

MARKET ANALYSIS NARRATIVE

1. INTRODUCTION

Illinois Solar Decathlon is an interdisciplinary registered student organization at the University of Illinois at Urbana-Champaign seeking to lead innovation in design and construction to advance towards an environmentally sustainable future. We are thrilled to present our latest project, RENU House.

RENU House is a 1,510 SF energy net-zero home. RENU represents the four guiding principles of our design and construction processes: Renewable, Economical, Nourishing, and Universal.



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ENEWABLE

The most important feature of the project is energy net-zero status, but we have also striven to reduce the effect on the surrounding environment in every other aspect of the home.

CONOMICAL

Sustainable developments must be financially feasible to be adopted. We have prioritized cost efficiency in every design choice to ensure the home remains affordable for our target clients.



OURISHING

The design seeks to encourage fulfilling lifestyles by prioritizing accessibility for all abilities and emphasizing the mental and physical health of occupants.



NIVERSAL

This design can be replicated in similar small-town markets across the United States, potentially bringing sustainable innovation to communities throughout America.

RENU House is nestled in the village of Rantoul, Illinois, a town of roughly 12,000 people fifteen miles north of the University of Illinois at Urbana-Champaign. Illinois Solar Decathlon has partnered with the Village of Rantoul Urban Planning Committee and the local Champaign County chapter of Habitat for Humanity for the build, consistently communicating with local stakeholders to ensure the home meets the needs of the occupants while effectively integrating into the small-town community.

RENU House was designed as a family residence, and can accommodate a diverse range of family dynamics such as a single parent or multigenerational household. Upon completion of the Department of Energy Solar Decathlon competition, the home will be fully donated to a local Habitat for Humanity family in need: Elonda, a single mother and intermittent wheelchair user, and her daughter, Monae, who is pregnant with her first child.



2. AFFORDABILITY AND COST EFFECTIVENESS

In every aspect of the design of RENU House, we strove to ensure the home remained economically feasible for our target demographic, Champaign-Urbana families. We also designed the home to be universally adoptable by using cost-effective materials that are consistently available in a rural American market. This commitment was demonstrated in our construction process, in which we sourced our materials and labor from local distributors and subcontractors.

Location of Permanent Site	Client Demographic	Household Income
Rantoul, IL	Champaign-Urbana Families	\$140,000

2.1 COST OF CONSTRUCTION AND AFFORDABILITY TO MARKET CLIENT

The contracted cost to build RENU House with our general contractor Nelson Builders amounted to \$335,000, with an additional \$118,100 in sponsored materials. These costs amount to a total value of construction of \$453,100. We expect a household income of \$140,000 should be able to afford to purchase RENU House. According to the U.S. Census Bureau, the median sale price of new houses sold in February 2023 was \$438,200. The average sales price was \$498,700. This means that RENU House follows U.S. trends and can be affordable at the national level.

2.2 COST OF OPERATIONS AND MAINTENANCE VERSUS PERFORMANCE

Homebuyers today believe that the use of smart technologies help them live a more comfortable life and with a sense of responsibility. The notable systems within RENU House include:

Multi V S Heat Pump - The electric furnace or boiler runs at an efficiency level between 95% and 100%, while a heat pump can run up to 400% efficiency (LG Global). This means that users can benefit from about 4 times more heat for each kW of electricity with the heat pump used in the house. While on the maintenance side, costs are lower compared to traditional systems due to the heat pump's self cleaning design. Additionally, the federal government is offering up to \$2000 in rebate until December 31, 2032 for this system. These energy savings and rebates will save homeowners both in the short and long term use.

Eco-36 Tankless Water Heater - Tankless water heaters require less maintenance and replacement parts compared to traditional water heaters. Furthermore, according to the Department of Energy, homeowners can save up to 50% on water heating costs with a tankless water heater.

SolarEdge - With a SolarEdge warranty, homeowners have 25 and 12 years of coverage for the power optimizer and central inverter, respectively. Additionally, we have calculated the cost of maintenance and operations are offset by the amount of energy produced by the solar panels in our payback period which is broken down in the next section of this report. Overall, the system will save homeowners about 80% on annual costs which totals over \$1000.





2.3 SOLAR PANEL INCENTIVES AND PAYBACK PERIOD

According to federal tax rules, in an effort to incentivize renewable energy, residents that install solar panels are eligible for federal tax credits. As per the regulations, residents would receive a 26% tax credit on expenses related to solar panel installations. These expenses include equipment,

permitting and installation costs up to an unlimited amount. However, in August of 2022, Congress passed an extension of ITC (Investment tax credit) such that solar panels installed between 2022 and 2032 would receive a tax credit of 30%. While the government federal offers tax incentives, the Illinois state government does not offer a similar program. However, the state does incentivize solar panel installation in



other ways. For instance, there is a property tax exemption clause, which allows homeowners to exclude the additional increase in property value that arises from the solar panel from the property tax calculation. Furthermore, due to state regulations and the renewable portfolio standards, states in the US offer solar renewable energy credits (SRECs). The credits are determined and paid out for every megawatt hour of energy the solar panel produces.

With all the various income streams in mind, we can calculate an estimate for the payback period of installing solar. We estimate a rate of about \$72 per MWh for the SRECs and an average of 1,400 kWh in excess energy per year. Our costs for the solar panel, with the battery bank included, come out to around \$34,000. After accounting for a myriad other factors, such as degradation, inflation, metering price, and annual production, we have found that the system has a payback period of 7.7 years. SolarEdge estimates that the solar panel has a useful life of 25 years, offering the resident more than a decade of long term savings.

3. MARKET ANALYSIS

3.1 RESPONSIVENESS TO CHARACTERISTICS AND REQUIREMENTS

The American household today looks a lot different compared to the traditional nuclear family of the past. This shift requires new designs in the layout and function of homes to fulfill the needs of these occupants.

For reference, the family that will live in RENU House is a perfect example of these changing family structures. Their family structure does not follow the traditional American family consisting of a mother, father, and two kids. The homeowners will be a mother and daughter, who is pregnant with her first child, also known as a multigenerational household. This family has lived in Champaign-Urbana for the last eight years. Now, the family is looking to live in a quieter area in a home that will support their growing family and lifestyle. Moreover, the features our homeowners want today include areas of shared and private spaces, an open floor plan and high accessibility, a



home with a lower environmental impact, and a nurturing space to support a multigenerational household.

3.2 DEMONSTRATE MARKET NEED

RENU House fulfills market needs for a home that can support physical and mental health, and be customizable to various family structures.

The design of a home can influence its level of ability to support the mental health of its inhabitants. According to the National Institute of Mental Health, in the past year an estimated 19.1% of U.S. adults and 31.9% of adolescents had any anxiety disorder. Therefore, the team chose to create a house that creates calm spaces that connect to nature and designated areas for creativity and work. This was done with the use of large south facing windows, a room designated for physical activity, and a flex room that can be used as an arts and crafts room, music room, office space, or other activities based on the family's needs throughout the years.

The mother who will live in RENU House moderately uses a wheelchair and requires a home that can accommodate her. Similarly, 11.1% of people in the U.S. have serious difficulty walking or climbing stairs according to the CDC. Due to our design focus on open concept and maintaining ADA compliant areas, the design of the house allows for easier movement for those who have a disability. All areas of the single level home are accessible by wheelchair and the flex or adjustable floor plan allows for a designated rehabilitation or exercise space to maintain a healthy lifestyle.

As the cost of living increases, a family dynamic that is on the rise in the United States is that of multigenerational households. A study by ABC Action News found that one in four millennials aged 26 to 41 are living with their parents in 2022. Likewise, the family that will live in RENU House will be a multigenerational household. Our team believes the design of our house is beneficial to this family type due to its separate areas for shared and private living, and the flex room offers the capability to house a growing family by either turning into a bedroom or second living/working space.

3.3 MARKETABILITY DUE TO ENERGY FEATURES

According to Forbes Homes, 75% of respondents said it's important for them to switch to solar within the next five years, and 60% are concerned about their home's environmental impact. However, the greatest delay for homeowners to make this change is the upfront cost of installing solar panels.



Since solar panels do not have standard rates or flat pricing, homeowners are hesitant to start the process of installing solar panels. RENU House removes these concerns since the system has been predetermined and calculated into the total cost of the house. Additionally, buyers have access to measured operation and maintenance costs of the solar panels, including payback period calculated by our team.





The environmentally conscious trend for green building has spilled over into market value, which is beneficial for RENU homeowners. In recent times, numerous industry studies suggest that green homes result in higher resale values, across the country. In fact, many buyers view sustainable features as "must haves". In 2021, homes with solar panels spent 13.3% less time on the market and were 24.7% more likely to receive an offer over asking (Quicken Loans). These trends mean homeowners can expect RENU House to be a promising investment and benefit the local communities by increasing property value.

On a larger scale, the federal government has a goal to achieve net-zero emissions buildings by 2045, including a 50% reduction by 2032. Additionally, the State of Illinois has passed legislation that focuses on moving toward 100% clean energy by 2050. Our home's design is capable of achieving this goal today due to its net zero status with the use of solar panels and energy efficient systems.

4. LIVABILITY

4.1 SUPPORT FOR SAFE, FUNCTIONAL, AND ENJOYABLE PLACE TO LIVE

Safety and security were top priorities throughout the design phase for RENU-House. The use of casement windows, exterior lighting, and fencing promote security and protect the house and its occupants. Additionally, the front, side, and back doorways provide various points of egress in the case of an emergency such as a fire.

To ensure that the design accommodates any occupant, an ADA accessible design philosophy was implemented. The sidewalk leading from the driveway to the front door of the house is fully accessible for occupants facing any disability related limitations. The wide, fully accessible doorways also promote a universal design. The child bathroom also meets ADA requirements, once again promoting a universal design which is able to adapt to the needs of RENU-House's occupants.

The functionality and enjoyability were also heavily considered throughout the design process to maximize the efficiency of the space for the occupants. The Flex Room has been designed, as the name suggests, to fit a wide-variety of needs and uses. This space can be used as a home office, workout area, kids play room, or a spare bedroom, among countless other applications. These various uses promote a universal design which adapts to a wide range of occupants. The floor plan also helps to create a space which is high in function as well as aids in enjoyability. The house's open concept design is formulated to have the living room, dining room and kitchen flow together. This can bring a family closer together, make the house feel larger, provide increased light exposure as well as increase the house's real estate value.

4.2 DESIGN TO ENCOURAGE THE USE OF FEWER RESOURCES

One of the biggest requirements we wanted to reach outside of fulfilling the financial goal of our project estimates was to try and acquire products that support the mission of RENU House. A requirement was that the products had to be both sustainable for the environment and benefit our target family of a single mother and her expecting daughter. To do this, the integration of rain barrels into downspouts leads to water conservation and aids in the prevention of runoff, which can lead to flooding. The energy efficient windows and doors prevent heated or cooled air from escaping the home, while the utilization of zip paneling and sprayed cellulose insulation on the exterior walls create a tight seal. This combination results in consistent interior temperatures and lower



requirements for running heating and cooling. Additionally, the HVAC system we have chosen is ductless, which is more efficient when compared to a ducted system as there are fewer leakages and increased efficiency compared to forced air. Bamboo flooring remains carbon neutral throughout its lifespan and has one of the fastest growth cycles compared to materials with similar functionality. The faucets in the kitchen and bathrooms utilize a low flow rate decreasing the amount of water consumed during use. Large south-facing windows bring in natural light which lowers the need to use interior lighting during the day, and at night the lighting fulfills energy efficiency. The home comes with a charging station which will encourage the use of an electric vehicle, lowering their carbon emissions. The addition of a home battery will store excess solar energy for use during later evening hours or power outages. All of these design choices were made to create a comfortable home for our residents while lowering the number of resources required.

5. BUILDABILITY

5.1 EFFECTIVENESS OF DRAWINGS, DOCUMENTATION, AND CONSTRUCTION

The team chose to use Revit to create all plans and specifications. This program allows for better work sharing and illustrates more information for owners, designers, and builders. Furthermore, RENU House is contrived with a streamlined architectural design that allows for efficient and productive work during the construction phase, as well as keeping in mind building materials that are common in the industry and rural America. The design allows the family to adjust the two secondary bedrooms per the number of family members and general needs. For example, the family moving into RENU House chose to expand one bedroom and convert the second bedroom into a workout room. This action was fairly easy since the structural design and plan set allowed the two rooms to be adjustable based on client needs. Finally, the design results in an estimated construction time of four to five months which is two months shorter than the national average according to the U.S. Census Bureau.

Because Rantoul is located in central Illinois, and has limited resources in labor and products, each material that we chose had to be easily accessible to our specified location as well as play a role in our overarching goal of sustainability and functionality. Due to this, the construction of the house did not require specialized labor forces. Each system was built by a local worker who referenced our plan sets. The plan sets allowed for detailed constructability of every system in the home, with little to no need for clarification between the designer and subcontractor.



The delivery method used to construct RENU House follows the Design-Bid-Build framework. This approach permits a family to review the base design of the house and make minor adjustments to have a layout that fits their needs. From there, the bidding process serves to lower the total construction cost of the house and employs a local contractor. Finally, the build phase consists of local subcontractors and

supplies. It was important for us to try and source these materials locally not only to minimize the financial cost but also to minimize the risk of lead times and delaying our product schedule. By



choosing local, we stimulate the area's economy and lower the carbon cost of transporting materials and workers.

6. SCALABILITY

6.1 U.S. MARKET IMPACT POTENTIAL

RENU House brings the beginning of a housing market into the fringes of Rantoul's residential area. Ever since the Air Force moved their base out of Rantoul, it has become an aging community with little growth. As Rantoul has an older demographic, we pushed on focusing marketing efforts toward the younger generation in the surrounding area. We worked with Rantoul's Urban Planning Committee to build RENU as a way of bringing in a younger population in hopes of improving the town's prospects. The sustainable and affordable nature of the house makes it attractive to younger residents, while its reliability and versatility appeals to older generations. The byproduct of this new spur of economic growth is the increased investments in the area, bringing in more revenue for the village and redefining the way the public views it. Overall, RENU House increases the future possibilities of Rantoul's market by incentivizing nearby future commercial construction and growing the town's population. Our team believes that this framework can be repeated in other towns in the U.S. that are facing similar challenges.

6.2 INTEGRATION OF OFF-SITE CONSTRUCTION TECHNIQUES

The houses Zip Panels, wall framing, and trusses were pre-fabricated and assembled on site. This reduced the time to build the framework to three days and incorporated local vendors. In general, prefabrication is beneficial since it lowers accidents, has better quality control, and is more sustainable as it lowers the amount of construction waste.

6.3 ABILITY FOR TRADES TO REPRODUCE THE DESIGN AT SCALE

The use of prefabricated walls and trusses can be scaled-up into an assembly-line type production which can create an efficient method in developing neighborhoods and empty lots in communities. The assembly format is possible since the majority of framing would remain consistent in each house built. The ability to adjust the floor plan, as mentioned before, does not affect the placement of major MEP components which allows trades to remain consistent in their work and recreate the design in each build at scale. This consistency will decrease planning time and prevent confusion during the construction phase.

6.4 IMMEDIATE AND LONG-TERM COMMERCIAL IMPACT IN MARKETPLACE

Part of the narrative behind RENU House is to revitalize the local community of the Village of Rantoul. The town has experienced a shrinking population since the closing of its air force base and limited commercial development. Our solution is to replace many of its vacant and dilapidated properties with new, modern, affordable and sustainable housing. By constructing RENU House throughout Rantoul, we believe new residents will move to Rantoul from areas such as neighboring Cities Champaign and Urbana. This influx of residents will result in a growth in commerce and stimulate the local economy. In fact, our homeowners are moving from Champaign to Rantoul due to the appeal of small town living.





Additionally, we strived to choose materials and a build process that supports the local area. The doors and windows were built by Jeld-Wen, a company with a manufacturing warehouse in the same town as the house. This locally sourced and built material creates a circular economy for Rantoul. While the employment of a local contractor, subcontractors, and workers further benefits the local economy and small businesses. Furthermore, the neighborhood where RENU House is located will directly benefit from its construction by increasing the property value of surrounding homes.

7. INNOVATION

7.1 INSPIRING THE PUBLIC IN FUTURE LIVABILITY AND BUILDABILITY

RENU House is the first of its kind in the Village of Rantoul and will push boundaries for what sustainable living can be in small town America. By following the four pillars of RENU House we inspire the public in how a house can be renewable, economical, nourishing, and universal. By choosing a highly efficient MEP



system and an overall design that promotes the use of less energy, our team was able to reach net zero status for the home. The choice in local materials and suppliers who value sustainability or hold carbon neutral status further lowered RENU House's environmental impact when looking at its life cycle. The affordability of our design makes it possible for a household with a median income in Champaign county to own RENU House. Additionally, the lowered maintenance requirements, efficient energy usage, and available government rebates for the systems of the house make long term ownership financially feasible to the public compared to standard homes on the market. The livable design was based around supporting the families mental, physical, and social complexities by creating a flex space, a single story that is highly accessible, with shared and private living, and biophilic design. Through this, we made a home that balances the nourishment of each family member while maintaining sustainability. The house as a whole can be replicated throughout the United States. By choosing local and readily available materials and systems, we achieved a shorter construction period that is achievable even in rural areas such as Rantoul.





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