MSB | Humming Home

Monash University [New Housing][February 21, 2023]

Project Summary

Monash Sustainable Buildings (MSB) is a multidisciplinary student team based at Monash University. Our new housing division consists of 13 members across multiple disciplines. Our submission to the Design Challenge is the Humming Home (HH) project, which aims to ensure that survivors of domestic violence, have a safe and restorative space to aid their recovery, while incorporating strategies for climate resilience.

RENDER: View of entry to house

In Victoria, domestic violence is the leading cause of homelessness for women and children. A lack of adequate crisis accommodation often leads to survivors being housed in motels and other locations unsuitable for aiding in their recovery. A study was conducted by the Australian Institute of Criminology (AIC) exploring intimate partner violence experienced by women in Australia in the first 12 months of the COVID-19 pandemic from February 2020. The study found that 32% of the ten thousand women surveyed had experienced emotionally abusive, harassing and controlling behaviours; 7.6% reported experiencing sexual violence, and 9.6% reported experiencing physical violence.

HH aims to offer a more affordable and accessible solution to the increased demand for crisis housing in Australia, which will also be designed to be net-zero and equipped with appliances and materials that maximise energy efficiency. It will provide occupants with temporary, emergency accommodation that will assist occupants to work towards finding a more permanent home. For HH to best accommodate the needs of its target demographic, the team has consulted Australian domestic violence organisations such as Kara House and the Lighthouse Foundation.

Design Strategy

Our team's key goals include designing a house that allows for flexibility in relation to different occupant configurations by improving living standards, accessibility, privacy, security, affordability, feasible constructability, maintainability and sustainability. The project aims to be resilient against Australia's high-risk climate and incorporate design features that assist in fire resistance. Further, the floor plan is designed so that the house can be constructed off-site in modules, thereby reducing the on-site construction time and cost.

Project Data

Location: Melbourne, Victoria, Australia

Climate Zone: 7

Lot Size: 1,363 m^2 or 14,671 ft^2

Building Size: 50 m^2 or 538 ft^2

Occupancy: 1-3 people

Construction Cost: $334,000 AUD or $225,405 USD

Energy Performance:
Energy Use Intensity (EUI):
without renewables: 30.72 kWh/m2/yr or 9.7 kBtu/ft2/yr

Home Energy Rating Score (HERS): without renewables - 44

Average Utility Cost: $100 USD/month

Annual Carbon Emissions: 2.14e4 kg CO2 eq/m2

Technical Specifications

R-Values:
Wall - 3.22 m^2-K/W or 18.28 ft^2-h-F/Btu
Floor - 3.97 m^2-K/W or 25.20 f^2-h-F/Btu
Roof - 2.43 m^2-K/W or 13.789 f^2-h-F/Btu

U-Values:
Window: 1.6 /m^2-K or 0.282 Btu/h-ft^2-F

HVAC:
Key systems: 3.4 kW Panasonic Ducted heat pump, Laros Lunos e2-60 ERV

On-Site PV:
2.3 kW system, 8 kWh Battery

Project Highlights

Architecture (A): The architectural design features aim for occupant recovery through sensory design, accommodate off-site and modular construction, improve fire resistance, and overall provide occupants with a private and safe dwelling that aims to re-establish a sense of autonomy and stability in their lives.

Engineering (E): HH will employ automated systems which prioritise efficiency, affordability and usability. Additionally.

Market Analysis (MA): We have been consulting with Kara House and the Lighthouse Foundation, both organisations that house victims of domestic violence. We have spoken directly with people who would actually live in such a house.

Durability and Resilience (DR): One of HH's key durability features is off-grid electricity generation and on-demand storage, facilitated by a combination of solar panels (PV) and batteries. Additionally, the HVAC system coupled with airtight zones will be capable of stopping fire spread by drawing air from affected areas in the event of a fire is also being considered. The house will be designed for disassembly to aid in repairs. The building's walls, floor and roof also incorporate a moisture barrier and vapour membranes to prevent the ingress of moisture into the building layers. To reduce water usage, we also implement a water recycling system that uses both harvested rainwater and household greywater for irrigation or to flush toilets. Climate resilience is a key design goal being targeted.

Embodied Environmental Impact (EEI): Materials that are non-toxic, composed of recycled material, and have a high reuse potential and recyclability at end-of-life will be considered. This includes the use of a structural timber frame and Durra Panel(R) (Braeside, Australia) to complete the wall structure which are made from 100% recyclable and biodegradable materials. Additionally, Design for Disassembly (DfD) has been implemented through panelised wall, floor and roof systems, which will be bolted together and facilitate disassembly. This will increase the circularity of the design when looking at a life cycle assessment. Furthermore, the footings will have lower embodied carbon than a traditional concrete slab; achieved through the use of Surefoot footings(R) (Epping, Australia), which can be disassembled and re-used. Prefabricated construction will further reduce the embodied environmental impact at later life cycle stages by reducing transport emissions and material wastage.

Integrated Performance (IP): The building's airtightness will be leveraged to reduce the need for HVAC in conjunction with a Heat Recovery Ventilation (HRV) system. In addition, a hot water heat pump will be installed for long-term efficiency and low ongoing cost and energy expenditure. The interior lighting levels will be able to be adjusted manually or automatically, with an automation system regulating the internal LED lighting based on room occupancy to prevent energy expenditure in unoccupied rooms. To mitigate internal noise, the walls will be constructed with acoustic insulation to dampen noise within the house.

Occupant Experience (OE): To aid the recovery of the occupants, we are implementing lighting that follows the Circadian rhythm. Colour psychology and sensory garden as well as a sound-proof quiet room are implemented as well as to aid the mental health of the occupants.

Comfort and Environmental Quality (CEQ): An energy recovery ventilator (ERV) system will be installed to ensure 15 cfm of fresh air per person, while maintaining the room temperature. Durra Panel(R) will be used as a sustainable material to insulate acoustics and heat, and volatile organic compounds will be significantly reduced.

Energy Performance (EP): Passive energy reduction strategies such as double glazing and strategic windows placement are crucial in controlling heat transfer. REM/rate(R) (Boulder, USA) is used to determine the HERS Index score of the house. We are also taking inspiration from the Green Star building code from the Green Building Council of Australia to consider additional sustainable concepts, including but not limited to water conservation, thermal comfort, indoor air quality, energy efficiency and material usage. We have decided to use the Jinko Solar PV (model JKM390N-6RL3) in conjunction with a hybrid inverter (General Electric GEH5.0-1U-10) will yield the lowest cost per watt, whilst also ensuring durability and low susceptibility to failure. DesignBuilder(R) (Australia) is used to estimate the energy consumption of the house and will be used to determine the number of panels required in order to reach net zero consumption. Generated energy will be stored in a vanadium flow battery (Redflow ZBM3) which can charge for long periods with minimal discharge.