U.S. DEPARTMENT OF ENERGY
SOLAR DECATHLON

Building the Next Generation

SUNBLOCK Esperanza System

The University of Arizona

New Housing (NH) | February 22, 2022

THE UNIVERSITY OF ARIZONA

Esperanza System

Project Summary

The Esperanza system is a modular alternative construction system designed to address the increasing housing demand in Tucson. This project aims to provide affordable housing through the use of Accessory Dwelling Unit (ADUs) that are propagated throughout the community. These units are aimed towards the families in the Miracle Manor neighborhood, located in Mid-Town Tucson. The modular nature of the Esperanza system allows for affordable construction, customizable spaces, and a D.I.Y. friendly building experience. The ADUs and their varying designs will provide residents with multi-generational living and opportunities for supplemental income. With the addition of passive design strategies, and roof-mounted photovoltaics, the Esperanza system units can support the energy requirements for itself and the adjacent house on site. Our goal with the Esperanza system is to provide energy efficient, affordable housing that fulfills the need for cost-effective living in an ever growing community.

Design Strategy

Utilizing the modularity, affordabillity and adaptability of the Esperanza System, the project will encourage the curation of self-sustaining neighborhoods across Tucson and the surrounding valley. The Esperanza system is a customizable and adaptable solution that can be implemented across various lot sizes while maintaining efficient solar orientation. These specific ADUs are comprised of handheld, locally sourced plywood boxes of varying dimensions that are filled with recycled denim-cotton insulation. The nature of the modules, and their connections, allows for efficiency of construction as well as the opportunity for disassembly which extends the life-cycle of materials. The Esperanza system will be a simplified alternative building method designed for do-it-yourself construction.

Figure 1. The Esperanza unit features local materials and creative cladding options in order to highlight the expression of the neighborhood's residents and preserve the natural beauty and culture of the community.

Project Data

- **Location:** Tucson, Arizona, USA
- **Climate Zone:** 2b
- **Lot Size:** 7,000 sf
- **Building Size(s):** 350 sf- 850 sf
- **Occupation:** 2- 6 people
- **Construction Cost:** ~ $77.72/sf
- **Target Source EUI:** 0 kBtu/ft^2/year
- **Average Utility Cost:** $551 Annual before PV
- **Annual Carbon Emissions:** 6.40E+04

Technical Specifications

R-Values

- Wall: 36.0
- Elevated Floor: 43.0

HVAC

- Chilltrix is an efficient air conditioning and air to water ductless heat pump that regulates its energy use by regulating the temperature at a more efficient rate.
- Natural ventilation and energy recovery ventilator

On-Site PV

- 27,988 kW roof-mounted

Partners

Industry Partners	Cuadro Habitat for Humanity Tucson
Design Partner	U-Build

2022 Design Challenge

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Project Highlights

1. Architecture

- Design innovation through flexibility of form and efficient modular design. The results of which reference regionally historic architectural traditions of solar orientation self-shading, and the inclusion of the traditional zaguan, or breezeway.

2. Engineering

- Reduced energy consumption along with efficient construction strategies lead to an affordable Accessory Dwelling Unit for the residents of Miracle Manor. To maintain comfort during exceedingly hot days, a Chilltrix heat-pump will be used to cool (and heat) the building by pumping hot and cold water throught the floor system to store thermal energy within the phase change material that is present there. The modular construction system, created in part by U-Build, encourages two person and hand tool construction.

3. Market Analysis

- The Esperaza system has the means to be a source of supplemental income for homeowners, as well as an option for affordable housing for those at any point in the housing continuum. The scale of the units is geared towards single individuals, small families, and multi-generational housing for the aging.

4. Durability & Resilience

- A smart membrane securing the building envelope, will efficiently seal and protect the units against adverse climatic conditions. To ensure limited waste as a result of traditional "end-of-life" construction, individual modules can be replaced as needed. In addition, the entirety of the unit can be disassembled and reassembled if seen fit.

5. Embodied Environmental Impact

- Reduction to the embodied environmental impact of the Esperanza system in Tucson is achieved through sourcing materials locally with minimally invasive extraction processes. Further investigation is to be made to ensure compliance to the PHIUS 2021 prescriptive pathway for house design.

6. Integrated Performance

- Passive and active renewable energy strategies are integrated into the base model units advertised by the Esperanza system. These strategies include building orientation, self-shading, and engineered mechanical system solutions such as photovoltaics panels and rainwater collection via the water retention space located below the units, the gabion walls to the east and west of the building and the grey water diversion strategies in conjuction with the dry wells bordering the units.

7. Occupant Experience

- The occupants' experience is enhanced by the project's public to private separation of spaces in the proposed base model units. Low maintenance of units and subsequent equipment alleviate occupant expenses by reducing both construction and operational costs.

8. Comfort & Environmental Quality

- Smart responsiveness from the units HVAC system, along with passive strategies will ensure efficient comfort control for users. Flexibility of spaces that are designed for comfort ensure a positive experience for all users across the housing continuum.

9. Energy Performance

- The Esperanza system of ADU's will reach net-zero energy consumption by achieving a HERS rating of 35 through thoughtful integration of renewable and passive energy strategies. Additional energy resources that are produced are to be shared with the main house on site, then into the SunBlock network of energy.