Value Created Through Operative Practice: Catalytic Affordable Housing and Legislation

JOHN FOLAN
Carnegie Mellon University

MARY HARDIN
University of Arizona

Over the past two decades, the vast housing expansion in the Sonoran Desert has focused almost entirely on market rate housing that addresses initial costs and market preference. In the same time span, there has been a dearth in the construction of housing that can serve below-market clients and the future oriented concerns of water use and energy demand. Projections for population growth, economic decline, energy demand, and water usage, indicate that market-rate housing will escalate in cost, be afforded by fewer, and will continue to be a liability in terms of environmental costs. For families at the threshold of regional poverty indices the initial costs of homeownership are often outstripped by cooling costs in the severe heat of the region. Rapidly diminishing water supplies suggest that water costs may soon contend for a significant portion of the homeowner's monthly budget. Alternative models of development and enlightened policy making is needed in an effort to arrive at a sustainable, future oriented solution.

Figure 1. *Civano Development*, Panoramic View, 1996

The Blueprint for Greening Affordable Housing produced by Global Green USA makes the case for the "greening" of affordable housing in America to provide significant environmental and social equity benefits [1]. The book provides a number of case study examples of Green affordable Housing projects around the country, and further provides a comprehensive list of all green affordable housing projects in the United States. Only two of the projects listed are located in the Greater Southwest region: Arroyo Chico in Santa Fe, New Mexico and Azoteca Senior Apartments in Alamogordo, New Mexico. None of the projects on the list are located in Arizona. On the *Design Matters:*

Best Practices in Affordable Housing website, featuring resource efficient projects (defined by efficient use of energy, water, and material resources) that were constructed or completed before 2000, again, only two projects represent the entire South-

west United States region [2]. Of greater significance is the fact that previous green affordable housing projects have not been all-encompassing to the extent of establishing value through the comprehensive union of research, performance guidelines, prototypical design, construction monitoring, and dissemination to the public; all of which are required in establishing credibility to effect greater, proactive sustainability legislation.

The Civano Demonstration Project seeks to establish a clarified definition for a set of affordable conservation strategies that achieve quantifiable results, demonstrated in practice, that can help in transforming local, state and federal legislation. As a comprehensive research investigation funded by the City of Tucson and Pima County, the work is founded on the outcomes of energy and water conservation strategies employed at the Civano Development, a 1,140 acre, market rate, pre-planned community located within the city limits of Tucson, Arizona, at the base of the Rincon Mountains. The Civano Development Plan, completed in 1996, was predicated on New Urbanist Design Principles intended to foster community interaction and quality neighborhoods *(Figure 1).* The housing design requirements for the Civano Development were established to elevate environmental performance standards, for the time, and position the development as a progressive sustainable community.

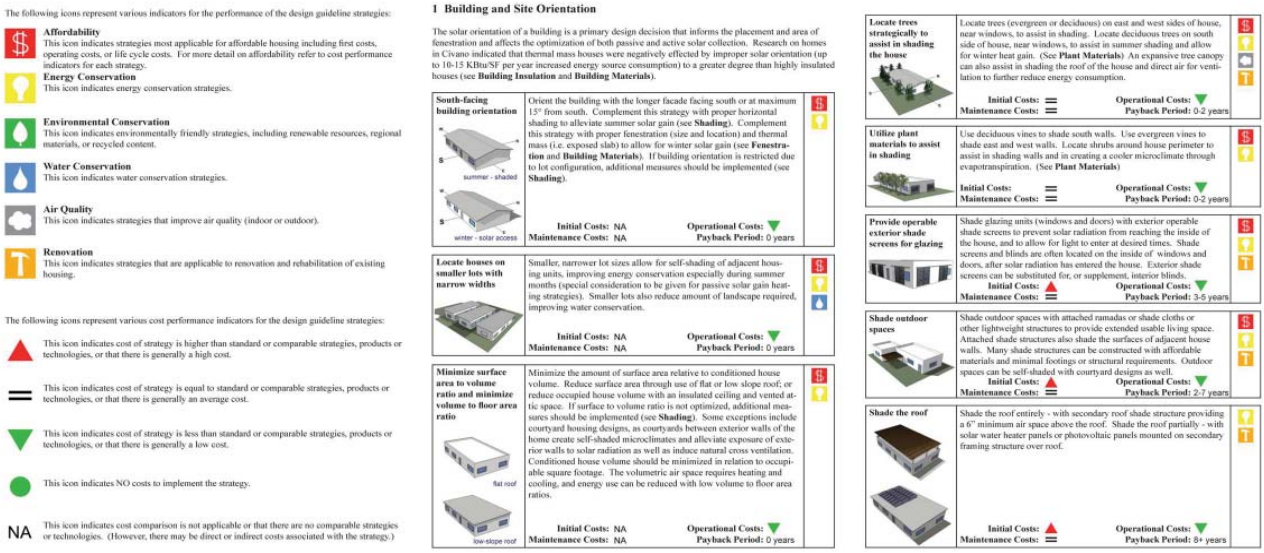

Figure 2. *Civano Demonstration Project Conservation Technologies for Affordable Housing Guidelines* excerpt from first iteration including value lexicon, 2006

The Civano Demonstration Project, initiated in 2005, commenced with the extraction of pertinent lessons learned and outcome-based research gathered at the original Civano Development. This information was codified into strategic guidelines to inform ongoing design and construction associated with the Civano Demonstration Project *(figure 2).* The award of the Civano Demonstration Project grant was based on a proposal to develop the reflective design of four, and construction of two, prototypical, sustainable, affordable housing units. The proposal stipulated that the two constructed prototypes, once occupied, would be monitored for energy and water use patterns over a one year period. The results of that monitoring and research will influence the revision of the strategic guidelines document which will be disseminated broadly to the A/E consulting, development and construction community in the southwestern United States. By virtue of the ground-up construction, the strategic guidelines will focus on energy and water conservation in new design and construction, but they also address strategies suitable for the retrofit of existing affordable housing. Broad dissemination will be facilitated through educational workshops and targeted outreach to sectors of the development community that can benefit from each of the research and design strategies explored. While the

work is, and will continue to be, focused regionally, it is intended that sensibilities will be transferrable on a broader scale that can influence legislation.

OPERATIVE PRACTICE: EXTENDING THE ROLE OF COMMUNITY OUTREACH AND EDUCATION

This project combines expertise of college faculty, students, and community partners to create modes for housing that will optimize the science of resource conservation within the lowest economic echelons of affordable housing. The project is innovative due to the nature of collaboration between four entities that each of those constituencies represent; Institute, University, Non-Profit, and City. The comprehensive approach which includes research and analysis, development of guidelines, design and construction of affordable homes, monitoring of occupied homes, production of re-evaluation guidelines with post-occupancy monitoring data, and dissemination of guidelines and designs to affordable housing developers and builders, enables the project's potential to have a broader influence than typical catalytic design-build interventions commonly affiliated with universities.

Because the Civano Demonstration Project has a significant design build component, it engages students throughout the design and construction phases, providing an educational environment with hands-on experience in sustainable building methods and exposure to community outreach, ultimately giving long term benefits to the design profession when these students engage in practice *(figure 3)*.

Figure 3. *Civano Demonstration Project,* Construction Sequence for Composite Construction Prototype 3 with students.

The involvement of students during the design and construction of these projects enables the prototypical dwellings to be made available to the lowest sector threshold of the affordable housing market – those demonstrating income levels at 60%, or below 60%, of the median household income. Architects and engineers working in the private sector will generally not donate pro bono time and exper-

tise necessary for generation of below market rate housing alternatives. Rather, their efforts focus on the 2% of the U.S. housing market that has the affluence necessary to employ professional services[3]. As a result, the presence of non-profit design-build entities within university settings is becoming more and more prevalent as a device for assisting communities desiring thoughtful, affordable, and well designed housing.

There are a number of non-profit design-build entities modeled after, or partnered with, Community Design Centers found throughout the United States. The coalition engaged in the Civano Demonstration Project is modeled similarly, but is distinctive in that it is an *Operative Practice*[4], one that is community oriented and educationally based, that achieves lasting positive change in the environments in which it interacts by extending work through legislation. The potency of the *Operative Practice* is historically reinforced through interdisciplinary and cooperative community partnerships; not through autonomous action.

Previous studies and research projects on green affordable housing that have been executed in regions other than the Southwest, have typically been conducted by single independent entities (i.e. either by builders/developers, government entities, or non-profit organizations). One example of regional sustainable design guidelines for housing executed by an independent entity is the Partnership for Advancing the Technology of Housing (PATH) *Guide to Green Building*, which is not specifically intended for affordable construction, but residential construction in general. The *Minnesota Green Affordable Housing Guide* is a website that provides strategies and well categorized information for the promotion of sustainable, healthy, durable, energy efficient affordable housing[5]. The set of strategies outlined in the Minnesota guide are comparable to the *Conservation Technologies for Affordable Housing* guidelines produced as part of the Civano Demonstration Project, but are for cold climates.

The Green Affordable Housing Coalition, composed of San Francisco area private and public sector professionals, is committed to advocating the implementation of green systems into affordable housing development within and around the bay area[6] but has not engaged in the construction of prototypical strategie; the coalition focuses on publication of fact sheets that address various technical issues associated with sustainable construction strategies. There is one example of residential construction technology guidelines for housing in general in the southwest region, A *Community Guide to Basic and Cost Saving Construction in the American Southwest*, prepared and published in September 2003 under the sponsorship of PATH through the Department of Housing and Urban Development (HUD)[7]. This set of residential construction guidelines provides an overview paragraph on relative costs associated with various strategies presented, but does not qualify the most cost effective strategies for affordable construction in the comprehensive way that the guidelines produced under this project do.

DEMONSTRATION AND TESTING THROUGH APPLIED RESEARCH

The exterior wall construction types utilized in the Civano Development homes studied for the *Conservation Technologies for Affordable Housing Guidelines* included thermal mass (rammed earth), high insulation materials (straw bale), and composite systems (insulated concrete forms). Although the performance of these construction methods tend to result in improved energy performance, the current material and labor costs for such systems tend to be more costly than traditional frame and wall designs. Additional design research was conducted to determine appropriate and affordable exterior wall construction for the development of the four model houses being designed as part of this project. The design research informed the idea of implementing a ventilated wall cavity with insulated frame construction to develop a strategy that will be tested and evaluated during the first year of occupancy. The choice of materials for the exterior walls includes metal panel and fiber cement board; both recyclable and recycled content materials. The selection of materials was intentionally biased toward a deviation from typical high embodied energy stucco exterior wall finish which is often utilized in affordable housing enclosure systems throughout the Southwestern United States.

The projects also incorporate hybrid exterior wall systems utilizing costlier thermal mass envelope construction in selective locations with more affordable insulated wood or metal frame walls where appropriate. This design strategy optimizes both

the energy and cost performance of the homes by combining passive solar strategies utilizing thermal mass materials with standard frame construction. Reflecting the desire to demonstrate affordable strategies on infill center city lots, the houses have been designed for narrow aspect ratios in both the east-west and north-south orientations. The aspiration of the work is to identify solutions that are compatible and specific to both orientations, alleviating sole dependency on solar optimization and allowing for both hybrid envelopes and ventilation strategies to provide energy performance enhancement.

Figure 4. *Civano Demonstration Project,* View from northeast corner and plan of Prototype 3.

For project houses located on the north-south oriented lots, adverse solar exposure of the east and west walls is addressed by minimizing fenestration on these facades and providing deep eave and vertical baffle overhangs by extending the metal panels beyond the building perimeter edges to shade the walls *(figure 4).* Project houses located on the east-west oriented lots focused on the use of operable insulative screening panels *(figure 5).*

Figure 5. *Civano Demonstration Project,* Views of Prototype 3.

As single exemplary strategies for each orientation typology, each produces a quantifiable performance characteristic that can be utilized as a metric in monitoring efficacy; those metrics can then be utilized in promoting incentivized legislation and code adoption that can facilitate localized awareness and intervention into broader, communal sensibilities. While those strategies address energy conservation, the use of xeriscaping and maximized water harvesting in all prototypes enables quantification and translation of water conservation strategies that may propel current legislation into broader acceptance.

CONTEXT: CURRENT AND RELEVANT SUSTAINABLE LEGISLATIVE POLICY

Selective policies are already in place in the state of Arizona which are intended to encourage sustainable residential development, such as tax credits for water conservation systems (ARS 43-1090), solar energy devices (ARS 43-1083), and tax incentives for energy efficient residences (ARS 43-1031). These incentive based statutes generally provide a tax credit or a deduction from the taxpayer's Adjusted Gross Income (AGI). The allowed amount is 25% of the cost for a solar energy device or water conservation system up to $1,000, while construction of an energy efficient home can qualify for 5% of the initial sales price, up to a maximum of $5,000. The state has a limit on the amount of these tax credits in any given year that are apportioned on a first-come first-serve basis. In the case of awarding the subtraction to a taxpayer's AGI for constructing an energy efficient residence, the statute outlines some general compliance criteria. The performance of the house must exceed the 1995 Model Energy Code (MEC) by 50% as determined by a rating system that complies with the US DOE HERS rating program. The Arizona Department of Commerce (DOC) Energy Office provides a comprehensive list of the criteria used to determine the energy efficiency rating that will qualify for such a subtraction. Other than these incentive based statutes, there is very little policy in place in the state of Arizona to enforce the construction of sustainable residential development.

ARS 9-461.05 for General Plans (defining authority and scope) outlines the components to be included in all Municipal Plans. The statute mandates that municipalities (depending on populations) include some fairly comprehensive planning elements, some of which include sustainable development direction such as:

1. Identifying programs and policies that promote infill or compact form development activity in the Land Use Element:
2. Provide consideration of air quality and access to incident solar energy for all general land use categories in the Land Use Element.
3. An Energy Element to identify policies that encourage and provide incentives for efficient use of energy.
4. A Conservation Element to regulate the conservation, development and utilization of natural resources.

The statute also includes components that may apply more specifically to affordable housing development: a *Housing Element* and a *Conservation, Rehabilitation and Redevelopment Element.* There is currently a Senate Bill (S.B. 1385) in the state legislature for amending the statute relating to Municipal Plans to provide a separate section for *Neighborhood Preservation and Revitalization Elements.*

Arizona is a Home Rule State. The codes are continually adopted and enforced on a local level. Today, thirty local municipal governments in Arizona have adopted energy codes or codes which incorporate energy provisions[8]. However, there are still some jurisdictions that do not require any specific energy standards to be met for residential construction. In addition, the energy codes that have been adopted in various jurisdictions are generally limited to the International Energy Conservation Code (IECC), and only a few municipalities have included local amendments to these code requirements for regional differences. The IECC requires that energy analysis calculations be provided for code compliance verification: the analysis programs often approved in various jurisdictions in the state of Arizona are ResCheck or ComCheck. Neither of these software programs account for solar orientation when conducting the energy performance analyses. This is a major problem for construction in the Southwest, as the findings from our demonstration project study indicate solar orientation to be a significant factor on the energy performance of a structure – particularly those that incorporate passive solar designs. In situations where proper solar orientation cannot be achieved, other features, such as additional insulation, should be enhanced to mitigate the encumbrances of poor orientation. The energy analysis programs for code compliance verification also do not account for passive strategies such as natural ventilation or passive solar gain. These are limiting code compliance barriers for the potential acceptance, improvement, and development of truly sustainable affordable housing.

Recently a House Bill (H.B. 2766) was withdrawn from the Arizona State Legislative process that included the establishment of energy efficiency goals for residential construction. The Bill also addressed renewable energy goals including renewable fuel sources. The precise reason for the withdrawal of the bill is unknown. Consensus speculation is that the bill was considered too all-encompassing, eliciting objections to a number of detail components by special interest groups. The most relevant provisions of the proposed bill for raising standards were the following:

1. Define energy efficient buildings as new residential and commercial buildings that meet or exceed specific metric based national energy efficiency standards.
2. Establish construction of energy efficient buildings as a state policy and recognize the IECC as the voluntary state energy code.
3. Establish statewide goals for new buildings phased over the next 12 years. The percentage of new buildings that must be more efficient, on average, than 2006 standards would be: 15% by 2012, 30% by 2016 and 50% by 2020.
4. Require the DOC Energy Office to track the number of energy efficient buildings constructed in Arizona, compile the information, submit an annual report and present the information to the legislature.
5. Require the Director of the Department of Housing to establish guidelines that require all new, state funded, multi-family housing construction to meet specific energy efficient standards.

This final condition aligns most closely with the goals of the Civano Demonstration Project. One of the major concerns with mandating stringent energy efficiency standards for affordable hosing development is that the cost impact will be burdensome to the extent of undermining project feasibility. The guidelines established under our project are targeted at assisting the Director of the Arizona Department of Housing (ADOH) make decisions on specific energy efficiency standards for guidelines that are feasible for affordable housing development. Upon review of the 2008 State of Arizona Qualified Allocation Plan (QAP) for Low Income Housing Tax Credit (LIHTC) projects, which are administered by ADOH, it was found that there is a Water Conservation section awarding up to 10 points but there is currently not a section or any provisions for Energy Conservation. The ideal positioning for the Civano Demonstration Project study findings to be implemented into policy most feasibly is through the State LIHTC QAP in coordination with the ADOH.

Global Green USA conducted a review of the state QAPs across the nation and provided a tax credit incentive report, titled *Making Affordable Housing Truly Affordable: Advancing Tax Credit Incentives for Green Building and Healthier Communities*, in December of 2005[9]. Global Green USA analyzed the various state QAP project points against the parameters of the US Green Building Council (USGBC) Leadership in Energy and Environmental Design (LEED) rating system[10].The findings indicate that the State of Arizona ranked within the top five of states assessed. However, only four states, excluding Arizona, reward or incentivize the use of renewable energy sources on a project. Considering the effectiveness of solar renewable energy in Arizona, as well as the need by utilities to offset their peak demand loads on electric infrastructure supply, there could be many possibilities for partnering or receiving donations from electric utilities to affordable housing projects[11].

The Global Green Report also indicates some strategies, or next steps, for improving the tax credit allocation policy for all states, indicating that there should be a national framework that is established for sustainable building requirements in all QAPs. It may be difficult to begin at the national level due to the continuing debates about cost impact on feasibility for LIHTC projects. There is already a financing gap that needs to be filled. And this can potentially create a higher construction budget, making implementation even more difficult. Our project's goals for policy implementation are to incorporate more rigorous and comprehensive sustainable building requirements into the state QAP and to test selected strategies at a regional level first, provisionally.

STATE LEGISLATIVE IMPLEMENTATION STRATEGY

The conservation technology based outcomes of this project will ultimately be implemented at a statewide level in affordable housing through the Low Income Housing Tax Credit (LIHTC) Qualified Allocation Plan (QAP) for the State of Arizona. The climate appropriate affordable conservation techniques put forward by this study can be incorporated into local affordable housing projects by local non-profit developers and affordable housing builders. The research will be extended beyond the local arena by inclusion in the LIHTC State QAP point system to count towards an improved qualifying total for projects that contend for the credits. The goal of implementing these conservation strategies through the State QAP is to see future LIHTC projects constructed and operated with greater energy efficiency and improved water conservation towards overall enhanced sustainability and improved affordability in the State of Arizona affordable housing development industry.

FEDERAL LEGISLATIVE IMPLEMENTATION STRATEGY

A further progression of this policy would be to incorporate selected conservation strategies into each state's LIHTC QAP for point benefits to be credited to projects throughout all states that choose to implement energy and water conservation concepts. Another possibility for future implementation is to include a set of selected conservation strategies within the Federal level HOPE VI Reauthorization legislation as a set of safe harbor guidelines that could be incorporated into the design of HOPE VI affordable housing projects for increasing the sustainability of affordable housing nationally.

EXPECTED EFFECTS AND RESULTS OF POLICY

The expected effects and results of implementing

energy efficiency criteria into the State LIHTC QAP can be quantified based on the average number of LIHTC residential units approved in the state each year. Historically, the number of LIHTC units approved in the State of Arizona has been: 1,418 total units in 2008, 1,201 total units in 2007, 1,527 total units in 2006, and 1,447 total units in 2005. Based on an average from these historic figures, the projection for 2010 when the potential integrated energy conservation points will be applied to the construction of new and renovated LIHTC project units is approximately 1,400 total units. The average LIHTC project is around 40-units each, providing an average of 35 projects per year statewide.

If it is assumed that half the LIHTC credits approved will include solar hot water heating, and our study indicated that solar hot water heating saves 4.6 KBtu/SF per year, for an average 800SF residential unit times 700 units, the resulting energy savings will total 2,576,000 KBtu per annum. The specification of high reflectance of materials (reflectance 0.75-0.9) provides an energy savings of approximately 0.5 KBtu/SF per year when compared to non-reflective roof materials. If we assume that three quarters of the future LIHTC projects (in 2010) implemented high reflectance roofing, the total energy savings could achieve 420,000 KBtu per year.

Although the current State of Arizona QAP includes a *Water Conservation* section, awarding points to projects that include such strategies as xeriscaping and graywater systems, if certain aspects within this section were mandated as requirements there could be an immense water resource savings. Xeriscape Landscaping requirements and reclaimed water use for landscaping with appropriate site grading for utilization of storm water provides an annual potable water savings of approximately 32,000-38,000 gallons per single family household. If all future LIHTC projects incorporated xeriscaping, rainwater catchment, and appropriate site grading for storm water use, the annual water savings in the first year of implementation could be approximately 5,600,000 gallons (assuming 160,000 gallons savings per project due to multi-family developments providing common landscaped outdoor space at about four times the amount of a single family residence assuming 35 projects).

Post Construction whole house pressurization allows for infiltration and air leakage testing of the project construction to ensure quality control and to optimize energy performance. If future LIHTC projects (both new and retrofit) instituted air leakage testing and remediation prior to occupancy, the heating season energy source consumption savings could be up to 20% and the cooling season energy source consumption savings could be up to 13%, providing for an immense reduction in statewide energy resource consumption. Since most energy resources in the State of Arizona are primarily sourced from coal powered plants, the carbon emission reduction from implementing simple air leak tests would extend as well to a great environmental savings.

It is imperative in this time of global climate change, natural resource depletion, and ever increasing socio-economic dispersion that enforcement and incentives for encouraging a movement towards resource efficient affordable housing construction be necessitated. The Civano Demonstration Project has defined and outlined a number of specific strategies to assist such a movement at the state and regional level. We are certain that the implementation of some of the strategies defined during our research, design, and construction will be beneficial to future affordable housing developments in the State of Arizona. We are also confident that the process undertaken on this project has and will award many design and construction professionals with resource conscious methodologies, providing a lasting effect on the future sustainability and value of affordable housing in this country.

ENDNOTES

1. Wells, Walker, ed. For Global Green USA, 2007. Blueprint for greening Affordable Housing. Washington, D.C.; Island Press.

2. City design center, *Design Matters: Best Practices in Affordable Housing*, *(wall.aa.uic.edu:62370/ahc/catalog/home/html)*, June 2008. Chicago, Il.

3. Bell, Bryan, ed. 2004, *Good Deeds Good Design*, New York, NY: Princeton Architectural Press.

4. Jason Pearson presents and defines the term "operative practice" in the final chapter of *Good Deeds Good Design*, 2004.

5. Center for Sustainable Building research, *Minnesota Green Affordable housing Guide*. *(www.greehousing.umn.edu/index.html)*, June 2008, Minneapolis, MN.

6. Green Affordable Housing Coalition, *(http://frontierassoc.net/greenaffordablehousing/Index.shtml)*, June 2008

7. Steven Winter Associates, Inc. and U.S. department of housing and Urban development. 2003. *A Community Guide to Basic and cost Saving Construction in the American Southwest*, Washington, D.C.; PATH.

8. Eisenberg, D., Done, R., and Ishida, L. 2002. *Breaking Down the Barriers: Challenges and Solutions to Code Approval of Green Building.* Tucson, AZ; Development Center for Appropriate Technology.

9. Global green USA. December 2005. *Making Affordable Housing Truly Affordable: Advancing Tax Credit Incentives for Green Building and healthier Communities.* Santa Monica, CA.

10. USGBC LEED Rating System is the most widely acknowledged green building third party verifying function currently instituted in the United States.

11. Habitat for Humanity recently developed affordable single family housing in Apache Junction, AZ and received a donation from the local energy utility of 3kW photovoltaic panel systems for each residence.

12. According to the Energy Information Administration (2000).