Missouri S&T Solar House Design Team
Suburban Single-Family FLIGHT House

Project Summary

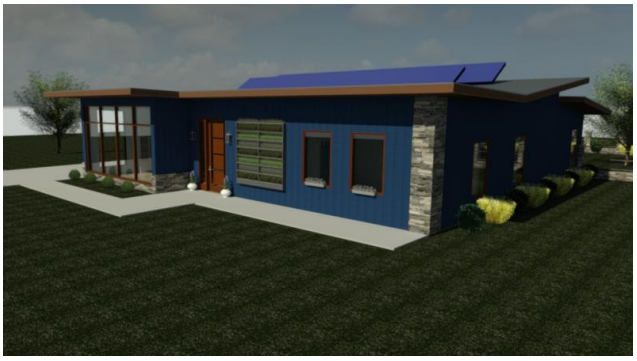

Figure 1 - Rendering of FLIGHT House

Freedom to Live Independently, Green Housing for Tomorrow (FLIGHT) home represents a net-zero single-family housing project that combines a highly efficient and environmentally-friendly design with accessible technology to grant lower limb veteran amputees with flight — or full motility in their daily activities. The design aims to provide affordable, accessible housing for millennial veterans with lower limb amputation by including systems that make daily tasks such as cooking, using the restroom, and getting dressed effortless. Additionally, the team aimed to locate the home where there would be optimal access to resources for veterans. Thus, the home was designed for a suburb of Rolla, Missouri, United States because it is close to the Fort Leonard Wood military base, as well as several other veteran organizations such as Disabled American Veterans.

Design Strategy

Drawing inspiration from the idea of flight, and the freedom of motility associated with it, the aim of the project creates a single-family suburban home that is wheelchair accessible, net-zero energy, and affordable for a millennial veteran with lower limb amputation renting their first home. The range of disabled-friendly technologies, products, and spaces integrated into the design help the project achieve these goals. The cohesive layout of the house reflects the team's intensive research on ADA-compliant floor plans. The implementation of sliding doors, grab bars, and concrete floors are some of the many features that make this house more accessible. To gain even more insight regarding the needs of the demographic, the team established a partnership with Operation Triage, an organization that provides emergency financial relief, mortgage-free homes, and home remodeling to disabled veterans, first responders, and active duty service members. Operation Triage will align the team with a veteran with lower limb amputation to serve as a client, giving a first-hand understanding of necessary design features.

Relevance of Project to Competition Goals

The Solar Decathlon challenges students to design highly efficient and innovative buildings powered by renewable energy. Thus, the FLIGHT house was designed to not only address the significant shortage of affordable, accessible housing in America but also push the boundaries of the cutting edge accessible technologies and systems. The design approach aims to help people with disabilities while maintaining a focus on sustainability and energy efficiency.

The market analysis criteria are exceeded through recognition of the financial capabilities of a millennial veteran with lower limb amputation. The project considers operational and maintenance costs as well as the life cycle cost of the home. The project also incorporates cost-effective market-ready construction materials. In addition, the FLIGHT house intends to optimize a disabled veteran's quality of life, health, and well-being through the implementation of accessible technology. The advanced building systems and appliances selected for the house will minimize occupant maintenance and maximize occupant convenience.

Within the home, the integrated building systems are designed for efficiency while ensuring occupant comfort and safety. The use of a hybrid heat pump water heater provides hot water quickly and more

efficiently compared to alternatives like a tankless water heater. In addition, mechanical systems were optimized with the use of heat recovery ventilation and a three zone ductless mini split system for use in both winter and summer months. Heat recovery ventilation, combined with MERV 13 filters, provides quality indoor air without causing too much fluctuation in indoor temperatures; air source heat pumps incorporated with smart technology give the occupants enhanced control of the interior environment.

Through the utilization of solar panels, the FLIGHT house produces enough energy to be self-sustaining. Self-sufficiency is achieved through diminished appliance loads and by storing excess energy generated by the solar panels into a Tesla Powerwall 2. By using ENERGY STAR quality appliances, a smart thermostat, and LED lighting, the team innovatively optimizes the efficiency of the home and thus minimizes energy consumption. By reducing appliance loads and other costly draws of power the home is able to maintain a system that is reasonable in size and price. Another reason the solar array is so effective is due to the panels being used within the array. The SPR-MAX3-400 collects an astounding amount of energy and produces a sum of around 400 watts. On top of the top of the line panels the FRO-SA-12-3-208L Advanced inverter is one of the industry leading in efficiency. When you take all of these variables into consideration the home is being powered by a reliable, efficient, compact PV system that will cut electrical cost dramatically year in and year out.

The team recognizes the interconnectedness between architecture and mechanical, plumbing, and electrical systems. The team considered the needed systems interaction while developing a design. For example, the kitchen, main bathrooms, and laundry were all placed in proximity to ensure more efficient delivery of hot water, reducing material costs of plumbing as well as energy use. Additionally, a high-performance building enclosure, combined with strategic window placement and sizing, will help reduce HVAC energy consumption. Table 1 displays the project data and technical specifications.

Project Data	**Technical Specifications**

• **Location:** Rolla, MO, USA; Climate Zone 4A (mixed humid)
• **Building Size:** 2972 sq. ft conditioned floor area
• **Lot Size:** 4000 sq. ft
• 2 bedrooms, 2 baths, 1 story, 2 occupants
• **(HERS) Index:** -2
• **Estimated Monthly Utility cost:** $0
	• **Envelope:** R30 walls, R19 foundation, R50 roof
	• **Window U-Value:** R15
	• **Ventilation:** Heat Recovery Ventilation
	• **Heating and Air Conditioning:** Ductless mini-split air source heat pump
	  o SEER 18.0
	  o HSPF 11.0
	• **Energy:** 10 kWh PV array and one battery making up 13.5 kWh of storage

Table 1: Project Data and Technical Specifications