Egg Harbor Residence

U.S. DEPARTMENT OF ENERGY SOLAR DECATHLON

University of Wisconsin-Madison & University of Wisconsin-Milwaukee

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INDUSTRY PARTNERS

Mark Isaacs, CEO, GS Research LLC (WonderWindow)

Becky Jewell, Senior Designer Gerhard's Kitchen and Bath

Jason Williams, D.E., HVAC Engineer, First Supply LLC

PROJECT DATA

- Egg Harbor, Wisconsin, USA
  - Climate Zone 6A
- **Lot Size:** 0.56 acres
- **Building Size:** 1,762 SF, 2 stories
  - 3 bed, 2.5 bath
- **Occupancy:** 2 (881 SF/person)
- **Construction Cost:** $158.75/SF
  - $279,711.11 total
  - +$16,000 w/renewables
- **HERS Score:** 27 | w/renewables: -11
- **Local Avg. Utility Cost:** $123/month
- **Embodied Carbon:** 159 lbs CO2e/SF

PROJECT SUMMARY

The mission of the Sunburst Solar team is to design a residential house that sparks innovation and adoption of Net-Zero houses in Wisconsin. Our team is composed of engineering students from UW - Madison and architectural students from UW-Milwaukee. Our goal is to demonstrate that creating an energy efficient home can be desirable for a modern, convenient lifestyle and competitively-priced compared with traditionally-built homes.

The house is designed to ensure energy efficiency despite the suboptimal climate conditions in Northern Wisconsin. Wisconsin experiences harsh winters with minimal sunlight during the day, which has discouraged the use of solar energy in homes. Ultimately, we want to showcase that Net-Zero homes are not limited to areas with warmer and sunnier climates. Our design combines a high performance building envelope with energy efficient heating and cooling systems to create a comfortable single family home.

TECHNICAL SPECIFICATIONS

R-Values
- Walls: R28.5
- Foundation/Floors: R20
- Roof: R50
- Windows: R5

HVAC
- Heating & Cooling: 42 kBtuh Air Source Heat Pump w/HSPF 12 & 22 SEER

On-Site PV
- 7 kW | 10,088 kWh annually
  - 21 roof-mounted panels

DESIGN STRATEGY

When designing the Egg Harbor residence, our team aimed to create an energy efficient, yet comfortable and affordable home. The home is equipped with high efficiency appliances, high wall insulation suited for the cold climate, large clerestory windows, and a 7 kW array system on the south facing roof. With input from the future homeowners, our team also aimed at creating a layout with an open kitchen and living area for hosting gatherings. The split floor plan can be built offsite in a factory to provide modularity and offer numerous ecological and economical benefits.

PROJECT HIGHLIGHTS

ARCHITECTURE

The scheme is derived from the movement of two rectangular forms shifted in opposite directions, creating an optimal plan for factory production methods. Sliding doors have replaced traditional swinging doors in the interior. Each bar is clad in its own material with vertical breaks on either side to accentuate the thin vertical idea present in every room. The shed roof on the south bar is at the optimal angle to capture the sun's rays throughout the year in the northern climate.

ENGINEERING

The efficient engineering design of systems within the house will reduce energy usage and costs, while maintaining a comfortable environment. The layout exhibits close proximity between appliances for plumbing optimization. The strategically placed water heater and a submanifold plumbing design allows for fast hot water delivery. The piping in the design is minimized, just as the ducting is in the HVAC layout. To account for the energy consumption of these systems, solar panels will be installed on the roof facing south for maximum solar gain.

MARKET ANALYSIS

The home was designed to make energy efficient construction a competitive and accessible alternative to conventional home design. Using energy efficient construction, instead of conventional methods resulted in a 15.58% increase in total home cost from $256,126 to $296,028. However, through the use of sustainable construction techniques, the difference in upfront cost can be mitigated. Passive design strategies can help reduce the home's overall energy use and the installation of a solar array will result in over $800 of energy savings annually.

DURABILITY AND RESILIENCE

Cold winters with heavy snowfall are prevalent in Northern Wisconsin. To combat the snow, the roof is inclined to increase the creep of the snow in the winter and water run-off from melting snow in the warmer months. Cellulose insulation is also used to prevent heat leakage and moisture creep within the structure. The wooden cladding on the exterior of the house has been kiln-dried to increase its lifespan

EMBODIED ENVIRONMENTAL IMPACT

Through the use of locally-sourced materials, the home will have decreased carbon emissions from shipping. Using rapid assembly components and recycled materials will reduce the embodied carbon from construction. The home will also be factory built, cutting down on carbon emissions.

INTEGRATED PERFORMANCE

The house design employs the use of passive design architecture to bolster the energy efficiency. With a large, angled roof and a large percentage of the windows facing South, the house will be optimized for energy production and heat gains in the winters. Features such as a gray water collection system and window shading will integrate the architectural features with the renewable energy production.

OCCUPANT EXPERIENCE

Windows reveal views of the surrounding forest and allow for the sun's warmth during the winter, while overhangs provide ample shade in the summer. The interior environment is controlled by smart systems. The open layout of social rooms and extending porches make the home feel large and ideal for gatherings. Bedrooms have operable clerestory windows and windows on multiple faces allow air flow to create passive cooling and comfort.

COMFORT AND ENVIRONMENTAL QUALITY

Designed with the clients' needs in mind, the home is split into public and private areas. The layout of the upstairs bedrooms create natural sound barriers and visual and auditory privacy. The forced air HVAC system, when paired with the building envelope and passive design, will provide efficient and effective cooling, heating, and ventilation.

ENERGY PERFORMANCE

To combat the harsh winters of Northern Wisconsin, special attention was paid to the thermal envelope of the house so that the photovoltaics can effectively carry the loads of the house. A tight envelope with double studded walls and triple-paned, glazed windows will minimize heat loss from the conditioned space. The use of Energy Star appliances throughout the house will add to the energy efficiency of the house.