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Pima County Residential Green Building Rating System Evaluation

Summary

Jurisdictions wishing to establish green building programs are faced with an array of choices regarding how to proceed with program development espousing nationally recognized principles as well as reflecting local conditions. While national standards need to form the framework of any program, there are many from which to choose, none of which necessarily reflect all local conditions very well. For example, since our jurisdiction is located in the desert southwest, not only is water of primary concern—and thus energy since they are interrelated—but we need to contend with national energy standards predicated on sealed/insulated buildings and heating degree days which do not necessarily account for highly performing passive mass walls and evaporative cooling systems. As such it was decided to proceed through analyzing both national standards as well as local applicability in the development of a local green building program.

An evaluation was undertaken to assess the performance of residential green building rating systems as applied to various types of housing found in Pima County, AZ. Five houses were rated using four systems, some currently under development: the US Green Building Council (USGBC) LEED for Homes rating system, the National Association of Home Builders (NAHB) Green Home Building Guidelines, the NAHB Green Home Building Guidelines as amended by the Pima County/City of Tucson Joint Green Building Subcommittee, and the City of Scottsdale, Arizona, Green Home Rating System—a well established local program. Common themes in each of the rating systems included prerequisite requirements and the awarding of points for attaining certain benchmarks in categories such as site development, energy, water, materials selection, and owner education.

The rated residences included a typical wood-framed production home from a large developer, a wood-framed production home that carried a premium label for its energy efficiency, a custom CMU home designed to be zero-net energy, a custom engineered passive solar home, and an owner-designed home incorporating permaculture land-use principles and natural materials. These houses were differentiated with regard to style and size, but were all within the norm of typical area construction. Each residence was also rated for siting in several locations—from urban infill to newly developing edge suburbs—in order to gauge the effect each rating system had with regard to location and linkages to existing services.

The results of this evaluation revealed a uniform trend in ranking for each of the rated houses across the four rating systems, with those residences incorporating renewable energy, environmentally sound site development practices, strategies to reduce energy and water consumption, and recycled/renewable materials scoring the highest. However, scores in individual categories did not necessarily follow this trend. For example, some of the "greenest" residences in the study lost points for using raw materials as surface treatments on walls because the rating system was structured to award points only for low or zero VOC paints and finishes and made no mention of using structural materials such as CMU as a finish. In

addition, evaluated homes that relied on thermal mass and low-tech passive solar techniques to achieve thermal comfort were not awarded points uniformly across the rating systems in proportion to those structures that incorporated advanced mechanical systems. House size was also considered differently, from no mention in one rating system to significant point awards for smaller-than-average house sizes in others.

Perhaps not surprisingly, the LEED system, the NAHB rating system, and to some extent even the locally amended NAHB system tend to award points for conventional building techniques but overlook strategies that have been demonstrated to be locally effective in our Sonoran Desert climate. The Scottsdale Green Building Program encourages many regional approaches with point awards. House size is also treated differently by the programs even though recent studies clearly relate the size of a residence to its energy and material use. Neglecting to factor in house size disregards this evidence, and may give the false impression that excessively large green homes are just as environmentally friendly as their smaller counterparts.

LEED and NAHB address the effects of choosing a centralized location with established community linkages. However, the Scottsdale program addresses infill development without examining proximity to public transportation (which may reflect the fact that public transportation is available throughout most of the urban Scottsdale area). Attention to creating connected communities that provide opportunities to walk, bike, or ride public transit is an increasingly important aspect of sustainable design. These elements should be reflected and rewarded in any rating system, especially in areas such as Pima County that have experienced the growth of many edge subdivisions which require automobile commuting to most services.

Finally, national rating programs provide a valuable tool that may be used as a basis for regional programs. However, it is important to recognize that no one rating system is a panacea for local green building guidelines. The inability of a "one size fits all" rating system to respond comprehensively to the issues facing every region is understandable given the complexities of climate, local market drivers, and construction techniques. While all of the rating systems provided a solid foundation for evaluating green homes, placing too much emphasis on adapting conventional techniques without recognizing the contributions of innovative technologies and proven materials may have the unintended consequence of keeping such innovation permanently out of the mainstream.

Context

Pima County, Arizona has a strong commitment to sustainable principles as reflected in the County Board of Supervisors adoption of a resolution to support county sustainability initiatives in May 2007. In the spirit of these initiatives, Development Services Department (DSD) is working to develop an incentive-based residential green building program that will be acceptable to local builders as well as provide meaningful progress towards reducing the environmental impacts of new housing construction in the area.

Once the decision to develop a green building rating system was made, the question arose whether to adopt one of the national residential programs currently under development, revise one of the national programs to fit the County's needs, base the Pima County system on another local jurisdiction's successful residential green building rating system, or devise a new rating system tailored to the Pima County area. While the decision was made to move forward with amending the NAHB guidelines based on local builder preference, the merits of the amended document were yet to be verified. As such, DSD decided to proceed with a comprehensive evaluation of five residences using the LEED for Homes Pilot criteria, the NAHB Green Home Building Guidelines, the NAHB locally amended guidelines, and the Scottsdale Green Building Rating System which has been used in the City of Scottsdale, for nearly ten years.

This evaluation thus aims to identify the strengths and weaknesses of the targeted rating systems in order to develop a green building rating system best aligned to our area conditions including local climate, culture

and community, so as to provide guidance to builders on the best choices they can make towards building greener homes.

Methodology

The evaluated residences were chosen from actual plans submitted to DSD over the last several years. They were selected to represent varying approaches towards "greenness," from conventional to specialty houses designed and engineered to be at the forefront of sustainable technologies. The houses varied in size from 988 square feet to 4071 square feet, providing a range of score adjustments within those rating systems that evaluate size.

The five selected residences were as follows:

Residence A- Passive Solar, masonry/rammed earth construction; designed & engineered by owner
Residence B- Zero Net Energy custom solar home; CMU insulated (exterior) construction
Residence C- Large-scale production model meeting minimum energy code requirements
Residence D- Owner designed/built rammed earth custom home; based on permaculture principles
Residence E- Large-scale production model exceeding minimum energy code

The issue of how location might affect scores was also examined by siting each evaluated residence in five simulated locations within Pima County, each having differing characteristics with regard to infill, community linkages, public transportation access, and available services.

The five simulated locations were selected to represent urban, suburban and developing edge areas:

> **Star Valley**- *Newly developing suburban edge*: Intersection of W Valencia Rd and S Mountain Eagle Drive
> Zoning: CB-1
> **Menlo Park** – *Redeveloping urban neighborhood*: W Congress at Grande Zoning: PAD-10 (City of Tucson)
> **Civano** – *"Sustainable" subdivision in rapidly growing area*: South Nightbloom Way and E Seven Generations Way
> Zoning: R-1
> **Marana** – *Subdivision in high growth corridor*: North El Uno Gordo and W Dos Rotundo Drive
> Zoning: TH
> **Midtown** – *Urban infill:* South Avenida de las Palmas and East Broadway Blvd.
> Zoning: R-1 (City of Tucson)

All evaluated rating systems have some similarities including categories addressing: energy efficiency, materials, water use, and indoor air quality. There are mandatory prerequisite measures outlined in the LEED for Homes and Scottsdale systems that must be met for a residence to be rated, and points are only awarded for measures that exceed or complement the prerequisites. The NAHB system has far fewer prerequisite measures that only address the energy efficiency and homeowner education categories. In all of the systems a residence must earn a required minimum number of points to be awarded a level of certification such as Entry or Advanced (Scottsdale), Bronze, Silver or Gold (NAHB), and Certified, Silver, Gold, or Platinum (LEED).

It is important to note that none of the plan sets were originally submitted to the County for evaluation in any of the evaluated green building rating systems. If the plans had been originally submitted for inclusion in a rating system, they may have been tailored to include information more pertinent to the rating system, and would thus have scored higher for some elements. Documentation of measures in plans or

specifications was sufficient evidence of meeting a requirement or earning points in a category. However, if no written evidence of implementation could be obtained, no points were awarded. Because the objective was to evaluate rating systems and not the actual homes, this approach was deemed appropriate for the purposes of this evaluation.

Simulated Locations for Evaluation

Energy performance in relation to the IECC (International Energy Conservation Code) version in effect at the time the plans were submitted was calculated using REScheck software version 4.1.0. If a rating system offered the choice of a performance path or a prescriptive path towards meeting energy efficiency requirements, the higher scoring of the two paths was used to rate the structure.

LEED for Homes

The LEED for Homes program was in the pilot phase when used within this study. The rating system is loosely structured on the LEED program for commercial projects that has been used throughout the United States since 2001. LEED for Homes rates residences in the following eight resource categories:

- Location & Linkages (LL) *10 Points Available; none required*
- Sustainable Sites (SS) *21 Points Available; Min 5 pts. required*
- Water Efficiency (WE) 15 *Points Available; Min 3 pts. required*
- Energy & Atmosphere (EA) *38 Points Available;*
- Materials & Resources (MR) *14 Points Available; Min.2 pts. required*

- Indoor Air Quality (IAQ) *20 Points Available; Min. 6 pts. required*
- Awareness & Education (AE) *3 Points Available; none required*
- Innovation & Design Process (ID) *9 Points Available*

There are a total of 79 measures divided among eight resource categories totaling 130 possible points available. The LEED for Homes program also incorporates a Home Size Adjuster to compensate for the effect of home size on resource consumption. The Home Size Adjuster adds or subtracts points necessary for a residence to reach a certification level based on the number of bedrooms and overall conditioned floor space. A "neutral" home is based on national average home size for that number of bedrooms.

Certified homes must earn 45 points, Silver 60 points, Gold 75 points, and Platinum 90 or more points.

NAHB Green Home Guidelines

The NAHB Green Home Building Guidelines was under development when used within this study. The system rates residences in the following seven categories:

- Lot Design, Preparation, & Development – *102 possible points*
- Resource Efficiency – *206 possible points*
- Energy Efficiency – *100 points for Performance or Prescriptive Path; ± 100 points for additional measures*
- Water Efficiency – *±100 possible points*
- Indoor Environmental Quality – *229 possible points*
- Operation, Maintenance, & Homeowner Education – *19+ possible points*
- Global Impact -*18 possible points*

Certification levels are achieved by obtaining a certain number of points in each category to achieve Bronze, Silver, or Gold levels. In addition to the basic certification levels, the residence must also achieve 100 additional points toward certification. Some innovation points are available to recognize strategies that are not covered in the main body of the rating system. NAHB is the only rating system that requires a certain number of points in each principle category. The table below outlines the point totals required per category in order to receive one of the rating levels:

NAHB Model Green Home Categories	BRONZE	SILVER	GOLD
Lot Design, Preparation, and Development	8	10	12
Resource Efficiency	44	60	77
Energy Efficiency	37	62	100
Water Efficiency	6	13	19
Indoor Environmental Quality	32	54	72
Operation, Maintenance, and Homeowner Education	7	7	9
Global Impact	3	5	6
Additional points from sections of your choice	100	100	100

The amended version of the NAHB Guidelines used the same rating structure, but point totals were adjusted and certain measures were added or deleted to better respond to the Pima County climate as well as measures that are already required by local government regulation.

Note: In August 2007, the NAHB released a draft version of a new standard: the National Green Building Standard. This standard also uses a similar point award system for implementing environmentally responsible strategies. However, it goes beyond the Green Home Guidelines by establishing mandatory requirements and additional performance levels for Green Subdivisions, Green Buildings, and Renovations/Additions. This standard was received too late for consideration within this evaluation but a cursory review indicates the standard has expanded the depth and coverage of site development issues, and includes sustainable subdivision and green remodeling criteria which hold promise for transforming this sector of the industry.

Scottsdale Green Building Program

The Scottsdale program has 28 mandatory measures and 14 rating categories. The rating categories are as follows:

- Site
- Structural Elements
- Energy Rating/Performance
- Thermal Envelope
- Heating, Ventilation & Air Conditioning
- Electrical Power, Lighting, Appliances
- Plumbing System
- Roofing
- Exterior Finishes
- Interior Finishes
- Int. Doors, Cabinets, & Woodwork
- Flooring
- Solid Waste
- Innovative Design

The Scottsdale Green Building Program also uses a size adjustment score to reward or penalize houses that fall outside the average home size, but the neutral score is pegged to the average for the City of Scottsdale, 3000 to 3500 square feet, considerably larger than the national average for the US. Once the scored residence meets the mandatory measures, points are awarded for measures in the rating categories noted above. Residences must accumulate 50-90 points (after size adjustment) to achieve an Entry Level rating; and 100 or more points earns the home an Advanced Level rating.

Scores for Evaluated Homes

Residence A- 2056 SF-Passive Solar, masonry/rammed earth construction earned the following overall scores:

Location	*LEED Homes*	*NAHB*	*NAHB-PC*	*Scottsdale*
A	**68**	**366**	**379**	**120**
B	**75**	**375**	**379**	**122**
C	**71**	**375**	**378**	**120**
D	**68**	**366**	**379**	**120**

E	**74**	**366**	**374**	**122**
Size Adj.	**4**	**N/A**	**N/A**	**8**

Certification Levels:
LEED for Homes: Gold or Silver (depending on location)
NAHB National: Fails to achieve certification
NAHB Pima County Revised: Fails to achieve certification
Scottsdale Green Building: Advanced Level

Residence B- 2169 SF Zero Net Energy custom solar home; CMU insulated (exterior) construction:

Location	*LEED Homes*	*NAHB*	*NAHB-PC*	*Scottsdale*
A	**49**	**414**	**402**	**104**
B	**54**	**423**	**411**	**106**
C	**50**	**413**	**411**	**104**
D	**47**	**414**	**402**	**104**
E	**53**	**409**	**402**	**106**
Size Adj	**2**	**N/A**	**N/A**	**8**

Certification Levels:
LEED for Homes: Certified
NAHB National: Fails to achieve certification
NAHB Pima County Revised: Fails to achieve certification
Scottsdale Green Building: Advanced Level

Residence C- 1600 SF Large-scale production model meeting minimum energy code requirements

Location	*LEED Homes*	*NAHB*	*NAHB-PC*	*Scottsdale*
A	**15**	**166**	**170**	**10**
B	**22**	**175**	**179**	**12**
C	**18**	**175**	**169**	**10**
D	**15**	**166**	**170**	**10**
E	**21**	**166**	**165**	**12**
Size Adj	**4**	**N/A**	**N/A**	**10**

Certification Levels:
LEED for Homes: Fails to achieve certification
NAHB National: Fails to achieve certification level
NAHB Pima County Revised: Fails to achieve certification level

Scottsdale Green Building: Fails to achieve certification level

Residence D- 988 SF Owner designed/built rammed earth custom home; based on permaculture principles.

Location	*LEED Home*	*NAHB*	*NAHB-PC*	*Scottsdale*
A	**70**	**372**	**394**	**142**
B	**77**	**381**	**403**	**144**
C	**73**	**381**	**393**	**142**
D	**70**	**372**	**394**	**142**
E	**74**	**372**	**384**	**144**
Size Adj	**7**	**N/A**	**N/A**	**20**

Certification Levels:
LEED for Homes: Silver
NAHB National: Fails to achieve certification
NAHB Pima County Revised: Fails to achieve certification
Scottsdale Green Building: Advanced Level

Residence E- 4071 SF Large-scale production model exceeding minimum energy code

Location	*LEED Homes*	*NAHB*	*NAHB-PC*	*Scottsdale*
A	**39.5**	**146**	**144**	**61**
B	**46.5**	**155**	**149**	**63**
C	**42.5**	**155**	**148**	**61**
D	**39.5**	**146**	**158**	**61**
E	**45.5**	**151**	**144**	**63**
Size Adj	**- 9**	**N/A**	**N/A**	**- 2**

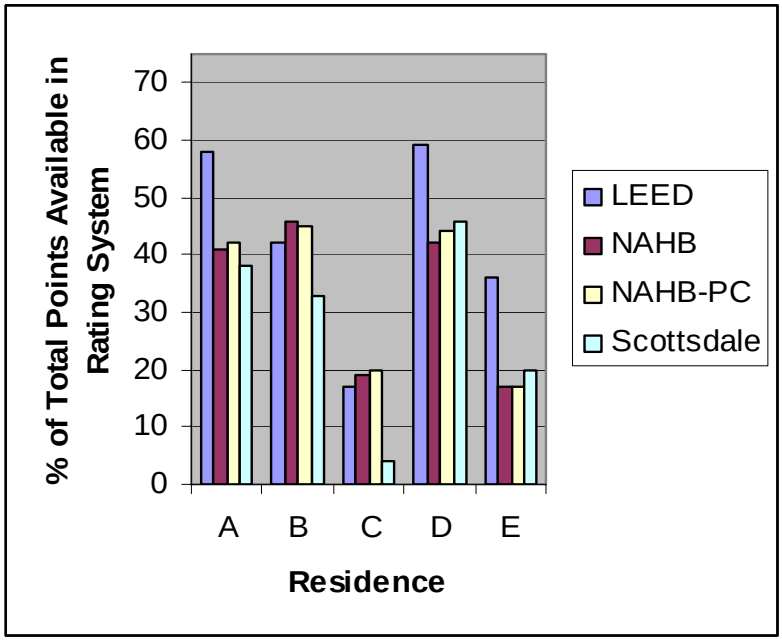
Certification Levels:
LEED for Homes: Certified in two locations; fails to achieve certification in other locations
NAHB National: Fails to achieve certification
NAHB Pima County Revised: Fails to achieve certification
Scottsdale Green Building: Entry Level

From the ratings above it can be seen that none of the houses achieved certification in the NAHB programs. Although Residence A, B, D and E passed many of the categories (some in the Gold level), none of these homes were able to attain enough points for certification in the Global Impact Category. This category includes the use of low- or no-VOC paints, sealants and adhesives. In the case of residences A and D, the surfaces of materials (rammed earth and concrete masonry units) were used as finishes with no added paint

or stain. The other residences may have used these products, but there was no documentation available for rating this element.

Another section of the Global Impact category awards points for products manufactured by companies that have developed an Environmental Management System that conforms to ISO 14001, a standard aimed at reducing a company's overall environmental footprint through improved efficiency and commitment to environmental benchmarking. Evidence of material used by companies that have registered under this standard was not available or included for the houses in the study. It is notable that the "Innovative Options" element of the Global Impact category awarded additional points if a *builder* was registered to meet the ISO 14001 program. Further investigation of the viability of requiring this certification, which is not widely held by builders in the Pima County area, may be warranted. Builders that complete few residences may find this criterion burdensome and other avenues for documenting responsible environmental management practices should be researched.

Percentage of Possible Points Attained



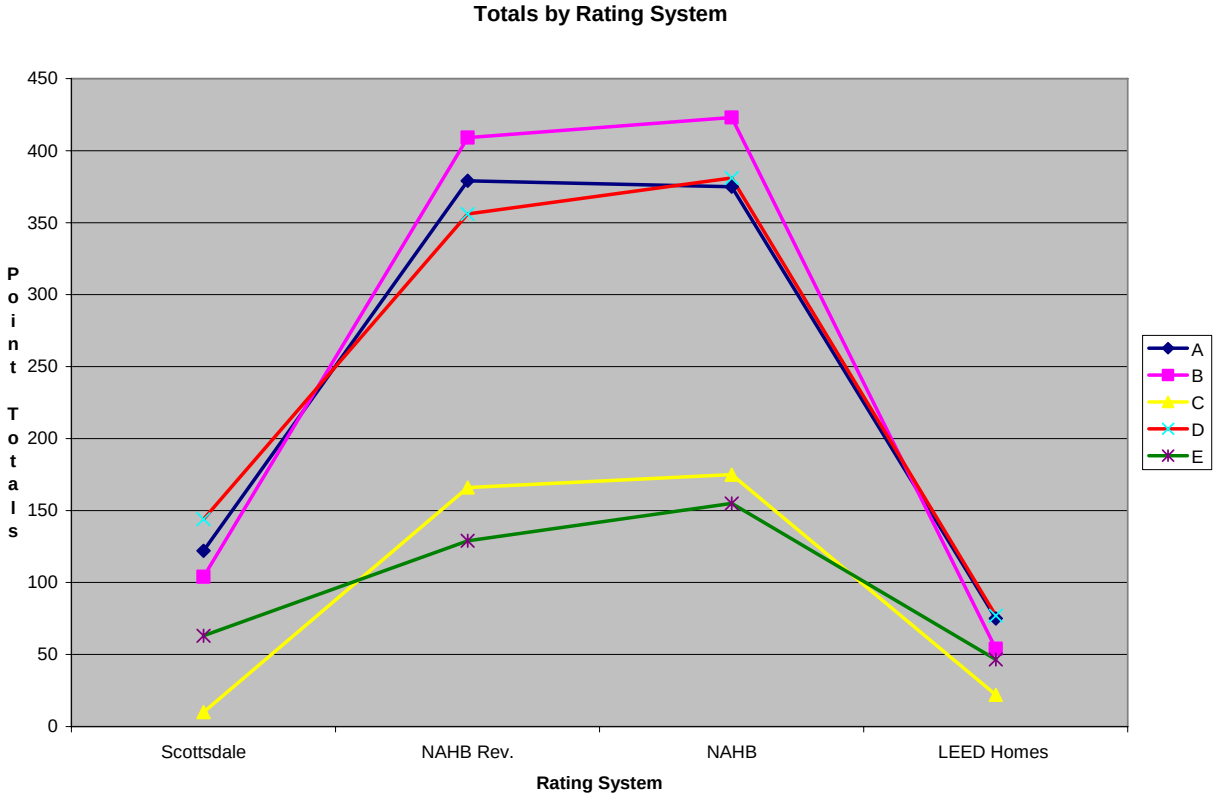
Each rating system has a different point scale, and the total number of points available ranges from 130 in the LEED Homes system to over 900 in the NAHB System. One way to compare the systems side-by-side is to calculate the points earned by a residence as a percentage of the total points available. Residence C, for example earned 20% of the available points in the NAHB-Pima County rating, but only 4% of the points possible in the Scottsdale rating system. The above graph illustrates this relationship and the variation of possible points attained among the systems.

Rank by Rating System

Residence	*LEED*	*NAHB*	*NAHB-PC*	*Scottsdale*
A– Custom passive solar masonry/rammed earth	1	3	2	1
B - Custom solar zero net energy CMU	3	1	1	2
C – Base model production home	5	4	4	5
D –Rammed earth w/permaculture principles	2	2	3	3
E – Production model exceeding energy code	4	5	5	4

As the above table illustrates, the rated homes performed differently in relation to each other across the rating systems. The Scottsdale and LEED Homes systems tended to lend more weight to low-tech, alternative construction materials and technologies suited to the local climate. The NAHB systems, in contrast, awarded points for conventional construction methods, the use of higher technology climate control systems and third party ratings (such as duct leakage certifications and blower door testing). The rammed earth permaculture home could not meet the indoor air quality point requirement since passive evaporative-cooled designs do not contain ducted assemblies.

As expected, those homes considered "green" which included renewable energy, water conservation features, and attention to sustainable site practices scored more highly than the production model homes in all of the rating systems. For example, the permaculture home plan was accompanied by a very complete owner's manual describing the principles of environmentally-friendly site development that were employed during the home's construction, as well as guiding the owner on practices that would ensure habitat conservation and sustainable lifestyle practices that be could employed in the future. This home scored highly in all rating systems' site development and homeowner education categories.



Location

The various simulated locations did not have a large effect on overall scores, although the Menlo Park and Midtown locations offered more opportunity for point awards due to the fact that they were infill sites with connections to services and public transportation. The Scottsdale program placed the least amount of emphasis on location; awarding 2 points for infill site development. The Scottsdale system did, however, award points for site development standards that were not location dependent, such as topsoil conservation. Both the LEED and the NAHB systems expanded point awards for locations in proximity to public transportation, redevelopment of previously disturbed sites, and avoidance of environmentally sensitive areas (already required in Pima County under the Sonoran Desert Conservation Plan). The LEED system also rewarded those locations that were in proximity to basic services and encouraged walking and bicycling over automobile use for transportation.

Size

LEED and Scottsdale rating systems awarded significant point values to homes that were smaller than average. NAHB, however, did not adjust point awards in this category, even though recent studies have indicated that larger homes use more energy and materials when compared to smaller residences.

Global impact

The NAHB scoring systems did not award points for using a structural material as a finish, therefore the masonry/rammed earth combination home and the permaculture rammed earth home, both of which use structural materials as interior finishes, lost points in the Global Impact Category. As noted above, this category also awards points for a builder certifying their operations through the ISO 14001 certification program. None of the evaluated plans had evidence of the builder having ISO 14001 certification, and scores in this category were low across all the homes as a result.

REScheck Scores for Evaluated Residences

Residence A - 21.4% better than code at time of submittal (2003 IECC) – (thermal mass)
Residence B- 58.2% better than code at time of submittal (2003 IECC)
Residence C- 0.6% better than code at time of submittal (2003 IECC)
Residence D- 4.2% better than code at time of submittal (2003 IECC) – (thermal mass)
Residence E- 27.1 % better than code at time of submittal (2003 IECC)

Pima County is located in the Sonoran Desert of Southern Arizona, a region characterized by warm, sunny days and cool to cold nights resulting in large diurnal temperature swings. The range of temperatures that occur throughout the year—from 20° F on winter nights to 110° F on summer afternoons—require adequate provisions for heating and cooling in all residential construction. The storage capacity of high thermal mass construction assemblies allows structures to absorb heat during the day and release it at night thus tempering internal temperature. This approach has been used in desert regions for thousands of years and yet there is limited data available on thermal mass material. This study found that those residences employing thermal mass did not rate well with basic software checking programs such as REScheck. While REScheck does a good job of evaluating conventional building assemblies, the benefits of thermal mass are not well reflected in the program's capabilities.

Conclusion

It is important to recognize that this study was not undertaken to rate the residences themselves, but instead to assess the approaches taken towards rating a variety of construction techniques by several green building

rating systems. When documentation was unavailable, assumptions were made that may not reflect the actual as-built conditions. In an operational green building program, client education and design charrettes would contribute to ensuring complete submittals.

Size adjustment criteria are important factors to fairly assess a homes' energy and material requirements. A doubling of house size results in a 15 to 50% increase in energy consumption, and an increase in materials use from 40% to 90% depending on design. In the period between 1982 and 2004, the typical new single-family home in the United States grew some 40 percent larger from 1,690 square feet to 2,366 square feet, while the average number of occupants per household was reduced from 3.3 to 2.6 persons. Whether the appropriate neutral measure for a rating system is the national average home size or the average home size for the local jurisdiction requires vetting. Many new homes under construction in the Pima County area exceed the national average and encouraging well-designed, smaller homes is a desirable outcome of employing sizing criteria.

Allowances for appropriate use of natural materials and methods should be included to accommodate owner-builders and developers wishing to employ these elements. Finding a user-friendly energy assessment tool, or providing basic energy modeling for applicants will encourage those wanting to use building assemblies which may not have gained popularity with large-scale developers. Some outlying technologies were not accommodated in the NAHB and LEED systems, except through the award of innovation points. Of all the rating systems, the Scottsdale program excelled at designating point awards for region-specific methods such as cooling towers (used in the Residence A of the evaluated homes in the study), and methods to reduce heat-island effect. The Scottsdale system and the revised NAHB system were also the only programs that recognized the low impact of evaporative cooling systems.

The limited treatment of thermal mass performance, as mentioned above, is endemic to all national model energy codes which are directed at sealed insulated buildings and do not provide for the type of passive thermal and evaporative cooling/ventilation which can perform efficiently in desert regions. Passive systems, along with emphasis on cooling degree days instead of heating degree days will need to be further developed, not just within a green building program, but in future amendments to adopted energy codes.

Wise use of water is of paramount importance to our region and water conservation and water harvesting techniques should be encouraged by including many of the measures identified in existing green building rating systems. The use of water for energy generation is also well documented, with an average of 0.75 gallons of water consumed for each kWh of thermoelectrically generated electricity. Encouraging energy conservation and renewable energy can have a significant overall effect on a community's water consumption. This includes measures such as Energy Star lighting and appliances, cool roofing materials, rainwater harvesting systems, ultra-low flow fixtures and heat island reduction strategies that are especially appropriate in a desert region.

Another variable across rating systems is balance between categories. By requiring a minimum number of credits in every category, NAHB ensures that a home design will not underemphasize one aspect of sustainable construction. LEED for Homes requires minimums credits in four of the eight categories in addition to meeting prerequisites. The Scottsdale Green Building Program allows applicants to choose credits at will from among the categories once the mandatory measures are met.

After evaluating these rating systems, it is evident that each has components that could be used successfully in a Pima County Program. Attention to water conservation-related elements and sensitive site development are especially appropriate to the region and may require some credits specifically weighted for these categories.

Summary of Program Areas of Effectiveness

Program	Size Adjustment	Required Points in Categories	Mandatory Measures	Responsive Climate Adaptations	Coverage of Alternative Construction
LEED for Homes	Yes	Some	Yes	Fair	Fair
NAHB	No	Yes	Energy Efficiency Only	Fair	Fair
NAHB-amended	No	Yes	Energy Efficiency Only	Good	Fair
Scottsdale Green Building	Yes (based on local avg. home size)	No	Yes	Excellent	Good

Outlining the strengths of each rating system in the areas of size adjustment, local adaptation for climate, setting baseline mandatory measures, balance across categories, and recognition of alternative construction methods illustrates that each system has a unique character and approach to rating. The ability to draw from the best of each system is a distinct advantage from the recent past, when there were few well-developed systems to review.

While feedback from community stakeholders regarding the results of this study will be actively solicited, it does seem clear that the County will need to proceed with compiling a hybrid program emphasizing those issues most critical to our region while striking a balance regarding scale and type of construction. This approach should provide the most successful route to transforming the residential construction industry into a sustainable partner in the region's future.

Furthermore, integration between an eventual green building program and greater County land and infrastructure planning will be at the forefront of consideration. The County is currently undertaking multiple efforts striving to enhance the sustainability of development and will coordinate alignment among these efforts.

Assumptions

- If U-factor is not known, vinyl double pane Low E glazing is assumed to have a U-factor of .4 per 2003 & 2006 IEEC.
- If U-factor for exterior doors was not known, the assumed U-factor for a Steel door with foam insert was .35 per 2003 IEEC.
- If U-factor for garage doors was not known, the assumed U-factor for .6 per 2003 IEEC.
- Unless noted otherwise, assume all ducts are sealed, and in conditioned space.
- Unless noted otherwise, assume all windows have screens with a shading coefficient of .45

- Unless noted otherwise, assume all mechanical system filters are MERV 8 or greater.
- Unless noted otherwise, assume all ducts are sealed.
- Unless noted otherwise, assume the U-factor for rammed earth thermal mass walls to be .165 per table 402.1.3 of the 2006 IECC
- Solar Fraction for Solar Hot Water Heaters taken from the SRCC (Solar Rating and Certification Corporation) July 2007 ratings, unless otherwise calculated.
- If no specific recycled material content or manufacturer designation was noted for a material, assumed no recycled material (unless material typically contains recycled content in normal manufacture)
- If no specific manufacturer was noted for a wood-based material, no credit was given for FSC or SFC ratings.
- If a rating-specific strategy was noted (a specific LEED checklist for example), credit was only given if a similar, relatively equivalent measure was used and available.
- The LEED-Neighborhood Development credit is on hold until the completion of the pilot phase, and was not awarded for any rated residence.
- The LEED Homes Credit SS 6 for Compact Development was awarded based on the home's actual construction site (in situ), as none of the chosen locations were fully developed.

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