005
	REGR factor score 5 for analysis 1	-.0071273980	.0100515821	-.011	-.709	.478
	dGreen	.0559332208	.0303781772	.028	1.841	.066

a. Dependent Variable: LnSalesPrice

Table 18: Descriptive Statistics for Homes with no Energy Features

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
DistFrCityCtr_Miles	254	1.08	21.22	11.017	3.609
LotSize_SF	254	3,289	155,466	14,872.756	18,702.646
LotSize_SFSqrd	254	10,817,521	24,169,677,156	569,610,714.693	2,195,321,896.654
Square_FT	254	929	7,456	2,780.941	1,077.319
Square_FtSqrd	254	863,041	55,591,936	8,889,678.555	8,284,768.069
dClosed1999	254	0	1	.173	.379
dClosed2000	254	0	1	.335	.473
dClosed2001	254	0	1	.303	.461
dClosed2002	254	0	1	.087	.282
dClosed2003	254	0	1	.059	.236
dClosed2004	254	0	1	.039	.195
dTotBath2p5	254	0	1	.354	.479
dTotBath3G	254	0	1	.413	.493
GarageCap3	254	0	1	.181	.386
PerPassAll	254	60	94	88.634	5.028
FloodCode	254	0	1	.020	.139
LnSalesPrice	254	11.184	14.431	12.545	.597
SalesPrice	254	72,000	1,850,000	340,194.681	254,782.455
Valid N (listwise)	254				

Table 19: Descriptive Statistics for Homes with at Least One Energy Feature

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
DistFrCityCtr_Miles	570	1.74	24.66	10.963	3.720
LotSize_SF	570	3,023	665,335	17,664.704	35,331.681
LotSize_SFSqrd	570	9,138,529	442,670,662,225	1,558,179,361.707	19,012,348,190.667
Square_FT	570	940	9,410	2,749.318	1,254.584
Square_FtSqrd	570	883,600	88,548,100	9,129,965.767	9,581,404.041
dClosed1999	570	0	1	.144	.351
dClosed2000	570	0	1	.274	.446
dClosed2001	570	0	1	.246	.431
dClosed2002	570	0	1	.126	.332
dClosed2003	570	0	1	.104	.305
dClosed2004	570	0	1	.082	.275
dTotBath2p5	570	0	1	.314	.465
dTotBath3G	570	0	1	.463	.499
GarageCap3	570	0	1	.275	.447
PerPassAll	570	60	94	85.707	8.219
FloodCode	570	0	1	.074	.261
LnSalesPrice	570	11.313	15.124	12.544	.674
SalesPrice	570	81,890	3,700,000	364,450.761	360,415.063
Valid N (listwise)	570				

Table 20: Green Building Program Energy Features

- Duct Work
- Earth-Sheltered Design
- Energy-Efficient Appliances
- Energy Recovery Ventilators
- Energy Saving Landscapes
- Insulation
- Lighting
- Natural Daylighting
- Passive Solar Design
- Photovoltaic Systems
- Radiant Barriers, Ridge, & Soffit Venting
- Solar Water Heating & Space Heating
- Ventilation Fans
- Water Heating

Table 21: Regression for Austin Homes with at least one Energy Feature

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.917[a]	.840	.833	.2750158715440

a. Predictors: (Constant), REGR factor score 5 for analysis 2, REGR factor score 4 for analysis 2, REGR factor score 3 for analysis 2, REGR factor score 2 for analysis 2, REGR factor score 1 for analysis 2, LotSize_SFSqrd, dClosed2001, dTotBath2p5, dClosed1999, dClosed2004, dClosed2003, Square_FtSqrd, VIEWCODE, dClosed2002, DistFrCityCtr_Miles, dFireplace1G, FLOODCODE, GarageCap3, PERPASSALL, dTotBath3G, LOTSIZE_SF, dClosed2000, SQUARE_FT

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	217.075	23	9.438	124.786	.000[a]
	Residual	41.296	546	.076		
	Total	258.371	569			

a. Predictors: (Constant), REGR factor score 5 for analysis 2, REGR factor score 4 for analysis 2, REGR factor score 3 for analysis 2, REGR factor score 2 for analysis 2, REGR factor score 1 for analysis 2, LotSize_SFSqrd, dClosed2001, dTotBath2p5, dClosed1999, dClosed2004, dClosed2003, Square_FtSqrd, VIEWCODE, dClosed2002, DistFrCityCtr_Miles, dFireplace1G, FLOODCODE, GarageCap3, PERPASSALL, dTotBath3G, LOTSIZE_SF, dClosed2000, SQUARE_FT

b. Dependent Variable: LnSalesPrice

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	11.255	.184		61.163	.000
	DistFrCityCtr_Miles	-.0289038492	.0037624435	-.160	-7.682	.000
	LOTSIZE_SF	6.620E-06	.0000008192	.347	8.081	.000
	LotSize_SFSqrd	-6.540E-12	.0000000000	-.185	-4.593	.000
	SQUARE_FT	6.176E-05	.0000392919	.115	1.572	.117
	Square_FtSqrd	1.451E-08	.0000000048	.206	3.048	.002
	dClosed1999	.2434346960	.0809899693	.127	3.006	.003
	dClosed2000	.3450046848	.0783007515	.228	4.406	.000
	dClosed2001	.4612400696	.0784038956	.295	5.883	.000
	dClosed2002	.4419327191	.0818209476	.218	5.401	.000
	dClosed2003	.4628904799	.0837414572	.209	5.528	.000
	dClosed2004	.3518536101	.0896079325	.144	3.927	.000
	dTotBath2p5	.1067748126	.0349193818	.074	3.058	.002
	dTotBath3G	.3622029737	.0433813789	.268	8.349	.000
	dFireplace1G	.2968256904	.0442534746	.147	6.707	.000
	GarageCap3	.0801851918	.0337489289	.053	2.376	.018
	PERPASSALL	.0030694323	.0020020109	.037	1.533	.126
	FLOODCODE	-.2874449280	.0566682853	-.112	-5.072	.000
	VIEWCODE	.1812121690	.0292646621	.134	6.192	.000
	REGR factor score 1 for analysis 2	.0954076908	.0144188476	.142	6.617	.000
	REGR factor score 2 for analysis 2	-.0433423147	.0132074807	-.064	-3.282	.001
	REGR factor score 3 for analysis 2	-.0350599822	.0153499642	-.052	-2.284	.023
	REGR factor score 4 for analysis 2	.0058487212	.0126256362	.009	.463	.643
	REGR factor score 5 for analysis 2	.0063534096	.0118619662	.009	.536	.592

a. Dependent Variable: LnSalesPrice

Table 22: Principal Component Analysis for Homes with at Least One Energy Feature

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.989	19.887	19.887	1.989	19.887	19.887	1.823	18.228	18.228
2	1.502	15.019	34.905	1.502	15.019	34.905	1.467	14.672	32.900
3	1.226	12.258	47.163	1.226	12.258	47.163	1.361	13.609	46.509
4	1.087	10.867	58.030	1.087	10.867	58.030	1.135	11.351	57.860
5	1.003	10.034	68.064	1.003	10.034	68.064	1.020	10.204	68.064
6	.929	9.286	77.350						
7	.760	7.599	84.949						
8	.583	5.830	90.780						
9	.509	5.092	95.872						
10	.413	4.128	100.000						

Extraction Method: Principal Component Analysis.

Table 23: Variable Loadings on Components

Rotated Component Matrix[a]

	Component				
	1	2	3	4	5
dCeilingFan	.324	.203	.081	.705	.073
dDblePaneWin	.446	.604	.072	.250	.001
dEnergyAudit	-.027	.314	.816	.047	-.040
dHeatPump	.096	-.639	.021	-.018	-.085
dProgThermo	.792	.030	.047	.051	-.022
dSolarScreen	-.231	.601	.029	-.342	-.202
dStormDoor	-.355	-.248	-.039	.672	-.111
dStormWin	.149	-.278	.822	-.007	.025
dWhlHouseFan	-.039	.009	-.010	-.007	.976
dZoneAirHeat	.823	-.230	.058	-.026	-.018

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 9 iterations.

Table 24: Green Building Program Stars for a Green Rating

STARS

		Frequency	Percent	Cumulative Percent
Valid	0	722	87.6	87.6
	1	14	1.7	89.3
	2	81	9.8	99.2
	3	7	.8	100.0
	Total	824	100.0	

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