Project Type: Multifamily Building

THE UNIVERSITY OF ARIZONA

bike score of 84

shared bike path lane to maximize physical circulation

water cistern storing captured rainwater

Bario Viejo cultural context to colorful doors and windows

allow local food stands to populate + serve the community

organic photovoltaics utilizing recycled plastic integrated as roof structure, providing shade to an urban pathway

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My passion is to explore different impactful designs that can better for future living. Utilizing new energy simulation tools to analyze net-zero buildings while enhancing occupants experience through architecture. Creating memories to inspire new generations. I would want to take many opportunities to learn in different firms around the world with the focus on local collective ideas.

My aspiration as an architecture student is to discover new innovative design strategies and technologies to build a more sustainable future. With building construction and materials accounting for near hal of the world's global emissions, I want to take part in the change to build a better tomorrow. The solar decathlon is a great opportunity for me to test these technologies and find ways to build more energy-efficient buildings. Post graduation, I would like to apply all the skills I've learned to work on residential designs, creating sustainable homes that are easy and low-cost to maintain.

My interest and passion for architecture, technology, and collaboration, has inspired me to discover effective design strategies that contribute to a sustainable future. The importance of architecture mitigating climate change captivates my full attention as I plan to take part in the charge for a regenerative future. The solar decathlon is a great opportunity to apply my knowledge in sustainable building design and proposing a brighter tomorrow.

My hope is to work in an environment that is progressive in its adoption of sustainable design principles. I see architecture as a tool to improve economic, environmental, and social dynamics of the world. Upon graduation, I want to join a firm that focuses on sustainable commercial design as I believe it will be a powerful avenue for making positive change communities.
Project Goals

Energy Hub

The large solar field found at the Avenue acts as a small power plant, generating and distributing energy to the surrounding area.

Passive Building

The Average EUI for a multifamily building is 59.6 kBtu/yr while the Avenue has an EUI of 7.3 kBtu/yr. The building utilizes an airtight enclosure with efficient mechanical systems.

Community

Creating a vibrant, socially and culturally active community.

Low Cost Energy

The rapidly developing technology of organic photovoltaics generates energy at a low cost.
Project Goals


Further propel the Tucson Climate Action Plan by designing a new residential community within SunBlock by implementing a PAD that revitalizes the Miracle Manor economy. Collaborate with the city of Tucson and produce a project that adheres to the needs of the residents of Miracle Manor. Further propel the Tucson Climate Action Plan by designing with regard to stormwater infrastructure and engineering a new approach to solar energy.

Community

- Act as a critical component of the SunBlock network by generating surplus energy to be stored and used throughout the community.
- Create a new residential community within SunBlock by implementing a PAD that revitalizes the Miracle Manor economy.
- Collaborate with the city of Tucson and produce a project that adheres to the needs of the residents of Miracle Manor.
- Further propel the Tucson Climate Action Plan by designing with regard to stormwater infrastructure and engineering a new approach to solar energy.

Prefabricated Assembly

B-Public Prefab is based out of Albuquerque, NM that provides prefabricated modular building components at a variety of sizes and R-value efficiencies.

Terracotta

Eco Cladding provides our terracotta rainscreen and other exterior finishes.

Organic Photovoltaics

Partnering with a potential company such as Nanoflex Power, local industry in OPV technology to construct canopy.

Partners

- City of Tucson
- LIHTCP
- Nash Elementary School
- B-Public Prefab
- Eco Cladding
- Nanoflex Power Corporation

Community

- Extending the adjacent schools program and offering after hour education for the community.
Site | Market Analysis

Site Connections

- Miracle Manor
- University of Arizona
- Downtown Tucson

Energy Hub

- Shared Energy
- Enough to Cool 280 homes
- Surplus Energy
- 95% of neighborhood

2.1 miles away
2.3 miles away

Downtown Tucson

Site Connections

W Grant Rd
N Oracle Rd
N Fairview Ave
W Jacinto St

Enough to Cool 280 homes
2,480,866 kWh/Year | Surplus Energy

95% of neighborhood
Miracle Manor is a low-income neighborhood, with the median annual salary of a working resident being only $22,000.

Our goal is to create economic opportunity for parents needing additional sources of income and facilities for after-school education activities for their children.

With the average rent price in the neighborhood being $670, many will not afford the rent price. To accommodate these residents and make The Avenue beneficial for all, we are exploring solutions to obtain funding and grants through LIHTC and ARPA.
Transforming Low Income Housing

Current | Future

Current Housing | Market Analysis

Transforming Low Income Housing

Current | Future
The **Avenue** restores historical Tucson values to the Miracle Manor neighborhood. The project uses color, landscape, and gathering space creating a mixed-use habitat for low-income families. The Avenue inspires creativity amongst its residents through a connection to Tucson’s *culture* and strong relationship to *nature* while *educating* the *community*.
Barrio Viejo is known for colorful houses, walkable spaces, and vibrant communities. The use of colorful accents against white terracotta projects the vernacular building traditions of the Sonoran desert. Bike paths and green walkways allow for a tight knit community inspired by Barrio Viejo.
Three different unit types are fitted together creating a larger massing form using the modular construction technique allowing for a fast and simple construction process.

<table>
<thead>
<tr>
<th>Residential</th>
<th>Mixes-Use</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor 1</td>
<td>104,406 sqft.</td>
<td>109,599 sqft.</td>
</tr>
<tr>
<td>Floor 2</td>
<td>273,560 sqft.</td>
<td>15,120 sqft.</td>
</tr>
<tr>
<td>Floor 3</td>
<td>186,550 sqft.</td>
<td>0 sqft.</td>
</tr>
<tr>
<td>Roof space</td>
<td>0 sqft.</td>
<td>186,550 sqft.</td>
</tr>
<tr>
<td>Total</td>
<td>564,516 sqft.</td>
<td>311,269 sqft.</td>
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</table>

<table>
<thead>
<tr>
<th>Dwellings</th>
<th>Occupants</th>
</tr>
</thead>
<tbody>
<tr>
<td>123 units</td>
<td>45 people</td>
</tr>
<tr>
<td>1 bed/1 bath</td>
<td>45 people</td>
</tr>
<tr>
<td>2 beds/2 baths</td>
<td>120 people</td>
</tr>
<tr>
<td>4 beds/4 baths</td>
<td>72 people</td>
</tr>
<tr>
<td>Total</td>
<td>123 units</td>
</tr>
</tbody>
</table>

<p>| | | |</p>
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<th></th>
</tr>
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<tbody>
<tr>
<td>Floor 1</td>
<td>Floor 2</td>
<td>Floor 3</td>
</tr>
<tr>
<td>4 Beds/4Baths</td>
<td>60 units</td>
<td>120 people</td>
</tr>
<tr>
<td>2 Beds/2baths</td>
<td>18 units</td>
<td>72 people</td>
</tr>
<tr>
<td>Total</td>
<td>33 units</td>
<td>237 people</td>
</tr>
</tbody>
</table>

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</tbody>
</table>
The shifting of the forms creates outdoor shaded circulation. Vertical circulation occurs where the super modules meet. Bridges connect the buildings.
Section Render | Architecture

- ERV | Chiltrix | Rooftop Garden
- Fire Sprinklers
- Bridge | Plumbing Route to Adjacent Building
- Centralized Mechanical Core
- OPV Panels

- Shaded Tree Canopy
- ADA Units
- Open Central Courtyard
- Bio-swells retaining rainwater
- View out to public courtyard

Modular assembly allows for a simple building process that is easily replicated. Units are constructed with properly insulated and weather resistant panels. A ventilated terracotta rain screen adds durability in the native climate.
Solar Exposure

A radiation analysis was used to quantify design decisions and its impact on solar exposure. The shifting of the forms provides self-shading. The impact of the canopy structure was then analyzed to understand the amount of reduction of solar exposure received by the buildings. The canopy provides enough solar radiation protection, reducing the cooling load and allowing the heat pump to run more efficiently.

Shade Canopy Modifications

Extending the canopy provides shade for the west-facing window. Panels are optimized for shading windows in the harsh afternoon western sun by fanning out.
Organic Photovoltaics (OPV) provide a low-cost energy production solar cell alternative. This technology is integrated into the canopy acting as a solar field.

Recycled Plastic For OPV: 177,934 SF surface area of recycled plastic

OPV currently can achieve efficiencies of 18%

Wholesale PV potential

Water | Integrated Performance

**Water Usage**

<table>
<thead>
<tr>
<th>Fixture Type</th>
<th>amount per variable</th>
<th>time per use</th>
<th>daily usage</th>
<th>total occupants</th>
<th>water needed per day (gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toilets</td>
<td>0.9 gallons per flush</td>
<td>per flush</td>
<td>1.71</td>
<td>378</td>
<td>1,701</td>
</tr>
<tr>
<td>Laudaties</td>
<td>1.5 gallons per minute</td>
<td>5 minutes</td>
<td>2,835</td>
<td>378</td>
<td>2,835</td>
</tr>
<tr>
<td>Showers</td>
<td>2 gallons per minute</td>
<td>5 minutes</td>
<td>2,835</td>
<td>378</td>
<td>2,835</td>
</tr>
<tr>
<td>Kitchen Faucets</td>
<td>1.5 gallons per minute</td>
<td>2 minutes</td>
<td>1,134</td>
<td>378</td>
<td>1,134</td>
</tr>
<tr>
<td>Dishwashers</td>
<td>2 gallons per minute</td>
<td>12 minutes per wash</td>
<td>1,701</td>
<td>378</td>
<td>1,701</td>
</tr>
<tr>
<td>Washing Machine</td>
<td>2 gallons per minute</td>
<td>15 minutes per load</td>
<td>1,417.5</td>
<td>378</td>
<td>1,417.5</td>
</tr>
<tr>
<td>Cleaning+</td>
<td>1.5 gallons per minute</td>
<td>5 minutes</td>
<td>1,417.5</td>
<td>378</td>
<td>1,417.5</td>
</tr>
</tbody>
</table>

Total water needed per day (gallons): 24,870.5
Total water needed per year (gallons): 122,722.5
CHILTRIX UNITS:

- IPLV: Cooling 26,150 BTU
- COP: 6.75
- EER: 23.02

\[(iCFA) \times 4.0 = 713,160\]

Estimated 28 Chiltrix units needed on site

PHIUS+ 2021

- Performance Criteria Calculator
- Envelope Area (ft²): 422,316
- iCFA (ft²): 178,290
- Dwelling Units (count): 123
- Total Bedrooms (count): 360
- Annual Heating Demand: 1.6 kBTU/ft²yr
- Annual Cooling Demand: 13.9 kBTU/ft²yr
- Peak Heating Load: 2.8 BTU/ft²hr
- Peak Cooling Load: 4.0 BTU/ft²hr

With an overabundance of OPV panels collecting solar energy, the project generates enough renewable energy to not only supply itself, but also partially fuels the Sunblock district. With high sun exposure and solar radiation in Tucson Arizona, OPV panels will have a great long term benefit for the building by capturing solar energy and doing it sustainably.

85% Sun

97% Efficiency of OPV (organic photo-voltaic) panels

3% Inverter efficiency

SUN

28% Wasted - uncaptured solar energy

15% Heat pump (in cooling mode) COP: 6.75

Storage losses

97% Inverter efficiency

Thermal energy transferred by heat pump

Energy Model Results

- Heating Demand: 1.39 kBTU/ft²yr
- Cooling Demand: 6.1 kBTU/ft²yr
- Heating Load: 1.82 Btu/hr ft²
- Cooling Load: 2.06 Btu/hr ft²
- Source Energy: 3.077 kWh/Person yr
- Site Energy: 7.29 kBTU/ft²yr

EUI: 2.9 Meets Phius 2022 Criteria

2,480,866 kWh/Year | Surplus Energy

Meets Phius 2022 Criteria

EUI: 7.29
OPV’s act as a small power plant generating enough energy to cool 28 homes. Energy is stored in thermal storage tanks and is easily distributed.
Still generates energy during cloudy days and even when damaged.

Easily insert replaceable panels.

Terracotta rain screen contributes to durability.

Enhancing the community while providing economical growth.
The building achieves an airtight assembly free of thermal bridging. Lightweight concrete over a drainage mat on the habitable roof areas integrated with the terracotta rainscreen enclosure ensures proper drainage throughout every part of the building.
Passive strategies contribute to the building's sustainability. Human comfort is achieved through self-shaded areas and enhanced cross ventilation. The units receive sufficient daylight, reducing the need for artificial light and the use of energy.

Site Section
Orientated east to west to minimizing solar exposure.

Ceiling fans initiate cross ventilation
Shifting of the units creates a self-shading form
Roof structure catches wind enhancing natural cross ventilation within the units and courtyards
Tally tracked the carbon impact of our project over a 60 life cycle. -3,734,374 (kg CO3e2) and 91% of the global warming potential coming from the end of life. Pre-fab is carbon friendly.

CMU yielded 2.28E+007 kg CO3e2 of global warming impact with 92% of global warming coming from the product life cycle.

Tally tracked the carbon impact of our project over a 6 life cycle. 16,273 metric tons kg CO3e2 of global warming coming from the pre-fabricated wall panel.
Open floor plans allow for adequate ventilation and distribution of light throughout the living space. Strategically placed windows enhance cross ventilation within each apartment while providing excellent light quality. Modern interior finishes give occupants a luxurious experience in each unit type while maintaining an affordable price.
Energy Efficient Appliances

- **Beko Brand Refrigerator**
  - 2.0 kW per year

- **Miele Brand Dishwasher**
  - 3.2 gal per cycle
  - 19 W per cycle

- **LG Brand Washer & Dryer**
  - 14 gal per cycle
  - 19 W per cycle

- **Low Flow Shower Head**
- **Energy Efficient Light Bulb**
- **Smart Home Thermostat**

Smartphone App

- **Educational Use**
- **Residential Use**

- **Smart Home Thermostat**
  - Tucson: 97°F Sunny H 104°F L 79°F
  - Indoor Temp: 75°F Sunny H 104°F L 79°F
  - Energy Generating: 9,235 kWh
  - Thermal Storage Tanks: 4 tanks
  - Current Temperature: 145°F
  - Total Water Used Today: 32 gallons
  - Total Electricity Used Today: 10 kWh
  - Lights: recommend off
  - Windows: recommend closed
  - Order Food
  - Pay Rent
Meandering paths connect the occupant to the desert landscape. Vegetation in bioswales keep pathways cool. The colorful light effect contrasted against white terracotta activates a playful interaction between materials. Green walkable spaces shaded by pigmented OPV panels. The translucency of the OPV panels creates a joyful engaging environment.
Thank you!
On behalf of the MultiFamily Sunblock team.