Paisano Green Community
4000 East Paisano Drive, El Paso, Texas
Housing Authority of the City of El Paso
Beyond IECC 2009

Project Narrative

Introduction

Paisano Green Community is on the leading edge of sustainable design and construction in affordable housing.

The community will be LEED Platinum and Enterprise Green Communities certified.

Through innovative design, the project will minimize its energy consumption. Solar and wind energy will be captured by renewable energy systems on site, allowing the project to achieve NetZero status. This means that energy produced on site, will equal or exceed energy consumed on site.

In addition, this project will be the first of its kind not to burn fossil fuels on site. Clean electric power generated by the sun and wind will be the sole sources of energy, minimizing the project's carbon footprint.

Paisano Green Community is a 73-unit senior housing facility located in central El Paso. It contains a mix of one and two bedroom units in a variety of configurations. Also on site is a community center with spaces for on-site management and community functions.

Sustainability and Energy Efficiency

The Paisano Green Community takes a comprehensive and broad based approach to sustainable design, paying attention to climate, site context, passive systems, active mechanical systems, and renewable energy generation systems.

Sensitivity to Place

Sustainable design is sensitive to "place". It responds to the conditions of the site — both built and natural. Important factors include topography, as well as plant cover and climate. The built context is also significant in shaping sustainable design. Buildings, roadways and other elements in the urban fabric inform and shape the design of a project.

Sustainable design is therefore unique to its place. An appropriate design solution in El Paso would be inappropriate in Seattle.

The design of the Paisano Green Community responds to the unique conditions of the site in El Paso. It is tailored to respond to the intense sun and wind of the Chihuahuan Desert locale. Water is the most precious resource in this environment — much more so than energy. The design responds to its urban location in ways that both integrate it into the built fabric, and at the same time protect it and its inhabitants from the surrounding environment. It is a solution so interwoven into the nature of its place that it could not be duplicated in another location.

Climate

El Paso is a hot desert climate. The sun shines almost constantly. With the exception of summer afternoons, skies are clear all day.

Average daytime temperatures range from 65 degrees during the winter to 95 degrees during the summer. It is not uncommon for summer daytime temperatures to exceed 105 degrees.

El Paso is unlike other desert communities however, as it is located at an elevation of 4,000 feet above sea level. As a result, nighttime temperatures are quite cool. Summer nighttime lows average 75 degrees. During the winter it is common for nighttime temperatures to hover around freezing.

The area receives less than eight (8) inches of rain per year. On summer afternoons clouds build over the desert to the southeast, move over the city and drop rain. It is common for the area to receive all of its yearly rainfall in a very few intense events each summer.

El Paso is also very windy during winter and spring months. Strong westerly winds during these seasons pick up sand and dirt from the desert and carry it across the city.

During summer months prevailing breezes come from the southeast.

Site/orientation

The project site is located in central El Paso very near the international border with Mexico. While at one time this area was mostly residential, it has slowly been taken over by industrial and civic uses. The result is a site nearly surrounded by large expanses of asphalt parking lots, freeways and highways that absorb and retain heat. In addition, these areas offer little to block winds.

The site itself is roughly rectangular in shape with its long axis running north/south. It is bounded on the north and east sides by public streets, on the west side by a facility operated by the State of Texas for inspection of commercial vehicles crossing the international border and on the south side by a large, deep gravel lined pit that serves as storm water detention for the truck facility.

Vehicular circulation on the site is pushed to the western and southern margins. Structures are used to create a well defined set of edges and organized around a large central garden that runs along a north/south axis through the site. Although the site's primary axis is north/south, buildings are mostly oriented with their primary axes running east/west to create favorable exposures for primary walls and window openings. In instances where the overall orientation of a building is north/south, smaller volumes are rotated so that individual spaces still have favorable orientation.

Energy Efficiency Strategies - Passive systems

Envelope: insulation

Design of the Paisano Green Community is based upon the understanding that conservation of energy within a structure produces the best return on investment. It is more cost effective to insulate a structure well to minimize heat loss in winter and heat gain in summer, than to invest in renewable energy systems.

At Paisano Green Community the walls are insulated to R-28 and the roofs to R-30. The insulation system is a hybrid of three installations:

- 1" rigid board insulation (R-4) on exterior face of wall to eliminate thermal bridging at wall framing.
- 1 1/2" blown in closed cell polyurethane foam (R-10) to provide air sealing and partial insulation in all exterior walls.
- 4" net and blown fiberglass fill insulation (R-14) in walls to provide the balance of the resistance to thermal conductance at lower cost.
- 8 1/2" open cell spray foam insulation to provide R-30 insulation and air sealing in the roofs.

There is one caveat to the concept of a well insulated envelope as the most cost effective way to conserve energy: studies for the Paisano Green Community have shown that for the climatic conditions at the site, as insulation levels exceed R-30 for roofs and R-28 for walls the additional energy reduction does not offset the cost of the additional insulating material. When insulation reaches and exceeds these levels infiltration losses become much more important in determining overall energy performance of the structure.

Envelope: air sealing

Although insulation is critical to conservation of energy, in cooling dominated climates infiltration loss is even more important. More energy is lost through air leakage, at gaps, cracks and penetrations of the wall and roof systems than by conduction through those same walls and roof. Making a building air-tight is key to energy efficiency in El Paso.

A goal of the Paisano Green Community was to achieve less than .15 air changes every hour, or approximately one air change every seven hours, to minimize infiltration losses.

To achieve this, the exterior skin of the structure is sealed on both the interior and exterior faces. The exterior of the building is wrapped with a vapor permeable infiltration/weather barrier. The infiltration barrier is continuous over all exterior surfaces. All seams are lapped and taped to prevent leakage.

Interior surfaces of the walls and roofs are sealed to prevent air infiltration. A spray-in-place closed cell polyurethane foam insulation is used to both insulate and seal all cavities in perimeter walls. This air sealing is further reinforced by careful sealing of all joints in wall framing systems and the perimeter of all penetrations to create a continuous barrier to air infiltration.

View of the south elevation of Flat A. Deep overhangs protect all south facing glass. White light shelves at the base of each opening reflect daylight into the apartments.

Envelope: high albedo surfaces

High albedo surfaces are used through out the project to reduce heat island effect and minimize cooling loads. Roof and wall surfaces are predominantly white or light colored to reflect as much of the sun's energy as possible and to minimize absorbed radiant energy.

White TPO roofing, light colored stucco and white metal roofing comprise most of the exterior surfaces of the building envelope.

Envelope: fenestration orientation

Most windows are located on south and north walls where sun exposure is most easily controlled. Eastern and western facing glass is minimized to avoid solar heat gain.

Shading

Windows within south facing walls are shaded by louvers or deep overhangs. Eastern facing glass is protected by horizontal louvers wherever possible. The few west facing windows are protected by very deep overhangs.

Depths of overhangs on the south wall are calibrated to the sun so that most windows receive full sun during winter months and no sun during summer months. The passive solar gain during winter helps reduce heating loads and improve thermal comfort of the residents. Summer shading minimizes solar gain to reduce cooling loads.

U-value/SHGC

Windows are dual glazed fiberglass. A low emissivity coating has been applied on the second face (inside face of the exterior pane of glass) because of the cooling dominated climate in El Paso. Individual window units have U-values of .27 and SHGC (Solar Heat Gain Coefficient) of .28.

Light shelves

Large south facing windows provide excellent daylighting to reduce artificial lighting loads. Deep ledges in the south wall are clad in light colored metal roofing. These “light shelves” reflect light — but not heat — into the interior, improving energy performance.

Radiant barriers

Energy models developed early in the design process showed that west facing walls have a critical relationship to energy performance due to the intensity of the sun in El Paso. In this climate west facing walls absorb a tremendous amount of radiant energy. A west facing wall - even when insulated to R-24 - will conduct as much heat to the interior of the structure as a south facing R-3 window.

A view to the north through the canopy wall structure. The perforated panel screen - visible on the left side of the image - shades the west facing walls of the apartments - visible on the right side of the image.

The design of the structures at Paisano Green Community paid special attention to this source of heat gain. The canopy wall structure on the west side of the site is a large radiant barrier that protects the west walls of the flats from the sun. This lightweight, open steel structure is clad in perforated metal panels and topped by an array of photovoltaic panels that prevent the sun from striking western facing walls. At the residential structures along Boone Avenue, the exterior west wall contains a ventilated cavity between the exterior skin and the insulated portion of the wall, preventing the sun’s energy from being transmitted to the interior.

Energy Efficiency Strategies - Active systems

HVAC

Heating and cooling of individual apartments is achieved through the use of high efficiency mini-split air source heat pumps. This decentralized system - where each apartment has its own mechanical unit - is far more flexible and energy efficient than a centralized system. Each mechanical unit can respond to the unique thermal requirements of the units' residents. The result is that energy consumption is reduced and thermal comfort is increased.

The HVAC units installed at Paisano Green Community are a minimum 16SEER, and are ductless. Ductless systems are inherently more efficient, as they eliminate the need for moving large quantities of conditioned air, whose conveyance results in energy losses to adjacent surfaces. Rather than ducting air, each system has multiple heads that are installed in living and bedroom spaces. This allows different heating and cooling zones for each individual space for better thermal comfort within each space.

Every unit has a digital programmable setback thermostat to allow space conditioning to be matched to the residents' patterns of inhabitation.

Water heating

Paisano Green Community was originally designed to have a solar thermal system to provide hot water to the residences. Energy models showed that for most of the time this system would provide water heating at minimal cost - in fact for much of the year it was expected that large amounts of energy would need to be dumped into the earth to keep the system from overheating during periods of low demand. The largest drawback to the solar thermal system was the need for a centralized gas-fired boiler back up system to provide hot water during those rare periods when the sun would not be shining and the demand for heated water would exceed the capacity of the solar thermal system's storage tanks. The boiler back up system had a high capital cost.

The water heating system for the project was changed at the start of construction when a new technology - air source heat pump water heaters - became available. These water heaters are two to three times more efficient at creating hot water than a traditional electric resistance water heater. In effect they work like a refrigerator in reverse. They remove heat from the air surrounding the unit and transfer it to the water inside the tank.

Air source heat pump water heaters have been installed in each apartment. This change allowed the solar thermal system and its central boiler back up system to be eliminated. Because the boiler system was the only natural gas fired system on the project, its elimination resulted in the elimination of all gas distribution piping on the site. The local gas utility no longer provides a tap for the site. Elimination of the solar thermal system freed up roof space to allow the solar photovoltaic system to be enlarged. The increased electrical generation from the enlarged PV system, offset the increased electrical consumption of the water heaters. This resulted in the project becoming energy neutral, or NetZero.

Air source heat pump water heaters provide a secondary benefit. By placing them within each individual apartment, the water heaters draw heat out of the air within the interior space, reducing the air-conditioning load.

ERV

Because of the extremely tight construction of the buildings at Paisano Green Community, HRV/ERV units are required to supply fresh air to the units, while capturing the energy of the interior air being exhausted. ERV (Energy Recovery Ventilation) units are air to air heat exchangers. These systems capture the energy in the air being exhausted and transfer it to incoming fresh air. The units draw in fresh outdoor air and temper it with the heated or cooled air being exhausted from the interior. The energy required to operate the ERV's, is far less than the energy that would be required to heat or cool the incoming fresh air.

The ERV units provide constant filtered fresh air — critical given the proximity to thousands of cars idling all day waiting to cross the adjacent international border and the likelihood of respiratory ailments for the resident senior population. The units are low noise, reduce allergens and toxins, and contribute significantly to the project's high energy efficiency goals.

Lighting

Energy efficient lighting has been used throughout the project. Within individual apartments all lighting uses fluorescent lamps. Circulation and site lighting is almost entirely LED. Circulation and site lighting has a secondary control system which dims fixtures late at night. During this late night period, motion sensors increase illumination levels temporarily as residents move across the site.

Appliances

All appliances installed within the Paisano Green Community are energy star rated.

Renewable Energy Systems

Solar

As noted earlier, the sun is a powerful force in El Paso. The sun shines more than 3,700 hours each year - roughly 83% of daylight hours. Solar insolation - a measure of the strength of the sun's energy that strikes the ground - is highest in desert regions of the southwestern United States. In El Paso solar insolation exceeds 2100 kWh/kW-yr. Solar photovoltaic systems installed in this region produce more electricity, and produce it more efficiently, than in other parts of the country.

At Paisano Green Community, the PV system's generating capacity is as follows:

Residential roof mounted panels	640	panels	155	kW
Community building roof panels	126	panels	27	kW
Total	766	panels	182	kW

The community building system can be expanded by a further 23kW to bring total system capacity for the site to 205kW.

View of the south elevation of Flat A with solar array visible on the roof.

Wind

Two 10 kW turbines have been installed at the northwest corner of the site. Each turbine is mounted on an 80' tall monopole so that the blades are at the bottom margin of laminar flow - where the wind tends to move at a constant speed and direction with limited turbulence from obstacles on the ground.

The wind turbines project a powerful visual image of the project's commitment to sustainable energy systems. During winter and spring months, when winds off the Chihuahuan Desert to the west blow strongest, the turbines contribute most significantly to energy produced on site.

View of the canopy wall from the west side with wind turbines to the north.

Energy analysis: design versus built to code

Paisano Green Community has been designed to achieve NetZero energy use. It has been the goal of the Housing Authority of the City of El Paso, as well as the design team, to create a set of buildings that will over the course of a year, produce as much energy on site as will be used on site. The goal for a NetZero project is achieved through careful design of structures to minimize energy consumption, coupled with on site energy production. In designing for net-zero, the project's structures require far more efficient envelopes than standards established by the local municipal requirements: at the time of design IECC 2003, and currently IECC 2009.

Code Comparison: HACEP Paisano Project and IECC 2009

The current energy code for the City of El Paso, Texas, is the 2009 IECC (International Energy Conservation Code). Table 1 shows a comparison of the code required envelope characteristics (found in Table 402.1.1 - INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT) for Climate Zone 3 and the as-built characteristics of the Paisano project. It is important to note that the 2009 IECC only details requirements for envelope and infiltration features; for the energy use comparison, the code base case was modeled with 10% CFL lighting, federal minimum appliance efficiencies, and no mechanical ventilation system, as seen in Table 1. The heating and cooling system of the code base case is a split air-source heat pump system meeting the current federal minimum efficiency standard, and the domestic hot water system is modeled with an electric water heater, also of federal minimum efficiency.

The building envelope elements and space-conditioning equipment efficiencies of the Paisano project are greater than or equal to the code base case, as shown in Table 1. In addition, the Paisano project includes more efficient lighting, improved ventilation and a high efficiency hot water heater.

Table 1: Comparison of Building Design versus Code Requirement

Building Element:	**HACEP Design**	**Code Base Case**
BUILDING ENVELOPE	As built	Values from IECC 2009 Tables 402.1.1 and 402.1.3 (Climate Zone 3B)
Above-grade walls	R-23 cavity insulation AND R-5 continuous exterior insulation	R-13 cavity insulation OR R-10 continuous exterior insulation
Slab Floor	none	none
Floor over ambient	R-30 cavity insulation	R-19 cavity insulation
Roof	R-30 cavity insulation	R-30 cavity insulation
Opaque Doors	U-factor = 0.23	U-factor = 0.50
Glass Doors	U-factor = 0.27, SHGC = 0.26	U-factor = 0.50, SHGC = 0.30
Windows	U-factor = 0.28, SHGC = 0.28	U-factor = 0.50, SHGC = 0.30
Infiltration	• 2.9 ACH50	Maximum of 7 ACH50
ELECTRICAL SYSTEMS		
Lighting	• 100% high-efficacy bulbs	• 10% high-efficacy bulbs
Appliances	• Energy Star	• Federal minimum standard
PV system	• 2.5 kW per unit	• none
MECHANICAL SYSTEMS		
HVAC System Type	Air-source heat pump. Cooling SEER = 16, Heating HSPF = 11.3	Air-source heat pump. Cooling SEER = 13, Heating HSPF = 7.7*
Domestic Hot Water	• 63-gallon air-source heat pump. EF = 2.35	• 50 gallon electric. EF = 0.92**
Ventilation System	• Heat recovery ventilator, 66% sensible recovery efficiency.	• none

** Federal minimum standard (Energy Conservation Standards for Residential Central Air Conditioners and Heat Pumps, effective Jan. 1, 2006)*
*** Federal minimum standard for electric water heaters*

Table 2 compares the estimated annual energy consumption and energy cost of a typical unit in the Paisano project to a geometrically identical unit meeting the IECC 2009 minimum requirements. A large photovoltaic system and two wind turbines provide renewable electrical energy to offset consumption of the 73 units in the Paisano project. The example unit was modeled with its photovoltaic portion of 2,100 watts. The IECC 2009 comparison unit was modeled without renewables.

Table 2: Annual energy consumption and cost for Paisano project 1 bedroom versus built to IECC 2009.

	Annual Energy Consumption (MMBtu/yr)		**Annual Energy Cost ($/yr)**	
	Paisano 1 bdrm (estimated)	**IECC 2009**	**Paisano 1 bdrm (estimated)**	**IECC 2009**
Heating	1.8	4.2	49	112
Cooling	2.1	3.8	58	104
Water Heating	3.0	7.7	81	208
Lights & Appliances	11.6	14.1	315	382
Photovoltaics	-14.3	0	-387	0
Service Charge			75	75
Total:	**4.3 MMBtu/yr**	**29.8 MMBtu/yr**	**$191/yr**	**$882/yr**

The project contains several types and sizes of apartments. The apartment modeled for this analysis is a one bedroom unit at the end of the top floor of one wing of flats. This unit has greater exterior wall areas and a roof area included within the model. Units on lower floors and non-end units will have lower energy consumption due to smaller building envelope losses.

Table 2 also shows the impact of patterns of inhabitation on energy consumption when building systems, both passive and active, are designed for energy efficiency. Energy use for lighting, appliances and other plug loads - home electronics, etc. - become disproportionately large in their effect on the overall energy performance. In a unit built to IECC standards, plug loads represent 47% of total energy use. In the Paisano Green Community units plug loads represent 63% of total energy use.

While the goal of the project is to achieve NetZero energy use, the design team and HACEP, were aware that energy usage by residents for non-space conditioning and water heating would be difficult to estimate accurately without data specifically applicable to the planned resident population - senior and disabled persons. HACEP opted to initially design and build to slightly less than NetZero, dramatically reducing capital costs, and to implement a two year monitoring program to measure actual consumption by the project's residents. At the conclusion of the monitoring program, the actual energy consumption on site will be known, and if needed, the photovoltaic array on the community building can be expanded, to achieve true NetZero.

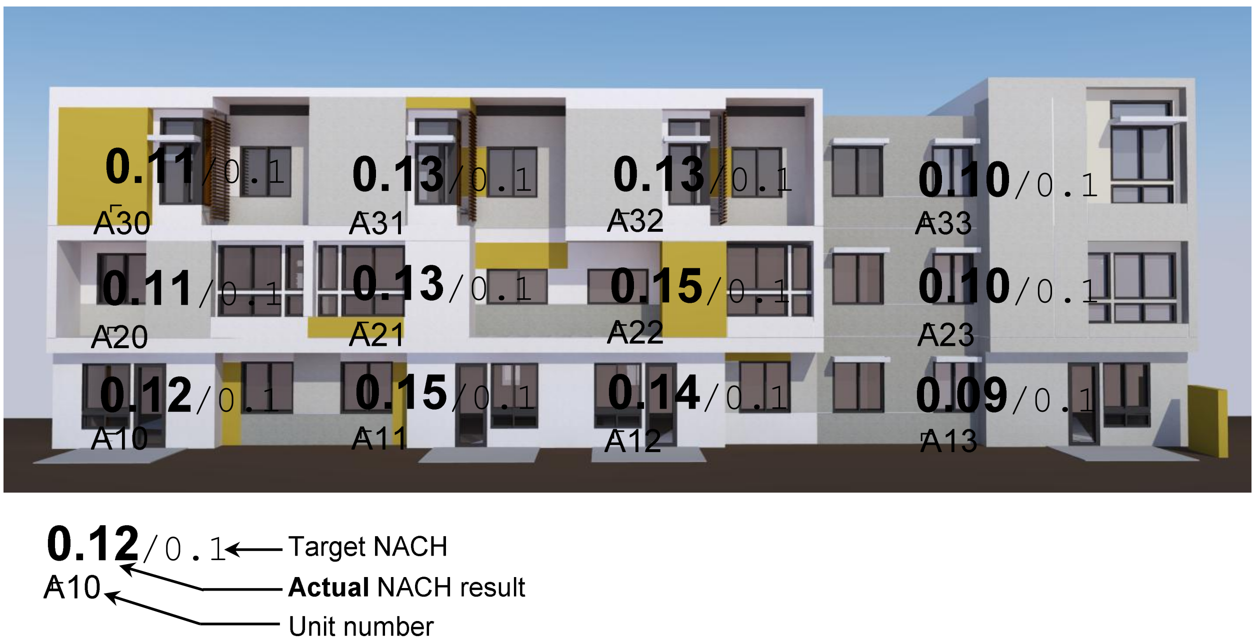
Beyond Modeling - Results

Blower door tests

During construction, Sustainably Built, the HERS rater and LEED green rater on the project, conducted blower door tests to measure the air-tightness of the units. Sample blower door test results for the apartments in one block of flats are shown in the graphic in Table 3.

The target rate for net air changes in the units was 0.15/hour. The achieved rates varied as shown in Table 3. The design team found that units with more perimeter wall actually performed better. It is believed that this is result of unit-to-unit leakage through party walls. Units with party walls on each side were not as airtight as those with only one.

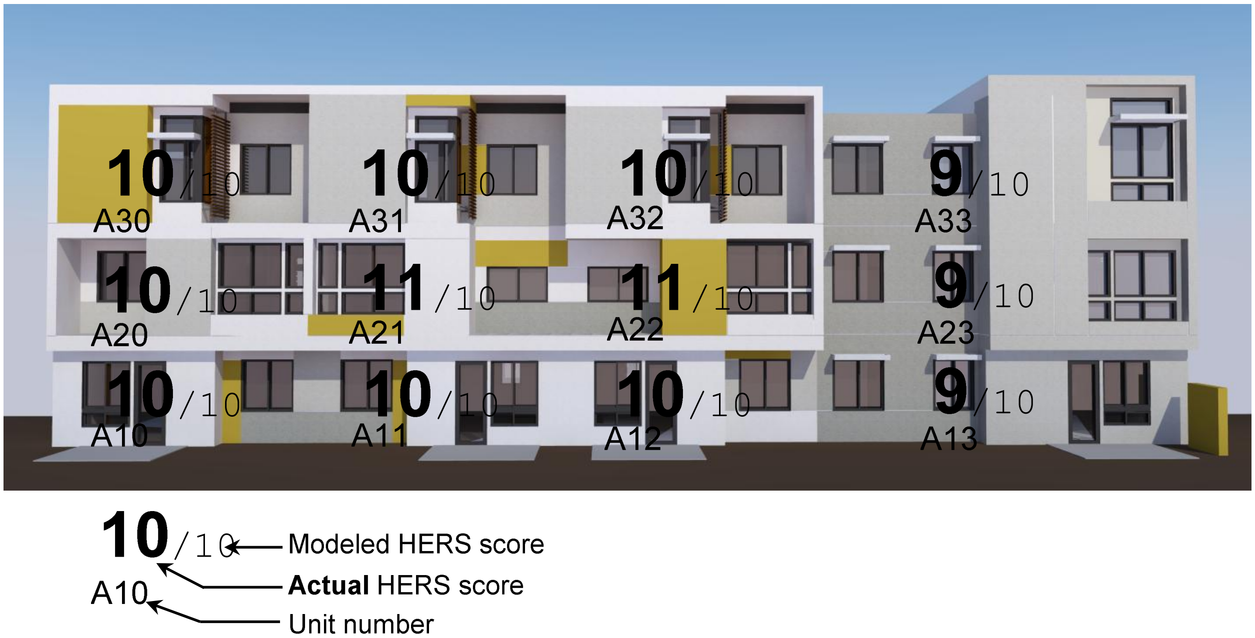
Table 3: Actual NACH result versus target NACH for units in Flat A.



HERS

HERS scores for units at Paisano Green Community are as shown in the graphic in Table 4. The units' actual HERS score and modeled HERS score are shown overlaid on the south elevation of the building. Perimeter units - those with the greatest amount of exterior wall - performed better with all of them meeting or exceeding the originally modeled score. This performance correlates closely with the infiltration performance shown in Table 3 above.

Table 4: Actual HERS score versus modeled HERS score for units in Flat A.



Performance

The property has recently been occupied by the residents as well as HACEP staff.

Renewable energy systems are being brought online as interconnection agreements are approved with the local utility provider. The energy monitoring program is just beginning and data is being collected.

One immediate observation by the design team is the importance of resident education and commitment to energy efficiency. We have noted that many residents, unaccustomed to being able to control the space conditioning in their unit or accustomed to living in units with evaporative cooling instead of refrigerated cooling, often leave windows open while air-conditioning systems are operating. Similarly we have observed that residents are often unaware that they can control entry lights outside their units, the result being that these lights are inadvertently left on all day and all night. These observations tell us that the data collected during the initial months of occupancy will likely be skewed away from the model's predictions. These observations further tell us that achieving true energy efficiency will require a robust educational program for residents, which will result in the proper operation of the units' various systems, ensuring the achievement of NetZero energy consumption at Paisano Green Community.

Conclusion

Paisano Green Community is one of the first public housing projects of its kind to eliminate dependence on fossil fuels, while pursuing a NetZero goal. This project has shown that with careful design and the incorporation of readily available technologies, these goals are achievable.