Chapter 5: The Appraisal of High Performance Single Family Homes

Andrew R. Sanderford
Annie R. Pearce

Abstract
Builders and developers are increasingly using high performance construction materials in new homes. However, problems with the availability of data to describe and differentiate traditional homes from high performance homes in appraisals appear to be a significant obstacle limiting further market adoption. This paper reports on data generated from a series of semi-structured interviews with sixteen real estate appraisers who have appraised a high performance home or have received training to do so (or both). The paper describes the methodological approaches used by this group of geographically and experientially diverse appraisers and analyzes the supporting elements these practitioners need to more precisely estimate the value contribution of high performance technologies within homes.

Introduction

Real estate and building construction research suggests that developers are greening (Bradshaw II, 2011) and that builders are using more high performance building technologies over time (McCoy, Koebel, & Sanderford, 2013). Additionally, studies indicate that homes with these technologies or energy efficient home certifications can command a premium over similar homes without the high performance features or certifications (Aroul & Hansz, 2011; Bloom, Nobe, & Nobe, 2011; Dastrup, Graff Zivin, Costa, & Kahn, 2012; Kok & Khan, 2012). However, it is not uncommon to hear horror stories from builders or homebuyers seeking to finance a high performance home. These stakeholders perceive that appraisers under-value, incorrectly value, or exclude the value contribution of the high performance building technologies and design of the home (Desiderio, 2012; Normand, 2012). As the lender uses the appraisal to guide their allocation of capital to the loan applicant, these errors in value estimation relative to the collateral could have significant effects on lending practice and the diffusion of high performance homes into the housing market.

Prima facie, this problem appears linked to the principal method of analysis appraisers use to estimate the value of single-family homes, the comparable sales method, and the availability of data used in comparable sale analyses. The comparable sales method relies on data from the transaction of similar homes to create adjustments for the differences between the subject property and the recently sold comparable properties. However, as there are approximately one and a half million green certified homes in the US[1], or 1.5% of the housing stock, identifying and using comparable transactions to value new high performance homes in many markets could prove difficult and force appraisers to innovate.

To gain insight into this problem, this paper seeks to answer the research questions, 1) at present, how do residential appraisers with green valuation training or experience estimate the contributory value of high performance building technologies within high performance homes; and 2) how are the methods and processes used substantively different from those used to appraise non-high performance homes? To answer these questions, the authors first review the appraisal literature, interspersing findings from the construction and real estate literature where necessary. Next, the authors analyze data and make observations about a series of semi-structured interviews conducted with residential real estate appraisers from across the US with green appraisal training and/or experience.

Literature Review

The central task of a real estate appraiser is to analyze various sets of market and property data to provide a client with an informed estimate of the market value of some interest in real property (Pagourtzi, Assimakopoulos, Hatzichristos, & French, 2003). The valuation process is a series of procedures that appraisers use to inform their opinion of value (AI, 2008). The valuation or appraisal process for nearly any subject property is most commonly described and taught as an eight-step process. After accepting the assignment, the Appraisal Institute trains appraisers to 1) identify the problem and type of value to be estimated; 2) determine the scope of work to be done; 3) collect data about

---

[1] This estimate captures the total number of homes certified through the three major green building rating systems: Energy Star, LEED, and NGBS. There are a number of major regional rating systems such as Earth Craft and Green Point that add approximately 25,000-50,000 more homes.

the subject property, comparable properties, and the market place; 4) analyze the data; 5) generate an opinion of the value of the site; 6) generate an opinion of the value of the improvements using the sales comparison, cost, or income capitalization methods; 7) reconcile variations across the different value estimates generated by different methods; and 8) issue a report describing and defending the appraisers' value estimate (AI, 2008).

Within the valuation process for single-family homes, the most common and required method of analysis for generating an estimate of value is the sales comparison method (Kummerow, 1997). The sales comparison method relies on the economic principle of substitution— the concept that absent major differences, consumers can substitute one similar product for another. In the sales comparison method, the appraiser uses the price differences observed among the transactions of similar homes and the subject property to define and make adjustments to the estimated value of the subject home (Pagourtzi, et al., 2003). To make his or her final estimate, the appraiser relies on the degree of comparability between properties, the quantity of information available about the comparable properties, and the authenticity or reliability of the data (AI, 2008; Colton, 2002).

In the markets where data on property attributes is available and reliable, researchers have used various regression techniques linked to the principles of comparable sales to analyze the contributory value of an array of home and site complex attributes including: proximity to mass transit (Bowes & Ihlanfeldt, 2001), traditional neighborhood design (Eppli & Tu, 1999), proximity to open space (Irwin, 2002), the presence of trees (Dombrow, Rodriguez, & Sirmans, 2000), environmental contamination (Patchin, 1994), views (Rodriguez & Sirmans, 1994), the presence of a basement (Andrus, 2012), homes in rural markets (Walker, 1994), the presence of satellite imagery in MLS listings (Benefield, Cain, & Gleason, 2012), and the presence of accessory dwelling units (Martin & Watkins, 2012). Research also provides guidance for the use of statistical methods (e.g., Monte Carlo simulation) to augment appraisal during periods of economic uncertainty (French, 2011).

These findings suggest that where appraisers have the data available to conduct variations of comparable sales analysis, the building blocks of the method itself are robust. Instead, it appears that with respect to high performance homes, appraisers might

be asking the method to answer a question that it cannot, because they are not providing the appropriate inputs. Further, there seems to be confusion as to what the appropriate inputs are when estimating the value of a high performance home.

The primary difference between a traditional home and a high performance home is the value proposition of each unit type. In addition to the constellation of reasons individuals and families purchase homes, high performance homes also include design and construction innovations that create superior environmental performance and translate into superior economic performance for the occupant. Relative to a similarly sized home in the same location but before occupant behavior, high performance homes are estimated and modeled to create significant measurable energy savings. Just as in agriculture, viticulture, consumer appliances, and forest products, builders attempt to summarize their product's value proposition with an eco-label. There are a significant number of eco-labels; the most common include Energy Star, Leadership in Energy and Environmental Design (LEED), the National Green Building Standard, Green Point, and Earth Craft.

Researchers confirm that price premiums exist in certain markets between eco-labeled homes and non-labeled homes, as well as in homes where data on presence of a high performance technology is available. Across California, eco-labeled homes have been observed to have sold at a 9% premium compared to non-labeled homes (Kok & Khan, 2012). In Fort Collins, Colorado, Energy Star labeled homes sold at a $8.66/sf premium over non-labeled homes (Bloom, et al., 2011). In Texas, homes with higher efficiency windows command a 3% price premium over those with less efficient windows (Aroul & Hansz, 2011). In Sacramento and San Diego, homes with solar panels sold for 3.5% more than those without from 2003 to 2011 (Dastrup, et al., 2012). These findings confirm earlier research that showed the extent to which energy savings can be included in the value of high performance homes (Nevin, Bender, & Gazan, 1999; Nevin & Watson, 1998).

Despite the growing evidence base for the superior environmental and economic value proposition of eco-labeled homes, scholars have shown that residential energy literacy is low (Brounen & Kok, 2010), that buyers of innovations that create energy savings typically misestimate discount rates (Howarth & Sanstad, 1995), and that

occupant energy behavior is susceptible to types of social pressure (Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007). Further, research indicates that data used for the valuation and underwriting of green buildings are fragmented and can be a significant obstacle for appraisers and lenders (Fuerst, McAllister, van de Wetering, & Wyatt, 2011). In addition to these problems and the limited numbers of eco-labeled units, each label conveys a different emphasis on attributes including building performance, material selection, and location. It is also difficult for an appraiser to compare across eco-labels.[2] Further, premiums associated with an eco-label from one market are not portable to other markets (Runde & Thoyre, 2010), so appraisers must develop and use data unique to their market to appraise high performance homes (AI, 2008).

  To combat problems related to the limited availability of comparables in a market place and to create an alternative method to reconcile estimates of value for high performance homes, the appraisal literature suggests that practitioners use a hybridized version of the comparable sales and income methods. Relying on the energy savings estimated for each new high performance home, appraisers can consider these energy savings as cash flows that can be capitalized into the value estimate (Adomatis, 2010, 2012; DeLisle, 1984; Lopez, 2013; Popescu, Mladin, Boazu, & Bienert, 2009; Watkins, 2011). However, some caution that cash flow based approaches can be affected by poor assumptions (Runde & Thoyre, 2010). This method could also fall out of the task of the single-family residential appraiser who is asked to consider what a knowledgeable buyer would pay. With low residential energy literacy, a propensity to mis-estimate discount rates, and variation present in the tools used to generate estimates of future energy performance (Durak, 2011; Institute & Group, 2009), it is plausible to suggest that the average buyer does not or cannot use this type of analysis, and therefore it shouldn't be used in appraisal. It is also plausible to interpret this variation as a lack of trust for estimated energy savings tools.

  The hybridized income-comparable sale method tracks with the commercial real estate underwriting literature that points towards the use of discounted cash flow analysis

---

[2] Green Energy Money, a firm based in Austin, Texas, has pioneered a tool that plots each of the major green building rating systems and their sub-categories (e.g., LEED silver and gold) onto the HERS index. Additionally, the Virginia Center for Housing Research is analyzing the three national green building rating systems to develop a 'right sized' comparison between systems to help advance this conversation.

as a method for incorporating high performance features of buildings (Finlay, 2011; Muldavin, 2010). For commercial real estate firms, estimating a discount rate is a straightforward process. Each firm must discount cash flows at a rate at least equal to their weighted average cost of capital. In housing, homebuyers don't often know what their analogous discount rate could be. Within the residential appraisal literature, there does not appear to be a consensus on how an appraiser should select a discount rate or how to select the term of analysis. Recent research advises appraisers to assess the sustainability uptake within the market and place the subject property in that context before making any adjustments to their value estimate (Runde & Thoyre, 2010).[3] This advice is particularly germane in the context of research on commercial real estate underwriting that points to the challenges of conducting property analysis when the data is disaggregated and difficult to access (Fuerst, et al., 2011).

In addition to the comparable sales method, appraisers can use the cost method to estimate the value of a home (AI, 2008). The cost method allows the appraiser to sum the published construction costs and depreciation of various technologies to generate an estimate either for reproduction or replacement cost. Reproduction costs represent the cost to re-create the house using temporarily specific materials and techniques; it is not as commonly used as replacement cost. Replacement cost describes the sum of the present costs of present materials and labor to replace the subject property with as similar a structure as can be created. The cost method is hamstrung by both geographical variation in cost data, the accuracy of first cost estimation strategies (A. Pearce, 2001; A. R. Pearce, 1997, 2008), and the conceptual disconnect between cost and market value. In other words, costs and values may vary, but they also must be placed in the context of market norms. Anecdotal conversations with builders reveal this to be a significant problem, as the builder must purchase and install all of the high performance technologies, but the market (buyers) may not recognize or give credit for the full cost of those technologies in the transaction prices of homes.

Related to costs of green homes and facilities, construction researchers have found that stakeholder perceptions of the initial cost of green projects continue to be a

---

[3] This also prevents the appraiser from making singular adjustments such as Nevin's multiplier. Nevins multiplier, similar to a price-earnings multiple, capitalizes every dollar of energy savings at a rate of $20.

barrier to their implementation (Ahn & Pearce, 2007; Klotz, Horman, & Bodenschatz, 2007; Wilkinson, James, & Reed, 2009). These responses demonstrate that the construction industry still believes that green building costs significantly more than conventional construction, despite the growing body of evidence to the contrary (Bartlett & Howard 2000). It is possible that these perceptions could have influenced appraisers, as many of these perspectives have been widely discussed in the popular and practitioner literature.

Despite the costing and premium research, there still remains a significant amount of missing information that appraisers confront when conducting an appraisal of a high performance home. Much of the data appraisers need for their work are found in the multiple listing services databases provided by boards of realtors. Typically, these databases under describe high performance technologies. However, there is change afoot. To help encourage the collection of high performance home data, both the National Association of Realtors (NAR) and the Appraisal Institute (AI) have created process tools. NAR has advanced a toolkit for greening the multiple listing services (MLS) (NAR, 2011). The Greening the MLS toolkit provides MLS service owners with strategies and tools to use to allow users to input and search for various types of data describing green and high performance homes. The AI has created an addendum to the Uniform Residential Appraisal Report (URAR) known as the Residential Green and Energy Efficient addendum (form 820.03) (AI, 2011). The addendum modifies the URAR documents from Freddie Mac and Fannie Mae (FHLMC, 2005; FNMA, 2006) and creates space for describing the green and energy efficient attributes and technologies of the subject property being appraised. Each of these tools will help to provide more data for use in estimating the value contribution of high performance systems and technologies. These tools will also allow appraisers and researchers to observe what buyers are paying versus construction costs.

Semi-Structured Interviews

To gain further insight into current appraisal practice relative to high performance homes, the authors conducted a series of semi-structured interviews with licensed

residential real estate appraisers from across the United States. The eighteen interviews took place by phone or in person from May through July of 2013.

Sample Description

At of the end of 2012, there were approximately 82,000 licensed appraisers practicing in the United States (AI, 2013). According to the AI), an appraisal trade organization, most appraisers were male, had 20+ years of experience, were licensed to practice in a single state, and worked in residential appraisal (AI, 2013). Within AI membership, there are 61 members that have passed the *Valuation of Sustainable Buildings Professional Development Program* and 74 members who claim Green Home Valuation as a core competency in their membership profile. Beyond the AI data, 119 individuals have completed the *Certified Residential Green Appraiser* course through Earth Advantage, a green building non-profit organization. Earth Advantage also offers a shorter course titled *Appraising Green Homes*—completed by 352 appraisers.[4] To distinguish between the two levels of training, both the *Valuation of Sustainable Buildings Professional Development Program* and *Certified Residential Green Appraiser* program were considered higher-level training courses due to their length and areas of emphasis.

The first step in generating the sample of appraisers for this paper was to contact members of the Appraisal Institute that listed green training in their online profiles. One respondent came from this effort, though nearly all who wrote back suggested a number of responses encouraging us to contact other appraisers. We were able to snowball a

---

[4] It is difficult to accurately estimate the universe of residential appraisers who have green or high performance home valuation training. Within the AI data, many of those who have taken and passed the *Valuation of Sustainable Buildings Professional Development Program* focus their appraisal practices on commercial buildings. We include all of those individuals in the denominator for our sample description calculations as the AI database returns their names when using the search designation 'Valuation of Sustainable Buildings: Residential'. There is likely to be some overlap between those appraisers who have taken a course from Earth Advantage (EA) and those Appraisal Institute (AI) members who claim a green home valuation competency, as Earth Advantage is one of the only other organizations providing training specific to green homes for appraisers. Organizations like the Building Performance Institute also provide continuing education for real estate professionals though participation by appraisers has been quite rare. As it is difficult to estimate the degree of overlap between the EA and AI data, we consider there to be none to avoid under-counting.

group of respondents from the leads provided by AI members. Following this effort, we attended an edition of *Certified Residential Green Appraiser* training in Virginia and were able to interview four residential appraisers following the training. Some of these individuals provided recommendations that led to an additional cluster of respondents. Finally, the authors used their collective professional networks within the residential construction and real estate services industries to connect to the remainder of the respondents. All in, there were 18 appraisers in the sample; 16 with green training and 2 without who helped provide the guideposts for typical appraisal practice.

The characteristics of the sample of appraisers interviewed for this research project generally aligned with the demographic characteristics of the appraisal industry. All appraisers interviewed were licensed to practice in a single state. Nearly all had more than 20 years of appraisal experience and primarily focused their practice on residential property. Six (or 33%) of the sample were licensed to practice in Virginia (including one specializing in the Washington, DC market area) while the remaining respondents were licensed to practice in California, Connecticut, Idaho, New York, North Carolina, Oregon, Texas, and Wisconsin. Of notable difference between the sample and the national data, 44% of the respondents were women, slightly higher than the percentage of women in the national data (AI, 2013).

Within the sample, sixteen individuals had appraised at least one green home in the last year (many had appraised more than 1), had taken a continuing education or certification course from AI or EA on the appraisal of green homes, or had both appraised a high performance home and completed valuation training. The two appraisers who had neither appraised a green home nor taken a green valuation-training course were familiar with the concepts due to their tenure in the business. These two appraisers provided significant insight into the decision-making practices of the 'rational' appraiser estimating the value of the traditional home. They also provided substantial guidance on where high performance home appraisal methods might need to differ from those used to appraise traditionally built homes.[5] Assuming no overlap within the Appraisal Institute data and further assuming no overlap within the Earth Advantage data, the sample of

---

[5] To gain more context about valuing high performance homes, the authors also had an extensive conversation with a member of a private equity firm specializing in the valuation and acquisition of sustainable commercial assets. We used this conversation as background and context during data analysis.

appraisers interviewed for this paper represents approximately 9% (16/180) of the total number of appraisers who have completed higher levels of green home appraisal training and approximately 3% (16/606) of the number of appraisers who have some form of green appraisal training.

Methods of Analysis

This study investigated the differences in appraisal practice between high performance new homes and traditionally built new homes. As this was principally an exploratory research project, the authors relied upon semi-structured interviews as the primary method used to collect data. Interviews typically lasted 45 minutes and were largely conducted via telephone. Interviews were not audio recorded. Instead, handwritten field notes were taken during the interviews and were typed immediately following the interview. The authors used the transcription of the field notes as an opportunity to expand upon anything not fully captured within the field notes. Where qualitative methods are less common in real estate and construction research, they help to provide tools for researchers where large samples are impractical and/or where nuance in practice can more easily be analyzed via interaction with practitioners (Pink, Tutt, Dainty, & Gibb, 2010).

To provide some structure for the interviews, the authors created a short list of general, probe, and clarification questions (Rubin & Rubin, 2011) designed to mimic pair-wise comparison between a traditionally built new single-family home and the same home including variations of high performance building technologies and eco-labels.[6] First, the respondents were asked how they would conduct the appraisal of a traditionally built home and then asked how that process would differ when assigned two high performance variations of the same home. For illustrative assistance, we created MLS

---

[6] For these interviews and analyses, the terms green and high-performance housing are equivalent and will be used to describe any new home in which technologies that have the capacity to create operational efficiencies such as reduced energy consumption and reduced water consumption are installed. This stands in contrast to most attributions of green that require some degree of certification from a rating system such as EPA's Energy Star (ES) or the US Green Building Council's Leadership in Energy and Environmental Design (LEED). Very simply, houses that have the technological capacity to deliver upon the value proposition as green or high-performance, whether or not they carry any official certification. Equally, those homes carrying a green certification without the technologies to realize the value proposition are considered to be non-green.

listing sheets for three variations of the same hypothetical home to control for location, size, and other non-high performance attributes (see Appendix). The base of the hypothetical home model was a new code built home in a generic subdivision. The first high performance variation included a number of moderately high performance technologies and a green building certification. The second variation included very high performance technologies but did not carry a green building certification. This packet of hypothetical home listings was sent to the respondent prior to the interview. Given the geographic diversity of the sample, the authors amended the hypothetical home variations for regional changes in technologies. However, in many instances, appraisers were substantially better at providing specific examples of individual homes or technologies that they had analyzed than the amended hypothetical listing templates.

The interview questions were designed to prompt the respondents to discuss and compare how they have appraised or would appraise a high performance home (e.g., the hypothetical variations) differently, if at all, than a similar traditionally built home. Given the comparative nature of the questions, as well as the fact that we were examining a multi-step process, we used an interpretive framework to analyze the data generated during the interviews (Gubrium & Holstein, 2002; Warren, 2002). The interpretive framework allowed for comparisons of procedural and analytical methods akin to the more mathematical tools of process mapping (PM) or fault tree analysis (FTA) (NASA, 2002). Though respondents were not asked to create a process map that could be analyzed with FTA, the interview questions were organized to allow for comparisons of both procedural aspects of appraisal as well as analytical tools used within the appraisal process.

To assess the data, we first read through the interviews and 'listened' for recurring broad themes using interpretive techniques summarized in Rubin & Rubin (2011) (Rubin & Rubin, 2011). Next, we re-read the interviews and focused within those broad themes that arose around procedural and analytical differences for sub-themes and nuance (Britten, 1995). Finally, we analyzed groups of interviews in clusters to assess whether geography, experience, or other factors might be associated with the development of themes (Gubrium & Holstein, 2002).

Findings

Based on several different assessments of the respondents' data, there does not seem to be a substantial procedural difference between the appraisal of a new high performance home and the appraisal of a new non-high performance home. Appraisers in this sample tended to follow the same procedural steps for both traditionally built and high performance homes. These steps tended to match those steps described as high quality practice by the two non-green appraisers in the sample. The steps described by the respondents also tended to match those steps enumerated in both the Appraisal Institute textbook and other publications (AI, 2008).

In the absence of procedural differences, each respondent described large and small differences in analytical methods used to estimate the value of high performance homes—or the contributory value of their technologies. Similarly to the appraisal literature, respondents articulated modified versions of each of the traditional methods of estimating value: comparable sales, cost, and income capitalization. In general, respondents described using both the comparable sales and cost methods with adaptations for construction cost and quality of high performance technologies. Many also described a method of analysis that modified the income capitalization method, a method not typically used in single-family residential appraisal, to capture the energy savings cash flows generated by high performance technologies. Embedded in the discussions of these differential methods of analysis were several sub-themes supporting appraisers' work on high performance homes: 1) vocabulary, construction, and awareness of substantive differences between green and non-high performance homes; 2) role of and availability of high performance housing data; 3) appropriate estimation of the potential buyer; and 4) the complex role of appraisal management companies (AMCs).

Key Differences in Analytical Tools

Within the sample, all of the appraisers detailed modifying at least one of the three primary analytical strategies when considering the appraisal of a high performance home: the comparable sales, cost, or the income method. None of the sixteen respondents with green valuation training described using an un-modified version of methods of analysis. While the authors did not ask respondents to express a preference

for a method of analysis, neither the respondents' experience or number of high performance homes appraised appeared to be associated with the method they spent the most time discussing. Instead, those respondents that noted commercial real estate experience or more extensive financial analysis training appeared more disposed to discussions about the modified income approach discussed below.

Both the comparable sales and cost methods are accepted in common appraisal practice for non-high performance homes; the comparable sales method is the method of analysis required when submitting the Uniform Residential Appraisal Report. Descriptions of the modifications to these two methods appear to be logical extensions of the base methods that allow appraisers to leverage their most familiar tools and strategies and mitigate risk in submitting reports to underwriters. Not surprisingly given the primary area of practice of the respondents, there was greater consensus on how to modify and apply the hybrid comparable and cost methods than the hybrid comparable-income method. As the income method is not traditionally applied during single-family residential property appraisal, respondents described, with less agreement, several variations that converted energy savings into estimates of contributory value.

With respect to the comparable sales method of analysis, respondents principally described adapting the method to make an adjustment for the perceived increase in construction quality of high performance homes. On a traditional home, respondents depicted the typical method using competitive comparables to create a series of range bound adjustments based on the superiority/inferiority of the comparables relative to the subject home. Respondents noted that the traditional method could be made more accurate through the use of matched pairs, a grouping technique that allows an appraiser to gain insight into the per-unit cost of an attribute (e.g., a comparable home and subject home are similar in all attributes except location—indicating that the difference in price is related to the difference in location). With respect to high performance homes, one respondent noted that she would prefer to use matched pairs for high performance appraisal but she rarely found matched pairs outside of subdivisions with limited numbers of home models. She then went on to suggest that finding a high performance matched pair was more akin to a needle in a haystack—at least in her market.

Once the typical adjustments were identified, the consensus from respondents was that they then went on to make an additional adjustment based on the increased quality of the materials associated with and included in high performance homes. In other words, respondents were able to use comparable sales to estimate the value of a high performance home largely in the absence of its high performance attributes. They added an incremental positive value adjustment based on the difference between the quality of the comparables and the subject property. All who described this method cited a perception of the superior quality of high performance building materials as well as a perception of increased attention to design as the basis for the adjustment. Three respondents explained further by saying they considered tightening of the building envelope and the decrease in air and moisture moving across walls, roofs, and basements to be the basis for their quality adjustments and extension of the home's economic life. With less air and moisture crossing through the systems, the building materials will not degrade as rapidly as a home with a looser envelope.[7]

Respondents also described a modified version of the traditional cost method that could be used to estimate the value of a high performance home. Using data from the Marshall and Swift Residential Valuation Handbook, an annual publication describing the per-unit costs of all manner of construction materials with adjustments for levels of quality and geography, appraisers can estimate the replacement cost of any structure. After establishing the value of the lot, an appraiser can use the Marshall and Swift's handbook to sum the per unit or per square foot cost of building materials into the total cost for improvements—both for traditional homes and high performance homes. None of the sample respondents suggested using the cost method as the primary method of analysis. They noted the differences between estimates of cost and value and illustrated their statements with examples of high performance homes that cost far more to build than the local market would seem to bear in sales prices. Often, these examples fell at the extreme end of high performance technology use where the prices of the building materials were quite high due to rarity of use or low market penetration (e.g., geo-thermal heating systems). The cost method was most often cited as a method of triangulating or

---

[7] An increase in economic life factored into both of the other commonly used analytical tools.

reconciling the estimate of value generated as part of the comparable sales or hybridized income-comparable sales methods.

In addition to the comparable sales and cost methods, over half of the respondents described using a hybridized income valuation and comparable sales method. Traditionally used in commercial real estate valuation, the income method capitalizes a stream of property-based cash flows into an estimate of what an investor might pay for the income generated by the building. The income method has not regularly been applied to single-family residential appraisal unless the property is owned by an investor and rented to a tenant. However, respondents cited the energy savings generated by high performance building technologies as cash flows that they could value using the income method. They described consensus around the notion that the present value of the estimated energy savings could be appended to the value of the home appraised in the absence of the high performance attributes—conceptually, a similarity to the methodological adaptation made to the comparable sales method. Two respondents suggested that they had been able to use the method slightly differently. Instead of making adjustments from non-high performance comparables, they estimated what each high performance subject property would rent for and then capitalized that rent stream using a gross rent modifier. These two then appended the present value of the energy savings to the capitalized rent stream. Nearly all respondents endorsing the hybrid method suggested that it could be used in situations where fewer potential comparable sales existed or where they felt that the comparable sales adjustment might not reflect what a typical buyer might pay.

While the present valuation of energy savings was the common refrain, there was little agreement among respondents on standard practice for discounting these cash flows. Respondents offered a range of discount rates from the current rate available for 30-year fixed-rate mortgages (currently ~4%), the rate prescribed in the Sensible Accounting to Value Energy (SAVE) Act (4%), a risk free rate such as the yield on the 10-year US Treasury bond (~2%), or some risk loaded rate that was based on a base rate plus a premium for the extra risk of the investment type. Additionally, there did not appear to be consensus on the period of the analysis for discounting the energy savings. Some advocated for the average period of time a home in the market area is typically held by an

owner; others suggested using the average of the useful lives of the combined high performance technologies. Still others argued for a thirty-year period—matching the term of the thirty-year fixed-rate mortgage. The lack of consensus on discounting assumptions and wider variation in accuracy formed the basis of several respondents' criticisms and lack of trust of this method. Among this sample, none raised the issue of trusting the energy savings data as a concern--a topic from the literature review that seemingly might have posed a larger obstacle.

Beyond the range of assumptions used to discount the energy savings, there did not appear to be an agreement on whether or not the present value of the energy savings calculation was to be added directly to the appraisal estimate or whether the present value figure was to be added net of the high performance-traditional technology cost differential. In other words, there was a bit of divergence around whether the calculation was one of present value versus or net present value. Perhaps, this divergence was due to the questions used during the interviews to catalyze conversation about these methods. However, regardless of the reason for the divergence, it will be important for future practitioners to determine whether a net present value calculation is superior or inferior to the simple present value of the energy savings.

Vocabulary and New Knowledge + Role of Data

To support the use of the modified methods of analysis described above, both the respondents in the sample and the green appraisal literature point toward the need for a more standardized vocabulary to differentiate between high performance and non-high performance homes (Adomatis, 2010, 2012; Fuerst, et al., 2011; Normand, 2012; Runde & Thoyre, 2010). The respondents also noted that an increase in accuracy of vocabulary would help distinguish between high performance technologies when submitting reports to underwriters. Respondents also articulated needs for searchable and more readily available data describing the performance and presence of technologies included in high performance homes. In many instances, these needs were contextualized by stories about knowledge bases and the defense of methods of analysis to underwriters. Very simply, without the ability to describe or search and find data using commonly defined or even

more technical terms, it appeared that the ability to produce an accurate and defensible value estimate declined.

Reflecting on his first high performance home appraisals, an appraiser from the East Coast indicated that he was underprepared and likely made some mistakes analyzing the house and estimating the home's value. However, he noticed that as he took green appraisal courses and developed a greater sensitivity to the differences in value propositions between the high performance houses and traditionally built houses, he was able to more accurately capture the logic and nuance that underwriters would accept in appraisal reports. A respondent from the West Coast recalled an assignment where she discovered that the subject home was constructed using structurally insulated panels (SIPS), a structural building system for roofs and walls that sandwiches rigid foam between sheets of oriented strand board. SIPS panels have a higher thermal resistance than do code built and insulated walls and are considered to be high performance building technologies (Bostic et al., 2012). The presence of the SIPS panels was not listed in the property data advertised within the local MLS's by the listing broker. Had this individual not recognized the presence of SIPS, her estimate of value would have been lower.

In a similar vein, several appraisers had conducted recent searches of their MLS' for eco-labeled homes. In one instance, the respondent's search for Energy Star certified homes returned several hundreds of listings. In reviewing the listings, the appraiser discovered that most homes simply included Energy Star certified appliances and did not carry whole house certification—particularly striking in that in preparation for the interview with this appraiser, the authors discovered that the market in which this respondent worked boasted several hundred homes with HERS index ratings. Those with similar stories expressed frustration at the inability to search their MLS databases for high performance attributes and noted the difficulty in developing comparables as the reason for moving towards one of the three innovative valuation methods described above. Where most had considered the lack of data to indicate a limited, if not non-existent, market for high performance attributes, one appraiser stressed his opposition. He made it clear that missing market data for an innovation didn't automatically indicate the market did not value the attribute. Instead, it prompted him to search for different types of data such as contracts between builders and buyers detailing attribute choices.

In an anecdote illustrating the complex interaction of vocabulary, data, and methods of analysis, an appraiser of a Net Zero home, or home that produces the same amount of energy it consumes, suspected that his extensive documentation of technological terms, assumptions, and descriptions of present value estimation methods helped move his report smoothly through the underwriting process. Other respondents shared similar stories about different types of high performance houses where a logical and carefully documented report assisted greatly with acceptance of the report by an underwriter.

Within discussions about knowledge base, vocabulary, and data supporting the modified methods of analysis, many respondents focused on the difference between the presence of high performance building technologies and the presence of a green building certification. There appeared to be consensus that certifications were helpful from a statistical perspective facilitating increased accuracy in market analysis and coarsely grouping potentially comparable houses. However, like the warnings from the literature, many cited the variability of focus within the green building rating system certifications and expressed preference for such things as a single scale such as the HERS index score on which all certifications can be plotted, a binary energy certification such as Energy Star, or MLS databases that included high performance attribute based searching.

Several respondents shared unique methods of working around data shortages. Two described keeping a separate file holding all of the green housing information available in their markets. When they appraised a home with high performance features, they would turn to these files as they contained data on transactions of other high performance homes. Interestingly, another respondent suggested that the common demand from underwriters for three comparables within ½ mile within the last 90 days was just that—a goal and not a rule. Instead, he noted that comparables that describe the market for the subject property are the standard and in some cases those comparables do not meet the distance, proximity, and temporal demands of the underwriter. Each of these three respondents argued that when sufficient data existed to identify comparables, the classic methods of analysis would work well.

Estimating the Potential Buyer

The Appraisal Institute's procedural guide for the valuation process highlights the creation of a scope of work and definition of the type of value to be estimated. Additionally, the classic comparable sales analysis technique requires appraisers to identify competitive comparable homes to the subject property. In other words, these steps and requirements compel the appraiser to estimate who the most probable buyer of the subject property would be and to estimate what they might pay for it under typical market conditions. Typical market conditions include appropriate market exposure, an arm's length transaction, and an assumption that both the buyer and seller are acting prudently and knowledgeably. The task of estimating the most probable buyer of a high performance house did not appear to have significant procedural or methodological differences for most respondents. As there is variation amongst the different types of single-family homes, there doesn't appear to be a great push towards a high-performance home specific method of estimating a buyer.

Although there was not a great deal of variation in response around this sub-theme, three respondents provided insight into some alternative perspectives. One questioned whether or not most buyers, even the most probable buyer type for a high performance home, met the criteria for acting prudently and knowledgably. Linking back to the hybrid income-comparable sales method, another suggested that he was not yet convinced that the average buyer was sophisticated enough to conduct a version of a discounted cash flow analysis and therefore the method should be lightly used—if at all. The third respondent raised the related issue of whether or not the appraiser's personal bias about the design of some types of high performance homes had the potential to both positively and negatively influence the estimate of value and most probable buyers. He acknowledged that all appraisers must do their best to strip away their own biases about architecture, construction, and neighborhoods—doing their best to anticipate what the most likely buyer of the subject house might offer to pay. However, he cited the age, lifestyle, and tendency towards path dependency among his colleagues as potential reasons bias against high performance products or design might creep into practice. This individual volunteered that the possibility of under-estimating the contributory value of high performance technologies and certifications by someone with a negative bias was

equal to the probability of the over-estimating for someone with a positive bias towards increased home energy performance.

Appraisal Management Companies

With several exceptions, respondents tended to suggest that Appraisal Management Companies (AMCs) created a net negative force on the more complex types of appraisals, including those of high performance homes. Created to protect consumers from collusion by lenders and appraisers, AMCs provide a firewall between the parties and serve as an intermediary for the lending institutions in creating a bidding process where appraisers can bid to provide appraisal services. In concept, the AMC is designed to increase appraiser independence and to prevent creation of relationships between lenders and appraisers based not on the value and accuracy of the services provided but on volume or preconceived outcome (e.g., asking an appraiser to deliver an estimate of value equal to the price to be paid by the borrower).

In general, the sample respondents were pessimistic that AMCs would lead to better appraisal practice relative to high performance homes. Many talked about the tendency of AMCs to accept the lowest bid for an appraisal and also their tendency to ignore geographical and product type competency requirements when accepting a bid by an appraiser for an assignment. One Virginia appraiser noted that AMCs seem to create a rush to the bottom in terms of price, speed, and quality of the outcomes. Together with a respondent from California, he was perplexed that given the added increase complexity and time required to conduct the appraisal of a high performance house, the AMC's have not demanded appraisers provide proof of competency before accepting a bid to conduct an appraisal.

Two appraisers from Texas shared that they had been asked to review and redo AMC assigned appraisals conducted on a high performance house because the lender had several significant questions. Using the hybridized income approach reconciled by the cost approach, the review appraisers felt that their revised appraisal more accurately reflected the high performance attributes of the home. The two noted that the review appraisal cost the lender a significant premium, but that the lender seemed pleased and was able to issue the loan on the home.

Limitations & Next Steps

One of the primary limitations of this research is the size of the sample. Given the pricing and time pressures facing most practicing appraisers, creating a sample of this size was a significant challenge. Further, where the universe of residential appraisers who have appraised a green home or are trained to do so is difficult to estimate, it is difficult to know whether or not the sample size is sufficiently large from which to make observations. Based on the publicly available information, it appears that the sample of appraisers who participated in interviews represents approximately 8-9% of the total number of residential appraisers that have higher level green home valuation training and 3% of the total number of appraisers that have at least a basic level of green home valuation training. To be clear, the findings presented represent the data from the sample and should not be quickly generalized to the broader population of appraisers. Further, they do not allow us to make comparisons about how non green-trained appraisers would tackle the hypothetical assignment. Additionally, given the sampling procedure, it is possible that there was some similarity in responses related to interviewing individuals that had attended the same training program.

Given these limitations, it seems appropriate that one next research step would be to explore the variance in outcomes produced by the range of inputs for each method of analysis described above. One actionable way to collect a larger sample of data and potentially to validate this work would be to integrate the research into future sessions of green appraisal training courses. Participants could asked to estimate the value of a hypothetical home using both methods and the value estimates as well as the ranges of inputs could be catalogued and analyzed given characteristics of the appraiser. An additional next step could be a more detailed survey of the methods of analysis appraisers are using to estimate the value of green and high performance homes. Data from a larger sample where respondents answer a standard set of questions (as opposed to the conversational basis of a semi-structured interview) could be analyzed using traditional quantitative analytical techniques. A survey distributed to a larger group would also help to eliminate, or at least mitigate, potential limitations related to snowballing and researcher bias. However, given the time constraints of practicing appraisers, execution

of the survey would need to rely on innovative distribution channels and be supported by a known topic champion.

Conclusions

Despite the growth in the use of high performance technologies in new single-family housing over the last ten years, estimating the contributory value of high performance technologies and certifications remains a difficult task for appraisers. Traditionally, appraisers use the comparable sales method to estimate what the most probable buyer would pay for a new home, often drawing on the principles of hedonic regression to establish prices for individual attributes of a home. However, with respect to high performance homes, much of the information upon which comparable units could be established or hedonic regression conducted is missing from common data sources such as MLS and county tax assessment databases. Without some significant modification, this missing data creates a substantial problem for appraisers as it short-circuits their most common method of analysis. Based on the sample of appraisers interviewed here, respondents trained to value or with experience valuing high performance homes indicated that they used two analytical strategies: 1) a quality of construction adjustment or 2) an adjustment for the present value of estimated future energy savings. These two methodological amendments to the comparable sales method allow appraisers to overcome the obstacle of limited comparable sales data and to generate a logical estimate of market value.

Though there was limited variation in the construction quality adjustment method, there was substantial variation in the assumptions that drive the present value method. This variation suggests a lack of consensus in practice that should be addressed by national organizations representing appraisers and other homebuilding or real estate interests. Policy makers have re-introduced the Sensible Accounting to Value Energy (SAVE) Act to the Senate as a way to help standardize these assumptions. However, hard-wiring those assumptions into appraisal models such that every high performance home will be analyzed using a discount rate of 4% and a period of analysis of 20 years fails to meet the criteria for estimating what an informed buyer would pay for a home. Instead of the fixed discount rate and analysis period, advocates should determine a

method of selecting assumptions that allows the appraiser to adjust for market and unit conditions as well as market based expectations. Recent draft guidance issued by the Appraisal Foundation's Appraisal Practices Board, the committee that provides legal oversight for professional practice, indicated that value estimates could be negatively influenced by insufficient or unsupportable assumptions. They advise amending the Uniform Standards of Professional Appraisal Practice (USPAP) competency requirements to ensure that those appraising high performance homes have sufficient training to recognize market data (in a range of forms) and convert it into value estimates.

Appraisers in the sample described this competency problem in the context of Appraisal Management Companies (AMCs) and the perceived race to the bottom of fees bid for complex assignments. Following the Great Recession, policy makers have been focused on creating lender-appraiser firewalls to benefit the homebuyer. In doing so, they appear to have created a system where AMCs have a perverse incentive to accept the lowest bid to conduct an appraisal. Many respondents believed that low bids were accepted while competency requirements were disregarded. It appears that their calls to the appraisal advocacy organizations have been heard. On July 15th, the Appraisal Practice Board recommended the development of competency standards for the appraisal of high performance homes. The push for a competency standard would promote a number of solutions to the problems referenced in the above interviews. Competency would demand training to recognize systems, technologies, and their relevant market data points. As these data points would then be catalogued they would begin to transform the valuation landscape and address data and vocabulary problems referenced by appraisers above.

In addition to the Appraisal Foundation, public policy makers could play a strong role in helping to solve the missing information problem. Though they do not have much influence over local MLS databases, they can demand the collection of various data about high performance homes as part of the builder permit and tax assessment process or as a part of the process to obtain a GSE guaranteed mortgage. The collection and storage of data in the tax assessment or GSE records would allow appraisers to search for comparable units more easily as the data would be both public and, in many cases allow the data to become mapable using GIS. The ability to use GIS would allow researchers

to assist appraisers in analyzing the market effects of high performance technologies but also their geographic diffusion over time. The missing information problem also creates some significant hurdles beyond the domain of appraisal. It has the potential to influence all parts of the mortgage underwriting decision from credit scoring a borrower through the securitization chain.

Traditionally, lenders have relied on credit scoring models to help them understand a borrower's likelihood of defaulting on mortgage and based on that probability to price the loan. While this practice has been widely accepted by the mortgage industry, it has some shortcomings. Primarily, credit-scoring models are created to examine a borrower's past—analyzing the extent to which they have repaid loans and other forms of non-mortgage commercial credit such as auto loans, credit cards, or other unsecured personal loans. The literature suggests that most models rely conceptually on the notion that past behavior will be correlated to future behavior. To that end, lenders and mortgage researchers have used credit scores (FICO or other) as surrogate variables to measure a borrower's ability to repay and the proposed Loan to Value ratio to help understand the probability of the borrower defaulting (and the extent to which the lender could suffer losses). At present, there is no way to distinguish, within a credit scoring model, the extent to which a borrower's probability of default is influenced by the energy efficiency of their home—models are not designed to assess this type of situation. Given the higher net cash flows to the borrower associated with high performance homes, it seems useful to consider versions of credit-scoring models that analyze a buyer's existing cash flow before and after purchase to help understand their probability of default. Quercia et al (2013) modeled the likelihood of default on a sample of 30,000 mortgages including a significant portion where the data stream included a HERS score (R. Quercia, Sahadi, Stellberg, Kaza, & Tian, 2013; R. G. Quercia & Stegman, 1992). They found strong evidence that borrowers on higher performance homes were less likely to default than the rest of the sample. They also showed a positive association between lower default and higher income and the negative association between loan to value ratio at origination and the potential for default. It seems, based on this strong initial evidence that where underwriters can collect data about the relative energy performance of the collateral underpinning a mortgage loan and include it as a

variable in a default or credit model, the predictive power of default models can be increased—which leads us to also consider Automated Underwriting tools.

Automated Underwriting (AU) models rose to prominence in the late 1990's replacing manual underwriting (software replacing humans). AU provided lenders with the ability to customize the credit scoring model and mortgage underwriting models used as well as discover ways to interact them. Studies of AU programs suggest that LTV and FICO scores are the key variables that predict future default. Straka (2000) suggests that as firms moved from manual underwriting to the process innovation of automated underwriting they increased the accuracy of their work (also increased efficiency and created time, servicing, and funding cost reductions) (Gerardi, Rosen, & Willen, 2010; Straka, 2000). By adopting AU as a process innovation, firms were able to incorporate better forms of data into their analyses. Adopting firms were more adroitly capable of analyzing a borrower's collateral, capacity to repay, and credit worthiness. It stands to reason based on Straka's review as well as Geradi et al's (2009) findings on the role of deregulation and innovation in the mortgage market, that the missing data problem related to high performance housing could also be addressed via changes to AU and credit scoring models (Gerardi, et al., 2010). AU models could be adapted for high performance loans, like they have been for affordable home loans or high-risk borrower loans, with the inclusion primarily of a relative energy performance variable such as the HERS index. Additionally, the models could include categorical variables for eco-labels or a long-term moving average variable for reported energy performance relative to estimated performance. The credit and underwriting literate suggests that there are two ways to generate better analytical outcomes: 1) create substantively different models that seek to analyze problem in some new way; or 2) include some new piece(s) of information in existing models. Overstreet and Beiling's yet unpublished working paper on the Flat Maximum effect indicates while new models may create better results, better information yields more consistently generates superior modeling results. Belotti & Crook (2009) confirms that radical types of information such as macro-economic variables can be included in credit scoring models and can increase their predictive abilities (Bellotti & Crook, 2008). Given these and other findings, future research should start to examine the role of high performance homes in the lending and underwriting

process as well as in the securitization chain. At present, this literature appears, on summary review, to be under-explored and a natural path forward for this and other related work.

References

Adomatis, S. K. (2010). Valuing high performance houses. *The Appraisal Journal, 78*, 195-201.

Adomatis, S. K. (2012). Residential appraising-describing the green house made easy. *Appraisal Journal, 80*(1), 21.

Ahn, Y. H., & Pearce, A. R. (2007). Green construction: Contractor experiences, expectations, and perceptions. *Journal of Green Building, 2*(3), 106-122.

AI. (2008). *The appraisal of real estate* (13 ed.). Chicago, IL: The Appraisal Institute.

AI. (2011). 820.03 residential green and energy efficient addendum: Appraisal Institute.

AI. (2013). Us valuation profesion fact sheet. In A.-R. Department (Ed.). Chicago, IL: Appraisal-Institute.

Andrus, S. (2012). Residential appraising-what is the value of a basement? *Appraisal Journal, 80*(3), 198.

Aroul, R. R., & Hansz, J. A. (2011). The role of dual-pane windows and improvement age in explaining residential property values. *The Journal of Sustainable Real Estate, 3*(1), 142-161.

Bellotti, T., & Crook, J. (2008). Credit scoring with macroeconomic variables using survival analysis. *Journal of the Operational Research Society, 60*(12), 1699-1707.

Benefield, J. D., Cain, C. L., & Gleason, A. (2012). Visual display of residential property information: Some additional evidence. *Journal of Real Estate Practice and Education, 15*(2), 89-100.

Bloom, B., Nobe, M. E. C., & Nobe, M. D. (2011). Valuing green home designs: A study of energy star homes. *The Journal of Sustainable Real Estate, 3*(1), 109-126.

Bostic, R., Brandes, U., Pontius, P., Schweitzer, J., Blanford, M., Bres, D., & Cocke, E. (2012). Measuring the savings of green building technologies: A selection of promising high-return-on-investment green building technologies for builders. In HUD_OPD&R (Ed.). Washington, D.C.

Bowes, D. R., & Ihlanfeldt, K. R. (2001). Identifying the impacts of rail transit stations on residential property values. *Journal of urban Economics, 50*(1), 1-25.

Bradshaw II, W. B. (2011). Creative construction: The capacity for environmental innovation in real estate development firms. *The Journal of Sustainable Real Estate, 3*(1), 274-311.

Britten, N. (1995). Qualitative interviews in medical research. *BMJ: British Medical Journal, 311*(6999), 251.

Brounen, D., & Kok, N. (2010). On the economics of energy labelling in the housing market. *Journal of Environmental Economics and Management*.

Colton, K. W. (2002). *Housing finance in the united states: The transformation of the us housing finance system*: Joint Center for Housing Studies, Harvard University.

Dastrup, S., Graff Zivin, J., Costa, D. L., & Kahn, M. E. (2012). Understanding the solar home price premium: Electricity generation and ,green, social status. *European Economic Review*.

DeLisle, J. (1984). Residential appraisal: A behavioral approach to energy efficiency. *The Appraisal Journal*, 41-47.

Desiderio, M. (2012). Occupy green: My 99% solution. Retrieved from http://www.homeinnovation.com/about/blog/99_percent_solution_for_green_housing_market

Dombrow, J., Rodriguez, M., & Sirmans, C. (2000). The market value of mature trees in single-family housing markets. *Appraisal Journal, 68*(1), 39-43.

Durak, T. (2011). *A framework for simplified residential energy consumption assessment towards developing performance prediction models for retrofit decision-making.* Doctor of Philosophy: Environmental Design and Planning, Virginia Tech.

Eppli, M., & Tu, C. (1999). *Valuing the new urbanism: The impact of the new urbanism on prices of single-family homes*: Urban Land Inst.

Uniform residential appraisal report: Form 70 (2005).

Finlay, J. (2011). *The resource appraisal: A due diligence report for energy efficiency, reource performance retro-fit financing*. Paper presented at the Strengthening the Green Foundation: Research and Policy Directions for Green Development and Finance, New Orleans, LA.

FNMA. (2006). *Uniform residential appraisal report (form 1004)*.

French, N. (2011). Valuing in the downturn: Understanding uncertainty. *Journal of Property Investment & Finance, 29*(3), 312-322.

Fuerst, F., McAllister, P., van de Wetering, J., & Wyatt, P. (2011). Measuring the financial performance of green buildings in the uk commercial property market addressing the data issues. *Journal of Financial Management of Property and Construction, 16*(2).

Gerardi, K. S., Rosen, H. S., & Willen, P. S. (2010). The impact of deregulation and financial innovation on consumers: The case of the mortgage market. *The Journal of Finance, 65*(1), 333-360.

Gubrium, J. F., & Holstein, J. A. (2002). *Handbook of interview research : Context & method*. Thousand Oaks, Calif.: Sage Publications.

Howarth, R. B., & Sanstad, A. (1995). Discount rates and energy efficiency. *Contemporary Economic Policy, 13*(3), 101-109.

Institute, E. A., & Group, C. S. (2009). Energy performance score (eps) 2008 pilot findings & recommendations report. Energy Trust of Oregon: EAI/CSG.

Irwin, E. G. (2002). The effects of open space on residential property values. *Land economics, 78*(4), 465-480.

Klotz, L., Horman, M., & Bodenschatz, M. (2007). A lean modeling protocol for evaluating green project delivery. *Lean Construction Journal, 3*(1), 1-18.

Kok, N., & Khan, M. (2012). The value of green labels in the california housing market: An economic analysis of the impact of green labeling on the sales price of a home: UCLA & Maastricht University.

Kummerow, M. (1997). Logical steps in property valuation. *Appraisal Journal, 65*, 25-31.

Lopez, T. (2013). Green energy money. GEM-Inc (Ed.) *Financial Solutions for a Sustainable Future-Residential Properties*.

Martin, J. B., & Watkins, T. (2012). Understanding and appraising properties with accessory dwelling units. *Appraisal Journal, 80*(4), 297.

McCoy, A. P., Koebel, C. T., & Sanderford, A. (2013, May 28-31). *Narrowing the chasm: Agile patterns of adoption and diffusion of innovation in the us housing industry from 2000-2010.* Paper presented at the Ewing Marion Kaufman Foundation 2013 Industry Studies Conference, Kansas City, MO.

Muldavin, S. (2010). *Value beyond cost savings: How to underwrite sustainable properties*: Green Building Finance Consortium.

NAR. (2011). The green mls tool kit, 2012, from http://www.greenthemls.org/about-us.cfm

NASA. (2002). Fault tree handbook with aerospace applications *Version 1.1*: NASA.

Nevin, R., Bender, C., & Gazan, H. (1999). More evidence of rational market values for home energy efficiency. *Appraisal Journal, 67*, 454-460.

Nevin, R., & Watson, G. (1998). Evidence of rational market valuations for home energy efficiency.

Normand, R. (2012). Seeing red on a green property appraisal Retrieved 11.20.12, 2012, from http://www.greenbuildingadvisor.com/book/export/html/25906

Pagourtzi, E., Assimakopoulos, V., Hatzichristos, T., & French, N. (2003). Real estate appraisal: A review of valuation methods. *Journal of Property Investment & Finance, 21*(4), 383-401.

Patchin, P. J. (1994). Contaminated properties and the sales comparison approach. *Appraisal Journal, 62*(3), 402-409.

Pearce, A. (2001). Sustainable vs. Traditional facility projects: A holistic cost management approach to decision making. *White paper prepared for US Army Forces Command, Fort McPherson, GA*.

Pearce, A. R. (1997). Cost-based risk prediction and identification of project cost drivers using artificial neural networks.

Pearce, A. R. (2008). Sustainable capital projects: Leapfrogging the first cost barrier. *Civil Engineering and Environmental Systems, 25*(4), 291-300.

Pink, S., Tutt, D., Dainty, A., & Gibb, A. (2010). Ethnographic methodologies for construction research: Knowing, practice and interventions. *Building Research & Information, 38*(6), 647-659.

Popescu, D., Mladin, E. C., Boazu, R., & Bienert, S. (2009). Methodology for real estate appraisal of green value. *Environmental Engineering and Management Journal, 8*(3), 601-606.

Quercia, R., Sahadi, R., Stellberg, S., Kaza, N., & Tian, C. (2013). Home energy efficiency and mortgage risks. Chapel Hill, N.C.: UNC Center for Community Capital & the Institute for Market Transformation.

Quercia, R. G., & Stegman, M. A. (1992). Residential mortgage default: A review of the literature. *Journal of Housing Research, 3*(2), 341-379.

Rodriguez, M., & Sirmans, C. (1994). Quantifying the value of a view in single-family housing markets. *Appraisal Journal, 62*, 600-600.

Rubin, I. S., & Rubin, H. J. (2011). *Qualitative interviewing: The art of hearing data*: Sage Publications, Incorporated.

Runde, T., & Thoyre, S. (2010). Integrating sustainability and green building into the appraisal process. *The Journal of Sustainable Real Estate, 2*(1), 221-248.

Schultz, P. W., Nolan, J. M., Cialdini, R. B., Goldstein, N. J., & Griskevicius, V. (2007). The constructive, destructive, and reconstructive power of social norms. *Psychological science, 18*(5), 429-434.

Straka, J. W. (2000). A shift in the mortgage landscape: The 1990s move to automated credit evaluations. *Journal of Housing Research, 11*(2), 207-232.

Walker, J. C. (1994). Accurate appraisals in a rural market: Some problems and solutions. *Appraisal Journal, 62*(2), 289-295.

Warren, C. A. (2002). Qualitative interviewing. *Handbook of interview research: Context and method*, 83-101.

Watkins, T. (2011). Appraising green homes: Valuation techniques. In W. Associates (Ed.), *Certified Residential Green Appraiser™ Series*.

Wilkinson, S. J., James, K., & Reed, R. (2009). Using building adaptation to deliver sustainability in australia. *Structural survey, 27*(1), 46-61.

C5_Appendix A

C5_HypoHome1

HypoHome 1

Unit Description: Size, Bed, Bath, Year Built	
Sub Type:	Single Family
Baths:	2.5
SF Bsmt Fin N/Egr/In:	0
SF Garage:	648
Bedrooms:	3
Total SqFt Livable:	2,230
SF Bsmt - Unf:	0
Studio/Loft:	0
SF Bsmt-Fin w/Egress:	0
SF Asry Dwell Det:	0
SF Deck:	250
Yr Remodeled Cmplete:	N/A
SF Per:	Assessor
Waterfront:	No
Year Built:	2012
Furnished:	
Agent Owned:	No

Public Remarks: Detailed Unit Description	
Public Remarks:	This home is in a wonderful convenient location. Great lot with incredible amenities nearby.
Realtor Remarks:	
Legal	Eagle's Landing Subdivision Lot 7
Directions	
Zoning	Residential-4 (4units/acre)
Land Ownership Type	Fee Simple
Construction Type	Site-built (Stick)
Style	2 Story
Specialty Rooms	Dining; Foyer/Entry
Heating & Air Conditioning	Electric Heat Pump
Features Interior	Cable TV; Gas Log
Items Included	All Ktchn Appliances
Exterior Finish	Brick, Wood
Features Exterior	Deck; Landscaping; Sprinkler Blw Ground; Undergrnd Utilities
Roof	Asphalt Single
Energy Related Features	None
Green Certification	None
Driveway	Asphalt
Road Surface	Paved
Road Access	Public
Water	City Connected
Garage	2 Car

C5_HypoHome2

HypoHome 2	
Unit Description: Size, Bed, Bath, Year Built	
Sub Type:	Single Family
Baths:	2.5
SF Bsmt Fin N/Egr/In:	0
SF Garage:	648
Bedrooms:	3
Total SqFt Livable:	2,230
SF Bsmt - Unf:	0
Studio/Loft:	0
SF Bsmt-Fin w/Egress:	0
SF Asry Dwell Det:	0
SF Deck:	250
Yr Remodeled Cmplete:	N/A
SF Per:	Assessor
Waterfront:	No
Year Built:	2012
Furnished:	
Agent Owned:	No

Public Remarks: Detailed Unit Description	
Public Remarks:	This green home is in a wonderful convenient location. Great lot with incredible amenities nearby. Built according to green building specifications.
Realtor Remarks:	
Legal:	Eagle's Landing Subdivision Lot 7
Directions:	
Zoning	Residential-4 (4units/acre)
Land Ownership Type	Fee Simple
Construction Type	Site-built (Stick)
Style	2 Story
Specialty Rooms	Dining; Foyer/Entry
Heat	Electric Heat Pump (SEER 13)
Features Interior	Cable TV; Gas Log
Windows	Double-Paned, Low-E/Argon Filled
Items Included	All Ktchn Appliances
Exterior Finish	Fiber-Cement (hardi-plank Wood
Features Exterior	Deck; Landscaping; Sprinkler Blw Ground; Undergrnd Utilities
Roof	Asphalt Shingle
Energy Related Features	HERS Index: 90, Energy Efficient Heat Pump, Energy Star Appliances, Double-Paned, Low-E Windows, Programmable Thermostat
Green Certification	None
Driveway	Asphalt
Road Surface	Paved
Road Access	Public
Water	City Connected
Garage	2 Car

HypoHome 3

Unit Description: Size, Bed, Bath, Year Built	
Sub Type:	Single Family
Baths:	2.5
SF Bsmt Fin N/Egr/In:	0
SF Garage:	648
Bedrooms:	3
Total SqFt Livable:	2,230
SF Bsmt - Unf:	0
Studio/Loft:	0
SF Bsmt-Fin w/Egress:	0
SF Asry Dwell Det:	0
SF Deck:	250
Yr Remodeled Cmplete:	N/A
SF Per:	Assessor
Waterfront:	No
Year Built:	2012
Furnished:	
Agent Owned:	No

Public Remarks: Detailed Unit Description	
Public Remarks:	This green home is in a wonderful convenient location. Great lot with incredible amenities nearby. Built to LEED specifications.
Realtor Remarks:	
Legal:	Eagle's Landing Subdivision Lot 7
Directions:	
Zoning	Residential-4 (4units/acre)
Land Ownership Type	Fee Simple
Construction Type	Site-built (Stick)
Style	2 Story
Specialty Rooms	Dining; Foyer/Entry
Heat	Geothermal (Need Efficiency Rating)
Features Interior	Cable TV
Windows	Triple Glazed/Argon-Filled Low-E Windows
Items Included	All Ktchn Appliances-Energy Star
Exterior Finish	Fiber-Cement (hardi-plant), Wood
Features Exterior	Composite Deck; Landscaping; Sprinkler Blw Ground; Undergrnd Utilities
Roof	Low-E Coated Standing Seam Metal
Energy Related Features	HERS Index: 50, Geo-thermal heat pump, Triple Glazed/Argon-Filled Low-E Windows, Programmable Thermostat, 3KW Photo-voltaic array, Icynene Spray Foam Insulation
Green Certification	LEED
Driveway	Permeable Concrete
Road Surface	Paved
Road Access	Public
Water	City Connected
Garage	2 Car