U.S. DEPARTMENT OF ENERGY
Solar Decathlon
Design Challenge

Building the Next Generation

University of North Texas
Al Hussein Tech University
Educational Building Division | April 4, 2023

EAGLES NEST
PRIMARY SCHOOLS FOR REFUGEE CAMP CHILDREN

Project Summary
People all around the world are fleeing their homes every day to refugee camps to avoid war and corruption. More than 50% of the fleeing population are children.

Children have no hope unless they are safe. Their physiological and safety needs must be met before they can develop friendships and a sense of connection. The primary school is designed to keep them safe, grant them new opportunities, and empower them. Within the primary school's boundaries, students actively observe how the built environment protects and supports them by observing the sustainable infrastructure that powers their growth. UNT students believe that education for all leads to a moral, just, equitable, and creative future for everyone. The construction of off-grid, net positive energy, low-cost buildings in these communities would not just change the lives of the students, but also provide peace of mind for the families.

Design Strategy
The design focuses on adaptability, modularity and pre-fabrication which can be constructed quickly, is cost efficient, and minimizes carbon footprint. The design adapts to local materials and available space to increase the ability to construct quickly where needed. Every aspect from color choices to layout focuses on our desire to provide a sense of security, opportunity, and empowerment. The modular units allow for scalability to meet the needs and space availability. The design uses color for navigation with a pallet of colors to create a calming effect. The use of natural ventilation, wind wall units, and thermal mass create heating, cooling, and air movement and reduce the energy need, costs, and maintenance.


Al-Za 'atari, Jordan


Cox's Bazar,


Pugnido, Ethiopia

Project Data

- **Location:**
  [1] Al-Za'atari, Jordan
  [2] Cox's Bazar, Bangladesh
  [3] Pugnido, Ethiopia
- **Climate Zone:**
  [1] 3B
  [2] 1A
  [3] 2B
- **Lot Size:** 1.2 acre
- **Building Size:** 23,125 ft^2; 1 story
- **Occupancy:** 300 people/Shift (2 Shifts)
- **Construction Cost (29-unit):**
  [1] $667,300
  [2] $383,000
  [3] $480,600
- **Energy Performance (EUI):**
  [1] 11.85 kBtu/ft^2
  [2] 14.68 kBtu/ft^2
  [3] 11.63 kBtu/ft^2
- **Annual Carbon Emissions (Saved):**
  [1] 115.2 ton CO_2e/yr
  [2] 97.3 ton CO_2e/yr
  [3] 101 ton CO_2e/yr

Technical Specifications

R-Values
- **Wall**: R- 22.4; **Roof**- R-24; **Windows**- R-1.5

HVAC
- Natural Ventilation, split-unit system

On-Site PV (MWh/yr)
- **[1]** 253.4 **[2]** 205 **[3]** 233.1

Partners and Collaborators

SOLAR SOLUTION
UNHCR
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2023 Design Challenge

Project Highlights

Architecture

The building design incorporates local materials available in desired construction area and prefabricated simplistic packages to create the ability to construct a facility quickly. The individual structures are hexagonal shaped and powered by visible, unique technologies to facilitate an excitement for attending and learning. The structures are designed as a teaching mechanism while offering a space to learn.

Engineering

The facility is engineered to maximize local resources and renewable energy sources. Regional packages are created for envelope materials and renewables to ensure the most efficient use of resources, adaptability, and availability for the location. PV panels are applied in areas based on daylight analysis. Wind panels are arranged to face the direction with highest wind level. The facility design incorporates multifunctional features. The support posts collect water, can create power from water and wind, and support the building. The water system collects and recycles water to combat the concerns of limited water availability.

Market Analysis

The market we aim to serve is composed of humanitarian groups and aid efforts providing education for refugee children. The design maximizes adaptability and construction speed for the use of high needs in locations with displaced communities. The self-supporting system provides the ability for placement in areas not possessing abundant resources. The focus of providing educational units in a quick and efficient manner to help refugee children find a level of peace, security, and empowerment in insecure situations can help meet the needs of the communities and agencies. The use of prefabricated material, local labor, and limited large equipment will help reduce the costs increasing the feasibility of incorporating the units.

Durability and Resilience

The wall panel construction of steel rebar welded into cages, filled with PET bottles, and concrete panels for interior walls allows for a flexible but rigid structure capable of withstanding earthquakes. The foundation can be elevated to decrease the effects of erosion or excessive rain. The walls are equipped with natural gravity ventilation allowing for constant air circulation to avoid build-up of mold, mildew, and fumes.

Embodied Environmental Impact

The employment of local contractors and current refugees for construction will financially stimulate the community and provide an intangible connection to the facility. Modular construction with prefabricated panels will increase the efficiency and decrease the impact on the environment by reducing the amount of energy, equipment needed, and the carbon footprint. Energy storage, sewage, and water treatment systems will be placed underground to maximize functionality while minimizing the use of limited space.

Integrated Performance

The subsystems in the building include multi-functional technologies. The facilities are integrated to support energy, drinking, lighting, heating, and cooling needs by maximizing the passive sources of wind, rain, and solar. The collection and energy production technologies are designed to enhance aesthetics, support the building, and provide the needed resources.

Occupant Experience

The design utilizes natural resources to enhance the experience of the occupant. Lighting is determined by use of area with strategies to provide sufficient daylight in working areas. A calming color scheme enhances the atmosphere while providing simple navigation for young students. Limited accessibility and external entrances with a play space provided in the center of the facility surrounded by structures allows for security, creativity, and physical activity.

Comfort and Environmental Quality

The building utilizes thermal mass to deliver heating and cooling. Natural ventilation is exploited with the use of wind-walls and multiple ventilation approaches to allow for comfort without energy consumption. Single-zone, split-unit heating and cooling systems allow for control per building unit reducing energy consumption. Window placement and shading provide light sources while regulating temperature and glare. The buildings are installed with intake air units at the floor and an exhaust system at the top creating a chimney effect.

Energy Performance

The unavailability of external power resources means the system provides its own energy and the possibility for supplying energy to a portion of the surrounding community. The implementation of compressed air energy storage allows continued functionality of systems during times of limited renewable energy production while the optimization of all sources of energy from wind, water, and solar achieve the ability to provide needed energy with diverse weather conditions.